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2001 Environmental Restoration Contractor Revegetation Monitoring Report

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2001 Environmental Restoration Contractor Revegetation Monitoring Report

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EXECUTIVE SUMMARY

This report documents the progress of revegetation monitoring conducted in March through July 2001. This is the sixth year of monitoring following revegetation on the Horseshoe Landfill and the fifth year following sagebrush planting on the Saddle Mountain Wildlife Refuge (North Slope Cheatgrass Area). Fourth year monitoring was conducted on the 600-104 (2,4-D) Bioremediated site and the 300-FF-1 sagebrush (*Artemisia tridentata*) and bitterbrush (*Purshia tridentata*) mitigation areas. Third year data were collected at the 316-5 Process Trenches, the Environmental Restoration Disposal Facility (ERDF) sagebrush plots on the Arid Lands Ecology (ALE) Reserve, and the 116-C-1 Restoration site. Second year monitoring was conducted at the 116-B-1, 116-B-11, and 116-C-5 revegetation sites. Monitoring of these sites is conducted annually to ensure the objectives of the revegetation efforts are accomplished, to note planting techniques that yield the greatest success, and to document successional recovery. It is important to understand that it typically takes 3 to 5 years before revegetation efforts in arid regions show signs of success.

The fifth year of monitoring on the Horseshoe Landfill was conducted last year, and the revegetation effort was declared a success. The 24 Command fire that burned over the area in June 2000 removed all standing vegetation. At the U.S. Department of Energy's request, the Horseshoe Landfill was monitored for one additional year in 2001 to document the plant community that survived the fire. Prior to the fire, the landfill was dominated by cheatgrass (*Bromus tectorum*), sagebrush, and Sandberg's bluegrass (*Poa sandbergii*). Vegetation surveys conducted in April 2001 found the site had 50% less cover than prefire conditions and dominated

by Sandberg's bluegrass, cheatgrass, and tumblemustard (*Sisymbrium altissimum*). Many of the native species remain on the site, and sagebrush seedlings were noted in the species list.

At the North Slope Cheatgrass Area on the Saddle Mountain Wildlife Refuge, sagebrush seedlings were transplanted in August and October 1996 along an access road. Survival of the sagebrush planted in August was very poor due to high temperatures, injured root systems, and low soil moisture. The sagebrush planted in October had an average survival of 77.8% after 5 years with an average height of 44.1 cm. This survival is within the acceptable rates for a planting effort. The objective of this planting effort was to provide the area with a seed source. This has been achieved as evident by sagebrush seedlings growing in the road and adjacent to the planted shrubs. Therefore this fifth year of monitoring will conclude observations of these plants.

Seeding of the 600-104 (2,4-D) Bioremediated site was completed in the fall of 1997. To further promote establishment of shrubs, 900 sagebrush tubelings were planted throughout the site in February 2001. All seeds and plants were derived from species on the Hanford Site. Thirty-five species were observed on the site this year, 13 more than observed in the 2000 survey. The February planted sagebrush appeared to be healthy; however, survival observed after an entire growing season will yield a more accurate future survival.

Sagebrush and bitterbrush survival was monitored on the 300-FF-1, 618-4 Burial Ground mitigation planting areas. Only one of the 50 bitterbrush tubelings that were planted in November 1999 was still alive. Therefore, an additional 50 bitterbrush were planted in place of the dead plants in January 2001, and then irrigated with 18.9 L (5 gal) of water each in mid-June

and August. Survival of the sagebrush planted in 1997 was only 42.3%. However, the sagebrush was planted in groups of three, and 73.4% of the groups had at least one plant that was still alive.

The 316-5 Process Trenches were remediated between mid- 1997 and early 1998. A majority of the trenches was regraded and contoured with the surrounding soils. During the fall of 1998, the site was broadcast seeded with 50 kg/ha of crested wheatgrass (*Agropyron cristatum*). Straw was used as mulch and then crimped into the soil. The third year monitoring conducted in May 2001 identified 29 plant species on the revegetated area, of which 19 were native. The most abundant plant species was cheatgrass with 16.8% canopy cover, followed by crested wheatgrass with 11.8% cover.

In November 1998, 73,800 sagebrush seedlings were planted in shrubless areas of the ALE Reserve as compensatory mitigation for habitat lost during the expansion of the ERDF. Five different areas on the ALE Reserve containing 56 plots were selected for revegetation and habitat enhancement. Areas 1 through 4 were burned in the June 2000 24 Command fire. Portions of Area 5 were burned; however, this area was also burned in the 1997 fire (prior to planting) and therefore lacked sufficient fuel to carry a continuous fire. The mosaic burn pattern spared some of the shrubs. The sagebrush survival in this area was estimated in July 2001. More plants were consumed in the fire than was initially thought, as only 11.1 % of the plants within the monitoring plots of Area 5 were still alive.

The 116-C-1 revegetation was conducted as a demonstration project to evaluate practical methods for revegetating remediated sites with native species. The 116-C-1 site was backfilled

with naturally occurring sand and cobble and was the planting medium for two of the four planting treatments. The remaining two treatments used topsoil salvaged from the expansion of the ERDF. In November 1998, a native seed mix was distributed across the site. Cryptobiotic soil/dust was also spread on the eastern half of the site to inoculate the soil surface, and then wheat straw mulch was applied across the site and crimped into the soil surface. Two hundred and one sagebrush tubelings were planted in groups of three and irrigated throughout the site. Irrigation was applied to one-half of the cobble substrate and one-half of the topsoil substrate. Vegetation analysis conducted in May 2001 found 35 plant species on the site, 23 of which were native, including all 7 of the planted species. Overall sagebrush survival remains high at 80.5%. Sagebrush seedling survival was highest on the non-irrigated and irrigated cobble treatments at 95.5% and 91.7%, respectively.

The 116-B-1, 116-B-11, and 116-C-5 sites were seeded in December 1999. Three different fertilizer formulas were applied on the backfilled areas. The native seed mix and fertilizer treatments were applied with a hydroseeder. The entire seeded area was mulched and irrigated with 0.62 cm of water per hectare. In December 2000, 2,600 sagebrush tubelings were planted across the sites. Vegetation analysis conducted in June 2001 found 28 species on the sites, of which 14 were native. All eight of the planted species were observed on the sites. Sandberg's bluegrass had the greatest canopy cover across all the treatments. Species diversity remained highest with 26 species on 116-C-5, which received a combination of micronutrient and triple 16 fertilizer. Sagebrush survival estimates were gathered from a representative plot on August 1, 2001. All but one of the 105 staked sagebrush were alive. Sagebrush survival remained high, possibly because the counts were gathered before the peak summer temperature.

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METRIC CONVERSION CHART

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	Millimeters
inches	2.54	Centimeters
feet	0.305	Meters
yards	0.914	Meters
miles	1.609	Kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	metric ton
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius

Out of Metric Units

If You Know	*Multiply By*	*To Get*
Length		
Millimeters	0.039	Inches
Centimeters	0.394	Inches
Meters	3.281	feet
Meters	1.094	yards
Kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
Hectares	2.47	acres
Mass (weight)		
Grams	0.035	ounces
Kilograms	2.205	pounds
metric ton	1.102	ton
Volume		
Milliliters	0.033	fluid ounces
Liters	2.1	pints
Liters	1.057	quarts
Liters	0.264	gallons
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit

1.0 INTRODUCTION

This report compiles the results of revegetation monitoring conducted in the spring and early summer of 2001. The monitoring sites on the North Slope include the 600-104 (2,4-D) Bioremediated site and sagebrush (*Artemisia tridentata*) survival on the Saddle Mountain Wildlife Refuge. On the Fitzner-Eberhardt Arid Lands Ecology (ALE) Reserve, surveys were conducted on the Horseshoe Landfill and sagebrush survival on the Environmental Restoration Disposal Facility (ERDF) Compensatory Mitigation plots. Additional areas on the Hanford Site include the 300-FF-1 sagebrush and bitterbrush (*Purshia tridentata*) mitigation area, the 316-5 Process Trenches, the 116-C-1 restoration site, and revegetation efforts on the 116-B-1, 116-B-11, and 116-C-5 sites. The locations of these sites are shown in Figure 1.

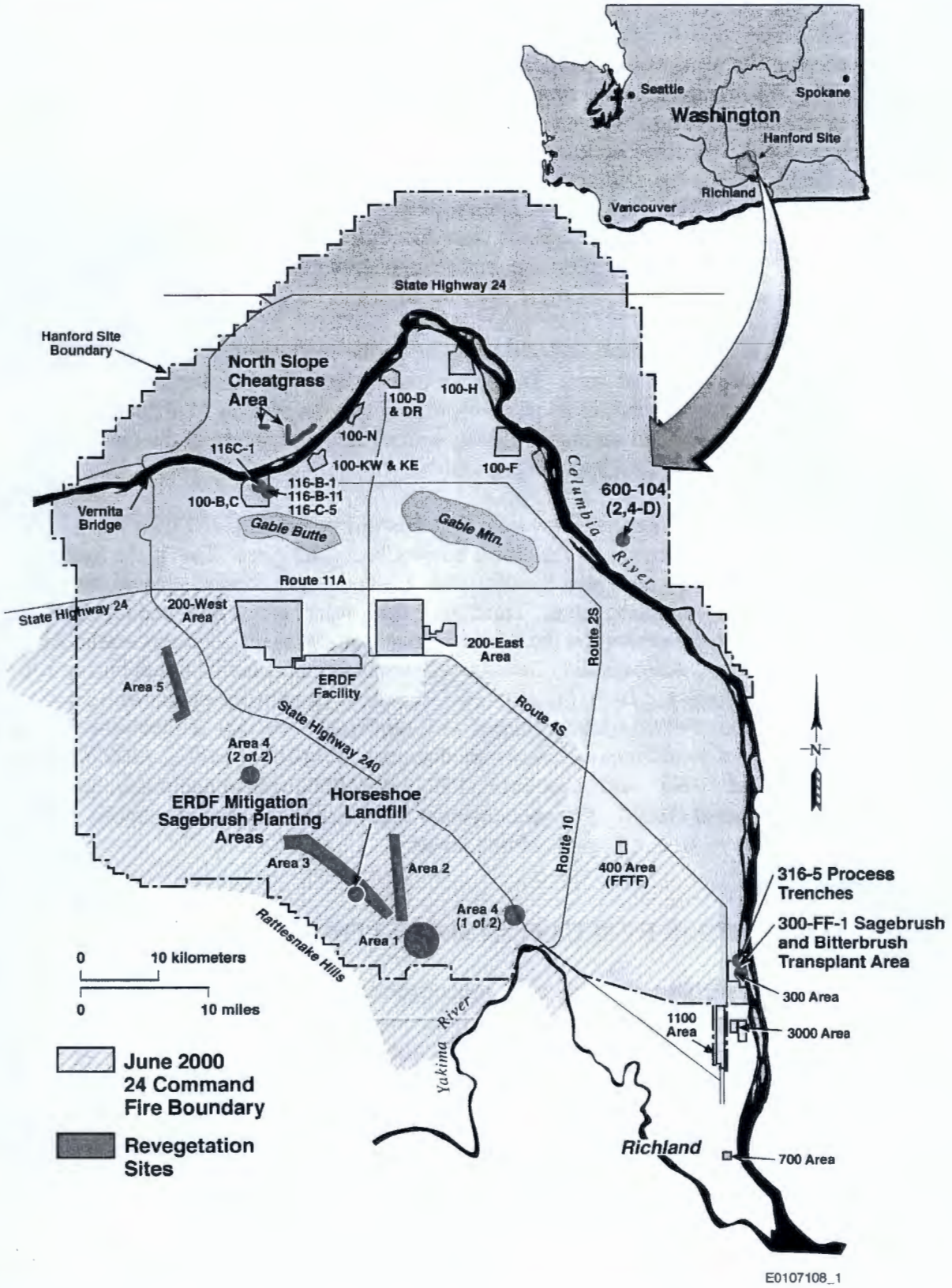
The extent of each revegetation effort varied depending on the surrounding habitat, existing conditions, and the future use of the area. The purpose of revegetation monitoring is to measure the progress of plant succession and, in some cases, to evaluate the success of different planting techniques. Each site is discussed separately, along with a brief description of the revegetation activities and the results of the 2001 monitoring efforts.

This report provides sixth year monitoring data on the Horseshoe Landfill and fifth year measurements of sagebrush survival on the North Slope Cheatgrass Area. This is the fourth year that measurements have been gathered at the 600-104 (2,4-D) Bioremediated site and 300-FF-1 sagebrush and bitterbrush mitigation areas. Third year measurements are provided for the 316-5 Process Trenches, sagebrush survival on the ERDF compensatory mitigation areas on the ALE Reserve, and the 116-C-1 restoration site. Second-year measurements are included for the 100-B/C revegetated sites, 116-B-1, 116-B-11, and 116-C-5, which were hydroseeded with a native seed mixture in December 1999, and then planted with sagebrush tubelings in December 2000. Results from the previous years' measurements are documented in Johnson et al. (2000), Gano et al. (1999), Kemp et al. (1998), and Gano et al. (1997); the 1996 measurements were provided in a letter report by Henckel (1996). The measurement data from these previous reports are provided in Appendices A, B, C, D, and E of this report.

1.1 METHODS USED IN EVALUATING VEGETATION RECOVERY

Vegetation monitoring in 2001 consisted of measuring the canopy cover of all plant species found on the site, the frequency of occurrence, and the survival of transplanted sagebrush and bitterbrush. All values were then converted to percentages. Canopy cover and frequency measurements were conducted using the methods of Daubenmire (1970). Canopy coverage is defined in Daubenmire (1970) as "the percentage of ground surface included in the vertical projection of a polygon drawn around the extremities of undisturbed foliage of a plant." This method can provide a measure of the amount of ground covered by each species. Because it is possible, in dense stands of vegetation, for species to overlap one another, total measured vegetative cover can exceed 100%. Within each location, a series of plot frames were analyzed for canopy cover of each species present. Frequency is represented as the percentage of

Figure 1. Hanford Site Showing Locations of Revegetation Sites and Fire Boundary.



occurrences that a species is observed in the number of plot frames measured. For example, if a species was represented in 10 out of 25 plot frames, its frequency would be 10/25 x 100 = 40%.

The relative magnitude of a frequency rating, when compared to a canopy coverage rating, provides an index of species distribution and its influence within a vegetation community. At sites where sagebrush were planted, the survival was measured by counting a representative number of plants at the site, determining if they were dead or alive, and then calculating the percent alive.

This report uses taxonomic nomenclature from Hitchcock and Cronquist (1973). Some plant taxonomic names have been updated, and the revised names are provided in Appendix F. Plant identification was conducted using Hitchcock and Cronquist (1973) and Sackschewsky et al. (1992).

The type and extent of each revegetation effort is based on the location of the project and the future land designation of that area. At the Horseshoe Landfill the objective was to restore the area with native bunchgrasses while suppressing the growth of nonnative species. The objective of transplanting sagebrush in the previously burned North Slope Cheatgrass Area was to promote sagebrush reestablishment by providing the area with a seed source. The results from monitoring efforts show that the objectives have been met and that monitoring can be discontinued at these sites.

The objective of revegetating the 600-104 (2,4-D) Bioremediated site was to stabilize the soils and promote establishment of native species. The 300-FF-1 sagebrush and bitterbrush areas were revegetated to compensate for the loss of shrubs during remediation of the 618-4 Burial Ground.

In the long-range planning, portions of the 300 Area have been designated for future industrial use. Therefore, the objective of the 316-5 Process Trenches revegetation was to stabilize the soils with crested wheatgrass (*Agropyron cristatum*). The objective of revegetation at most remedial action sites is to restore the land to plant communities dominated by native plants that will eventually provide wildlife habitat. Secondary objectives often include improving success rates using experience from previous plantings. For example, the secondary objective at 116-C-1 was to evaluate the effectiveness of revegetation efforts in different soil types with supplemental irrigation. The secondary objective of revegetation efforts on the 116-B-1, 116-B-11, and 116-C-5 sites was evaluating the effectiveness of establishing the areas with native species under different fertilizer treatments.

Success criteria are often different for each site due to varying soil types and microclimatic conditions. For example, sandy areas contain different species with different recovery rates and plant densities than rocky soils. Therefore, the criteria for judging success will be different. All sites will be evaluated based on plant canopy cover, plant community composition, and survival and growth of transplanted shrubs. These criteria are detailed in the *Revegetation Manual for the Environmental Restoration Contractor* (McLendon et al. 1997). A revegetation effort will be considered successful if the area is stabilized to prevent erosion and is dominated by recovering stands of native sagebrush, forbs, and grasses. Areas designated for future industrial use will

have the objective of stabilization but may not be planted with native species because of the potential of future disturbance.

2.0 HORSESHOE LANDFILL

The Horseshoe Landfill is located on the ALE Reserve (Figure 2). It was sampled and remediated as part of the remediation work outlined in the ROD for the 1100 Area National Priorities List site (EPA 1993). The completion of the remediation work was documented in the *Close-Out Report Fitzner-Eberhardt Arid Lands Ecology Reserve Remedial Action, Hanford, Washington* (DOE-RL 1996a).

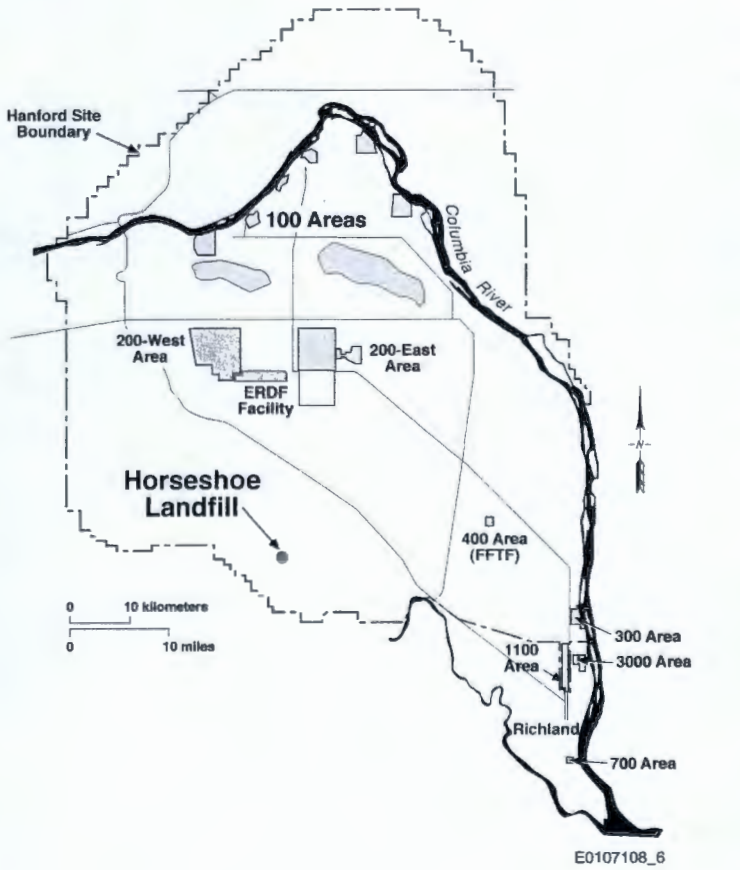
The revegetated area on the landfill measures approximately 35 m by 70 m. The soils disturbed during remediation were revegetated with transplanted bunchgrasses in the fall of 1995. The landfill was covered with topsoil that had native sagebrush seed mixed in the soil from plants previously growing in the area. The exceptionally wet winter of 1994-1995 allowed the seeds to germinate and mature.

The revegetation effort on Horseshoe Landfill was announced a success in May 2000. However, DOE requested one additional year of montioring to be conducted to document vegetative recovery following the June 2000 wildfire that burned through the area. The vegetation growing on the Horseshoe Landfill and a reference site adjacent to the waste site was measured for canopy cover and frequency of occurrence on April 24, 2001. Because the native plant community had become well established on the landfill prior to the fire, bunchgrasses and forbs were expected to return. As predicted, species composition has remained nearly identical to the prefire composition. Although the number of species is constant on the landfill, the total canopy cover was reduced by 50% from last year's survey. A majority of the canopy cover reduction on the landfill was a result of sagebrush and cheatgrass (*Bromus tectorum*) removal. Total canopy cover on the Horseshoe Landfill in 2001 was 41.7 % (Table 1). Total cover on the reference site has also fallen from 131.7% to 78.5% cover. The reduction in cover on the reference site can be contributed to a significant decline in cheatgrass, sagebrush, and spring whitlow (*Draba verna*). Despite the reduction in cover by cheatgrass on both sites, frequency of occurrence remains very high with 92% on the landfill and 72% on the reference site (Table 2). Sandberg's bluegrass (*Poa sandbergii*) cover and frequency has remained consistent from observations on both sites in 2000. Sagebrush seedlings ranging in height from 2 to 3 cm were observed on the landfill. The seedlings were a result of germinating seeds that were deposited by the resident shrubs prior to the fire.

Figure 2. Horseshoe Landfill.

December 1995

May 1999



July 2000

April 2001

Table 1. Percent Canopy Cover on Horseshoe Landfill in 2001.

Species	Waste Site	Reference Site
*Bromus tectorum** (cheatgrass)	5.7	3.3
Artemisia tridentata (big sagebrush)	0.4	--
Agropyron spicatum (bluebunch wheatgrass)	0.1	0.2
Poa sandbergii (Sandberg's bluegrass)	15.4	54.8
Sitanion hystrix (bottlebrush squirreltail)	0.1	X
*Poa bulbosa** (bulbous bluegrass)	2.6	--
Festuca octoflora (six-weeks fescue)	2.2	0.6
Oryzopsis hymenoides (Indian ricegrass)	0.8	0.7
*Sisymbrium altissimum** (tumblemustard)	5	7.9
*Melilotus officinalis** (sweetclover)	0.6	--
Epilobium paniculatum (tall willowherb)	0.5	0.1
*Lactuca serriola** (prickly lettuce)	0.4	0.3
Crepis atrabarba (slender hawksbeard)	1.6	4.3
*Salsola kali** (Russian thistle)	0.9	--
Descurainia pinnata (western tansymustard)	0.5	0.2
Erigeron filifolius (threadleaf fleabane)	X	0.1
*Lepidium perfoliatum** (clasping pepperweed)	X	--
Lupinus sulphureus (sulfur lupine)	X	--
Lupinus leucophyllus (velvet lupine)	0.7	1.5
*Tragopogon dubius** (yellow salsify)	0.2	X
Lomatium grayi (Gray's desertparsley)	--	X
Phlox longifolia (longleaf phlox)	X	--
*Holosteum umbellatum** (jagged whitlow)	0.9	0.5
Achillea millefolium (yarrow)	0.7	--
Calochortus macrocarpus (sagebrush mariposa lily)	X	0.1
*Erodium cicutarium** (storksbill)	0.2	X
Amsinckia lycopsoides (tarweed fiddleneck)	0.1	X
Lomatium macrocarpum (bigseed desertparsley)	0.3	1.7
Draba verna (spring whitlow)	0.5	0.5
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--
Chrysothamnus nauseosus (gray rabbitbrush)	X	--
Linum perenne (wild blueflax)	0.2	0.1
Machaeranthera canescens (hoary aster)	0.1	--
Balsamorhiza careyana (Carey's balsamroot)	X	--
Chaenactis douglasii (hoary falseyarrow)	X	--
Helianthus cusickii (Cusick's sunflower)	0.8	X
Astragalus caricinus (buckwheat milkvetch)	X	--
Ambrosia acanthicarpa (bur ragweed)	0.2	--
*Descurainia sophia** (flixweed)	--	1.5
*Amaranhus albus** (pigweed)	--	0.1
Biotic Crust	54.1	35.3
Bare Soil	63.3	42.8
Litter	10.1	2.5
Total Cover (does not include biotic crust, bare soil or litter)	**41.7**	**78.5**

* Introduced species.
X = Present but not counted in the plot frames.
-- = Not occurring on site.

Table 2. Percent Frequency of Occurrence on Horseshoe Landfill in 2001.

Species	Waste Site	Reference Site
*Bromus tectorum** (cheatgrass)	92	72
Artemisia tridentata (big sagebrush)	16	--
Agropyron spicatum (bluebunch wheatgrass)	4	8
Poa sandbergii (Sandberg's bluegrass)	96	96
Sitanion hystrix (bottlebrush squirreltail)	4	X
*Poa bulbosa** (bulbous bluegrass)	48	--
Festuca octoflora (six-weeks fescue)	88	24
Oryzopsis hymenoides (Indian ricegrass)	32	8
*Sisymbrium altissimum** (tumblemustard)	84	64
*Melilotus officinalis** (sweetclover)	24	--
Epilobium paniculatum (tall willowherb)	20	4
*Lactuca serriola** (prickly lettuce)	16	12
Crepis atrabarba (slender hawksbeard)	44	72
*Salsola kali** (Russian thistle)	36	--
Descurainia pinnata (western tansymustard)	20	8
Erigeron filifolius (threadleaf fleabane)	X	4
*Lepidium perfoliatum** (clasping pepperweed)	X	--
Lupinus sulphureus (sulfur lupine)	X	--
Lupinus leucophyllus (velvet lupine)	28	60
*Tragopogon dubius** (yellow salsify)	8	X
Lomatium grayi (Gray's desertparsley)	--	X
Phlox longifolia (longleaf phlox)	X	--
*Holosteum umbellatum** (jagged whitlow)	36	20
Achillea millefolium (yarrow)	8	--
Calochortus macrocarpus (sagebrush mariposa lily)	X	4
*Erodium cicutarium** (storksbill)	8	X
Amsinckia lycopsoides (tarweed fiddleneck)	4	X
Lomatium macrocarpum (bigseed desertparsley)	12	12
Draba verna (spring whitlow)	20	20
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--
Chrysothamnus nauseosus (gray rabbitbrush)	X	--
Linum perenne (wild blueflax)	8	4
Machaeranthera canescens (hoary aster)	4	--
Balsamorhiza careyana (Carey's balsamroot)	X	--
Chaenactis douglasii (hoary falseyarrow)	X	--
Helianthus cusickii (Cusick's sunflower)	12	X
Astragalus caricinus (buckwheat milkvetch)	X	--
Ambrosia acanthicarpa (bur ragweed)	8	--
*Descurainia sophia** (flixweed)	--	4
*Amaranhus albus** (pigweed)	--	4
Biotic Crust	100	100
Bare Soil	100	100
Litter	100	80

* Introduced species.
X = Present but not counted in the plot frames.
-- = Not occurring on site.

3.0 WAHLUKE NORTH SLOPE

3.1 NORTH SLOPE CHEATGRASS AREA

Sagebrush seedlings were planted along the road shoulder in a burned area of the Saddle Mountain Wildlife Refuge in August and October 1996. This area had the sagebrush component removed due to repeated fires. Sagebrush were planted to provide the area with a seed source and initiate recovery.

Approximately 3,000 sagebrush were salvaged from a gravel pit along Highway 24 and transplanted in groups of three along an access road in the North Slope Cheatgreass Area. The August plantings included three slightly different techniques. All the sagebrush were planted directly in the soil and watered. One small area included planting the sagebrush into the ground and then surrounding them with black plastic to help control competition from weeds. Another group of sagebrush were planted with a commercial grade vegetable gel, (Dri-Water™) that slowly releases water into the soil over an extended period of time. Survival of the August planted sagebrush was very poor, only 5.5% after the first year, and therefore these sagebrush are no longer monitored.

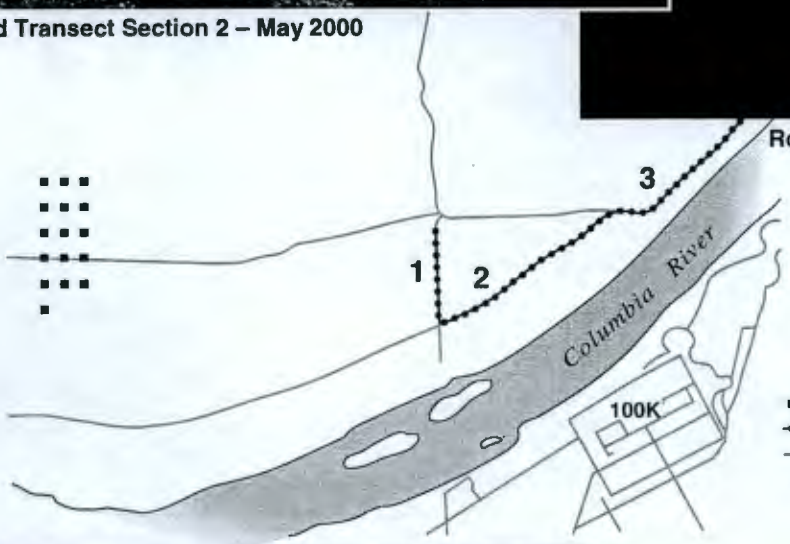
An additional 2,700 sagebrush were planted in October 1996. The sagebrush were salvaged from an area south of the Hanford Site's 300 Area. The sagebrush were planted in groups of three along the access road (road transect) and in small transect plots perpendicular to the access road. For monitoring purposes, the road transect was divided into three sections (Figure 3). Sagebrush survivorship was counted in June 2001 and continued to be high. Sagebrush survival rate for sections 1, 2, and 3 were 85.5%, 73.9%, and 77.9%, respectively, yielding an average survival of 77.8% after 5 years (Table 3). The average height of the sagebrush for all three sections was 44.1 cm and ranged from 15 cm to 63 cm. The sagebrush has started to produce seed, as evident by the sagebrush seedlings growing in the road and adjacent to the planted groups. During the survey this year, it was also noted that the cheatgrass around a majority of the sagebrush plants had been trampled, indicating that wildlife have started to utilize the plants (probably for shelter). This planting effort will not be monitored beyond this fifth year, as the goals of this planting effort have been achieved.

The dramatic improvement of the survival of the October versus August planted sagebrush demonstrates that late summer planting may not be a successful approach. High daily temperatures, low soil moisture, and injured root systems of the salvaged plants were the primary factors contributing to the low survivorship of the August planting.

Figure 3. Sagebrush Transplant Sites on the North Slope Cheatgrass Area.

Road Transect Section 2 – May 2000

Road Transect Section 1 – June 2001



Regeneration – Road Transect Section 2 – June 2001

Trampled Cheatgrass Around the Plants – Road Transect Section 3 – June 2001

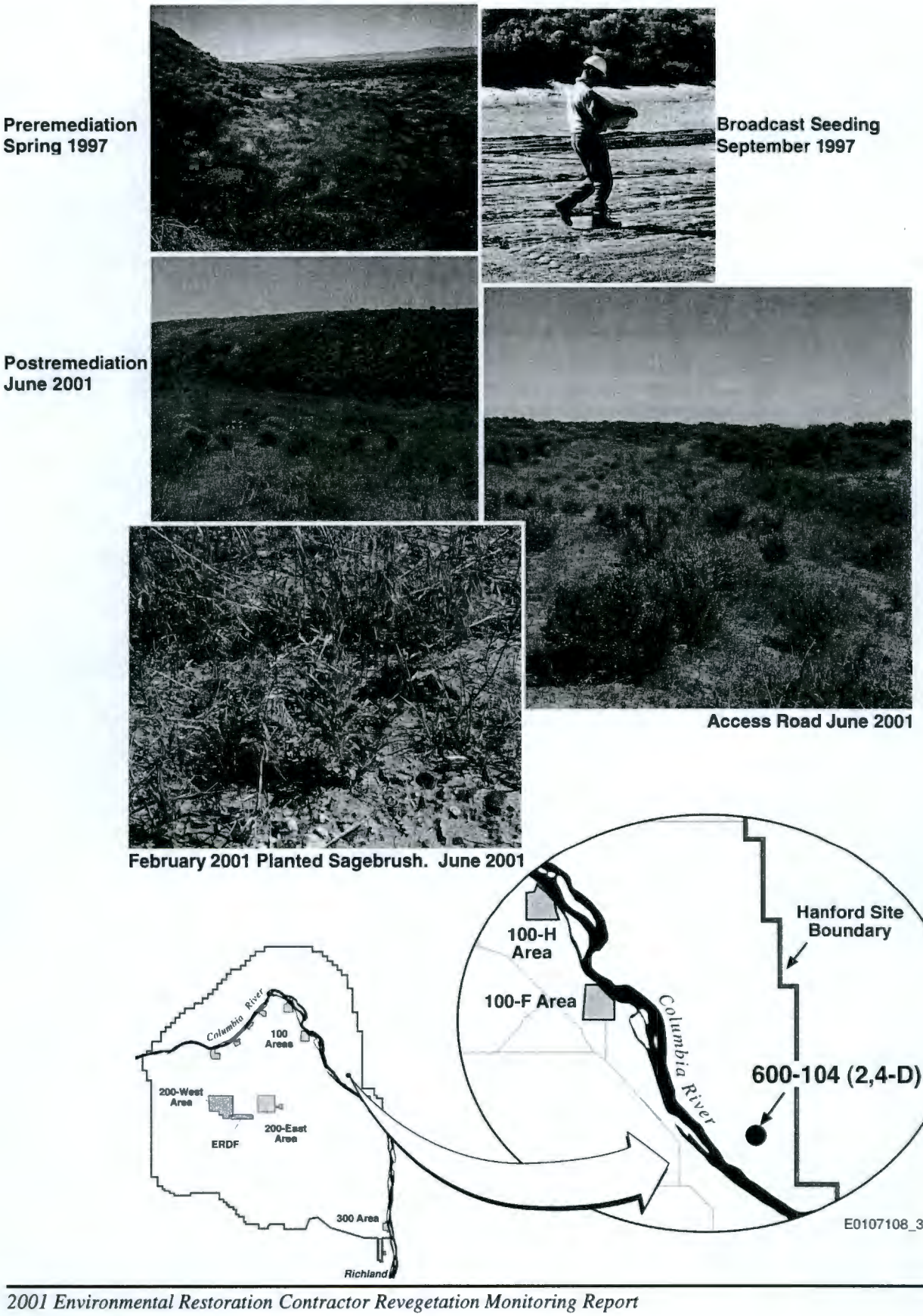
Table 3. Percent Survival of Planted Sagebrush.

Site	1997	1998	1999	2000	2001
North Slope Cheatgrass Area					
Small Plots (August)	5.5	--	--	--	--
Small Plots (October)	92.7	--	--	--	--
Road Transect	85.7	81.8	76.7	77.4	77.8
300-FF-1 1997 Sagebrush Only	--	70	54	--	--
Sagebrush 1997 Planting and 1999 Replacements	--	--	--	98.5	42.3
Sagebrush 1999 Planting	--	--	--	--	1
Bitterbrush 1999 Planting	--	--	--	100	2
Bitterbrush 2001 Planting	--	--	--	--	55
ERDF Sagebrush Mitigation					
Area 1	--	--	93	73.9	--
Area 2	--	--	97.8	86.6	--
Area 3	--	--	91.6	65.9	--
Area 4	--	--	70.5	--	--
Area 5	--	--	57.8	48.6	11.1
116-C-1					
Non-irrigated Cobble	--	--	100	95.5	95.4
Irrigated Cobble	--	--	91.7	86.1	91.6
Non-irrigated Topsoil	--	--	83.3	61.9	64.2
Irrigated Topsoil	--	--	78.9	75.4	68.4
116-C-5					
Sagebrush	--	--	--	--	99

3.2 600-104 (2,4-D) BIOREMEDIATION SITE

The 600-104 (2,4-D) Bioremediated site is located north of the Columbia River, northeast of the 100-F Area (Figure 4). This 1 ha site was used by the Bureau of Reclamation to dispose of 11 empty tanks and 2,4-D contaminated soil. Prior to remediation, the site was dominated by cheatgrass and tumblemustard. In August 1997, the tanks were exhumed and the soils were bioremediated. In September 1997, the site was broadcast seeded with 1 kg/ha of sagebrush, 0.75 kg/ha of snow buckwheat (*Eriogonum niveum*), 5 kg/ha Sandberg's bluegrass, 1 kg/ha of Indian ricegrass (*Oryzopsis hymenoides*), and 20 kg/ha of balsamroot (*Balsamorhiza careyana*), and then irrigated with 5 cm of water (100,000 L over the entire site). The access road was also closed to vehicle travel and seeded with native species. In February 2001, 900 sagebrush tubelings were planted across the site to further promote the establishment of shrubs in this community.

Figure 4. 600-104 (2,4-D) Bioremediated Site.



During vegetation surveys conducted in May 2001, 35 species were found on the site, of which 28 were native (Table 4). All five of the planted species were observed. Cheatgrass remains the dominant species on the site with 23.6% cover, up from 18.1% in 2000. Russian thistle (*Salsola kali*) cover remains low, recorded around 3%. Two new bunchgrasses, needle-and-thread grass (*Stipa comata*) and bulbous bluegrass (*Poa bulbosa*), were observed on the site this year. Canopy cover for Sandberg's bluegrass increased from 0.9% to 3.1% this year. The occurrence of an increasing number of native species and the development of biotic crust indicates that the site is continuing to recover from the 1997 remedial action disturbance. In addition to the waste site, the access road has demonstrated significant recovery. Sagebrush and many native forbs have moved into the road from the adjacent undisturbed sagebrush community. The sagebrush planted in February 2001 also appears to be healthy. Some sagebrush had noticeable top and foliar growth; however, survival observations after an entire growing season will yield more accurate survival rates.

Table 4. Percent Canopy Cover and Frequency of Occurrence on the 600-104 (2,4-D) Site in 2001. (2 Pages)

Species	% Cover	% Frequency
*Bromus tectorum** (cheatgrass)	23.6	96
*Salsola kali** (Russian thistle)	3.1	64
*Sisymbrium altissimum** (tumblemustard)	0.2	8
Ambrosia acanthicarpa (bur ragweed)	0.8	32
Poa sandbergii (Sandberg's bluegrass)	3.1	28
Festuca octoflora (six-weeks fescue)	0.5	20
Rumex venosus (winged dock)	0.2	8
Lappula redowskii (western stickseed)	0.2	8
Amsinckia lycopsoides (tarweed fiddleneck)	0.2	8
*Holosteum umbellatum** (jagged chickweed)	0.7	28
Draba verna (spring whitlow)	0.4	16
Achillea millefolium (yarrow)	1.1	24
Epilobium paniculatum (tall willowherb)	0.6	24
*Lactuca serriola** (prickly lettuce)	0.1	4
Microsteris gracilis (annual phlox)	0.1	4
Artemisia tridentata (big sagebrush)	0.3	12
Machaeranthera canescens (hoary aster)	0.2	8
Phlox longifolia (longleaf phlox)	1.5	4
Eriogonum niveum (snow buckwheat)	0.7	8
Mentzelia albicaulis (whitestem stickleaf)	X	X
Lupinus pusillus (low lupine)	0.1	4
Oryzopsis hymenoides (Indian ricegrass)	0.1	4
*Poa bulbosa** (bulbous bluegrass)	X	X
Balsamorhiza careyana (Carey's balsamroot)	X	X
*Tragopogon dubius** (yellow salsify)	X	X
Astragalus caricinus (buckwheat milkvetch)	X	X
Astragalus sclerocarpus (stalked-pod milkvetch)	2.5	4
Chrysothamnus viscidiflorus (green rabbitbrush)	0.6	4
Chrysothamnus nauseosus (gray rabbitbrush)	0.2	8

Table 4. Percent Canopy Cover and Frequency of Occurrence on the 600-104 (2,4-D) Site in 2001. (2 Pages)

Species	% Cover	% Frequency
Collomia linearis (narrow leaf collomia)	X	X
Phacelia hastata (whiteleaf scorpionweed)	X	X
Plantago patagonica (Indian wheat)	0.2	8
Fritillaria pudica (yellow bell)	X	X
Stipa comata (needle-and-thread grass)	X	X
Erigeron filifolius (threadleaf fleabane)	X	X
Biotic crust	1.1	44
Bare soil	48.9	100
Litter	23	100
Total cover (does not include biotic crust, bare soil or litter)	**41.3**	

* Introduced species.
X = Present but not counted in plot frames.

4.0 300 AREA

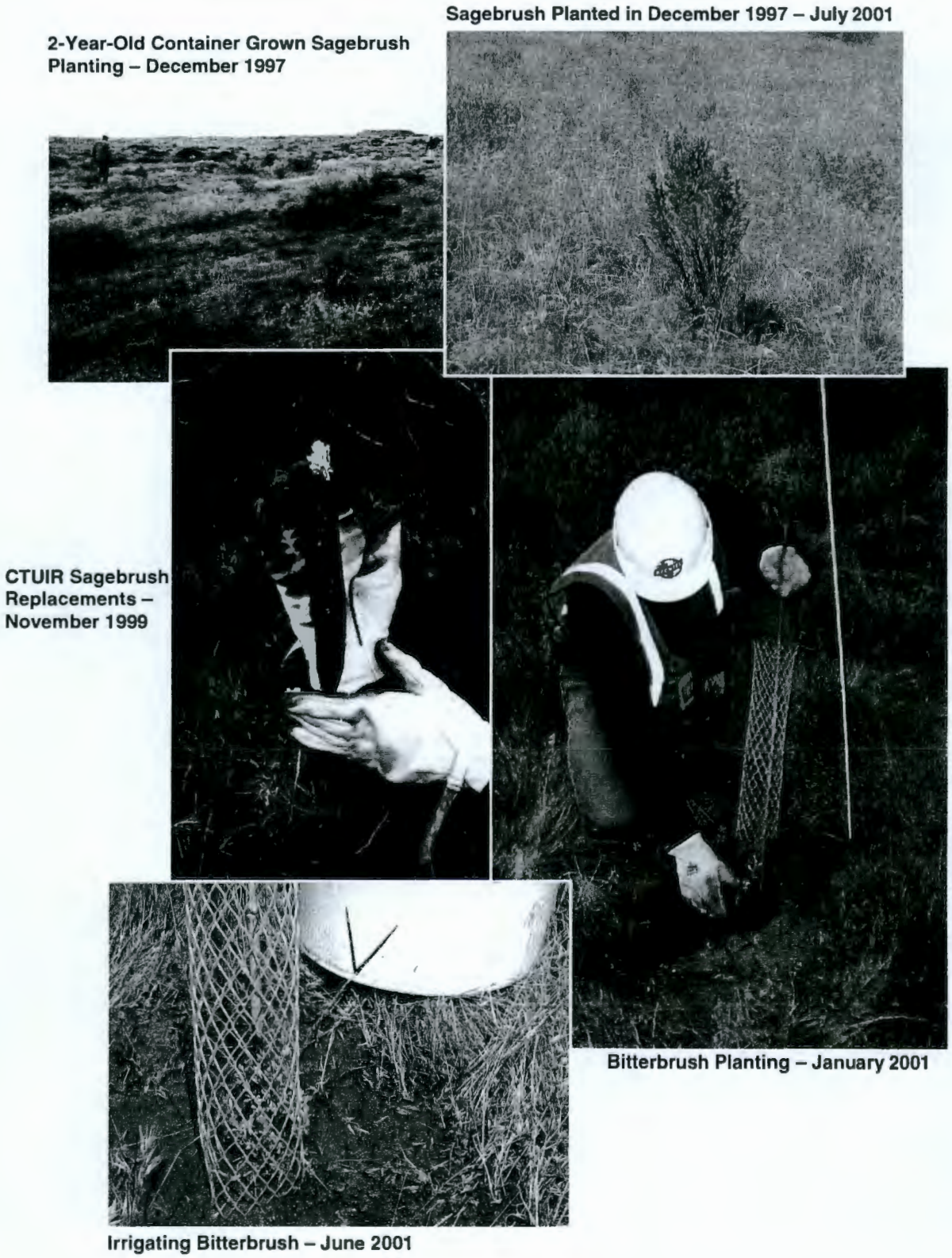
4.1 300-FF-1 SAGEBRUSH AND BITTERBRUSH TRANSPLANT AREA

On October 16 and 17, 1997, 24 bitterbrush were salvaged from the perimeter of the 618-4 Burial Ground and moved 200 m east. The salvaging effort was conducted to mitigate for the loss of mature shrubs on the 618-4 Burial Ground during the initial stages of remediation (Weiss 1996). The salvaged plants were 0.25 to 0.5 m in height. The bitterbrush were planted in groups of three over a 500-m^2 area.

The area where the plants were salvaged had coarse sandy gravel covered by a thin veneer of fine soil. Although the plants were extracted with extreme care using a 1/4 yard backhoe, the soil fell from the root mass, consequently causing root damage. The plants were immediately transplanted in holes that had been filled with water and allowed to drain. On August 31, 1998, the bitterbrush were examined for survival and all 24 plants had died. The loss of fine roots during excavation was likely the major cause of mortality.

On December 2, 1997, 293 2-year-old container grown sagebrush plants were planted over a 3,100-m^2 area north of the bitterbrush planting area (Figure 5). This sagebrush planting effort was additional mitigation for the loss of shrubs on the 618-4 Burial Ground. Five rows of plants were placed in groups of three, spaced 0.5 to 1.0 m apart, with group spacing of 4.6 m. In November 1999, survivorship was determined to be 51%. All of the dead plants were replaced, and an additional 180 tubelings from the Umatilla Native Plant Nursery of the Confederated Tribes of the Umatilla Indian Reservation in Umatilla, Oregon were added to the plot.

Figure 5. 300-FF-1 Sagebrush and Bitterbrush.



In addition to planting sagebrush, 50 bitterbrush tubelings were planted east of the 618-4 Burial Ground in the previously failed transplant area. The plants were in excellent condition with top growth ranging from ~15 to 25 cm. All plants were protected with biodegradable plastic mesh tubes and staked to prevent browsing by deer. The bitterbrush was surveyed for survival in January 2001, and all but one bitterbrush had died. At that time, an additional 50 bitterbrush tubelings were planted in the same location with protective mesh tubes. The plants had top growth ranging from ~15 to 25 cm. However, just prior to planting, each tubeling had the upper one-third of its top growth removed.

In June and August 2001, each bitterbrush was irrigated with 18.9 L (5 gal) of water. A 18.9 L (5-gal) bucket, with a 1/64 inch hole drilled in the bottom to slowly release water, was placed at the base of each plant. At the June irrigation, all but four of the bitterbrush were alive, yielding a 92% survivorship. At the August irrigation, 28 plants were still alive for a 55% survivorship.

Sagebrush survival was estimated on June 15, 2001. Survival of the November 1997 planting was 42.3%; however, the 180 sagebrush from the Umatilla Native Plant Nursery had a survival of only 1%. Despite the low survival of the 1999 planted sagebrush, at 73.5% of the original planting locations at least one of the three plants is still alive.

One possible explanation for the difficulty of getting tubeling shrubs established in this area is because it is an established community dominated by Sandberg's bluegrass, cheatgrass, snow buckwheat, scurfpea (*Psoralea lanceolata*), and rabbitbrush (*Chrysothamnus nauseosus*).

4.2 316-5 PROCESS TRENCHES

The 316-5 Process Trenches became active in 1975 as a replacement for the north and south process pond system in the 300 Area (Figure 6). The trenches received process effluent from the uranium fuel fabrication facilities and liquid from the laboratories that were determined to be below discharge limits in the 300 Area. The 316-5 Process Trenches were two parallel unlined trenches about 468 m long, 3 m wide, and 3.7 m deep, spaced 15 m apart. The trenches were covered with screen to minimize access by birds to the sediments in the bottom of the trenches.

Trench remediation activities were initiated in July 1997 and completed in February 1998. Approximately 34,000 metric tons of contaminated soil and debris were excavated and shipped to ERDF. The process trenches was regraded and contoured with the surrounding soils adjacent to the trench in mid- to late 1998. A small southern section of the trenches was not regraded due to the close proximity of the North Process Pond yet to be remediated. This portion of the trench will be completed with the process pond work. In long range planning, this section of the 300 Area has been designated as future industrial use (EPA 1996). Therefore, the area was broadcast seeded with 50 kg/ha of crested wheatgrass. Straw mulch was applied across the site and then crimped into the soil using a serrated disk.

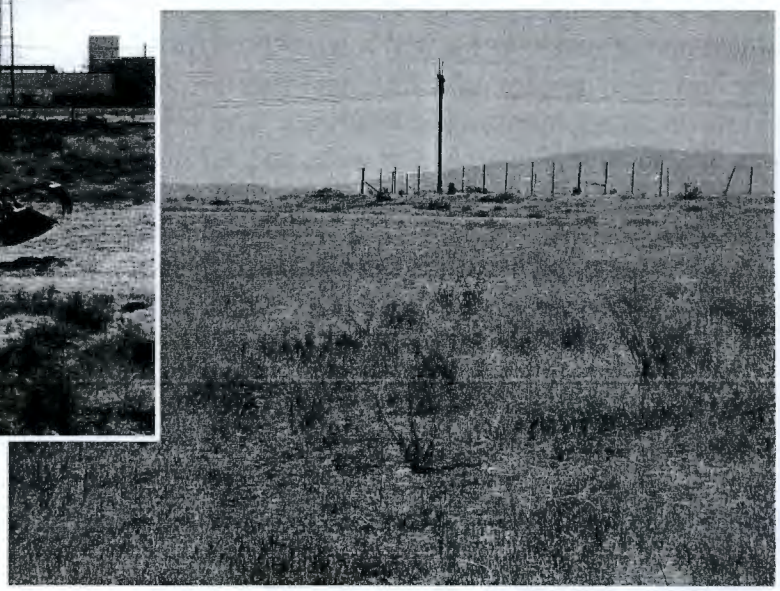
On May 8, 2001, 29 species were found on the 316-5 Process Trenches. Of the species observed, 19 were native (Table 5). This year's survey identified seven new species on the site, including yarrow (*Achillea millefolium*), needle-and-thread grass, and bitterbrush seedlings.

Figure 6. 316-5 Process Trenches.

Remediation 316-5 Process Trenches

316-5 Process Trenches – May 2001

Planting the 316-5 Process Tenches



Rabbitbrush Moving onto the Trenches From Mature Plants Adjacent to the Site – July 2001

Crested wheatgrass cover increased from 5% to 11.8% with a 76% frequency across the site. There are a few small areas of the trench that are very sandy, and the crested wheatgrass is having difficulty stabilizing them. However, there are several other species observed on the site including dune scurfpea, whiteleaf scorpionweed (*Phacelia hastata*), Columbia cutleaf (*Hymenopappus filifolius*), and evening primrose (*Oenothera pallida*) that will also help stabilize the sandy areas.

Table 5. Percent Canopy Cover and Frequency of Occurrence on the 316-5 Process Trenches in 2001.

Species	% Cover	% Frequency
*Bromus tectorum** (cheatgrass)	16.8	96
*Salsola kali** (Russian t'histle)	1.8	72
Ambrosia acanthicarpa (bur ragweed)	0.2	8
Microsteris gracilis (annual phlox)	0.1	4
*Holosteum umbellatum** (jagged chickweed)	1.2	48
Draba verna (spring whitlow)	1.5	40
*Lactuca serriola** (prickly lettuce)	X	X
Amsinckia lycopsoides (tarweed fiddleneck)	1	20
*Sisymbrium altissimum** (tumblemustard)	0.6	24
*Erodium cicutarium** (storksbill)	4.5	44
Machaeranthera canescens (hoary aster)	0.1	4
Plantago patagonica (Indian wheat)	0.2	8
*Melilotus alba** (sweetclover)	0.3	12
Psoralea lanceolata (dune scurfpea)	X	X
*Agropyron cristatum** (crested wheatgrass)	11.8	76
Achillea millefolium (yarrow)	X	X
Phacelia hastata (whiteleaf scorpionweed)	X	X
Poa sandbergii (Sandberg's bluegrass)	X	X
Eriogonum niveum (snow buckwheat)	X	X
Oenothera pallida (evening primrose)	X	X
Chrysothamnus nauseosus (gray rabbitbrush)	X	X
Brodiaea howellii (Howell's clusterlily)	X	X
Phacelia linearis (threadleaf scorpionweed)	X	X
*Tragopogon dubius** (yellow salsify)	X	X
Hymenopappus filifolius (Columbia cutleaf)	X	X
*Centaurea diffusa** (diffuse knapweed)	X	X
Chaenactis douglasii (hoary falseyarrow)	X	X
Purshia tridentata (bitterbrush)	X	X
Stipa comata (needle-and-thread grass)	X	X
Biotic Crust	0.7	28
Bare Soil	61.1	96
Litter	26.9	100
Total (does not include biotic crust, bare soil, or litter)	**40.1**	

* Introduced species.

X = Present but not counted in plot frames.

5.0 ERDF SAGEBRUSH MITIGATION

In November 1998, 73,800 sagebrush seedlings were planted as compensatory mitigation for 20.25 ha (50 acres) of mature sagebrush habitat lost to the expansion of the ERDF. Sagebrush habitat is considered a priority habitat by Washington State because it supports a diverse assemblage of species. The loss of this habitat affects a number of arid lands fauna, including sage sparrow (*Amphispiza belli*) and the loggerhead shrike (*Lanius ludovicianus*), both of which are species of concern on the Hanford Site requiring mitigation if impacted. The *Hanford Site Biological Resources Management Plan* (DOE-RL 1996b) requires that if more than 1 ha (2.47 acres) of this habitat is destroyed, then compensatory mitigation must take place at a rate of 3:1. Planting of 73,800 sagebrush took place in shrubless areas on the ALE Reserve. The sagebrush were planted at approximately 988 plants per hectare (400 plants per acre) over a total of 77 ha (191 acres). This resulted in a compensation ratio of approximately 4:1.

The goal of this mitigation project was to replace the habitat lost to the sage sparrow and loggerhead shrike. It was anticipated that when the shrubs matured, the habitat would also support sage thrashers (*Oreoscoptes montanus*) and potentially sage grouse (*Centrocercus urophasianus*).

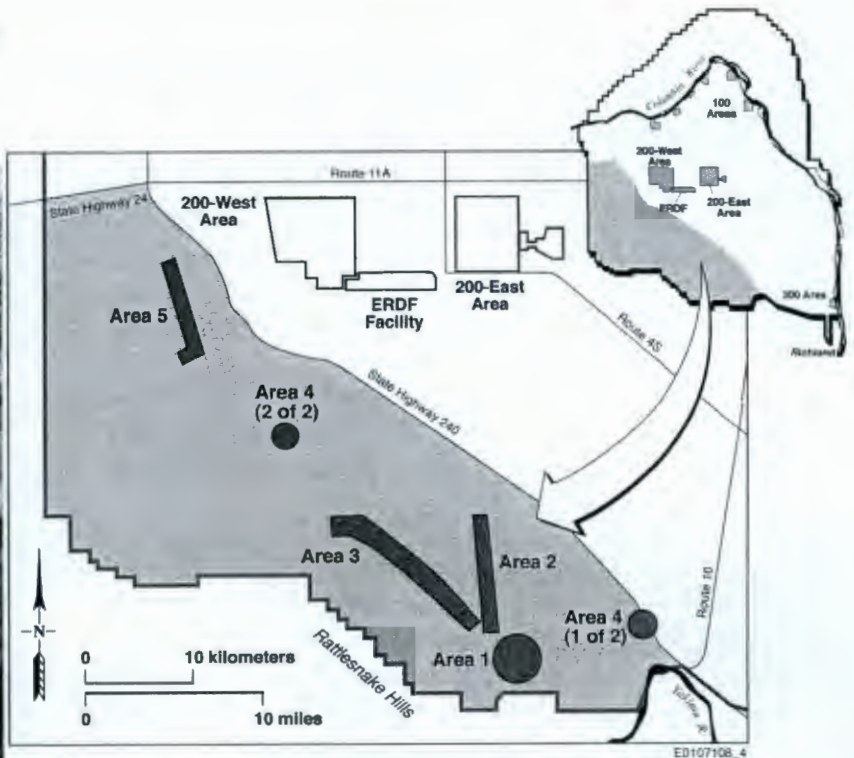
In preparation for this project, an Interagency Agreement (DOE-RL 1997) was drawn between the U.S. Department of Energy and the United States Fish and Wildlife Service that called for the cultivation and planting of 75,000 sagebrush seedlings. Native seeds were collected from the Hanford Site in 1997 and sent to three native plant nurseries: Lucky Peak of Boise, Idaho; Plants of the Wild of Tekoa, Washington; and the Umatilla Native Plant Nursery of the Confederated Tribes of the Umatilla Indian Reservation in Umatilla, Oregon. In November 1998, 45,000 bare-root sagebrush were provided by Lucky Peak; 25,000 tubeling sagebrush were provided by Plants of the Wild; and an additional 3,800 bare-root seedlings were provided by the Umatilla Native Plant Nursery.

Five areas on the ALE Reserve were selected for habitat enhancement with planting of the sagebrush seedlings (Figure 7). The plots planted were primarily on the north facing slopes of draws, areas dominated by cheatgrass, areas of mixed cheatgrass/bunchgrasses, and pure bunchgrass communities. The intent was to take advantage of the more favorable soil moisture conditions that exist in these areas. Sagebrush seedlings were planted by four workers from C&N Forestry of Coeur d'Alene, Idaho, at a rate of 9,600 plants per day. They were planted in rows, with individuals spaced approximately 3.4 m apart.

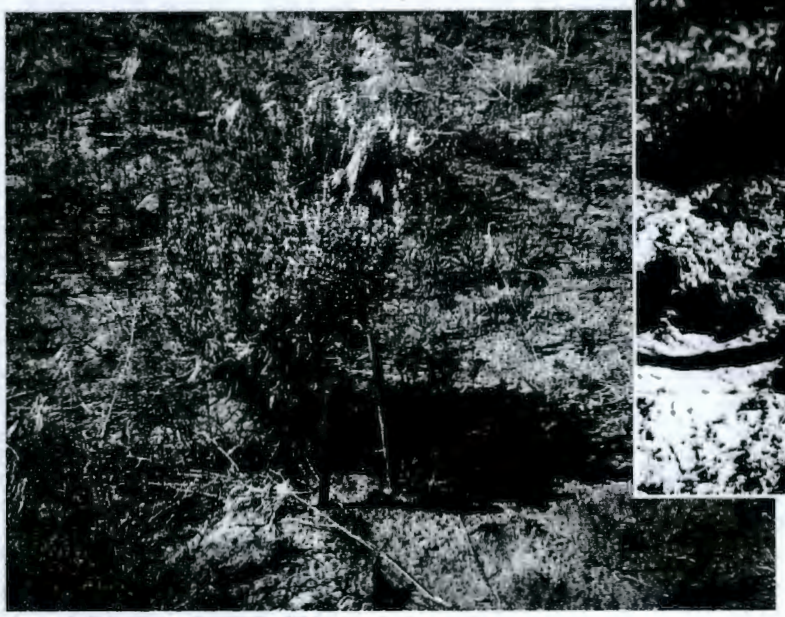
Sagebrush survival was assessed in February and March 1999 to obtain an initial estimate of survival before the stresses of summer drought. Representative plots of each area were selected, and 100 plants (dead and alive) were marked with small stakes so they could be located in future counts. Survival of sagebrush was assessed at one plot in Area 1, five plots in Area 2, five plots in Area 3, and five plots in Area 5. A plant was considered alive if any portion of it was green.

Figure 7. Environmental Restoration Disposal Facility Sagebrush Mitigation Areas.

Planting Sagebrush on the ALE – November 1998



Burned Stake and Sagebrush – July 2000



Area 5 Sagebrush– July 2001

On June 27, 2000, a wildfire was started from an automobile accident along Highway 24, which borders the north end of the ALE Reserve. The fire spread south and east consuming an estimated 66,371 ha (164,000 acres) covering all of the ALE Reserve and a large portion of the southwestern section of Hanford Site proper (Figure 1). Only small islands of vegetation on the ALE Reserve were spared. Surveys of the areas indicate that all of the plots in Areas 1 through 4 were burned in the fire. Portions of Area 5 escaped the fire or burned with low intensity, and some shrubs have survived.

Area 5 is located along a road running north from Rattlesnake Springs, in a region burned by a lightning-caused fire in the summer of 1997. Area 5 consisted of eight 4-ha (10-acre) plots and one 2-ha (5-acre) plot planted with alternating bare-root and tubeling sagebrush. Plot 5-8 was planted with bare-root seedlings from the Umatilla Native Plant Nursery.

In December 1999, an additional 250 sagebrush tubelings received from the Umatilla Native Plant Nursery were planted in Area 5, plot 8, to help compensate for the low survival rates of the previously planted seedlings. These plants were lost in the 2000 fire and will not be monitored in subsequent years.

The sagebrush within the areas of plot 5 were monitored on July 16, 2001 to estimate survival and determine which areas the June 2000 fire spared. The fire consumed more plants than originally thought, contributing to significantly lower sagebrush survival than the 2000 survey (Table 3). Area 5-2T had 7.8% survival, down from 60.9%; area 5-4B survival was 14.3%, down from 80.6%; and Area 5-9B had no live plants within the monitoring plot. However, unburned sagebrush observed adjacent to the monitoring plot at 5-2T averaged 15 cm to 46 cm tall with flower buds on about half of the plants seen.

6.0 100-B/C AREA

6.1 116-C-1

The 116-C-1 site was remediated as a part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) Remedial Action Project for the 100-B/C Area (EPA 1995). Revegetation of the 116-C-1 site was conducted as a demonstration project to evaluate the effects of two different soil types and supplemental irrigation on revegetation success with native species. The revegetation effort was also to stabilize the soils and initiate establishment of native vegetation.

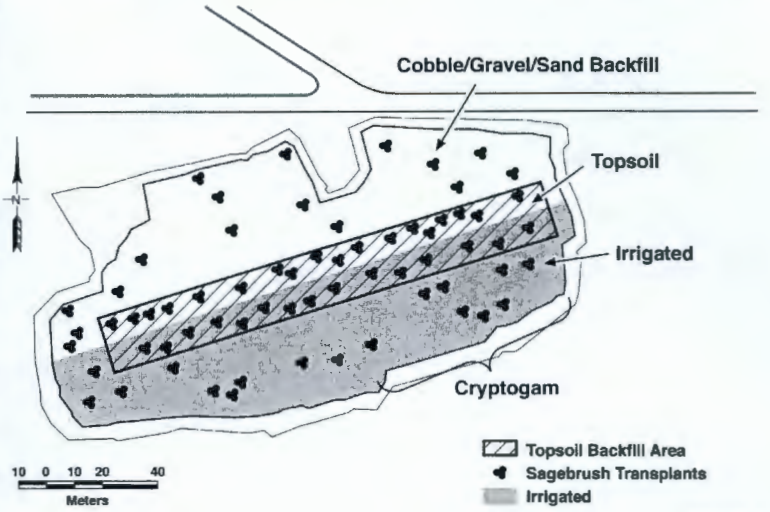
Four treatments were used on the remediated site. The backfill material used for remediation was a coarse assortment of cobble, gravel, and sand from a nearby borrow pit and served as the planting medium for two of the four treatments. The cobble backfill material is representative of naturally occurring soils that were deposited as the Columbia River changed course over time, and is similar to backfill material used on other sites. The other two treatments used topsoil grubbed from the ERDF excavation in the summer of 1995. On November 5, 1998, a seed mix of native species was planted across four treatments (Weiss and Kemp 1998): irrigated cobble, irrigated topsoil, non-irrigated topsoil, and non-irrigated cobble (Figure 8).

Figure 8. Soil and Irrigation Treatments on the 116-C-1 Site.

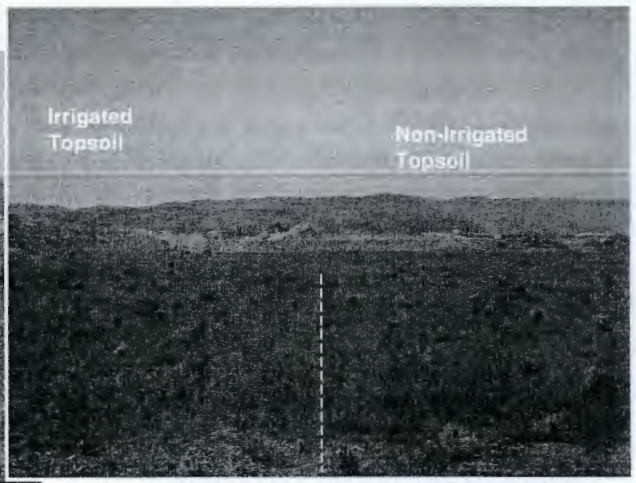
Non-irrigated Cobble – May 2001

Soil Preparation

Bunchgrasses – April 2000



Irrigated Cobble – May 2001



Irrigated and Non-irrigated Topsoil Treatments – May 2001

Sandberg's bluegrass (11.2 kg/ha), Indian ricegrass (2.2 kg/ha), and sagebrush (1.1 kg/ha) were planted using a range drill. Snow buckwheat (0.56 kg/ha), Carey's balsamroot (0.56 kg/ha), yarrow (0.28 kg/ha), needle-and-thread grass (1.1 kg/ha), and additional Indian ricegrass (0.28 kg/ha) were planted using a hand-broadcast seeder. Cryptobiotic soil/dust (9.1 kg) was also hand-cast over the eastern half of the site to inoculate the soil surface and evaluate if it would stimulate the growth of this important soil component. Wheat straw mulch was applied at the rate of 6.7 metric tons per hectare, then crimped. Following the crimping, 201 sagebrush tubelings were planted in groups of three across the four treatments. Irrigation was applied to one-half of the cobble substrate and one-half of the topsoil substrate from March 15 to June 4, 1999.

The second year of irrigation was initiated on May 11, 2000, and continued through June 26, 2000. The water was applied in 30,283-L (8,000-gal) increments with applications equivalent to just over 5 cm/ha (2 in./acre), to one-half of the cobble substrate, and one-half of the topsoil substrate (Table 6). That concluded the final irrigation application to this site.

Table 6. Precipitation and Irrigation Received at the 116-C-1 Site.

Month	Water (inches)				
	Irrigation 1999	Monthly Rainfall 1999	Irrigation 2000	Monthly Rainfall 2000	Monthly Rainfall 2001
March	0.37	0.06	0	0.94	0.67
April	0.83	Trace	0	0.57	0.83
May	0.67	0.34	0.98	0.77	0.08
June	0.44	0.31	1.18	0.25	1.27
Total	**2.31**	**0.71**	**2.16**	**2.53**	**2.85**

In May 2001, 35 plant species were identified on the 116-C-1 site, 12 more species than identified in the 2000 survey. Species diversity remains highest on the irrigated and non-irrigated cobble treatments with 24 and 22 species, respectively, while the topsoil treatments had 17 species (Table 7). Canopy cover remained greatest on the non-irrigated and irrigated topsoil treatments with 87.1% and 86.7% (Table 8). However, these treatments are dominated by cheatgrass with 65.2% and 54.9% cover, followed by Sandberg's bluegrass, which has the next highest dominance across all treatments. Sagebrush survival was highest on the non-irrigated and irrigated cobble treatments with 95.5% and 91.7%, followed by irrigated and non-irrigated topsoil treatments with 68.4% and 64.3%, respectively (Table 3). This survival is still within the acceptable rates for a planting effort.

Table 7. Percent Frequency of Occurrence on the 116-C-1 Site in 2001.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irrigated Topsoil	Non-Irrigated Cobble
*Bromus tectorum** (cheatgrass)	92	100	100	88
*Salsola kali** (Russian thistle)	48	24	12	40
Poa sandbergii (Sandberg's bluegrass)	84	80	84	56
Stipa comata (needle-and-thread grass)	12	X	X	4
*Triticum spp.** (wheat)	--	--	--	X
Achillea millefolium (yarrow)	X	X	X	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	X	4	--
Artemisia tridentata (big sagebrush)	4	--	4	4
Chrysothamnus nauseosus (gray rabbitbrush)	60	16	X	16
Descurainia pinnata (western tansymustard)	--	4	24	4
Epilobium paniculatum (tall willowherb)	X	--	--	--
Eriogonum niveum (snow buckwheat)	4	--	X	4
*Erodium cicutarium** (storksbill)	4	--	--	X
*Lactuca serriola** (prickly lettuce)	--	X	--	X
Oryzopsis hymenoides (Indian ricegrass)	32	X	X	32
*Sisymbrium altissimum** (tumblemustard)	8	44	68	--
*Tragopogon dubius** (yellow salsify)	X	--	--	4
Machaeranthera canescens (hoary aster)	X	--	--	X
Astragalus caricinus (buckwheat milkvetch)	X	X	--	--
*Poa bulbosa** (bulbous bluegrass)	--	--	--	X
*Centaurea diffusa** (diffuse knapweed)	X	X	--	X
Balsamorhiza careyana (Carey's balsamroot)	X	X	--	4
Sporobolus cryptandrus (sand dropseed)	4	--	--	4
Erigeron poliospermus (cushion fleabane)	--	--	--	X
Erigeron piperianus (Piper's daisy)	--	--	--	X
*Agropyron cristatum** (crested wheatgrass)	X	X	4	X
Oenothera pallida (evening primrose)	X	X	X	X
Ambrosia acanthicarpa (bur ragweed)	X	--	--	--
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--	--	--
Agastache occidentalis (western horsemint)	X	--	--	--
Sphaeralcea munroana (Munro's globemallow)	X	--	--	--
*Descurainia sophia** (flixweed)	--	X	--	--
*Holosteum umbellatum** (jagged chickweed)	--	--	4	--
Mentzelia albicaulis (whitestem stickleaf)	--	--	X	--
Agoseris heterophylla (mountain dandelion)	--	--	X	--
Bare soil	92	84	88	96
Litter	100	100	100	100

* Introduced species.
X = Present but not counted in plot frames.
-- = Not present onsite.

Table 8. Percent Canopy Cover on the 116-C-1 Site in 2001.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irrigated Topsoil	Non-Irrigated Cobble
*Bromus tectorum** (cheatgrass)	14.2	54.9	65.2	11.8
*Salsola kali** (Russian thistle)	1.2	0.6	0.3	1
Poa sandbergii (Sandberg's bluegrass)	9.9	26.3	13.6	7.2
Stipa comata (needle-and-thread grass)	0.3	X	X	0.1
*Triticum spp.** (wheat)	--	--	--	X
Achillea millefolium (yarrow)	X	X	X	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	X	0.1	--
Artemisia tridentata (big sagebrush)	0.6	--	0.1	0.1
Chrysothamnus nauseosus (gray rabbitbrush)	5.4	3.2	X	0.4
Descurainia pinnata (western tansymustard)	--	0.1	2.1	0.1
Epilobium paniculatum (tall willowherb)	X	--	--	--
Eriogonum niveum (snow buckwheat)	0.1	--	X	0.1
*Erodium cicutarium** (storksbill)	0.1	--	--	X
*Lactuca serriola** (prickly lettuce)	--	X	--	X
Oryzopsis hymenoides (Indian ricegrass)	0.8	X	X	3.6
*Sisymbrium altissimum** (tumblemustard)	0.2	1.6	5.5	--
*Tragopogon dubius** (yellow salsify)	X	--	--	0.1
Machaeranthera canescens (hoary aster)	X	--	--	X
Astragalus caricinus (buckwheat milkvetch)	X	X	--	--
*Poa bulbosa** (bulbous bluegrass)	--	--	--	X
*Centaurea diffusa** (diffuse knapweed)	X	X	--	X
Balsamorhiza careyana (Carey's balsamroot)	X	X	--	0.1
Sporobolus cryptandrus (sand dropseed)	0.1	--	--	0.1
Erigeron poliospermus (cushion fleabane)	--	--	--	X
Erigeron piperianus (Piper's daisy)	--	--	--	X
*Agropyron cristatum** (crested wheatgrass)	X	X	0.1	X
Oenothera pallida (evening primrose)	X	X	X	X
Ambrosia acanthicarpa (bur ragweed)	X	--	--	--
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--	--	--
Agastache occidentalis (western horsemint)	X	--	--	--
Sphaeralcea munroana (Munro's globemallow)	X	--	--	--
*Descurainia sophia** (flixweed)	--	X	--	--
*Holosteum umbellatum** (jagged chickweed)	--	--	0.1	--
Mentzelia albicaulis (whitestem stickleaf)	--	--	X	--
Agoseris heterophylla (mountain dandelion)	--	--	X	--
Bare soil	48.8	11.7	15.6	44.3
Litter	51.5	85.6	78.4	48
Total cover (does not include bare soil or litter)	**32.9**	**86.7**	**87.1**	**24.7**

* Introduced species.
X = Present but not counted in plot frames.
-- = Not present onsite.

6.2 116-B-1, 116-B-11, AND 116-C-5 REVEGETATION SITES

The 116-B-1, 116-B-11, and 116-C-5 sites were also remediated as part of the CERCLA Remedial Action Project for the 100-B/C Area (EPA 1995). Revegetation of these three waste sites was performed December 6 through 9, 1999. The objective of revegetation at these sites is to stabilize the soils and establish a plant community dominated by native species while minimizing the influence of introduced species within the community.

The material used to backfill the remediated wastes sites was excavated from the nearby borrow Pit 24. The backfill material is representative of naturally occurring soils in the area and consists of rocky sand and gravel. The top horizon of the remediated sites is backfill material excavated from subsoil horizons in the pit, which was very nutrient deficient. To compensate, three fertilizer treatments were applied on the backfilled sites to evaluate the practical application of fertilizer formulas in native revegetation establishment.

On the southern half of the 116-B-11 site, a mixture of micronutrient fertilizer containing sulfur (22.36%), soluble pot ash (1.6%), nitrogen (1.24%), magnesium (0.08%), zinc (0.24%), and boron (0.04%) was applied at a rate of 112 kg/ha. The northern half of 116-B-11 received triple-16 (16% each of nitrogen, phosphorous, and potassium) fertilizer applied at a rate of 112 kg/ha. The 116-C-5 site received a combination of triple-16 and micronutrient fertilizers applied to the entire site at a rate of 112 kg/ha each. As a control site, no fertilizer was applied to the 116-B-1 site (Figure 9).

A native seed mixture was broadcast with a hydroseeder across all sites. The seed mixture and seeding rates included Sandberg's bluegrass (22.4 kg/ha), needle-and-thread grass (2.24 kg/ha), sagebrush (1.12 kg/ha), snow buckwheat (1.12 kg/ha), Carey's balsamroot (1.12 kg/ha), and yarrow (0.28 kg/ha). Small amounts of cushion fleabane (*Erigeron poliospermus*) and Piper's daisy (*Erigeron piperianus*) were also mixed in the hydroseeder and applied to the 116-C-5 site, but due to the small size and amount of seed, the quantities were not measurable. Following the seeding, grass straw mulch was applied across all sites at a rate of 4.5 metric tons per hectare (Figure 10).

The sites were irrigated with 0.62 cm/ha (1/10 in./ac) of water. Half of the water was applied through the hydroseeder during the application of the seed and fertilizer mix. The remaining irrigation was applied after the distribution of the grass straw mulch.

In December 2000, 2,600 sagebrush tubelings were planted across the sites. Due to the rocky backfill, holes were augured into the ground and then filled with moist sand with each tubeling planted in the center of the sand.

Second year vegetation surveys were conducted in June 2001. Twenty-eight species were observed on the sites, 14 of which were native (Table 9), including all eight of the planted species. Species diversity and canopy cover remains highest on the 116-C-5 site, which received a combination of triple-16 and micronutrient fertilizers with 47.5% cover and 26 species (Table 10), followed by the northern half of 116-B-11, which received only triple-16 fertilizer

Figure 9. Fertilizer Treatments.

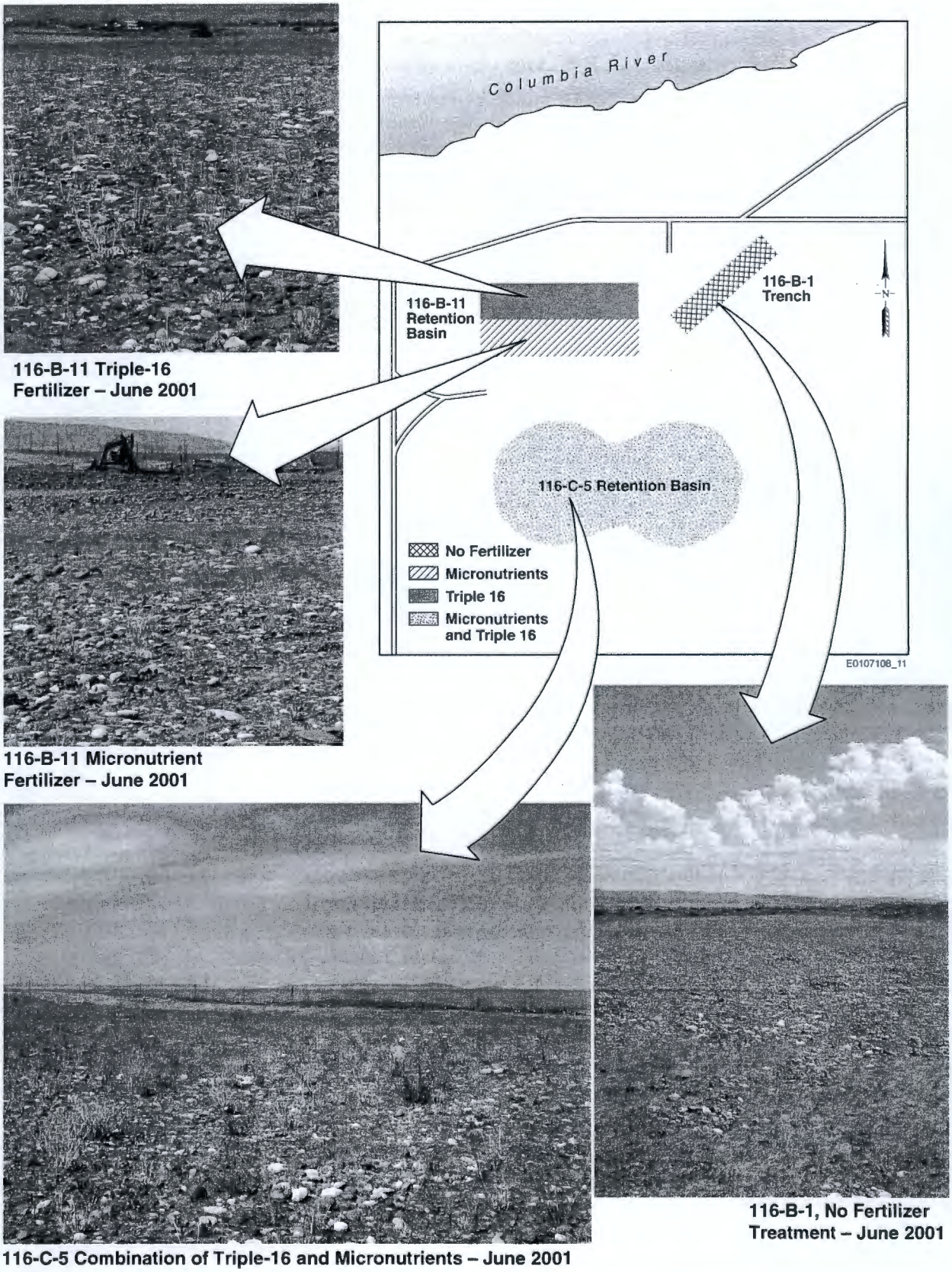


Table 9. Percent Canopy Cover on 100-B/C Revegetation Sites in 2001.

Species	116-C-5	116-B-11 (16-16-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	34.5	24.8	17.4	6.9
Eriogonum niveum (snow buckwheat)	1.6	2.7	1.4	2.1
*Salsola kali** (Russian thistle)	1.1	1.2	1.7	1.3
Achillea millefolium (yarrow)	1.8	0.1	0.1	0.1
*Sisymbrium altissimum** (tumblemustard)	0.1	X	X	X
Descurainia pinnata (western tansymustard)	0.9	X	0.4	0.1
*Centaurea diffusa** (diffuse knapweed)	X	X	--	X
Artemisia tridentata (big sagebrush)	0.5	0.6	0.1	0.1
Chrysothamnus nauseosus (gray rabbitbrush)	0.5	0.3	0.1	0.2
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--	--	0.1
Balsamorhiza careyana (Carey's balsamroot)	X	0.1	0.1	X
*Bromus tectorum** (cheatgrass)	0.5	1.2	1.2	4.2
*Lactuca serriola** (prickly lettuce)	X	0.2	X	X
Machaeranthera canescens (hoary aster)	X	X	X	X
Epilobium paniculatum (tall willowherb)	0.1	0.1	0.2	0.1
*Poa bulbosa** (bulbous bluegrass)	1.6	X	--	0.1
Draba verna (spring whitlow)	--	--	--	--
*Medicago sativa** (alfalfa)	X	X	X	X
Agropyron dasytachyum (thickspike wheatgrass)	4.0	3.1	3.6	3.9
Stipa comata (needle-and-thread grass)	0.4	0.1	0.2	0.1
*Tragopogon dubius** (yellow salsify)	0.1	X	X	--
Erigeron poliospermus (cushion fleabane)	0.1	X	--	--
Erigeron piperianus (piper's daisy)	X	--	--	--
*Holosteum umbellatum** (jagged chickweed)	X	--	--	--
*Vulpia myuros** (rattail fescue)	0.1	--	--	--
*Daucus spp.** (carrot)	X	--	--	--
*Hordeum leporinum** (hare barley)	X	--	--	--
*Agropyron cristatum** (crested wheatgrass)	--	0.8	X	--
Ambrosia acanthicarpa (bur ragweed)	--	--	--	--
*Erodium cicutarium** (storksbill)	--	--	--	X
Bare soil	63.0	49.8	41.3	73.2
Litter	35.7	43.1	43.5	22.1
Total cover (does not include bare soil or litter)	**47.5**	**35.3**	**26.5**	**19.3**

* Introduced species.
X = Present but not counted in plot frames.
-- = Not present onsite.

Table 10. Percent Frequency of Occurrence on 100-B/C Revegetation Sites in 2001.

Species	116-C-5	116-B-11 (16-16-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	92	96	92	68
Eriogonum niveum (snow buckwheat)	32	48	36	24
*Salsola kali** (Russian thistle)	44	48	68	52
Achillea millefolium (yarrow)	22	4	4	4
*Sisymbrium altissimum** (tumblemustard)	2	X	X	X
Descurainia pinnata (western tansymustard)	34	X	16	4
*Centaurea diffusa** (diffuse knapweed)	X	X	--	X
Artemisia tridentata (big sagebrush)	10	24	4	4
Chrysothamnus nauseosus (gray rabbitbrush)	8	12	4	8
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--	--	4
Balsamorhiza careyana (Carey's balsamroot)	X	4	4	X
*Bromus tectorum** (cheatgrass)	20	28	28	72
*Lactuca serriola** (prickly lettuce)	X	8	X	X
Machaeranthera canescens (hoary aster)	X	X	X	X
Epilobium paniculatum (tall willowherb)	2	4	8	4
*Poa bulbosa** (bulbous bluegrass)	16	X	--	4
*Medicago sativa** (alfalfa)	X	X	X	X
Agropyron dasytachyum (thickspike wheatgrass)	42	44	64	24
Stipa comata (needle-and-thread grass)	6	4	8	4
*Tragopogon dubius** (yellow salsify)	4	X	X	--
Erigeron poliospermus (cushion fleabane)	2	X	--	--
Erigeron piperianus (piper's daisy)	X	--	--	--
*Holosteum umbellatum** (jagged chickweed)	X	--	--	--
*Vulpia myuros** (rattail fescue)	2	--	--	--
*Daucus spp.** (carrot)	X	--	--	--
*Hordeum leporinum** (hare barley)	X	--	--	--
*Agropyron cristatum** (crested wheatgrass)	--	12	X	--
*Erodium cicutarium** (storksbill)	--	--	--	X
Bare soil	96	96	92	96
Litter	98	92	92	72

* Introduced species.
X = Present but not counted in plot frames.
-- = Not present onsite.

Figure 10. Aerial View of 100-B/C Sites.

Hydroseeding 116-C-5 – December 1999

Mulching 116-C-5 – December 1999

Auguring Holes to Plant Sagebrush – December 2000

Moist Sand to Plant Sagebrush into – December 2000

with 35.3% cover and 21 species. All three fertilizer treatment areas had a significant increase in canopy cover. The 116-B-1 site received no fertilizer and had a decrease in cover from 30.2% to 19.3%. This decrease in canopy cover at 116-B-1 is due to a reduction in tansymustard (*Descurania spp.)* from 10.3% in 2000 to 0.1% this year.

Sagebrush survival was estimated on August 1, 2001 within a representative plot on the 116-C-5 site containing 105 sagebrush plants marked with bamboo stakes. Survival remains high for the transplanted sagebrush; however, survival estimates gathered after an entire growing season will better indicate future survival. Therefore, this year's survival estimate of 99% should be used as a baseline for future counts since these plants have not been through an entire growing season.

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APPENDIX A

2000 REVEGETATION MONITORING RESULTS

APPENDIX A

2000 REVEGETATION MONITORING RESULTS

Table A-1. Percent Canopy Cover on Horseshoe Landfill in 2000.

Species	Waste Site	Reference Site
*Bromus tectorum** (cheatgrass)	29.8	33.8
Artemisia tridentata (big sagebrush)	22.4	13.7
Agropyron spicatum (bluebunch wheatgrass)	4.3	6.4
Poa sandbergii (Sandberg's bluegrass)	13.8	51.1
*Poa bulbosa** (bulbous bluegrass)	0.4	--
Festuca octoflora (six-weeks fescue)	2.5	2.4
Oryzopsis hymenoides (Indian ricegrass)	0.6	1.3
*Sisymbrium altissimum** (tumblemustard)	0.3	0.6
*Melilotus officinalis** (sweetclover)	0.6	--
Epilobium paniculatum (tall willowherb)	0.2	X
*Lactuca serriola** (prickly lettuce)	0.4	--
Crepis atrabarba (slender hawksbeard)	0.5	2.9
*Salsola kali** (Russian thistle)	X	X
Descurainia pinnata (western tansymustard)	0.3	--
Erigeron filifolius (threadleaf fleabane)	0.1	0.9
*Lepidium perfoliatum** (clasping pepperweed)	X	--
Lupinus sulphureus (sulfur lupine)	0.5	1.9
Lupinus leucophyllus (velvet lupine)	X	--
*Tragopogon dubius** (yellow salsify)	0.1	--
Lomatium grayi (Gray's desertparsley)	--	X
Plantago patagonica (Indian wheat)	X	0.1
Phlox longifolia (longleaf phlox)	X	--
*Holosteum umbellatum** (jagged whitlow)	2.4	3
Achillea millefolium (yarrow)	0.7	0.1
Sitanion hystrix (bottlebrush squirreltail)	0.8	--
Calochortus macrocarpus (sagebrush mariposa lily)	0.1	0.6
Agoseris heterophylla (annual mountain dandelion)	0.1	--
*Erodium cicutarium** (storksbill)	0.1	--
Amsinckia lycopsoides (tarweed fiddleneck)	0.1	0.1
Lomatium macrocarpum (bigseed desertparsley)	0.1	0.3
Draba verna (spring whitlow)	--	11.8
Chrysothamnus viscidiflorus (green rabbitbrush)	0.1	--
Chrysothamnus nauseosus (gray rabbitbrush)	X	0.6
Linum perenne (wild blueflax)	0.1	0.1
Machaeranthera canescens (hoary aster)	X	--
Balsamorhiza careyana (Carey's balsamroot)	X	X
Chaenactis douglasii (hoary falseyarrow)	X	--
Helianthus cusickii (Cusick's sunflower)	X	X
Astragalus caricinus (buckwheat milkvetch)	X	--
Antennaria unbrinella (umber pussytoes)	X	X
*Agropyron cristatum** (crested wheatgrass)	--	X
Biotic crust	68.5	86.6
Bare soil	28.9	12.2
Litter	66.1	76.4
Total cover (does not include biotic crust, bare soil, or litter)	**81.4**	**131.7**

* Introduced species.
X = Present but not counted in the plot frames.
-- = Not occurring on site.

Appendix A – 2000 Revegetation Monitoring Results

Table A-2. Percent Frequency of Occurrence on Horseshoe Landfill in 2000.

Species	Waste Site	Reference Site
*Bromus tectorum** (cheatgrass)	88	96
Artemisia tridentata (big sagebrush)	80	52
Agropyron spicatum (bluebunch wheatgrass)	56	28
Poa sandbergii (Sandberg's bluegrass)	92	96
*Poa bulbosa** (bulbous bluegrass)	16	--
Festuca octoflora (six-weeks fescue)	80	76
Oryzopsis hymenoides (Indian ricegrass)	4	12
*Sisymbrium altissimum** (tumblemustard)	12	24
*Melilotus officinalis** (sweetclover)	24	--
Epilobium paniculatum (tall willowherb)	8	X
*Lactuca serriola** (prickly lettuce)	16	--
Crepis atrabarba (slender hawksbeard)	20	76
*Salsola kali** (Russian thistle)	X	X
Descurainia pinnata (western tansymustard)	12	--
Erigeron filifolius (threadleaf fleabane)	4	16
*Lepidium perfoliatum** (clasping pepperweed)	X	--
Lupinus sulphureus (sulfur lupine)	24	76
Lupinus leucophyllus (velvet lupine)	X	--
*Tragopogon dubius** (yellow salsify)	4	--
Lomatium grayi (Gray's desertparsley)	--	X
Plantago patagonica (Indian wheat)	X	4
Phlox longifolia (longleaf phlox)	X	--
*Holosteum umbellatum** (jagged whitlow)	56	44
Achillea millefolium (yarrow)	8	4
Sitanion hystrix (bottlebrush squirreltail)	12	--
Calochortus macrocarpus (sagebrush mariposa lily)	4	24
Agoseris heterophylla (annual mountain dandelion)	4	--
*Erodium cicutarium** (storksbill)	4	--
Amsinckia lycopsoides (tarweed fiddleneck)	4	4
Lomatium macrocarpum (bigseed desertparsley)	4	12
Draba verna (spring whitlow)	--	56
Chrysothamnus viscidiflorus (green rabbitbrush)	4	--
Chrysothamnus nauseosus (gray rabbitbrush)	X	4
Linum perenne (wild blueflax)	4	4
Machaeranthera canescens (hoary aster)	X	--
Balsamorhiza careyana (Carey's balsamroot)	X	X
Chaenactis douglasii (hoary falseyarrow)	X	--
Helianthus cusickii (Cusick's sunflower)	X	X
Astragalus caricinus (buckwheat milkvetch)	X	--
Antennaria unbrinella (umber pussytoes)	X	X
*Agropyron cristatum** (crested wheatgrass)	--	X
Cryptobiotic crust	100	100
Bare soil	100	84
Litter	100	100

* Introduced species.
X = Present but not counted in plot frames.
-- = Not occurring on site.

Table A-3. Percent Canopy Cover and Frequency of Occurrence on 600-104 (2,4-D) Site in 2000.

Species	% Cover	% Frequency
*Bromus tectorum** (cheatgrass)	18.1	92
*Salsola kali** (Russian thistle)	2	60
*Sisymbrium altissimum** (tumblemustard)	0.3	12
Ambrosia acanthicarpa (bur ragweed)	0.6	24
Descurainia pinnata (western tansymustard)	0.1	4
Poa sandbergii (Sandberg's bluegrass)	0.9	16
Festuca octoflora (six-weeks fescue)	X	X
Rumex venosus (winged dock)	X	X
Lappula redowskii (Western stickseed)	X	X
Amsinckia lycopsoides (tarweed fiddleneck)	0.1	4
*Holosteum umbellatum** (jagged chickweed)	0.5	20
Achillea millefolium (yarrow)	5.8	24
Oenothera pallida (evening primrose)	X	X
Artemisia tridentata (big sagebrush)	X	X
Machaeranthera canescens (hoary aster)	X	X
Phlox longifolia (longleaf phlox)	1.2	8
Astragalus caricinus (buckwheat milkvetch)	X	X
Astragalus sclerocarpus (stalked-pod milkvetch)	X	X
Chrysothamnus viscidiflorus (green rabbitbrush)	X	X
Chrysothamnus nauseosus (gray rabbitbrush)	X	X
Collomia linearis (narrowleaf collomia)	X	X
Phacelia hastata (whiteleaf scorpionweed)	X	X
Bare soil	59.4	100
Litter	25.7	100
Total cover (does not include bare soil or litter)	**29.7**	

* Introduced species.
X = Present but not counted in plot frames.

Table A-4. Percent Canopy Cover and Frequency of Occurrence on the 316-5 Process Trenches in 2000.

Species	% Cover	% Frequency
*Triticum spp.** (wheat)	X	X
*Bromus tectorum** (cheatgrass)	14.4	76
*Salsola kali** (Russian thistle)	6.7	72
Ambrosia acanthicarpa (bur ragweed)	0.2	8
Microsteris gracilis (annual phlox)	0.4	16
*Holosteum umbellatum** (jagged chickweed)	15.3	80
Draba verna (spring whitlow)	6.6	36
Lactuca serriola (prickly lettuce)	0.2	8
Amsinckia lycopsoides (tarweed fiddleneck)	3	44
*Sisymbrium altissimum** (tumblemustard)	1.2	28
*Erodium cicutarium** (storksbill)	4.8	76
Machaeranthera canescens (hoary aster)	0.1	4
Plantago patagonica (Indian wheat)	0.2	8
*Melilotus alba** (sweetclover)	X	X
Psoralea lanceolata (dune scurfpea)	X	X
*Agropyron cristatum** (crested wheatgrass)	5	64
Epilobium paniculatum (tall willowherb)	0.1	4
Phacelia hastata (whiteleaf scorpionweed)	0.1	4
Poa sandbergii (Sandberg's bluegrass)	X	X
Eriogonum niveum (snow buckwheat)	X	X
Oenothera pallida (evening primrose)	X	X
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	4
Descurainia pinnata (western tansymustard)	0.1	4
*Poa bulbosa** (bulbous bluegrass)	X	X
Brodiaea howellii (Howell's clusterlily)	X	X
Layia grandulosa (white-daisy tidytips)	X	X
Astragalus caricinus (buckwheat milkvetch)	X	X
*Centaurea diffusa** (diffuse knapweed)	X	X
Agoseris heterophylla (annual mountain dandelion)	X	X
Bare Soil	38.6	100
Litter	49.5	100
Total (does not include bare soil or litter)	**58.5**	

* Introduced species.
X = Present but not counted in plot frames.

Table A-5. Percent Canopy Cover on the 116-C-1 Site in 2000.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irr. Topsoil	Non-Irr. Cobble
*Bromus tectorum** (cheatgrass)	2.2	38.2	47.7	6.1
*Salsola kali** (Russian thistle)	0.7	0.6	1.1	1
Poa sandbergii (Sandberg's bluegrass)	6.8	24.7	13.9	2.4
Stipa comata (needle-and-thread grass)	0.3	--	--	--
*Triticum spp.** (wheat)	0.1	X	X	0.3
Achillea millefolium (yarrow)	--	X	--	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	X	X	X
Artemisia tridentata (big sagebrush)	X	--	--	--
Chrysothamnus nauseosus (gray rabbitbrush)	--	0.1	X	0.2
Descurainia pinnata (western tansymustard)	--	0.1	0.9	0.1
Epilobium paniculatum (tall willowherb)	--	--	--	X
Eriogonum niveum (snow buckwheat)	1.2	X	--	X
*Erodium cicutarium** (storksbill)	--	--	--	X
*Lactuca serriola** (prickly lettuce)	X	--	--	X
Oryzopsis hymenoides (Indian ricegrass)	X	0.1	X	1.5
*Sisymbrium altissimum** (tumblemustard)	0.3	3	3.6	0.3
*Tragopogon dubius** (yellow salsify)	X	X	X	X
Machaeranthera canescens (hoary aster)	0.1	--	--	X
Astragalus caricinus (buckwheat milkvetch)	X	--	--	--
Layia grandulosa (white-daisy tidytips)	--	--	X	X
*Poa bulbosa** (bulbous bluegrass)	--	--	--	X
Centaurea diffusa (diffuse knapweed)	X	X	--	X
*Medicago sativa** (alfalfa)	X	--	--	--
Bare soil	34.4	35.4	34.8	35.2
Litter	62.2	61.6	63.5	65
Total cover (does not include bare soil or litter)	**11.7**	**66.8**	**67.2**	**11.9**

* Introduced species.
X = Present but not counted in plot frames.
-- = Not present on site.

Table A-6. Percent Frequency of Occurrence on the 116-C-1 Site in 2000.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irr. Topsoil	Non-Irr. Cobble
*Bromus tectorum** (cheatgrass)	68	96	100	72
*Salsola kali** (Russian thistle)	28	24	44	40
Poa sandbergii (Sandberg's bluegrass)	92	88	80	76
Stipa comata (needle-and-thread grass)	12	--	--	--
*Triticum spp.** (wheat)	4	X	X	12
Achillea millefolium (yarrow)	--	X	--	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	X	X	X
Artemisia tridentata (big sagebrush)	X	--	--	--
Chrysothamnus nauseosus (gray rabbitbrush)	--	4	X	8
Descurainia pinnata (western tansymustard)	--	4	16	4
Epilobium paniculatum (tall willowherb)	--	--	--	X
Eriogonum niveum (snow buckwheat)	8	X	--	X
*Erodium cicutarium** (storksbill)	--	--	--	X
*Lactuca serriola** (prickly lettuce)	X	--	--	X
Oryzopsis hymenoides (Indian ricegrass)	X	4	X	20
*Sisymbrium altissimum** (tumblemustard)	12	64	64	12
*Tragopogon dubius** (yellow salsify)	X	X	X	X
Machaeranthera canescens (hoary aster)	4	--	--	X
Astragalus caricinus (buckwheat milkvetch)	X	--	--	--
Layia grandulosa (white-daisy tidytips)	--	--	X	X
*Poa bulbosa** (bulbous bluegrass)	--	--	--	X
Centaurea diffusa (diffuse knapweed)	X	X	--	X
*Medicago sativa** (alfalfa)	X	--	--	--
Bare soil	100	100	100	100
Litter	100	100	100	100

* Introduced species.
X = Present but not counted in plot frames.
-- = Not present on site.

Appendix A – 2000 Revegetation Monitoring Results

Table A-7. Percent Canopy Cover on 100-B/C Revegetation Sites in 2000.

Species	116-C-5	116-B-11 (16-16-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	11.9	9	5.7	3.3
Eriogonum niveum (snow buckwheat)	0.55	0.3	X	0.3
*Salsola kali** (Russian thistle)	1	2	0.8	2
Achillea millefolium (yarrow)	1.6	0.8	0.4	X
*Sisymbrium altissimum** (tumblemustard)	1	0.3	0.3	1.1
Descurainia pinnata (western tansymustard)	7.6	4.7	4	10.3
*Centaurea diffusa** (diffuse knapweed)	0.05	X	--	--
Artemisia tridentata (big sagebrush)	0.15	0.4	0.1	1.6
Chrysothamnus nauseosus (gray rabbitbrush)	0.15	0.2	--	X
Balsamorhiza careyana (Carey's balsamroot)	0.05	X	X	--
*Poa spp.** (residual from straw)	1.4	2.7	1.4	3.9
*Bromus tectorum** (cheatgrass)	X	--	0.2	7.7
Oryzopsis hymenoides (Indian ricegrass)	--	--	0.1	--
*Melilotus officinalis** (sweetclover)	X	--	--	--
*Lactuca serriola** (prickly lettuce)	X	X	X	X
Machaeranthera canescens (hoary aster)	X	--	X	--
Epilobium paniculatum (tall willowherb)	X	0.1	X	X
Microsteris gracilis (annual phlox)	X	--	--	--
*Amaranthus albus** (pigweed)	X	--	--	--
*Senecio vulgaris** (common groundsel)	X	--	--	--
Draba verna (spring whitlow)	--	X	--	--
Bare soil	52.45	50.5	41.8	60.1
Litter	46.25	46.7	55.2	37.6
Total cover (does not include bare soil or litter)	**25.45**	**20.5**	**13**	**30.2**

* Introduced species.
X = Present but not counted in plot frames.
-- = Not present on site.

Table A-8. Percent Frequency of Occurrence on 100-B/C Revegetation Sites in 2000.

Species	116-C-5	116-B-11 (16-16-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	90	84	88	76
Eriogonum niveum (snow buckwheat)	22	12	X	12
*Salsola kali** (Russian thistle)	40	40	32	60
Achillea millefolium (yarrow)	16	12	16	X
*Sisymbrium altissimum** (tumblemustard)	20	12	12	24
Descurainia pinnata (western tansymustard)	34	16	28	64
*Centaurea diffusa** (diffuse knapweed)	2	X	--	--
Artemisia tridentata (big sagebrush)	6	16	4	8
Chrysothamnus nauseosus (gray rabbitbrush)	6	8	--	X
Balsamorhiza careyana (Carey's balsamroot)	2	X	X	--
*Poa spp.** (residual from straw)	26	48	36	20
*Bromus tectorum** (cheatgrass)	X	--	8	56
Oryzopsis hymenoides (Indian ricegrass)	--	--	4	--
*Melilotus officinalis** (sweetclover)	X	--	--	--
*Lactuca serriola** (prickly lettuce)	X	X	X	X
Machaeranthera canescens (hoary aster)	X	--	X	--
Epilobium paniculatum (tall willowherb)	X	4	X	X
Microsteris gracilis (annual phlox)	X	--	--	--
*Amaranthus albus** (pigweed)	X	--	--	--
*Senecio vulgaris** (common groundsel)	X	--	--	--
*Poa bulbosa** (bulbous bluegrass)	--	--	--	--
Draba verna (spring whitlow)	--	X	--	--
Bare soil	92	88	88	84
Litter	100	100	100	100

* Introduced species.
X = Present but not counted in plot frames.
-- = Not present on site.

APPENDIX B

1999 REVEGETATION MONITORING RESULTS

APPENDIX B

1999 REVEGETATION MONITORING RESULTS

Table B-1. Percent Canopy Cover on the Horseshoe Landfill in 1999.

Species	Waste Site	Reference Site
*Bromus tectorum** (cheatgrass)	49.6	33.7
Artemisia tridentata (big sagebrush)	19.1	19
Agropyron spicatum (bluebunch wheatgrass)	8.5	2.1
Poa sandbergii (Sandberg's bluegrass)	9.8	56.7
Sitanion hystrix (bottlebrush squirreltail)	0.7	2
*Poa bulbosa** (bulbous bluegrass)	0.4	--
Festuca octoflora (six-weeks fescue)	5.9	1.9
Oryzopsis hymenoides (Indian ricegrass)	0.1	2.1
Stipa comata (needle-and-thread-grass)	--	1.5
*Sisymbrium altissimum** (tumblemustard)	4.8	1.1
*Melilotus officinalis** (sweetclover)	0.9	--
Epilobium paniculatum (tall willowherb)	1.5	0.6
*Lactuca serriola** (prickly lettuce)	1.4	0.5
Crepis atrabarba (slender hawksbeard)	0.9	3.7
*Salsola kali** (Russian thistle)	0.3	0.4
*Descurainia spp.** (tansymustard)	0.2	X
Amsinckia lycopsoides (tarweed fiddleneck)	X	--
Chaenactis douglasii (hoary false yarrow)	X	--
Erigeron filifolius (threadleaf fleabane)	0.1	0.1
Linum perenne (wild blueflax)	X	0.6
*Lepidium perfoliatum** (clasping pepperweed)	0.1	--
Lupinus leucophyllus (velvet lupine)	0.5	4
*Tragopogon dubius** (yellow salsify)	1.4	0.6
Chrysothamnus nauseosus (gray rabbitbrush)	X	--
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--
Helianthus cusickii (Cusick's sunflower)	X	X
Lomatium grayi (Gray's desertparsley)	0.1	0.7
Plantago patagonica (Indian wheat)	0.1	X
Phlox longifolia (longleaf phlox)	0.1	--
*Erodium cicutarium** (storksbill)	X	--
Biotic Crust	59.3	88.7
Bare Soil	19.9	7.9
Litter	74.8	83.6
Total cover (does not include biotic crust, bare soil or litter)	**106.5**	**131.3**

* Introduced species.
X = Present but not counted in the plot frames.
-- = Not occurring on site.

Table B-2. Percent Frequency on the Horseshoe Landfill in 1999.

Species	Waste Site	Reference Site
*Bromus tectorum** (cheatgrass)	100	100
Artemisia tridentata (big sagebrush)	76	72
Agropyron spicatum (bluebunch wheatgrass)	52	8
Poa sandbergii (Sandberg's bluegrass)	64	96
Sitanion hystrix (bottlebrush squirreltail)	8	20
*Poa bulbosa** (bulbous bluegrass)	16	--
Festuca octoflora (six-weeks fescue)	44	56
Oryzopsis hymenoides (Indian ricegrass)	4	8
Stipa comata (needle-and-thread-grass)	--	4
*Sisymbrium altissimum** (tumblemustard)	56	24
*Melilotus officinalis** (sweetclover)	36	--
Epilobium paniculatum (tall willowherb)	60	24
*Lactuca serriola** (prickly lettuce)	56	20
Crepis atrabarba (slender hawksbeard)	16	68
*Salsola kali** (Russian thistle)	12	16
*Descurainia spp.** (tansymustard)	8	X
Amsinckia lycopsoides (tarweed fiddleneck)	X	--
Chaenactis douglasii (hoary false yarrow)	X	--
Erigeron filifolius (threadleaf fleabane)	4	4
Linum perenne (wild blueflax)	X	24
*Lepidium perfoliatum** (clasping pepperweed)	4	--
Lupinus leucophyllus (velvet lupine)	20	80
*Tragopogon dubius** (yellow salsify)	56	4
Chrysothamnus nauseosus (gray rabbitbrush)	X	--
Chrysothamnus viscidiflorus (green rabbitbrush)	X	--
Helianthus cusickii (Cusick's sunflower)	X	X
Lomatium grayi (Gray's desertparsley)	4	8
Plantago patagonica (Indian wheat)	4	X
Phlox longifolia (longleaf phlox)	4	--
*Erodium cicutarium** (storksbill)	X	--
Biotic Crust	96	100
Bare Soil	96	100
Litter	96	100

* Introduced species.
X = Present but not counted in the plot frames.
-- = Not occurring on site.

Appendix B – 1999 Revegetation Monitoring Results

Table B-3. Percent Canopy Cover and Frequency of Occurrence on 600-104 (2,4-D) Site in 1999.

Species	% Cover	% Frequency
*Bromus tectorum** (cheatgrass)	20.8	96
*Salsola kali** (Russian thistle)	45.6	100
*Sisymbrium altissimum** (tumblemustard)	0.7	28
Ambrosia acanthicarpa (bur ragweed)	0.6	24
Descurainia spp. (tansymustard)	0.2	8
Poa sandbergii (Sandberg's bluegrass)	0.7	8
Festuca octoflora (six-weeks fescue)	0.5	20
Rumex venosus (winged dock)	0.2	8
Lappula redowskii (Western stickseed)	0.2	8
Amsinckia lycopsoides (tarweed fiddleneck)	0.3	12
*Holosteum umbellatum** (jagged chickweed)	0.7	28
Draba verna (spring whitlow)	0.2	8
Achillea millefolium (yarrow)	1.8	32
Oenothera pallida (evening primrose)	0.1	4
Epilobium paniculatum (tall willowherb)	0.4	16
*Lactuca serriola** (prickly lettuce)	0.6	24
Microsteris gracilis (annual phlox)	0.2	8
Artemisia tridentata (big sagebrush)	0.1	4
Machaeranthera canescens (hoary aster)	0.1	4
Phlox longifolia (longleaf phlox)	0.7	8
Eriogonum niveum (snow buckwheat)	0.1	4
Mentzelia albicaulis (whitestem stickleaf)	0.1	4
Lupinus pusillus (low lupine)	X	
Oryzopsis hymenoides (Indian ricegrass)	X	
*Poa bulbosa** (bulbous bluegrass)	X	
Balsamorhiza careyana (Carey's balsamroot)	X	
*Tragopogon dubius** (yellow salsify)	X	
Astragalus spp. (milkvetch)	X	
Chaenactis douglasii (hoary falseyarrow)	X	
Chrysothamnus viscidiflorus (green rabbitbrush)	X	
Chrysothamnus nauseosus (gray rabbitbrush)	X	
Thelypodium laciniatum (cutleaf ladyfoot mustard)	X	
Bare soil	54.8	100
Litter	25.3	100
Total cover (does not include bare soil or litter)	**74.9**	

* Introduced species.
X = Present but not counted in plot frames.

Table B-4. Percent Canopy Cover and Frequency of Occurrence on 316-5 Process Trenches in 1999.

Species	% Cover	% Frequency
*Triticum spp.** (wheat)	10	100
*Bromus tectorum** (cheatgrass)	6.25	100
*Salsola kali** (Russian thistle)	8.5	100
*Agropyron cristatum** (crested wheatgrass)	2	80
Ambrosia acanthicarpa (bur ragweed)	3	70
Microsteris gracilis (annual phlox)	0.5	20
*Holosteum umbellatum** (jagged chickweed)	2.25	90
Draba verna (spring whitlow)	1.5	60
*Lactuca serriola** (prickly lettuce)	1.5	60
Amsinckia lycopsoides (tarweed fiddleneck)	3.25	80
*Sisymbrium altissimum** (tumblemustard)	4.5	80
*Erodium cicutarium** (storksbill)	2.5	50
Machaeranthera canescens (hoary aster)	0.75	30
Plantago patagonica (Indian wheat)	1.75	70
*Melilotus alba** (sweetclover)	0.25	10
Psoralea lanceolata (dune scurfpea)	0.25	10
Epilobium paniculatum (tall willowherb)	0.25	10
Phacelia hastata (whiteleaf scorpionweed)	0.25	10
Poa sandbergii (Sandberg's bluegrass)	X	
Eriogonum niveum (snow buckwheat)	X	
Oenothera pallida (evening primrose)	X	
Biotic Crust	0	
Bare Soil	64	
Litter	22.75	
Total cover (does not include biotic crust, bare soil or litter)	**49.25**	

* Introduced species.
X = Present but not counted on plot frames.

Table B-5. Percent Canopy Cover on 116-C-1 in 1999.

Species	Irrigated Backfill	Irrigated Topsoil	Non-irrigated Topsoil	Non-irrigated Backfill
*Bromus tectorum** (cheatgrass)	0.5	19.5	11.3	0.3
*Salsola kali** (Russian thistle)	1.9	14.9	12.8	1.2
Poa sandbergii (Sandberg's bluegrass)	1.1	3.2	2.5	0.5
Stipa comata (needle-and-thread grass)	1.2	0.6	0.3	0.2
*Triticum spp.** (wheat)	2.5	4.9	5.1	1.9
Achillea millefolium (yarrow)	X	--	X	--
Agropyron spp. (wheatgrass)	X	X	X	--
Ambrosia acanthicarpa (bur ragweed)	--	0.1	0.1	X
Amsinckia lycopsoides (tarweed fiddleneck)	--	--	0.1	--
Artemisia tridentata (big sagebrush)	X	X	X	--
Balsamorhiza careyana (Carey's balsamroot)	0.1	--	--	--
Chenopodium spp. (goosefoot)	--	--	0.1	--
Chrysothamnus nauseosus (gray rabbitbrush)	0.5	0.3	0.6	X
Descurainia spp. (tansymustard)	X	2.1	0.7	X
Epilobium paniculatum (tall willowherb)	0.2	0.1	--	X
Eriogonum niveum (snow buckwheat)	X	X	X	X
*Erodium cicutarium** (storksbill)	--	--	--	X
*Holosteum umbellatum** (jagged chickweed)	--	--	X	X
*Lactuca serriola** (prickly lettuce)	X	0.1	0.1	0.1
Mentzelia albicaulis (whitestem stickleaf)	--	--	0.1	--
Oenothera pallida (evening primrose)	--	--	X	--
Oryzopsis hymenoides (Indian ricegrass)	--	X	X	--
*Sisymbrium altissimum** (tumblemustard)	X	3.6	0.1	--
*Tragopogon dubius** (yellow salsify)	--	--	0.1	0.1
Bare soil	20.5	19.4	19.1	42.3
Litter	71.8	69.9	70.9	52.6
Total cover (does not include bare soil or litter)	**8**	**49.4**	**34**	**4.3**

* Introduced species.
X = Present but not counted in plot frames.
-- = Not present on site.

Appendix B – 1999 Revegetation Monitoring Results

Table B-6. Percent Frequency of Occurrence on 116-C-1 in 1999.

Species	Irrigated Backfill	Irrigated Topsoil	Non-irrigated Topsoil	Non-irrigated Backfill
*Bromus tectorum** (cheatgrass)	20	88	68	12
*Salsola kali** (Russian thistle)	76	76	88	48
Poa sandbergii (Sandberg's bluegrass)	44	48	60	20
Stipa comata (needle-and-thread grass)	48	24	12	8
*Triticum spp.** (wheat)	80	56	64	76
Achillea millefolium (yarrow)	X	--	X	--
Agropyron spp. (wheatgrass)	X	X	X	--
Ambrosia acanthicarpa (bur ragweed)	--	4	4	X
Amsinckia lycopsoides (tarweed fiddleneck)	--	--	4	--
Artemisia tridentata (big sagebrush)	X	X	X	--
Balsamorhiza careyana (Carey's balsamroot)	4	--	--	--
Chenopodium spp. (goosefoot)	--	--	4	--
Chrysothamnus nauseosus (gray rabbitbrush)	20	12	24	X
Descurainia spp. (tansymustard)	X	24	8	X
Epilobium paniculatum (tall willowherb)	8	4	--	X
Eriogonum niveum (snow buckwheat)	X	X	X	X
*Erodium cicutarium** (storksbill)	--	--	--	X
*Holosteum umbellatum** (jagged chickweed)	--	--	X	X
*Lactuca serriola** (prickly lettuce)	X	4	4	4
Mentzelia albicaulis (whitestem stickleaf)	--	--	4	--
Oenothera pallida (evening primrose)	--	--	X	--
Oryzopsis hymenoides (Indian ricegrass)	--	X	X	--
*Sisymbrium altissimum** (tumblemustard)	--	28	4	--
*Tragopogon dubius** (yellow salsify)	--	--	4	4
Bare soil	20	72	60	96
Litter	100	100	100	100

* Introduced species.
X = Present but not counted in plot frames.
-- = Not present on site.

APPENDIX C

1998 REVEGETATION MONITORING RESULTS

APPENDIX C

1998 REVEGETATION MONITORING RESULTS

Table C-1. Percent Canopy Cover on the Horseshoe Landfill in 1998.

Species	Waste Site	Reference Site
*Bromus tectorum** (cheatgrass)	25.5	15.7
Artemisia tridentata (big sagebrush)	14.4	30.3
Agropyron spicatum (bluebunch wheatgrass)	3.4	8.2
Poa sandbergii (Sandberg's bluegrass)	9.8	36.2
Sitanion hystrix (bottlebrush squirreltail)	1	0.2
*Poa bulbosa** (bulbous bluegrass)	0.2	--
Festuca octoflora (six-weeks fescue)	1.5	1.6
Oryzopsis hymenoides (Indian ricegrass)	X	2.8
*Sisymbrium altissimum** (tumblemustard)	0.3	--
*Melilotus officinalis** (sweet clover)	10.1	--
Epilobium paniculatum (tall willowherb)	0.6	0.6
*Lactuca serriola** (prickly lettuce)	1.1	0.2
Crepis atrabarba (slender hawksbeard)	1.9	3.7
Descurainia spp. (tansymustard)	0.7	0.1
Amsinckia lycopsoides (tarweed fiddleneck)	0.1	--
Chaenactis douglasii (hoary falseyarrow)	0.1	--
Erigeron filifolius (threadleaf fleabane)	0.1	0.9
Linum perenne (wild blueflax)	0.3	0.1
*Lepidium perfoliatum** (clasping pepperweed)	1.6	--
Lupinus sulphurous (sulfur lupine)	0.6	8.8
*Tragopogon dubius** (yellow salsify)	0.2	0.3
Machaeranthera canescens (hoary aster)	0.8	0.1
Holosteum umbellatum (jagged chickweed)	2.4	0.4
Draba verna (spring whitlow)	--	3.2
Agoseris grandiflora (mountain dandelion)	0.1	--
Chrysothamnus nauseosus (gray rabbitbrush)	1.3	--
Chrysothamnus viscidiflorus (green rabbitbrush)	0.6	--
Achillea millefolium (yarrow)	X	--
Helianthus cusickii (Cusick's sunflower)	X	--
Lomatium macrocarpum (bigseed desertparsley)	X	--
Festuca idahoensis (Idaho fescue)	X	--
Bare soil	10.8	3.6
Biotic crust	2	49.1
Total cover (does not include biotic crust or bare soil)	**78.7**	**113.4**

* Introduced species.
X = Present but not counted in plot frames.
-- = Not occurring on the site.

Appendix C – 1998 Revegetation Monitoring Results

Table C-2. Percent Frequency on the Horseshoe Landfill in 1998.

Species	Waste Site	Reference Site
*Bromus tectorum** (cheatgrass)	100	76
Artemisia tridentata (big sagebrush)	64	76
Agropyron spicatum (bluebunch wheatgrass)	36	24
Poa sandbergii (Sandberg's bluegrass)	64	100
Sitanion hystrix (bottlebrush squirreltail)	20	8
*Poa bulbosa** (bulbous bluegrass)	8	--
Festuca octoflora (six-weeks fescue)	40	44
Oryzopsis hymenoides (Indian ricegrass)	--	16
*Sisymbrium altissimum** (tumblemustard)	12	--
*Melilotus officinalis** (sweet clover)	56	--
Epilobium paniculatum (tall willowherb)	24	24
*Lactuca serriola** (prickly lettuce)	44	8
Crepis atrabarba (slender hawksbeard)	16	68
Descurainia spp. (tansymustard)	28	4
Amsinckia lycopsoides (tarweed fiddleneck)	4	--
Chaenactis douglasii (hoary falseyarrow)	4	--
Erigeron filifolius (threadleaf fleabane)	4	16
Linum perenne (wild blueflax)	12	4
*Lepidium perfoliatum** (clasping pepperweed)	8	--
Lupinus sulphurous (sulfur lupine)	24	80
*Tragopogon dubius** (yellow salsify)	8	12
Machaeranthera canescens (hoary aster)	32	4
*Holosteum umbellatum** (jagged chickweed)	76	16
Draba verna (spring whitlow)	--	16
Agoseris grandiflora (mountain dandelion)	4	--
Chrysothamnus nauseosus (gray rabbitbrush)	12	--
Chrysothamnus viscidiflorus (green rabbitbrush)	4	--
Bare soil	80	48
Biotic crust	40	100

* Introduced species.

X = Present but not counted in plot frames.

-- = Not occurring on the site.

Table C-3. Percent Canopy Cover and Frequency of Occurrence on 600-104 (2,4-D) Site in 1998.

Species	Percent Cover	Percent Frequency
*Bromus tectorum** (Cheatgrass)	34.7	96
*Salsola kali** (Russian thistle)	6.2	56
*Sisymbrium altissimum** (tumblemustard)	1.0	20
Ambrosia acanthicarpa (bur ragweed)	0.5	20
Descurainia spp. (tansymustard)	0.2	8
Poa sandbergii (Sandberg's Bluegrass)	2.0	40
*Poa bulbosa** (bulbous bluegrass)	0.1	4
Festuca octoflora (six-weeks fescue)	0.1	4
Rumex venosus (winged dock)	0.1	4
Lappula redowskii (Western stickseed)	0.1	4
Amsinckia lycopsoides (tarweed fiddleneck)	0.3	12
Holosteum umbellatum (jagged chickweed)	0.2	8
Draba verna (spring whitlow)	0.3	12
Plantago patagonica (Indian wheat)	0.1	4
Bare soil	81	96
Total Cover	**45.9**	

* Introduced species.

Appendix C – 1998 Revegetation Monitoring Results

APPENDIX D

1997 REVEGETATION MONITORING RESULTS

APPENDIX D

1997 REVEGETATION MONITORING RESULTS

Table D-1. Percent Canopy Cover on the Horseshoe Landfill in 1997.

Species	Waste Site	Reference Site
*Bromus tectorum** (cheatgrass)	36.1	25
Artemisia tridentata (big sagebrush)	5.5	10.1
Agropyron spicatum (bluebunch wheatgrass)	0.9	2.5
Poa sandbergii (Sandberg's bluegrass)	2.4	51.4
Sitanion hystrix (bottlebrush squirreltail)	1.1	--
Stipa comata (needle-and-thread grass)	--	0.1
*Poa bulbosa** (bulbous bluegrass)	0.1	--
Festuca octoflora (six-weeks fescue)	0.2	--
Oryzopsis hymenoides (Indian ricegrass)	0.1	0.1
*Sisymbrium altissimum** (tumblemustard)	2.2	0.1
*Melilotus officinalis** (sweet clover)	1.6	--
Epilobium paniculatum (tall willowherb)	1.6	0.1
*Lactuca serriola** (prickly lettuce)	1.8	--
Crepis atrabarba (slender hawksbeard)	0.7	4.7
*Kochia scoparia** (red belvedere)	0.1	--
*Salsola kali** (Russian thistle)	0.1	--
Descurainia spp. (tansymustard)	0.2	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	0.1
Chaenactis douglasii (hoary falseyarrow)	0.1	0.2
Erigeron filifolius (threadleaf fleabane)	0.8	1.2
Linum perenne (wild blueflax)	--	0.1
*Lepidium perfoliatum** (clasping pepperweed)	0.1	--
Lupinus sulphurous (sulfur lupine)	0.3	13.5
*Tragopogon dubius** (yellow salsify)	--	0.5
Balsamorhiza careyana (Carey's balsamroot)	--	0.1
Machaeranthera canescens (hoary aster)	2.0	--
Biotic crust	--	88.3
Total cover (does not include biotic crust)	**58**	**109.8**

* Introduced species.

-- = Not occurring on site.

Table D-2. Percent Frequency of Occurrence on the Horseshoe Landfill in 1997.

Species	Waste Site	Reference Site
*Bromus tectorum** (cheatgrass)	88	84
Artemisia tridentata (big sagebrush)	64	60
Agropyron spicatum (bluebunch wheatgrass)	36	4
Poa sandbergii (Sandberg's bluegrass)	56	92
Sitanion hystrix (bottlebrush squirreltail)	24	--
Stipa comata (needle-and-thread grass)	--	4
*Poa bulbosa** (bulbous bluegrass)	4	--
Festuca octoflora (six-weeks fescue)	8	--
Oryzopsis hymenoides (Indian ricegrass)	4	4
*Sisymbrium altissimum** (tumblemustard)	48	4
*Melilotus officinalis** (sweetclover)	64	--
Epilobium paniculatum (tall willowherb)	64	4
*Lactuca serriola** (prickly lettuce)	52	--
Crepis atrabarba (slender hawksbeard)	8	68
*Kochia scoparia** (red belvedere)	4	--
*Salsola kali** (Russian thistle)	4	--
Descurainia spp. (tansymustard)	8	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	4
Chaenactis douglasii (hoary falseyarrow)	4	8
Erigeron filifolius (threadleaf fleabane)	12	28
Linum perenne (wild blueflax)	--	4
*Lepidium perfoliatum** (clasping pepperweed)	4	--
Lupinus sulphurous (sulfur lupine)	12	76
*Tragopogon dubius** (yellow salsify)	--	20
Balsamorhiza careyana (Carey's balsamroot)	--	4
Machaeranthera canescens (hoary aster)	40	--
Biotic crust	--	96

* Introduced species.

-- = Not occurring on site.

APPENDIX E

1996 REVEGETATION MONITORING RESULTS

APPENDIX E

1996 REVEGETATION MONITORING

Table E-1. Percent Canopy Cover on the Horseshoe Landfill in 1996.

Plant Name	Percent Cover
*Melilotus officinalis** (sweetclover)	7.8
*Bromus tectorum** (cheatgrass)	7.2
Artemisia tridentata (big sagebrush)	2.8
Descurainia spp. (tansymustard)	2.7
*Sisymbrium altissimum** (tumblemustard)	2.1
Epilobium paniculatum (tall willowherb)	1.2
Agropyron spicatum (bluebunch wheatgrass)	1.1
Crepis atrabarba (slender hawksbeard)	1.0
Lupinus sulphurous (sulfur lupine)	0.7
Erigeron filifolius (threadleaf fleabane)	0.7
Linum perenne (wild blueflax)	0.7
*Lactuca serriola** (prickly lettuce)	0.6
*Salsola kali** (Russian thistle)	0.5
*Kochia scoparia** (red belvedere)	0.5
Poa sandbergii (Sandberg's bluegrass)	0.3
Sitanion hystrix (bottlebrush squirreltail)	0.3
*Lepidium perfoliatum** (clasping pepperweed)	0.2
Chenopodium leptophyllum (slimleaf goosefoot)	0.2
Amsinckia lycopsoides (tarweed fiddleneck)	0.2
Chaenactis douglasii (hoary falseyarrow)	0.2
Machaeranthera canescens (hoary aster)	0.2
Ambrosia acanthicarpa (bur ragweed)	0.1
Chrysothamnus nauseosus (gray rabbitbrush)	0.1
Total cover	**31.4**

* Introduced species.

Table E-2. Percent Frequency of Occurrence on the Horseshoe Landfill in 1996.

Plant Name	Percent Frequency
*Bromus tectorum** (cheatgrass)	92
Artemisia tridentata (big sagebrush)	52
Agropyron spicatum (bluebunch wheatgrass)	44
*Sisymbrium altissimum** (tumblemustard)	44
*Melilotis officinalis** (sweetclover)	40
Epilobium paniculatum (tall willowherb)	28
*Lactuca serriola** (prickly lettuce)	24
Crepis atrabarba (slender hawksbeard)	20
*Kochia scoparia** (red belvedere)	20
*Salsola kali** (Russian thistle)	20
Descurainia sp (tansymustard)	12
Poa sandbergii (Sandberg's bluegrass)	12
Sitanion hystrix (bottlebrush squirrel)	12
Amsinckia lycopsoides (tarweed fiddleneck)	8
Chaenactis douglasii (hoary falseyarrow)	8
Chenopodium leptophyllum (slimleaf goosefoot)	8
Erigeron filifolius (threadleaf fleabane)	8
*Lepidium perfoliatum** (clasping pepperweed)	8
Linum perenne (wild blueflax)	8
Lupinus sulphurous (sulfur lupine)	8
Machaeranthera canescens (hoary aster)	8
Ambrosia acanthicarpa (bur ragweed)	4
Chrysothamnus nauseosus (gray rabbitbrush)	4

* Introduced species.

APPENDIX F

NAME CHANGES INCLUDED IN INTEGRATED TAXONOMIC INFORMATION SYSTEM

APPENDIX F

NAME CHANGES INCLUDED IN INTEGRATED TAXONOMIC INFORMATION SYSTEM

Name changes included in Integrated Taxonomic Information System (ITIS 1998).

Recent name changes for species mentioned in this report. The first name is that used in Hitchcock and Cronquist (1973) and the second is the more recent version.

Agropyron spicatum = *Pseudoroegneria spicata ssp. spicata*
Chrysothamnus nauseosus = *Ericameria nauseosa* ssp. *nauseosa* var. *nauseosa*
Cymopterus terebinthinus = *Pteryxia terebinthina* var. *terebinthina*
Epilobium paniculatum = *Epilobium brachycarpum*
Festuca octoflora = *Vulpia octoflora* var. *octoflora*
Microsteris gracilis = *Phlox gracilis* ssp. *gracilis*
Oryzopsis hymenoides = *Achnatherum hymenoides*
Poa sandbergii = *Poa secunda*
Psoralea lanceolata = *Psoralidium lanceolatum*
Sitanion hystrix = *Elymus elymoides* ssp. *elymoides*
Stipa comata = *Hesperostipa comata* ssp. *comata*

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