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Rev. 0

2000 Environmental Restoration Contractor Revegetation Monitoring Report

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*Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Environmental Restoration*

Submitted by: Bechtel Hanford, Inc.

BHI-01406
Rev. 0

2000 Environmental Restoration Contractor Revegetation Monitoring Report

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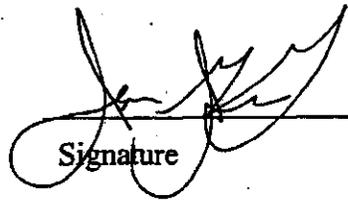
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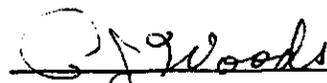
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EXECUTIVE SUMMARY

This report documents the results of revegetation monitoring conducted in early January through early May 2000. This was the fifth-year following revegetation efforts on the Horn Rapids Landfill, Horseshoe Landfill, Nike Landfills, Bridge Overlook, PSN 72/82 sites, and PSN 12/14 sites. It was the fourth year after planting sagebrush on the Saddle Mountain Wildlife Refuge (North Slope Cheatgrass Area). Typically, 3 to 5 years are required before revegetation efforts in arid regions such as the Columbia Basin begin to show signs of success. Monitoring has been conducted at these sites to ensure that the objectives of the revegetation efforts were met. The objective at the Horn Rapids Landfill was to establish a vegetative community to stabilize the soils and protect the landfill cap. At the other sites, the objectives were to stabilize the soils and initiate natural plant succession that would lead to a late seral community typical of the surrounding area. The results from monitoring efforts show that the objectives have been met and monitoring can be discontinued at these sites.

On April 25, 2000, the above-mentioned sites were toured by representatives of the U.S. Department of Energy, Richland Operations Office, the U.S. Environmental Protection Agency (EPA), and Bechtel Hanford, Inc., to assess the adequacy of the revegetation efforts and determine if the objectives had been achieved. The lead regulatory agency (the U.S. Environmental Protection Agency) agreed that the revegetation objectives had been met and that no further monitoring was required.

Third-year monitoring was conducted at the 600-104 waste site (2,4-D cleanup site), the 300-FF-1 sagebrush (*Artemisia tridentata*) and bitterbrush (*Purshia tridentata*) transplant areas,

Executive Summary

the 216-A-25 emergency extension site, and the 200-ZP-1 Injection Well Pipeline.

Second-year monitoring was conducted at the 300 Area Process Trench, the Environmental Restoration Disposal Facility (ERDF) mitigation sagebrush sites on the Arid Lands Ecology (ALE) Reserve, and the 116-C-1 restoration site. First-year monitoring was conducted at the 100-B/C revegetation sites; 116-B-1, 116-B-11, and 116-C-5.

The Horn Rapids Landfill was revegetated with crested wheatgrass (*Agropyron cristatum*) and Siberian wheatgrass (*Agropyron sibericum*) during the fall of 1995. Canopy cover of wheatgrasses has changed very little from 1998 measurements with cover ranging from 18% to 28% among plots. Frequency of occurrence for wheatgrasses was very similar across the six plots ranging from 72% to 96%. Cheatgrass (*Bromus tectorum*) appears to be lower on most plots this year with the exception of plots 4 and 6, which increased only 1% from last year. Russian thistle (*Salsola kali*) presence is nominal, averaging 0.27%, making this plant no longer a significant component to this vegetative community.

On June 27, 2000, a wildfire started as a result of an automobile accident along Highway 24, which borders the northern edge of the ALE Reserve. The fire spread south and east, consuming an estimated 66,371 hectares (164,000 acres), covering all of ALE and a large portion of the southwestern section of the Hanford Site proper. Only small islands of vegetation on ALE were spared. The Horseshoe and Nike Landfills were burned in the fire. Because the native plant communities had become well established on the Horseshoe and Nike Landfills, the bunchgrasses and forbs should return next year. The shrubs, however, will return only if there is a viable seed bank and sufficient precipitation is received during the winter of 2000-2001.

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The presence of numerous native bunchgrasses and forbs on the Horseshoe Landfill before the fire demonstrates that a diverse native plant community had developed and should continue into late seral conditions, as exhibited by 39 species observed on the landfill, 29 of which were native. The canopy cover of volunteer sagebrush plants on the Horseshoe Landfill had increased to 22.4% from 5.5% in 1997.

In addition to the revegetation sites on ALE, the 200-ZP-1 Injection Well Pipeline on the western edge of the 200 West Area was also burned in the fire. The vegetation in the area was completely consumed. The grasses and forbs will return next spring; however, shrubs are expected to return only if sufficient precipitation is received and seeds in the soil germinate.

The vegetation recovery at Bridge Overlook and PSN 72/82 continues to look promising. The 1995 revegetation effort used salvaged plants from the ERDF construction site. Measurements taken in 2000 identified 29 species on the Bridge Overlook site, 25 of which were native. Cryptobiotic crust continues to develop and increased to 23.4% this year from 5.9% in 1999, indicating that the soils are continuing to recover. On the PSN 72/82 Well Mound site, 22 plant species were identified, 17 of which were native. Cryptobiotic crust on the waste site has significantly increased to 47.6% from 19.8% last year. All the planted species except turpentine springparsley (*Cymopterus terebinthinus*) were identified on the small staging area adjacent to the Well Mound site. In addition to the planted species, the small staging area is also being colonized by many native species, including six-weeks fescue (*Festuca octoflora*), annual phlox (*Microsteris gracilis*), spring whitlow (*Draba verna*), western tansymustard (*Descurainia pinnata*), hoary aster (*Machaeranthera canescens*), and matted cryptantha (*Cryptantha circumscissa*).

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At PSN 12/14, seven plots were revegetated in 1995 with sagebrush tubelings and salvaged bunchgrasses from the ERDF construction site. However, the access road was seeded with a mixture of sagebrush, bitterbrush, snow buckwheat (*Eriogonum niveum*), turpentine springparsley, Carey's balsamroot (*Balsamorhiza careyana*), and Sandberg's bluegrass (*Poa sandbergii*) in 1996. This year, plot 5 had the greatest diversity of bunchgrasses, while plot 1 had the highest percentage of bunchgrass canopy cover with 32%. All plots are recovering well and have cryptobiotic crust recorded on each plot. In 2000, 26 plant species were observed on the access road, 20 of which were native. New native species colonizing the road included six-weeks fescue, annual phlox, yellow salsify (*Tragopogon dubius*), Indian wheat (*Plantago patagonica*), threadleaf scorpionweed (*Phacelia linearis*), and rough wallflower (*Erysimum asperum*).

Salvaged sagebrush seedlings were planted along an access road in a burned area on the Saddle Mountain Wildlife Refuge (North Slope Cheatgrass Area) in August and October 1996. Survival of the sagebrush transplanted in August was very low due to high temperatures, injured root systems, and low soil moistures. The sagebrush planted in October had an average survival of 77.4% after 4 years and an average height of 39 cm, ranging from 11 to 60 cm. The survivorship from 1999 to 2000 did not change.

Revegetation of the waste sites 600-104, 216-A-25 emergency extension, 300-FF-1 sagebrush mitigation, and the 200-ZP-1 Injection Well Pipeline was conducted in the early fall of 1997 and late winter of 1998. All seeds and plants were derived from species on the Hanford Site.

Seeding was conducted on the 600-104 site after bioremediation of 2,4-D contaminated soils.

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Twenty-two species were observed on the site this year, of which 18 were native. The dominant species were cheatgrass at 18.1% and yarrow with 5.8% canopy cover. Sagebrush planted at the 216-A-25 emergency extension site had an estimated sagebrush survival close to that seen in 1999 at 65%. In March 2000, the 300-FF-1 sagebrush and bitterbrush mitigation planting areas were examined for survivorship. All 50 bitterbrush and 98.5% of the sagebrush seedlings planted were alive and very healthy.

The 300 Area Process Trench was remediated in mid-1997 through early 1998. A majority of the trench was regraded and contoured with the surrounding soils; then in the fall of 1998, the site was broadcast seeded with 50 kg per hectare of crested wheatgrass. Straw was applied as mulch and crimped into the soil. The second year of monitoring, conducted in April 2000, found 29 plant species on the revegetated site, of which 18 were native. The most abundant species present were jagged chickweed (*Holosteum umbellatum*) and cheatgrass. However, wheatgrass canopy cover increased from 2% to 5% this year.

In November 1998, 73,800 sagebrush seedlings were planted in shrubless areas on the ALE Reserve as compensatory mitigation for habitat lost during the expansion of ERDF. Five different areas on ALE containing 56 plots were selected for revegetation and habitat enhancement. Sagebrush survival was assessed in February and March 2000 to determine transplant survival. Survival remained lowest on area 5 with 48.6% and highest in area 2 with 86.6%, with an overall survival across all plots of 68.9%. However, the wildfire that spread across ALE in June 2000 consumed all but a few portions of the plots in area 5 where the fuel load was still sparse as a result of the fire that occurred in 1997.

The 116-C-1 waste site revegetation was done as a demonstration project to evaluate practical methods for revegetating remediated sites with native species. Backfill material representative of naturally occurring soils in the area served as the planting medium for two of four treatments. The other two treatments used topsoil retrieved from the ERDF construction site during excavations. In November 1998, a native seed mix was distributed across the entire area. Cryptobiotic soil/dust was also applied to the eastern half of the site to inoculate the soil surface, and then wheat straw mulch was applied to the entire area and crimped. Sagebrush tubelings were planted throughout the site in groups of three. Irrigation was applied to one-half of the backfill substrate and one-half of the topsoil substrate. Analysis in April 2000 found 23 plant species on the 116-C-1 site, 13 of which were native including 6 of the 7 species planted. Species count was highest on the cobble treatments with 18 species on the nonirrigated area and 15 species on the irrigated cobble area. Overall sagebrush survival was high at 81.1%. Sagebrush seedling survival was highest on the nonirrigated and irrigated cobble treatments with 95.5% and 86.1%, followed by the irrigated and nonirrigated topsoil treatments with 75.4% and 61.9%, respectively.

The 116-B-1, 116-B-11, and 116-C-5 sites were revegetated in December 1999. Three different fertilizer treatments were used on the backfill sites. 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. Initial vegetation surveys conducted in April 2000 found 22 species on the sites, 13 of which were native. Five of the eight species planted were observed on the sites. Sandberg's bluegrass had the greatest canopy cover across all treatments. Species diversity was highest on the 116-C-5 site with 19 species, which received a combination of micronutrients and triple-16 fertilizer.

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METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>	<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>
Length			Length		
inches	25.4	millimeters	millimeters	0.039	Inches
inches	2.54	centimeters	centimeters	0.394	Inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			Area		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			Mass (weight)		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			Volume		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit

1.0 INTRODUCTION

This report documents the results of revegetation monitoring conducted in 2000. The monitoring sites included the Horseshoe and Nike Landfills on the Arid Lands Ecology (ALE) Reserve and the Horn Rapids Landfill (HRL) near the City of Richland. Waste sites on the Hanford North Slope include the former Army sites titled Bridge Overlook, PSN 72/82, and PSN 12/14, as well as the 600-104 (2,4-D) bioremediation site. Additional sites include the 300-FF-1 mitigation and revegetation areas; the 216-A-25 emergency extension site; the 200-ZP-1 Injection Well Pipeline; the 116-C-1 revegetation site; and revegetation efforts on 116-B-1, 116-B-11, and 116-C-5. Sagebrush survival was monitored at the North Slope Cheatgrass Area and at several revegetation sites on ALE, collectively called the Environmental Restoration Disposal Facility (ERDF) compensatory mitigation sites. Figure 1-1 shows the locations of these sites.

The extent of the revegetation efforts conducted at each monitoring site varied depending on the surrounding habitat, existing conditions, and the future use of the site. The purpose of the revegetation monitoring is to measure the progress of plant succession and, in most cases, compare it to the surrounding undisturbed plant community. Each site is discussed separately, along with a brief description of the revegetation activities and the results of the 2000 monitoring efforts.

This report provides the fifth-year measurements at the Horseshoe Landfill, Nike Landfills, and HRL. Results from the previous years' measurements are documented in 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, and D of this report. A comparison of the vegetation changes over the previous years is provided in this document.

This is the fourth year that measurements have been taken at the Bridge Overlook, PSN 72/82, PSN 12/14, and the North Slope Cheatgrass Area. Revegetation at these sites, except for the Cheatgrass Area, began in the spring of 1995 with the salvage and transplanting of bunchgrasses from the Hanford Site. In 1996, supplemental plantings using locally collected seed were conducted at the PSN 12/14 access road and at the PSN 72/82 sites. The Cheatgrass Area was planted with salvaged sagebrush (*Artemisia tridentata*) seedlings in August and October 1996. Third-year measurements are provided for the 600-104 (2,4-D) waste site, 216-A-25 emergency extension site, the 300-FF-1 sagebrush and bitterbrush mitigation sites, and the 200-ZP-1 Injection Well Pipeline. Second-year measurements are provided for the 316-5 Process Trench, the 116-C-1 restoration site, and sagebrush survival on the ERDF compensatory mitigation areas on the ALE Reserve. First-year measurements are included for the 100 B/C liquid effluent disposal sites, 116-B-1, 116-B-11, and 116-C-5, which were hydroseeded with a native seed mix in December 1999.

Introduction

1.1 METHODS USED IN EVALUATING VEGETATION RECOVERY

The vegetation monitoring consisted of measuring the canopy cover of all plant species found at a site, the frequency of occurrence, and the survival of transplanted bunchgrasses and sagebrush. 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, to have species overlapping each other, total measured vegetative cover can exceed 100%. Within each location, a series of plot frames were analyzed for canopy coverage of each species present. Frequency is represented as the percentage of 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 $10/25 \times 100 = 40\%$.

The relative magnitude of a frequency rating, when compared to a canopy coverage rating, provides an index of distribution of a species and its influence within a vegetative stand. At sites where bunchgrasses and/or sagebrush were transplanted, the survival (if it could still be determined in 2000) was measured by counting a representative number of plants at the site, determining if they were dead or alive, and 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 E. Plant identification was conducted using Hitchcock and Cronquist (1973) and Sackschewsky et al. (1992).

The objective of all revegetation efforts is guided by the type of restoration that is conducted, as well as the criteria that is used to assess the success of the effort. At the HRL, the objective was to stabilize the topsoil and protect the landfill cap, while at the Horseshoe and Nike Landfills, the objective was to restore the areas with native bunchgrasses while suppressing the growth of exotic plant species such as cheatgrass (*Bromus tectorum*). All of the North Slope revegetation sites are surrounded by high-quality habitat; therefore, the objective was to restore those sites to blend with the adjacent plant community. The objective of revegetating the North Slope Cheatgrass Area was to promote sagebrush reestablishment in a previously burned area. The objective at the 600-104, 216-A-25, and 200-ZP-1 Injection Well Pipeline sites was to stabilize the soils and provide onsite rectification for lost sagebrush habitat. The objective at the 300-FF-1 sagebrush and bitterbrush (*Purshia tridentata*) sites was to compensate for the loss of shrubs during remediation of the 618-4 Burial Ground.

Reference sites in the vicinity of Horseshoe Landfill and North Slope sites were selected based on their similar physical and biological components to the pre-waste site areas. For this monitoring effort, the reference sites were used to identify the plant composition of the surrounding area then used to compare the plant establishment of the revegetated area. In some cases, such as the 300-FF-1 sagebrush site, reference sites were not used because sagebrush was planted into an area comprised of late successional perennial grasses and forbs. The purpose of the planting was to reestablish the shrub component in the vegetative community.

Introduction

Success criteria are often different for each waste site due to different objectives of each revegetation effort. However, all sites will be evaluated based on plant canopy cover, plant community composition, and survival and growth of transplants. These criteria are detailed in the *Revegetation Manual for the Environmental Restoration Contractor* (McLendon et al. 1997). Revegetation efforts will be considered successful if the areas are stabilized to prevent erosion and dominated by recovering stands of native sagebrush, bunchgrasses, and other native species.

This was the fifth year following revegetation of the HRL, Horseshoe Landfill, Nike Landfills, Bridge Overlook, PSN 72/82 sites, PSN 12/14 sites. It was the fourth year after planting sagebrush at the North Slope Cheatgrass Area. Typically, 3 to 5 years are required before a revegetation effort in arid regions such as the Columbia Basin begin to show signs of success. The results from monitoring efforts show that the objectives have been met and that monitoring can be discontinued at these sites.

On April 25, 2000, the sites mentioned above were toured by representatives of the U.S. Department of Energy (DOE), Richland Operations Office (RL), the U.S. Environmental Protection Agency (EPA), and Bechtel Hanford, Inc. (BHI) to assess the adequacy of the revegetation efforts and determine if the objectives had been met. The lead regulatory agency (EPA) agreed that the revegetation objectives had been met and that no further monitoring was required.

On June 27, 2000, a wildfire started as a result of an automobile accident along Highway 24, which borders the northern edge of the ALE Reserve. The fire spread south and east, consuming an estimated 66,371 hectares (164,000 acres) covering all of ALE and a large portion of the southwestern section of Hanford Site proper. Only small islands of vegetation on ALE were spared. The Horseshoe and Nike Landfills were burned in the fire. In addition, the 200-ZP-1 Injection Well Pipeline located on the western edge of the 200 West Area was also burned in the fire.

2.0 HORN RAPIDS LANDFILL

The HRL is a 20-hectare area located in the 1100-EM-1 Operable Unit immediately north of Richland, Washington. The landfill was used primarily to dispose of office and construction waste, asbestos, sewage sludge, and fly ash. The remedial investigation/feasibility study for the 1100-EM-1 Operable Unit (DOE-RL 1992) identified about 230 m³ of polychlorinated biphenyl (PCB)-contaminated soil in the landfill. The remedial action, documented in the 1100 Area Record of Decision (ROD) (EPA 1993), included excavation of the PCB-contaminated soil and capping the 10.3 hectare landfill. The landfill cap consisted of a 0.5-m layer of gravel covered with 15.2 cm of topsoil. The objective of this revegetation project was to stabilize the topsoil and protect the landfill cap. The site was revegetated with crested wheatgrass (*Agropyron cristatum*) and Siberian wheatgrass (*Agropyron sibericum*) in the fall of 1995 with guidance and concurrence from the Hanford Natural Resource Trustee Council.

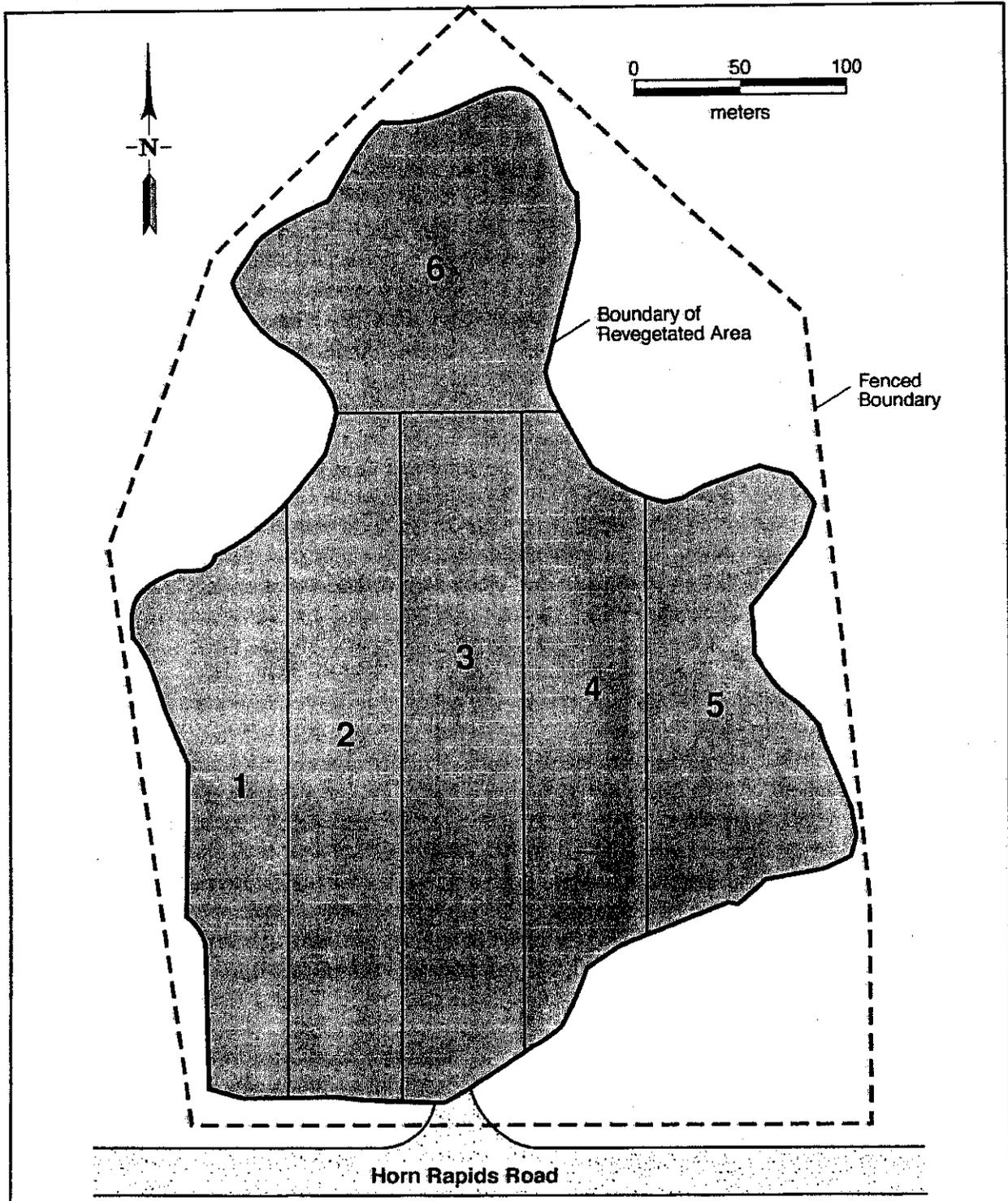
A secondary goal of the revegetation effort was to compare planting techniques using a traditional rangeland seed drill and an imprinter planting device. The imprinter has been successfully used for planting in arid climates (St. John and Dixon 1995). A special imprinter was used at the HRL that had an added capability to inoculate the soil with mycorrhizal fungi. Mycorrhizal fungi form a beneficial symbiotic relationship with the roots of many late seral plants, including bunchgrasses. The fungus absorbs nutrients from the soil and passes them to the plant in exchange for sugars from the plant. This relationship is not usually formed with the early seral stage weedy plant species.

2.1 REVEGETATION PLAN

Five different planting treatments were implemented to determine the most successful technique and provide information that will be useful in planning future restoration projects. The area of the landfill that was revegetated was divided into six roughly equal plots for the purpose of establishing treatment areas (Figure 2-1). Two treatments using a range land seed drill were established. The first treatment included planting seed with a fertilizer application rate of 22.5 kg of nitrogen per hectare and mulching the area with wheat (*Triticum spp.*) straw (plots 1 and 6). This method has been used many times on the Hanford Site and has proven successful with this seed mix. The second treatment using the range land drill (plot 2) applied seed and straw mulch without fertilizer.

Three treatments were used to test the efficacy of the imprinter under local conditions. The first was the application of seed, mycorrhizal fungi, and wheat straw mulch (plot 3). The second was the application of seed and mycorrhizal fungi with no mulch (plot 4), and the third was the application of seed alone (plot 5). The application of straw mulch was intended to reduce wind erosion and increase soil moisture retention. The mulch may also serve an added function by tying up excess available soil nitrogen, reducing competitiveness of early successional weedy species (Klein et al. 1996). Straw was spread over the appropriate treatment areas at a rate of 4.5 metric tons per hectare.

Figure 2-1. Horn Rapids Landfill Showing Six Treatments.



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Horn Rapids Landfill

The target seeding rate was 16.8 kg/hectare pure live seed on all treatments with a 50% mix of Siberian and crested wheatgrasses. The actual seeding rate varied between the Imprinter and the range drill due to the difference in the metering systems on the two pieces of equipment. The three plots planted with the range drill (plots 1, 2, and 6) and plots 3 and 5 planted with the Imprinter received similar rates of seed. However, plot 4 was the first to be planted and received a higher seeding rate because the metering system was not initially calibrated to the proper rate.

2.2 MONITORING RESULTS

The vegetation on the HRL was measured on April 4, 2000, by estimating canopy coverage and frequency of occurrence. Twenty-five plot frames measuring 20 by 50 cm were analyzed for each treatment. Thirty-six species were recorded on the HRL in 2000, which was an increase from previous years as compared to 30 in 1999, 28 in 1998, 20 in 1997, and 10 in 1996. The species having the greatest canopy cover were spring whitlow, wheatgrasses (*Agropyron spp.*), jagged chickweed (*Holosteum umbellatum*), and cheatgrass. Spring whitlow (*Draba verna*) and jagged chickweed are small (usually less than 5 cm tall) winter annual plants that are very common early successional species. This was the first year cryptobiotic crust was observed and recorded on the landfill. One of the most important factors of soil stability is the cryptobiotic soil crust development. Important components of crust development include cyanobacteria, mosses, and lichens which all affect soil stability, soil moisture, nutrient status, and enhancement of seedling establishment and success. The percentage of crust cover recorded among the plots ranged from 38.6% on plot 1 to 66.3% on plot 4. In addition, frequency of crust occurrence was 100% for all plots except plot 6, which was 96%.

Canopy cover for wheatgrasses has changed very little since 1999, ranging from 18.2% to 27.8% among plots (Table 2-1). All the changes were minimal and within the expected fluctuations using these methods. Frequency of wheatgrass occurrence was high across the all plots ranging from 72% to 96% (Table 2-2). It appears that, regardless of the planting technique used, canopy cover of the wheatgrasses has plateaued and is maintaining across all plots and is now comparable to a mature stand of wheatgrass. For comparison, the canopy cover of a mature stand of Siberian wheatgrass/thickspike wheatgrass (*Agropyron dasytachyum*) that was planted on the 216-T-35 Burial Ground on the Hanford Site was measured at 18.3% after more than 10 years of growth (WHC 1994). However, HRL had a higher density of smaller plants than a mature stand of wheatgrass. The density and stature of the plants is expected to continue changing. Because the soils are similar across all plots and exposed to the same weather conditions, the canopy cover and frequency of occurrence is expected to remain comparable across the plots. There was no apparent difference in fertilizer treatments (plots 1 and 6) compared to the other plots, which was likely due to the high quality topsoil used in the upper horizon of the landfill cap.

Horn Rapids Landfill

Table 2-1. Percent Canopy Cover on Horn Rapids Landfill for 2000.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
<i>Agropyron spp*</i> (wheatgrasses)	24.2	27.8	24.3	18.2	22.6	22.3
<i>Salsola kali*</i> (Russian thistle)	0.1	0.1	0.4	0.4	0.4	0.2
<i>Bromus tectorum*</i> (cheatgrass)	18.8	14.1	15	12.9	12	21.4
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	1.8	1.1	X	0.1	X	0.5
<i>Sisymbrium altissimum*</i> (tumblemustard)	0.2	0.1	0.3	0.2	0.3	0.8
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.9	0.9	0.1	0.3	0.8	2.1
<i>Convolvulus arvensis*</i> (field bindweed)	--	--	X	--	0.1	--
<i>Holosteum umbellatum*</i> (jagged chickweed)	12	9.7	19	14.1	12.1	32.7
<i>Lactuca serriola*</i> (prickly lettuce)	0.3	0.3	--	0.2	--	0.1
<i>Draba verna</i> (spring whitlow)	24.3	32.5	28.5	31	24.3	24.4
<i>Descurainia pinnata</i> (western tansymustard)	0.7	0.1	--	--	--	--
<i>Epilobium paniculatum</i> (tall willowherb)	0.1	X	0.1	--	--	X
<i>Poa sandbergii</i> (Sandberg's bluegrass)	0.2	0.2	X	X	X	2.7
<i>Erodium cicutarium*</i> (storksbill)	0.5	1.1	0.5	1.3	1.2	--
<i>Tragopogon dubius*</i> (yellow salsify)	X	0.1	0.1	--	X	X
<i>Eriogonum niveum</i> (snow buckwheat)	X	--	X	X	X	0.4
<i>Astragalus caricinus</i> (buckwheat milkvetch)	X	X	X	--	--	--
<i>Machaeranthera canescens</i> (hoary aster)	X	X	--	--	X	X
<i>Achillea millefolium</i> (yarrow)	--	X	--	X	--	--
<i>Medicago sativa*</i> (alfalfa)	X	0.1	X	X	X	--
<i>Chondrilla juncea*</i> (skeletonweed)	X	--	--	--	--	--
<i>Cardaria draba*</i> (whitetop)	--	--	--	--	X	--
<i>Chrysothamnus nauseous</i> (gray rabbitbrush)	2.1	X	X	X	X	X
<i>Oenothera pallida</i> (evening primrose)	--	X	--	--	--	X
<i>Microsteris gracilis</i> (annual phlox)	0.2	0.3	0.3	1.5	0.5	0.5
<i>Agastache occidentalis*</i> (western horsemint)	--	--	0.3	0.1	0.2	--
<i>Sphaeralcea munroana</i> (globemallow)	--	--	--	--	X	--
<i>Centaurea diffusa*</i> (diffuse knapweed)	--	--	X	--	X	X
<i>Poa bulbosa*</i> (bulbous bluegrass)	0.3	0.1	--	--	X	--
<i>Brodiaea douglasii</i> (Douglas' clusterlily)	X	--	--	--	--	0.1
<i>Purshia tridentata</i> (antelope bitterbrush)	X	--	--	--	--	--
<i>Lomatium spp.</i> (desertparsely)	X	--	X	--	--	--
<i>Taraxacum officinale*</i> (dandelion)	X	X	--	--	--	--
<i>Festuca octoflora</i> (six-weeks fescue)	--	--	--	0.1	--	--
<i>Senecio vulgaris</i> (common groundsel)	0.1	--	--	--	X	--
<i>Artemisia tridentata</i> (big sagebrush)	X	--	--	--	--	--
Cryptobiotic crust	38.6	49.1	51.6	66.3	60.2	47
Bare soil	32	40.9	39.7	60.9	54.5	33.9
Litter	44.4	45.1	49.8	32.5	33	54.3
Total (does not include crust, soil, or litter)	86.8	88.6	88.9	80.4	74.5	108.2

* Introduced species.

X = Present but not counted in plot frames.

-- = Not occurring on the plot.

Horn Rapids Landfill

Table 2-2. Percent Frequency of Occurrence on Horn Rapids Landfill for 2000.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
<i>Agropyron spp*</i> (wheatgrasses)	80	88	76	96	84	72
<i>Salsola kali*</i> (Russian thistle)	4	4	16	16	16	8
<i>Bromus tectorum*</i> (cheatgrass)	96	88	100	96	100	92
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	16	24	X	4	X	20
<i>Sisymbrium altissimum*</i> (tumblemustard)	8	4	12	8	12	12
<i>Ambrosia acanthicarpa</i> (bur ragweed)	36	36	4	12	32	44
<i>Convolvulus arvensis*</i> (field bindweed)	--	--	X	--	4	--
<i>Holosteum umbellatum*</i> (jagged chickweed)	96	96	100	96	96	96
<i>Lactuca serriola*</i> (prickly lettuce)	12	12	--	8	--	4
<i>Draba verna</i> (spring whitlow)	100	88	96	100	96	84
<i>Descurainia pinnata</i> (western tansymustard)	28	4	--	--	--	--
<i>Epilobium paniculatum</i> (tall willowherb)	4	X	4	--	--	X
<i>Poa sandbergii</i> (Sandberg's bluegrass)	8	8	X	X	X	12
<i>Erodium cicutarium*</i> (storksbill)	20	44	20	12	28	--
<i>Tragopogon dubius*</i> (yellow salsify)	X	4	4	--	X	X
<i>Eriogonum niveum</i> (snow buckwheat)	X	--	X	X	X	16
<i>Astragalus caricinus</i> (buckwheat milkvetch)	X	X	X	--	--	--
<i>Machaeranthera canescens</i> (hoary aster)	X	X	--	--	X	X
<i>Achillea millefolium</i> (yarrow)	--	X	--	X	--	--
<i>Medicago sativa*</i> (alfalfa)	X	4	X	X	X	--
<i>Chondrilla juncea*</i> (skeletonweed)	X	--	--	--	--	--
<i>Cardaria draba*</i> (whitetop)	--	--	--	--	X	--
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	8	X	X	X	X	X
<i>Oenothera pallida</i> (evening primrose)	--	X	--	--	--	X
<i>Microsteris gracilis</i> (annual phlox)	8	12	12	20	20	20
<i>Agastache occidentalis*</i> (western horsemint)	--	--	12	4	8	--
<i>Sphaeralcea munroana</i> (globemallow)	--	--	--	--	X	--
<i>Centaurea diffusa*</i> (diffuse knapweed)	--	--	X	--	X	X
<i>Poa bulbosa*</i> (bulbous bluegrass)	12	4	--	--	X	--
<i>Brodiaea douglasii</i> (Douglas' clusterlily)	X	--	--	--	--	4
<i>Purshia tridentata</i> (antelope bitterbrush)	X	--	--	--	--	--
<i>Lomatium spp.</i> (desertparsely)	X	--	X	--	--	--
<i>Taraxacum officinale*</i> (dandelion)	X	X	--	--	--	--
<i>Festuca octoflora</i> (six-weeks fescue)	--	--	--	4	--	--
<i>Senecio vulgaris</i> (common groundsel)	4	--	--	--	X	--
<i>Artemisia tridentata</i> (big sagebrush)	X	--	--	--	--	--
Cryptobiotic crust	100	100	100	100	100	96
Bare soil	96	100	96	96	96	88
Litter	100	100	100	100	100	100

* Introduced species.

X = Present but not counted in plot frames.

-- = Not occurring on plot.

Horn Rapids Landfill

Cheatgrass cover appeared to be slightly lower on most plots in 2000. On plots 1 and 3, cheatgrass canopy cover decreased by 11.5% and 15.1% from 1999. Russian thistle (*Salsola kali*) continues to be present, but the cover is extremely low, averaging 0.27%. At this low percentage, Russian thistle is no longer considered a significant component of this community. Most other species occurred in low numbers and are expected to maintain a low occurrence due to the dominance of the wheatgrasses. The percent "bare soil" was comparatively higher across all sites, not due to reduced cover by vegetation, but rather due to the vegetation analysis being conducted 5 weeks earlier than in previous years. The plants were at a younger, smaller growth stage at the time of the analysis compared to previous years. Vegetation analysis timing is also a contributing factor to the decline in cheatgrass canopy cover on all plots. It is likely that the cheatgrass cover was comparable to 1999, and the low canopy cover values observed in 2000 indicate that the plants were at a younger stage of development at the time of data collections.

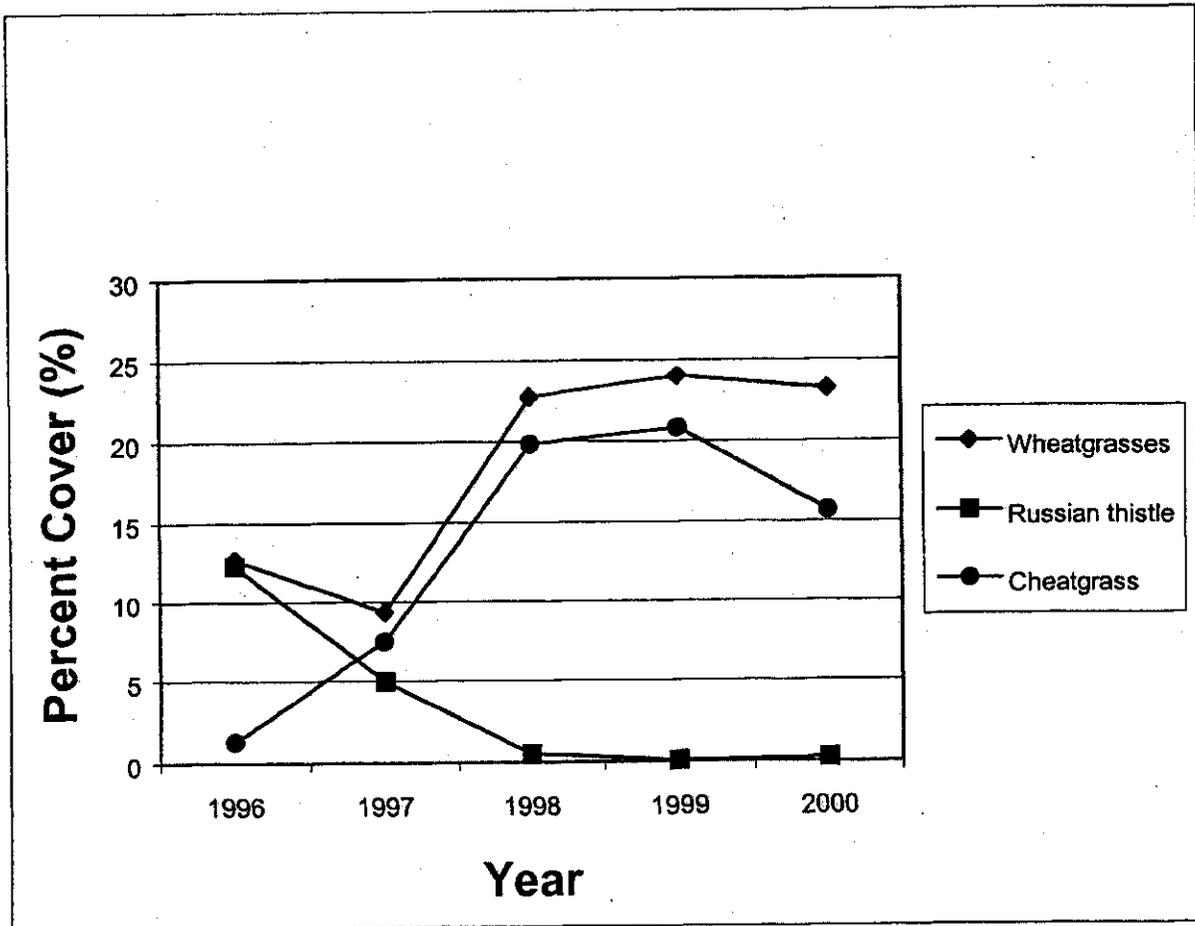
Several species were observed on the landfill that did not occur in an individual plot frame. These occurrences represented the pioneering of plants from the surrounding community. Some plants will continue to increase their presence, while others remain at a low level or even disappear as succession progresses. Gray rabbitbrush (*Chrysothamnus nauseosus*), in particular, has increased its presence on the landfill. It was recorded in a plot frame on plot 1 and observed on all the remaining plots. Additionally, six-weeks fescue (*Festuca octoflora*), bulbous bluegrass (*Poa bulbosa*), Douglas' clusterlily (*Brodiaea douglasii*), and bitterbrush were all observed on the site this year. The noxious weeds rush-skeletonweed (*Chondrilla juncea*), whitetop (*Cardaria draba*), and diffuse knapweed (*Centaurea diffusa*) were also observed in some of the plots and spot sprayed with a broadleaf control prior to seed development. Herbicide applications will be monitored for effectiveness and determination of future applications.

Trends in canopy cover were examined for a duration of 5 years for three species on the HRL. Species examined were Russian thistle, cheatgrass, and wheatgrasses. Between 1996 and 2000, Russian thistle declined in abundance from 12.3% to 0.27% cover, due to increased competition by other species (Figure 2-2). The number of species observed on HRL increased from 10 species in 1996 to 37 species in 2000. This trend is typical in the early stages of plant succession on disturbed soils.

Cheatgrass showed an overall increase in abundance from 1996 to 1999, rising from 1.3% cover in 1996 to 20.1% in 1999. While this increase appeared to be dramatic, 2000 canopy cover data indicate that the population may be stabilizing at less than 20% cover.

Representation of wheatgrasses at the HRL showed expected variation between 1996 and 2000. An inflated seeding rate during planting in 1995 resulted in good production of wheatgrass in 1996 (12.3% cover), followed by a subsequent decrease in abundance (9.35% cover in 1997), due to crowding and self thinning. By 1998, canopy coverage by wheatgrass had recovered and risen to 23%. The wheatgrass population at the HRL site appears to be stabilizing with only a 1% fluctuation in cover between 1998 and 2000 (Figure 2-2).

Figure 2-2. Comparison of Canopy Cover Trends on Horn Rapids Landfill, 1996-2000.



3.0 HORSESHOE LANDFILL

The Horseshoe and the Nike Landfills are located on the Fitzner-Eberhardt Arid Lands Ecology (ALE) Reserve and are included in the 1100-IU-1 Operable Unit (Figure 3-1). They were 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).

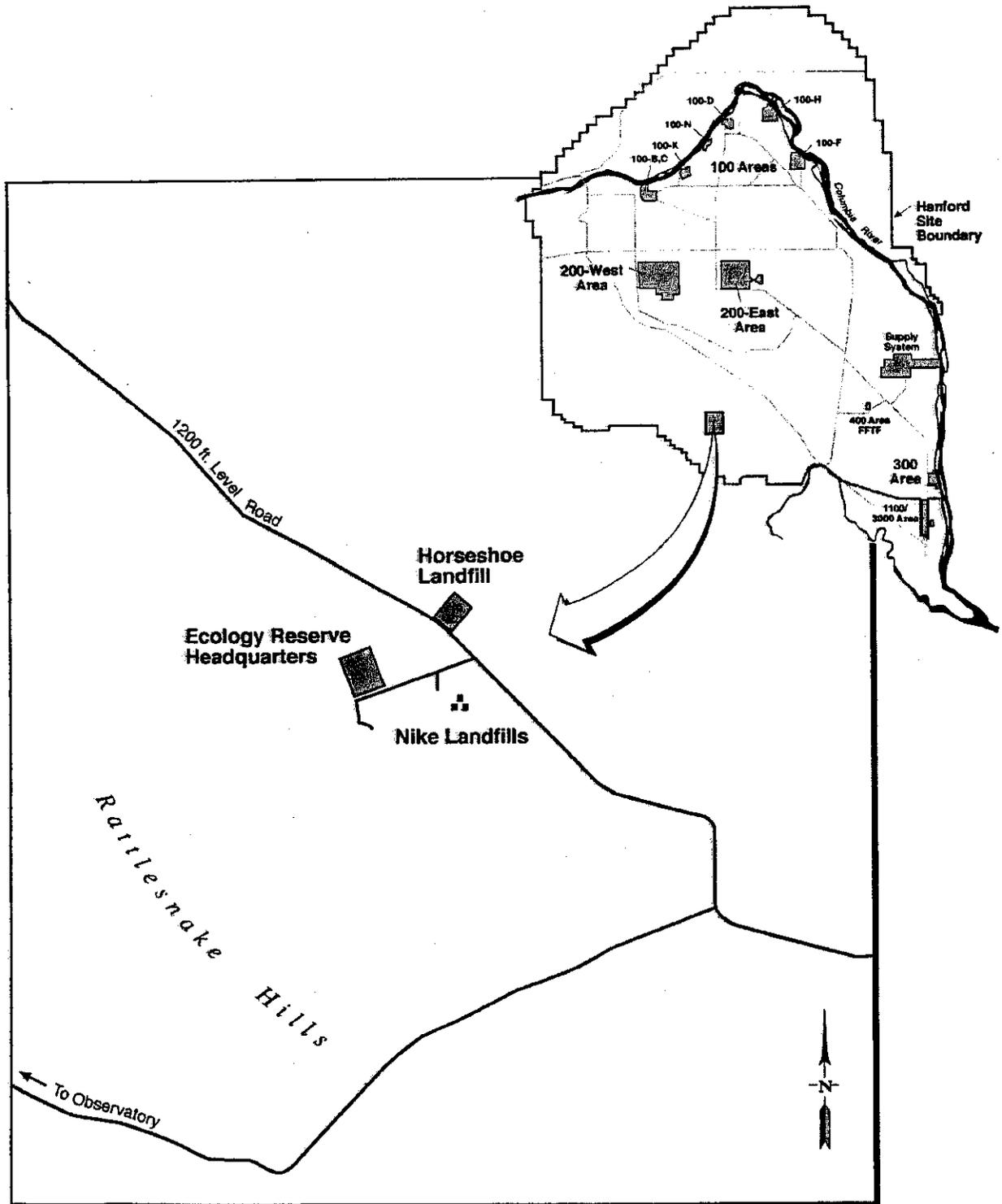
On the Horseshoe Landfill, transects running across the width of the revegetated area were counted. On the three small Nike Landfill sites, all bunchgrasses and sagebrush were counted and compared to previous years. The revegetated area of the Horseshoe Landfill measures approximately 35 by 70 m. The revegetated area on the Nike Landfill consists of three small sites measuring approximately 4 by 23 m (plot 1), 6 by 9 m (plot 2), and 4 by 9 m (plot 3). The disturbed soils on the surface of these sites were revegetated in the fall of 1995. Work began on November 29, 1995, and was completed on December 7, 1995.

The Horseshoe Landfill was revegetated with transplanted bunchgrasses. 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 become established. The three small Nike Landfill sites varied in vegetative cover from nearly bare to having some small sagebrush, cheatgrass, and Sandberg's bluegrass (*Poa sandbergii*). These sites were planted with bunchgrasses and an additional 12 to 15 sagebrush seedlings each.

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, 2000, using classic Daubenmire methods (Daubenmire 1970). Within the Horseshoe Landfill and the reference site, 25 plot frames measuring 50 by 100 cm were analyzed.

Survival of the planted bunchgrasses on the Horseshoe Landfill was measured by examining the bunchgrasses for green plant material in the crown area. If any green leaves were present, the plant was recorded as alive. On the Horseshoe Landfill, transects running across the width of the revegetated area were counted. On the three small Nike Landfill sites, all observed sagebrush and bunchgrasses were counted and species occurring inventoried.

Figure 3-1. Horseshoe and Nike Landfills.



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Horseshoe Landfill

3.1 MONITORING RESULTS

Forty-one species of plants were observed on the Horseshoe Landfill in 2000, 30 of which were native. The reference site had 26 species observed on the site; 21 of the species observed were native (Table 3-1). Cheatgrass continues to have the highest canopy cover on the landfill with 29.8%, down from 49.6% in 1999, followed closely by sagebrush with 22.4% cover in 2000. Sandberg's bluegrass cover was 13.8% in 2000, increasing from 9.8% last year. Tumblemustard (*Sisymbrium altissimum*) cover fell to 0.3% this year from 4.8% cover in 1999, with all other species canopy cover changing only slightly.

The canopy cover of cheatgrass on the reference site remained constant for the last 2 years at 34%. Sandberg's bluegrass is the dominant bunchgrass on the reference site with 51.1% cover and 96% frequency (Table 3-2). Sagebrush cover appears to have decreased from 19.1% in 1999 to 13.7% in 2000 at the reference site. Because the plants on the reference site are old-growth shrubs, it is not likely the canopy cover has actually declined. The discrepancy is more likely due to a difference in data collection. The shrubs are clustered and not evenly distributed. This adds to the year-to-year variability because the transects and plot frame locations are not in the same place year to year.

Cryptobiotic crust is an important component of the native shrub-steppe community. It is composed of a mixture of lichens, mosses, and algae that bind the soil surface helping to reduce erosion and facilitate seed germination. A well-developed cryptobiotic crust is indicative of a mature native community, particularly in areas with fine soils. Ground coverage of biotic crust was measured on the landfill and reference site. The amount of ground covered with biotic crust on the reference site was 86.6% in 2000, and 68.5% cover on the landfill an increase from 59.3% in 1999. This indicates that the soils are continuing to recover and stabilize from the remedial action disturbance.

The survival of the transplanted native bunchgrasses on the landfill was difficult to establish due to the difficulty of identifying the transplanted individuals from recruitment plants occurring throughout the site. Estimated survival of 326 transplants counted, found 218 alive, yielding a 67% survival rate, slightly lower than the estimated 71% in 1999 (Table 3-3). Bunchgrass counts fluctuates slightly from year to year due to the location of the transects. As demonstrated on the site, survival remains sufficient to sustain the population and continue contributing to seedling regeneration.

On the three Nike Landfill sites, as in previous years, transplant survival was difficult to determine. Instead, the total number of live sagebrush at each site was counted and compared to values in previous years. Sagebrush survival and recruitment was high in 2000 for all three Nike Landfill sites. Plot 1 contained 77 bunchgrass plants and 80 sagebrush, 20 more sagebrush plants than last year. Plot 2 contained 51 bunchgrass plants and 50 sagebrush, 10 more sagebrush plants than 1999, and plot 3 contained 52 sagebrush and 22 bunchgrass plants. Species diversity across all three plots ranged from 12 species on plot 2 to 15 on plot 1, signifying the sites are recovering and proceeding through succession while stabilizing the disturbed area.

Horseshoe Landfill

Table 3-1. Percent Canopy Cover on Horseshoe Landfill in 2000.

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

* Introduced species.

X = Present but not counted in the plot frames.

-- = Not occurring on site.

Table 3-2. Percent Frequency of Occurrence on Horseshoe Landfill in 2000.

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

Horseshoe Landfill**Table 3-3. Percent Survival of Transplanted Bunchgrasses and Sagebrush Plants in 2000.**

Site Name	Sagebrush				Bunchgrass			
	1997	1998	1999	2000	1997	1998	1999	2000
PSN 12/14								
Plot 1	91.3	59			54	66		
Plot 2	75	58			96.8	82	62.9	
Plot 3	76.5	73			62.5	74		
Plot 4	93.8	69			66.7	61	46.2	
Plot 5	58.1	43			72	76	80.9	56
Plot 6	57.8	59			74.4	88	69.4	
Plot 7	57.3	57			81.3	88	64.2	
Bridge Overlook					94			
NS Cheatgrass Area								
Small Plots (Aug)	5.5							
Small Plots (Oct)	92.7							
Road Transect	85.7	81.8	76.7	77.4				
Horseshoe Landfill					68	70	70.6	67
Nike Landfill								
Plot 1					83			
Plot 2					92			
Plot 3					86			
300-FF-1		70	54					
Sagebrush Original and Replacement*				98.5				
Bitterbrush				100				
200-ZP-1		54	29	21				
216-A-25		84	65	65				
ERDF Mitigation Sagebrush Planting								
Area 1			93	73.9				
Area 2			97.8	86.6				
Area 3			91.6	65.9				
Area 4			70.5	N/A				
Area 5			57.8	48.6				
116-C-1								
Nonirrigated backfill			100	95.5				
Irrigated backfill			91.7	86.1				
Nonirrigated Topsoil			83.3	61.9				
Irrigated Topsoil			78.9	75.4				

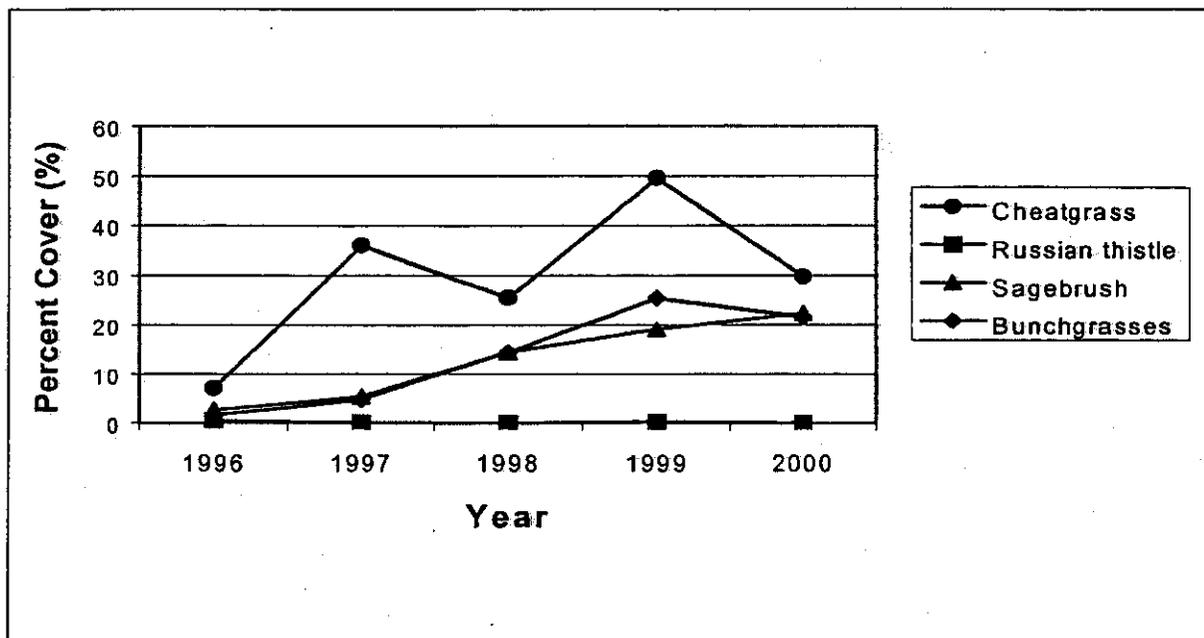
* Percent survival after replanting in 1999.

Horseshoe Landfill

Trends in canopy cover were examined over a duration of 5 years for the Horseshoe Landfill. Species examined were Russian thistle, cheatgrass, sagebrush, and bunchgrasses. Canopy cover representation by Russian thistle remained under 1% from 1996 to 2000. Cheatgrass canopy cover in 2000 decreased from 49.6% in 1999 to 29.8% in 2000, but was relatively consistent with 1998 canopy cover of 25.5%. Cheatgrass demonstrated an overall increase of 22.6% over the 5 year monitoring period but is not anticipated to increase cover in future years due to the competitiveness of the native community.

The grasses at Horseshoe Landfill monitored for trends in canopy cover included the following bunchgrasses: bluebunch wheatgrass (*Agropyron spicatum*), Sandberg's bluegrass, bottlebrush squirreltail (*Sitanion hystrix*), bulbous bluegrass, six-weeks fescue, and Indian ricegrass (*Oryzopsis hymenoides*). Grasses at Horseshoe Landfill showed an increasing trend in abundance, rising from 1.7% cover in 1996 to 21.6% cover in 2000 (Figure 3-2). Individual grass species also showed an increase in representation from year to year.

Figure 3-2. Comparison of Canopy Cover Trends on Horseshoe Landfill, 1996 – 2000.



Sagebrush canopy cover increased from 2.8% to 21.6%, yielding an increase of 19.6% over the 5-year monitoring period as a result of maturing sagebrush, and the recruitment of new seedlings, filling the shrub niche and contributing to the decrease in the canopy cover of non-native species.

This year was the fifth year of recovery for the vegetation at this site. Monitoring of the recovery has been conducted since 1996. The objectives of restoration at this site were to stabilize the soil surface and to restore the vegetation to a plant community dominated by indigenous species that would eventually develop into a late seral community typical of the

Horseshoe Landfill

surrounding area. The results from monitoring efforts show that both objectives have been met and that plant succession at the site continues to progress toward a late seral community typical of the surrounding habitat.

On April 25, 2000, the site was toured by representatives of DOE-RL, EPA, and BHI to assess the adequacy of the revegetation effort and determine if the objectives had been met. The lead regulatory agency (EPA) agreed that the revegetation objectives had been met and that no further monitoring was required.

The wildfire that started on June 27, 2000, burned the Horseshoe and Nike Landfills. Typically, when wildfires burn through native communities of sagebrush/bunchgrass habitat, the perennial grasses and forbs return the following year along with many of the annual species. The sagebrush, however, do not resprout from the crowns and can be very slow to return. Results from a study on the effects of the 1973 fire on ALE showed production of biomass from all plants averaged 79 g/m² in the burned area compared to 59 g/m² in the unburned areas over the 3 years following the fire (Rickard and Vaughan 1988). Perennial grasses had the highest increase followed by annual grasses and annual forbs. Biomass was lower in the burn area for perennial forbs and half-shrubs.

Because the native plant communities had become well established on the Horseshoe and Nike Landfills, the bunchgrasses and forbs are expected to return next year. The shrubs, however, will return only if there are viable seeds in the soil and sufficient precipitation falls during the winter of 2000-2001.

The cryptobiotic crust was not completely developed and frequent foot traffic on the site increased the chance of some seeds being worked into the top layer of soil, increasing the probability of sagebrush returning on these landfills.

4.0 NORTH SLOPE SITES

There were 39 distinct waste sites identified within the 100-IU-3 Operable Unit of the 100 Area National Priority List site. The 100-IU-3 Operable Unit is located on the Hanford Site North Slope area. The cleanup of these waste sites was documented in the *Close-Out Report North Slope (Wahluke Slope) Expedited Response Action, Hanford Washington* (DOE-RL 1994a) to satisfy milestone No. M-16-82 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989 and Lerch 1998a). The sites were remediated and cleanup activities took place in 1994 with the exception of waste site 600-104, which was remediated in 1997.

A detailed description of the remediation activities is provided in *A Compendium of Field Reports for the North Slope (Wahluke Slope) Expedited Response Action* (DOE-RL 1994b) and *100-IU-3 Waste Site 600-104 Remediation Summary, January 1998* (Lerch 1998a). The Hanford North Slope was delisted in July 1998 by the EPA (*Federal Register* July 8, 1998, Volume 63, Number 130).

Most of the remediation efforts involved the removal of physical hazards associated with military and pre-World War II agricultural activities. Site remediation included decommissioning of abandoned water wells, debris removal, excavation of landfills, and backfilling of open cisterns. In 1997, a remediation effort was conducted to remove tanks and bioremediate 2,4-D contaminated soils from a Bureau of Reclamation disposal site.

The restoration plan for the North Slope sites was based on the quality of the vegetation surrounding the waste sites. The vegetation on and surrounding many of the sites prior to cleanup consisted primarily of cheatgrass, Russian thistle, tumbled mustard, and other introduced species with some localized recolonization of big sagebrush and Sandberg's bluegrass. The soils at the revegetation areas are generally coarse, well-drained, and easily eroded by wind when exposed.

Three North Slope sites (Bridge Overlook, PSN 72/82, and PSN 12/14) were selected for revegetation in 1995 because of surrounding high-quality habitat, project timing, and available resources (Hughes 1995). The revegetation efforts primarily used salvaged plant materials and sagebrush tubelings grown from seed collected on the Hanford Site. An additional area on the North Slope was selected for restoring the sagebrush component to a cheatgrass/Sandberg's bluegrass community after a previous burn (Figure 1-1). The purpose of planting sagebrush at this site was to compensate for not revegetating a number of very small waste sites within the North Slope area. Those areas were determined by the Hanford Site Natural Resources Trustee Council to be poor-quality habitat. Furthermore, these sites were determined to be either too small or had the potential for agricultural development in the future.

Waste site 600-104 (2,4-D waste site) was revegetated on September 29, 1997, after bioremediation of 2,4-D contaminated soils. The dominant species on the waste site were cheatgrass and tumbled mustard before the site was exhumed and contaminated soils were bioremediated. After backfilling, the site was seeded with big sagebrush, yarrow (*Achillea millefolium*), snow buckwheat (*Eriogonum niveum*), Sandberg's bluegrass, and balsamroot (*Balsamorhiza careyana*).

4.1 REVEGETATION PLAN BACKGROUND

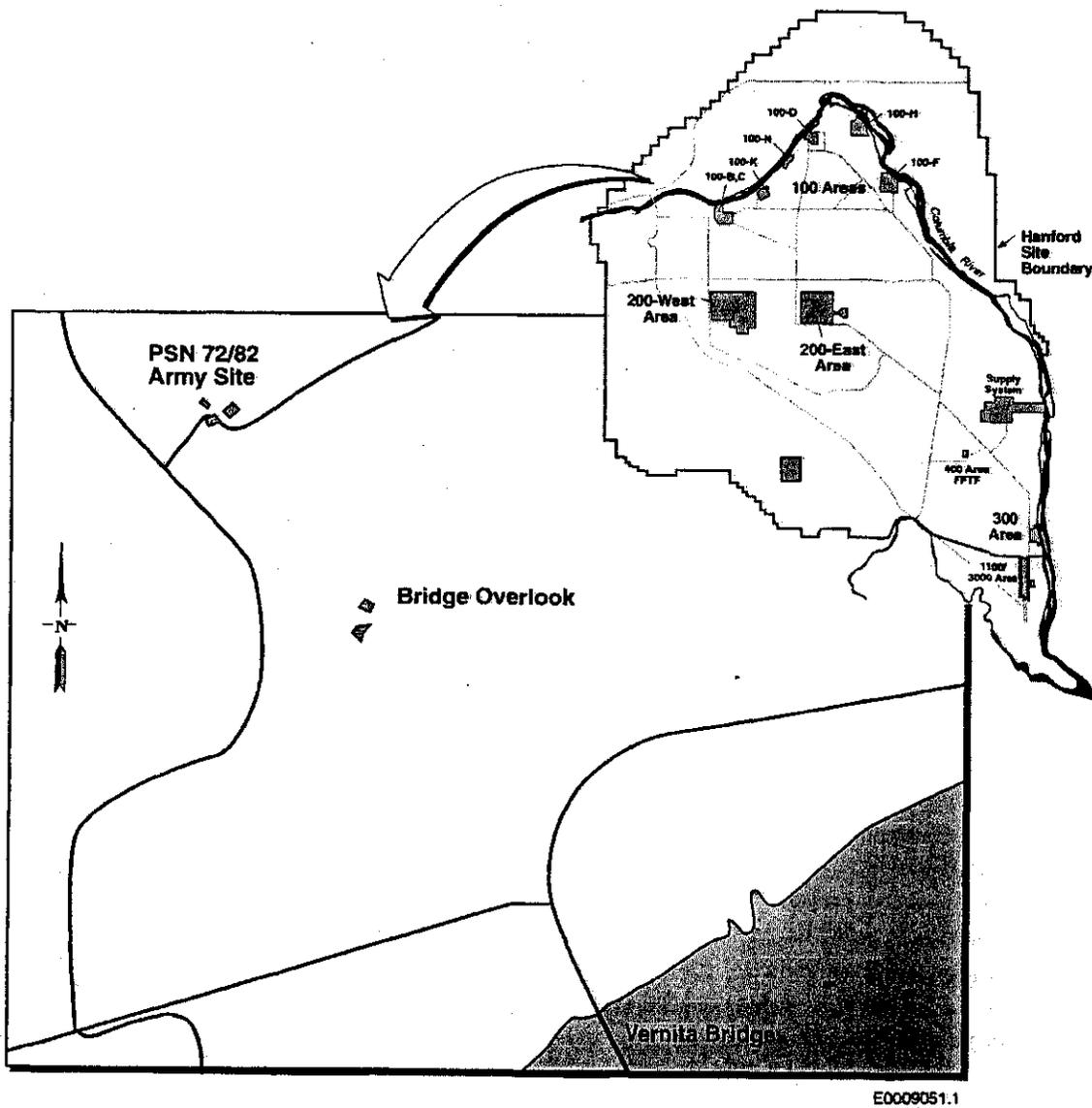
Native bunchgrass plants were salvaged from the Environmental Restoration Disposal Facility (ERDF) and were used for the initial planting on Bridge Overlook, PSN 72/82, and PSN 12/14. An estimated 9,000 plants were salvaged from ERDF in February 1995. Of all the salvaged plants, an estimated 90% were needle-and-thread grass (*Stipa comata*), and the remaining 10% were Indian ricegrass, Sandberg's bluegrass, pine bluegrass (*Poa scabrella*), and prairie junegrass (*Koeleria cristata*).

As part of the site preparation, soil samples were taken from each of the three revegetation sites and sent to a local laboratory for percent organic matter, nitrogen, and potassium analysis. The results of the analysis indicated that the soils were deficient in phosphorus. A fertilizer with an analysis of 11-52-0 (11% N, 52% P₂O₅, and 0% K₂O) was recommended to correct the soil fertility deficiency (Hughes 1995). All plants at PSN 72/82 and the Bridge Overlook along with an estimated 4,000 plants at three of the PSN 12/14 plots received fertilizer. Volunteer revegetation crews were directed to add 15 mL of fertilizer for plants in 3.8-L pots and 30 mL of fertilizer for plants in larger pots. Additionally, 30 native grass plants at both the Bridge Overlook (with fertilizer) and PSN 12/14 (without fertilizer) were planted in areas of undisturbed soil adjacent to the landfill areas (Hughes 1995). These reference areas were not permanently identified and could not be found in later monitoring efforts. Hughes also noted that maintenance irrigation was applied to selected areas of PSN 72/82 and PSN 12/14 throughout the growing season. The Bridge Overlook transplants and approximately 900 of the PSN 12/14 transplants did not receive supplemental irrigation because of their remote location. The different irrigation regimes were done to test the effect of watering on transplant establishment. Unfortunately, the selected areas and plants that were irrigated were not identified in the field by markings or on a map; therefore, monitoring of these treatments was not possible.

4.2 BRIDGE OVERLOOK

The Bridge Overlook site is located approximately 1.6 km (1 mi) northwest of the Vernita Bridge (Figure 4-1). The vegetation on the Bridge Overlook site was measured on May 10, 2000. This year, a total of 29 plant species were identified on the waste site, 25 of which were native (Table 4-1). Eight additional species were observed on the waste site this year that were not seen in 1999. These included Sandberg's bluegrass, pine bluegrass, bottlebrush squirreltail, six-weeks fescue, bitterbrush, whitestem stickleaf (*Mentzelia albicaulis*), spring whitlow, and jagged chickweed. Cheatgrass remains the most dominant plant in the canopy cover with 20.8% cover on the waste site and 47.5% cover on the reference site. Dune scurfpea (*Psoralea lanceolata*), a rhizomatous soil stabilizing legume had a canopy cover of 12.2% on the waste site. Snow buckwheat cover increased from 2.3% in 1999 to 4.4% in 2000. In addition, turpentine springparsley (*Cymopterus terebinthinus*) increased from an observance on the site in 1999, to 3.4% cover in the plot frames. Total cover on the waste site is up 10% from last year. The cryptobiotic crust, which was 5.9% in 1999, increased to 23.4% in 2000, and has a 96% frequency of occurrence on the waste site (Table 4-2). Wide-spread occurrence of cryptobiotic crust suggests that the site has begun to stabilize and will continue to promote establishment of native species.

Figure 4-1. Bridge Overlook and PSN 72/82 Revegetation Sites.



North Slope Sites

Table 4-1. Percent Canopy Cover on Bridge Overlook Sites in 2000.

Species	Waste Site	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	20.8	47.5
<i>Salsola kali</i> * (Russian thistle)	2.3	0.2
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.8	0.3
<i>Psoralea lanceolata</i> (dune scurfpea)	12.2	0.3
<i>Stipa comata</i> (needle-and-thread-grass)	1.3	--
<i>Gilia leptomeria</i> (Great Basin gilia)	4.1	3
<i>Mentzelia albicaulis</i> (whitestem stickleaf)	1.6	0.4
<i>Oenothera pallida</i> (evening primrose)	0.7	X
<i>Descurainia pinnata</i> (western tansymustard)	5.4	3.6
<i>Cryptantha circumscissa</i> (matted cryptantha)	0.6	1.3
<i>Eriogonum niveum</i> (snow buckwheat)	4.4	5.5
<i>Artemisia tridentata</i> (big sagebrush)	X	7.6
<i>Purshia tridentata</i> (antelope bitterbrush)	2.5	3.1
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	--	0.8
<i>Grayia spinosa</i> (spiny hopsage)	1.5	8.7
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	X	1.3
<i>Festuca octoflora</i> (six-weeks fescue)	0.3	0.6
<i>Cymopterus terebinthinus</i> (turpentine springparsley)	3.4	4.4
<i>Layia grandulosa</i> (white-daisy tidytips)	0.7	0.9
<i>Comandra umbellatum</i> (bastard toadflax)	--	2.1
<i>Microsteris gracilis</i> (annual phlox)	0.1	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	0.9
<i>Machaeranthera canescens</i> (hoary aster)	3.1	0.7
<i>Cryptantha pterocarya</i> (winged cryptantha)	0.5	1.4
<i>Poa sandbergii</i> (Sandberg's bluegrass)	X	0.1
<i>Koeleria cristata</i> (prairie junegrass)	1.5	X
<i>Poa scabrella</i> (pine bluegrass)	X	--
<i>Sitanion hystrix</i> (bottlebrush-squirreltail)	0.6	--
<i>Draba verna</i> (spring whitlow)	0.1	--
<i>Holosteum umbellatum</i> * (jagged chickweed)	0.1	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	X
<i>Sisymbrium altissimum</i> * (tumblemustard)	X	--
<i>Phlox longifolia</i> (longleaf phlox)	--	0.1
<i>Abronia millifera</i> (white sandverbena)	--	0.6
<i>Erysimum asperum</i> (rough wallflower)	--	0.1
Cryptobiotic crust	23.4	57.5
Bare soil	40.6	21.6
Litter	49.1	62
Total (does not include crust, soil, or litter)	68.6	95.5

* Introduced species.

X = Present but not counted in plot frames.

-- = Not occurring on site.

North Slope Sites

Table 4-2. Percent Frequency of Occurrence on Bridge Overlook Sites in 2000.

Species	Waste Site	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	88	100
<i>Salsola kali</i> * (Russian thistle)	72	8
<i>Ambrosia acanthicarpa</i> (bur ragweed)	32	12
<i>Psoralea lanceolata</i> (dune scurfpea)	64	12
<i>Stipa comata</i> (needle-and-thread-grass)	12	--
<i>Gilia leptomeria</i> (Great Basin gilia)	64	60
<i>Mentzelia albicaulis</i> (whitestem stickleaf)	24	16
<i>Oenothera pallida</i> (evening primrose)	8	X
<i>Descurainia pinnata</i> (western tansymustard)	76	84
<i>Cryptantha circumscissa</i> (matted cryptantha)	24	52
<i>Eriogonum niveum</i> (snow buckwheat)	20	60
<i>Artemisia tridentata</i> (big sagebrush)	X	20
<i>Purshia tridentata</i> (antelope bitterbrush)	4	8
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	--	12
<i>Grayia spinosa</i> (spiny hopsage)	4	24
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	X	12
<i>Festuca octoflora</i> (six-weeks fescue)	12	24
<i>Cymopterus terebinthinus</i> (turpentine springparsley)	4	24
<i>Layia grandulosa</i> (white-daisy tidytips)	8	36
<i>Comandra umbellatum</i> (bastard toadflax)	--	44
<i>Microsteris gracilis</i> (annual phlox)	4	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	16
<i>Machaeranthera canescens</i> (hoary aster)	12	8
<i>Cryptantha pterocarya</i> (winged cryptantha)	20	36
<i>Poa sandbergii</i> (Sandberg's bluegrass)	--	4
<i>Koeleria cristata</i> (prairie junegrass)	X	X
<i>Poa scabrella</i> (pine bluegrass)	4	--
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	X	--
<i>Draba verna</i> (spring whitlow)	4	--
<i>Holosteum umbellatum</i> * (jagged chickweed)	4	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	4	X
<i>Sisymbrium altissimum</i> * (tumblemustard)	X	--
<i>Phlox longifolia</i> (longleaf phlox)	X	4
<i>Abronia millifera</i> (white sandverbena)	--	4
<i>Erysimum asperum</i> (rough wallflower)	--	4
Cryptobiotic crust	96	96
Bare soil	100	76
Litter	100	100

* Introduced species.

X = Present but not counted in plot frames.

-- = Not occurring on site.

North Slope Sites

The reference area just west of the waste site contained 28 plant species observed on the site, of which 26 were native. The reference site had a cryptobiotic crust component of 57.5% and a dominant shrub canopy of spiny hopsage (*Grayia spinosa*) with 8.7% and sagebrush with 7.6% cover. The reference site had a diverse forb and bunchgrass understory community including snow buckwheat, tansymustard (*Descurainia spp.*), turpentine springparsley, Great Basin gilia (*Gilia leptomeria*), and Indian ricegrass.

The survival of transplanted bunchgrasses was very difficult to determine due to the lack of documentation on the number of plants planted and original planting patterns. Furthermore, as plants die and organic material decomposes or blows away, it becomes impossible to distinguish where the transplants resided. The results of survival counts then become artificially high because only the survivors can be counted. Therefore, survival has not been measured in recent years. However, observable bunchgrass recruitment throughout the site indicates continued recovery of the understory community.

Trends in canopy cover were examined over a duration of 4 years on the Bridge Overlook site (Figure 4-2). The species examined were cheatgrass, Russian thistle, bunchgrasses, and cryptobiotic crust. Cheatgrass cover increased 15% over the 4 years, but remains within an expected cover class at 21% cover. This site is small at approximately 0.01 ha with mature stands of shrubs and native perennials surrounding the site, likely attributing to reduced cheatgrass cover as additional native species move into the area and compete for resources.

Russian thistle cover has remained less than 5% from 1997 to 2000. Russian thistle cover is low at 2.3% cover in 2000. This cover is not expected to increase in the future, but rather maintain or even fall as a result of competition from native species. This species does not significantly contribute to the functioning community.

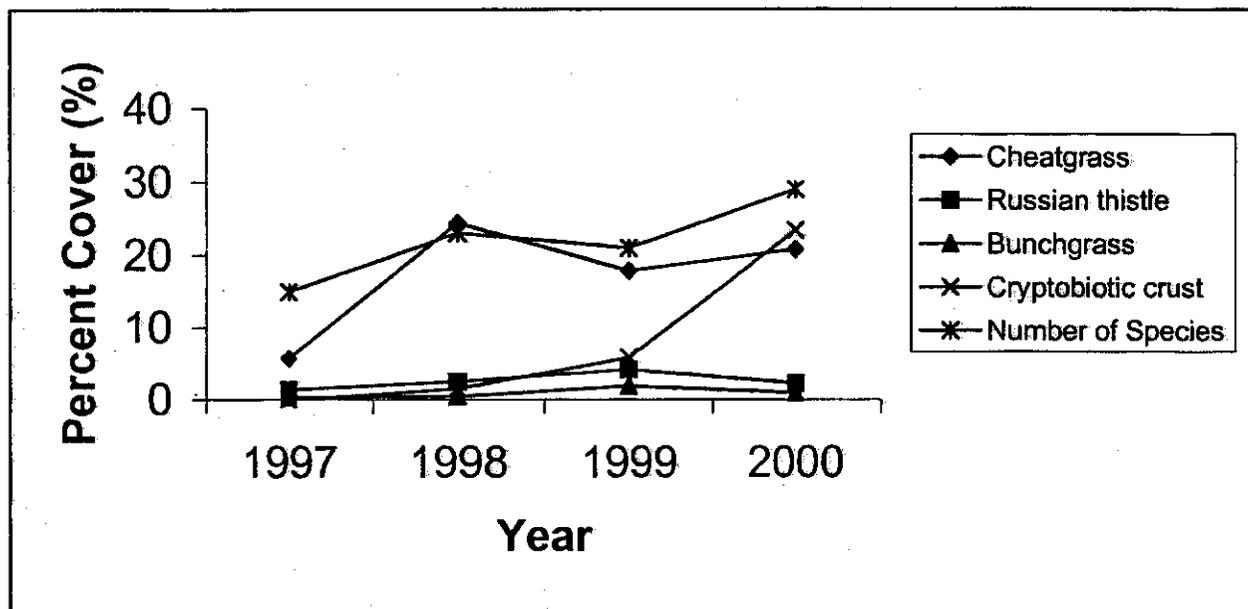
The species included in the canopy cover of bunchgrasses include needle-and-thread grass, Indian ricegrass, six-weeks fescue, Sandberg's bluegrass, prairie junegrass, pine bluegrass, and bottlebrush squirreltail. Bunchgrass has maintained a low cover around 1% despite transplantation of several species. However, the biotic crust has developed since 1997 to yield a cover of 23.4% this year, suggesting that the soils have begun to stabilize and increased recruitment of native species including bunchgrasses is expected.

This year was the fifth year of recovery for the vegetation at this site. Monitoring of the recovery has been conducted since 1997. The objectives of restoration at this site were to stabilize the soil surface and to restore the vegetation to a plant community dominated by indigenous species. The results from monitoring efforts show that both objectives have been met, and plant succession at the site continues to progress toward a late seral community typical of the surrounding habitat.

On April 25, 2000, the site was toured by representatives of DOE-RL, EPA, and BHI to assess the adequacy of the revegetation effort and determine whether the goals had been met. The lead regulatory agency (EPA) agreed that the revegetation objectives had been met and that no further monitoring was required.

North Slope Sites

Figure 4-2. Comparison of Canopy Cover Trends on Bridge Overlook, 1997-2000.



4.3 PSN 72/82

The PSN 72/82 site is located near the Bridge Overlook site (Figures 1-1 and 4-1). The areas that were revegetated included the PSN 72/82 Well Mound and a small staging area on the access road adjacent to the Well Mound. Sagebrush tubelings and bunchgrass plants salvaged from ERDF were planted on the Well Mound in March 1995, with fertilizer added to each hole. The 2000 vegetation survey of the Well Mound site identified 22 species, of which 17 were native species (Table 4-3). Shrub cover of sagebrush and gray rabbitbrush on the site has fallen slightly from 1999; this change is not due to mortality, but rather the random placement of the plot frames. Recruitment of gray rabbitbrush is continuing as seen in the increase of frequency from 6.7% in 1999 to 36% in 2000 (Table 4-4). The four bunchgrass species initially transplanted onto the site were prairie junegrass, Indian ricegrass, Sandberg's bluegrass, and needle-and-thread grass. The percent canopy cover for most species has not changed much since 1999. Cryptobiotic crust cover has significantly increased since last year from 19.8% to 47.6% cover. Bunchgrass and sagebrush survival was not counted this year because it was too difficult to distinguish the transplants from recruitment that had occurred within the last 5 years. The bunchgrasses and sagebrush are producing seed and recruitment is continuing on the site.

North Slope Sites

Table 4-3. Percent Canopy Cover on PSN 72/82 Well Mound Sites in 2000.

Species	Waste Site	Road	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	36.5	22.9	57
<i>Salsola kali</i> * (Russian thistle)	0.6	--	--
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.7	1	--
<i>Oenothera pallida</i> (evening primrose)	0.7	0.6	--
<i>Artemisia tridentata</i> (big sagebrush)	0.7	1.6	26.9
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	1.4	1.5	0.2
<i>Poa sandbergii</i> (Sandberg's bluegrass)	0.6	4.4	10.4
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	X	--	--
<i>Stipa comata</i> (needle-and-thread grass)	2.5	X	--
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	X	--	--
<i>Festuca octoflora</i> (six-weeks fescue)	6	16.9	1.2
<i>Microsteris gracilis</i> (annual phlox)	1.7	4.8	5.5
<i>Holosteum umbellatum</i> * (jagged chickweed)	1	0.8	--
<i>Draba verna</i> (spring whitlow)	2.7	0.5	13.5
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.1	0.4	2.1
<i>Sisymbrium altissimum</i> * (tumblemustard)	1.4	0.5	0.7
<i>Descurainia pinnata</i> (western tansymustard)	0.1	X	0.3
<i>Erodium cicutarium</i> * (storksbill)	11.8	1.6	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	X	0.1	5
<i>Machaeranthera canescens</i> (hoary aster)	3.9	5.9	--
<i>Cryptantha circumscissa</i> (matted cryptantha)	--	1.4	0.1
<i>Eriogonum niveum</i> (snow buckwheat)	--	3.1	--
<i>Plantago patagonica</i> (Indian wheat)	--	1.5	--
<i>Gilia leptomeria</i> (Great Basin gilia)	--	0.6	0.2
<i>Cryptantha pterocarya</i> (winged cryptantha)	--	0.1	0.3
<i>Astragalus caricinus</i> (buckwheat milkvetch)	1.5	--	--
<i>Agropyron cristatum</i> * (crested wheatgrass)	--	--	1.2
<i>Phlox longifolia</i> (longleaf phlox)	--	--	0.6
<i>Epilobium paniculatum</i> (tall willowherb)	0.2	0.1	0.1
<i>Descurainia spp.</i> * (tansymustard)	--	--	0.8
Cryptobiotic crust	47.6	27.2	72.8
Bare soil	44.3	55.1	24.5
Litter	49.4	33.6	65.6
Total (does not include crust, soil, or litter)	74.1	70.9	126.1

* = Introduced species.

X = Present but not counted in plot frame.

-- = Not occurring on site.

North Slope Sites

Table 4-4. Percent Frequency of Occurrence on PSN 72/82 Well Mound Sites in 2000.

Species	Waste Site	Road	Control Site
<i>Bromus tectorum</i> * (cheatgrass)	100	96	100
<i>Salsola kali</i> * (Russian thistle)	24	--	--
<i>Ambrosia acanthicarpa</i> (bur ragweed)	28	40	--
<i>Oenothera pallida</i> (evening primrose)	8	4	--
<i>Artemisia tridentata</i> (big sagebrush)	8	8	76
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	36	40	8
<i>Poa sandbergii</i> (Sandberg's bluegrass)	4	36	68
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	X	--	--
<i>Stipa comata</i> (needle-and-thread grass)	40	X	--
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	X	--	--
<i>Festuca octoflora</i> (six-weeks fescue)	48	96	28
<i>Microsteris gracilis</i> (annual phlox)	68	96	84
<i>Holosteum umbellatum</i> * (jagged chickweed)	20	32	--
<i>Draba verna</i> (spring whitlow)	48	20	48
<i>Amsinckia lycopoides</i> (tarweed fiddleneck)	4	16	28
<i>Sisymbrium altissimum</i> * (tumblemustard)	16	20	28
<i>Descurainia pinnata</i> (western tansymustard)	4	X	12
<i>Erodium cicutarium</i> * (storksbill)	84	24	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	X	4	24
<i>Machaeranthera canescens</i> (hoary aster)	56	56	--
<i>Cryptantha circumscissa</i> (matted cryptantha)	--	36	4
<i>Eriogonum niveum</i> (snow buckwheat)	--	48	--
<i>Plantago patagonica</i> (Indian wheat)	--	40	--
<i>Gilia leptomeria</i> (Great Basin gilia)	--	24	8
<i>Cryptantha pterocarya</i> (winged cryptantha)	--	4	12
<i>Astragalus caricinus</i> (buckwheat milkvetch)	4	--	--
<i>Agropyron cristatum</i> * (crested wheatgrass)	--	--	8
<i>Phlox longifolia</i> (longleaf phlox)	--	--	4
<i>Epilobium paniculatum</i> (tall willowherb)	8	4	4
<i>Descurainia spp.</i> * (tansymustard)	--	--	32
Cryptobiotic crust	100	96	100
Bare soil	100	100	88
Litter	100	100	100

* Introduced species.

X = Present but not counted in plot frames.

-- = Not occurring on site.

On the reference site, a total of 18 plant species were identified, 14 of which were native species. Big sagebrush with 26.9% cover was the dominant shrub overstory species, with cheatgrass (57% cover), Sandberg's bluegrass (10.4% cover), and six-weeks fescue (1.2% cover) being the main grasses present. The cryptobiotic crust and bare soil cover were 72.8% and 24.5%, respectively. Litter cover decreased from 83.2% in 1999 to 65.6% in 2000.

North Slope Sites

The small staging area (road) adjacent to the Well Mound site was planted in the fall of 1996 with a seed mix of sagebrush, snow buckwheat, turpentine springparsley, Carey's balsamroot, and Sandberg's bluegrass. A total of 23 plant species were identified, 19 of which were native (Table 4-3). All planted species, except turpentine springparsley, were observed on the site. The percent canopy cover increased from 12.8% to 16.9% in 2000 for six-weeks fescue and 0.3% to 4.4% for Sandberg's bluegrass. In addition to the planted species, the site is being colonized by many native species including annual phlox, spring whitlow, Indian wheat, hoary aster, and matted as well as winged cryptantha. The frequency of snow buckwheat, Indian wheat, and Great Basin gilia has roughly doubled since 1999, and the cryptobiotic crust development has significantly increased from 3.1% to 27.2% cover in 2000.

Trends in canopy cover were examined for a duration of 4 years for the PSN 72/82 waste site (Figure 4-3). Species examined were cheatgrass, Russian thistle, bunchgrasses, and cryptobiotic crust. Russian thistle canopy cover was low all 4 years, around 1% cover. Cheatgrass demonstrated an overall increase of 13.4% over the 4-year monitoring period with 36.5% cover observed this year. However, cheatgrass cover is not anticipated to increase in future years due to increased competitiveness of native species.

The grasses on the PSN 72/82 site monitored for trends in canopy cover included needle-and-thread grass, Indian ricegrass, six-weeks fescue, Sandberg's bluegrass, Prairie junegrass, pine bluegrass, and bottlebrush squirreltail. Grasses showed an increasing trend in abundance increasing from 0.24% cover in 1997 to slightly more than 3% cover in 2000. Individual grass species also showed an increase in representation from year to year.

Cryptobiotic development is a key factor in soil stabilization. Crust development significantly increased from 0.1% cover in 1997 to 47.6% cover in 2000. Biotic crust is composed of important elements including lichens, cyanobacteria, green algae, and microfungi. Biotic crust increases water holding capacity, soil stability, and fertility enhancing seed germination and establishment.

Plant succession on the PSN 72/82 revegetation sites appears to be progressing, but at a slower rate than other sites. However, species diversity is very good with 30 species identified on the site. Additionally, biotic crust was observed in all the plot frames during the monitoring efforts, suggesting that the areas are recovering well. The waste site is progressing through succession with species moving onto the waste site from adjacent undisturbed areas.

4.4 PSN 12/14

The PSN 12/14 site is located in the northeast corner of the Hanford Site, approximately 6.4 km east of the White Bluffs Landing (Figures 1-1 and 4-4). Both sagebrush tubelings and salvaged bunchgrasses from ERDF were planted on all seven PSN 12/14 plots from March 27 through April 1, 1995. The access road into the PSN 12/14 waste sites was revegetated in the fall of 1996 with a seed mix consisting of sagebrush, bitterbrush, snow buckwheat, turpentine springparsley, Carey's balsamroot, and Sandberg's bluegrass.

North Slope Sites

Figure 4-3. Comparison of Canopy Cover Trends on PSN 72/82 Well Mound Sites, 1997-2000.

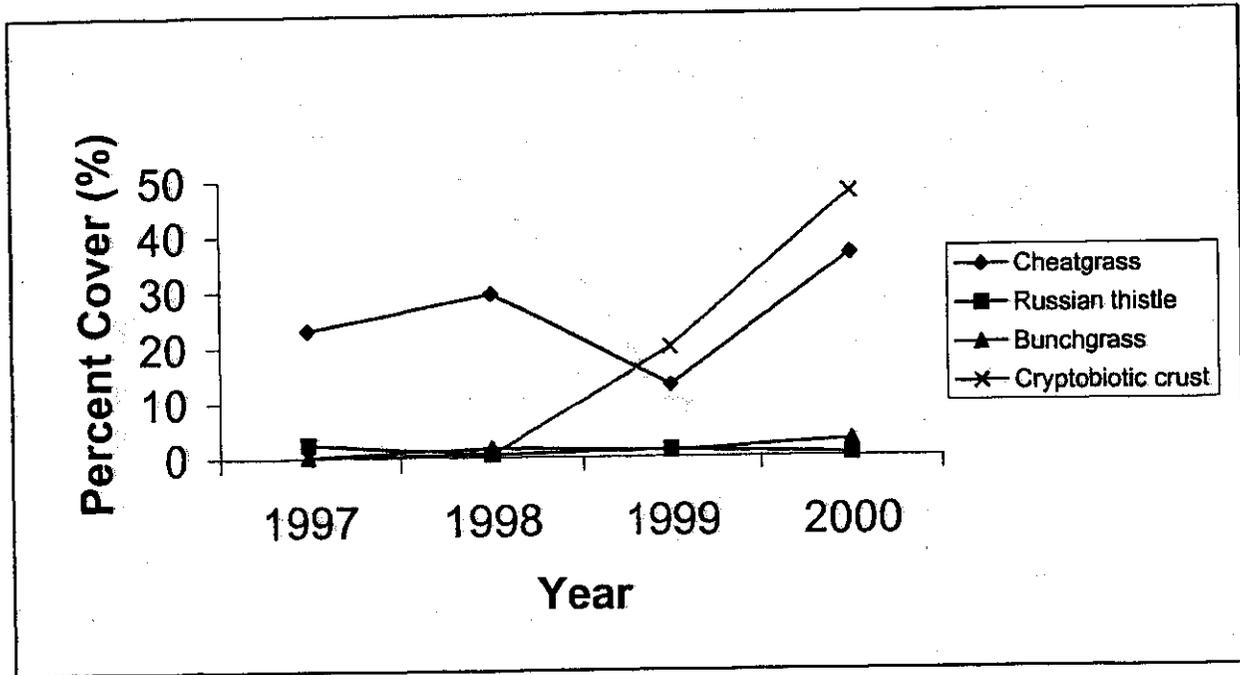
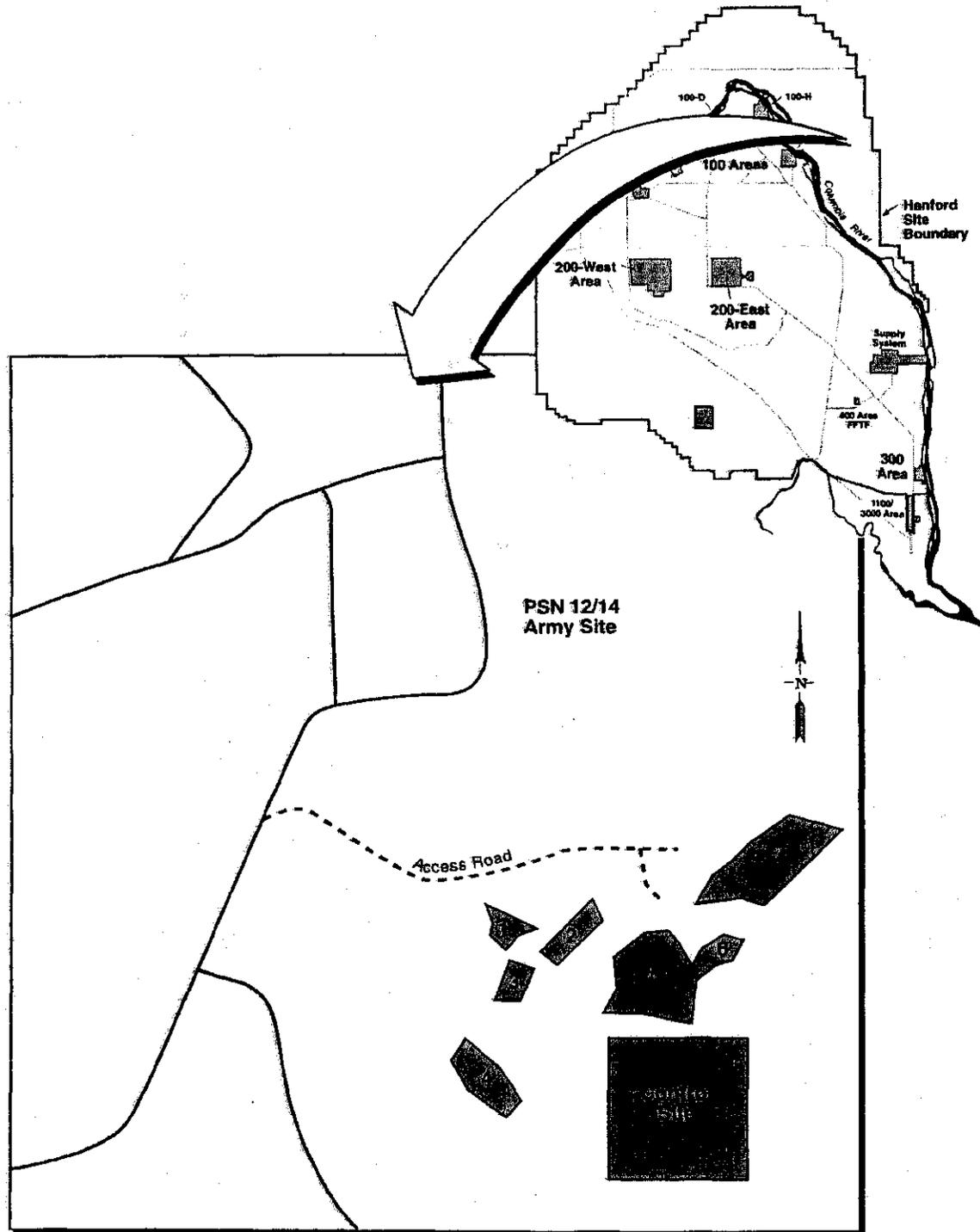


Figure 4-4. PSN 12/14 Revegetation Sites.



E0009051.2

North Slope Sites

On May 11, 2000, monitoring consisted of estimating percent canopy cover and percent frequency of occurrence on plots 1, 2, 4, and 5, the access road, and a reference site. Survival of the transplanted bunchgrasses was also evaluated on plot 5 finding an estimated survival of 56% (Table 3-3). An accurate estimate of transplant survival was difficult to determine due to success of recruitment plants.

The access road had 26 species observed on the revegetated surface, 20 of which were native species; six more than observed in 1999 (Table 4-5). The new species colonizing the road in 2000 included annual phlox, Indian wheat, rough wallflower, storksbill (*Erodium cicutarium*), yellow salsify, and threadleaf scorpionweed. The road remains dominated by cheatgrass with cover of 18%, slightly higher than 11% in 1999, but significantly lower than 45.2% observed in 1998. Cryptobiotic crust and litter cover has increased substantially this year, yielding an increase of 20.8% and 20.9%, respectively, from 1999.

On the waste sites, all plots remain dominated by cheatgrass. Plots 1, 2, and 4 have increased cheatgrass coverage from last year by 9.8%, 26.8% and 5.6% respectively, while plot 5 cheatgrass cover fell slightly from 19.8% to 16% in 2000. Russian thistle coverage fell across all plots; each has cover of less than 1%. Sandberg's bluegrass cover increased across all plots, with the exception of plot 5. Sandberg's bluegrass had the greatest increase on plots 2 and 4 with increases from 3.6% to 10.1% and 6.9% to 18.8%, respectively. Cryptobiotic crust cover increased across all plots. The greatest increase occurred on plots 1 and 2 with increases of 22.2% and 15.2%. Plot 4 had the highest cover and frequency of bunchgrasses, while plot 5 had the greatest species diversity of bunchgrass occurrence. As anticipated, all plots are demonstrating active bunchgrass recruitment.

On the reference site, a total of 27 species were identified, 22 of which were native. Cheatgrass had a 100% frequency (Table 4-6) with a canopy cover of 54.8%, down from 63.3% cover in 1999. The shrub canopy included sagebrush, bitterbrush, and green (*Chrysothamnus viscidiflorus*) and gray rabbitbrush. The bunchgrass understory consisted of Sandberg's bluegrass and six-weeks fescue, while the forbs included turpentine springparsley, Carey's balsamroot, annual phlox, bastard toadflax (*Comandra umbellata*), and yarrow.

Trends in canopy cover have been monitored for 4 years for Russian thistle, bunchgrasses, and shrubs occurring on the site. Values from all five plots were combined to produce overall trends for the PSN12/14 site (Figure 4-5). Russian thistle cover has remained low, with the maximum cover of 4.3% in 1999 and the lowest cover of 0.6% in 2000. The bunchgrasses monitored for canopy cover trends were Sandberg's bluegrass, needle-and-thread grass, Indian ricegrass, thickspike wheatgrass, six-weeks fescue, pine bluegrass, prairie junegrass, and bottlebrush squirreltail. Bunchgrass cover has increased from 4.9% cover in 1997 to 21.9% cover in 2000, suggesting that the transplanted species have been producing viable seed and initiating regeneration within the site, further stabilizing the soil.

The shrubs monitored for canopy cover were sagebrush, bitterbrush, and gray and green rabbitbrush. Shrub canopy cover has increased from 1% to 6% cover in the last 4 years. Shrub cover increased as a result of individual plants maturing and producing seedlings.

North Slope Sites

Table 4-5. Percent Canopy Cover on PSN 12/14 Sites in 2000.

Species	Reference	Plot 5	Plot 4	Plot 2	Plot 1	Road
<i>Bromus tectorum</i> * (cheatgrass)	54.8	16	39.9	54.8	47.1	18
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.4	2.4	1.2	1.5	0.5	3.4
<i>Sisymbrium altissimum</i> * (tumblemustard)	0.4	0.4	1.5	7.1	6.9	0.1
<i>Salsola kali</i> * (Russian thistle)	0.3	0.3	0.9	0.7	0.9	0.2
<i>Artemisia tridentata</i> (big sagebrush)	20.6	0.6	1.6	2.6	5.2	1.3
<i>Purshia tridentata</i> (antelope bitterbrush)	1.5	--	--	--	--	--
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	6.1	X	X	X	--	0.7
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	X	X	X	0.3	4.7	3.9
<i>Poa sandbergii</i> (Sandberg's bluegrass)	16.9	X	18.8	10.1	7.9	4.2
<i>Stipa comata</i> (needle-and-thread grass)	--	7.8	6.2	10.2	3.1	--
<i>Oryzopsis hymenoides</i> (Indian Ricegrass)	--	1.9	X	X	0.1	--
<i>Agropyron dasythachyum</i> (thickspike wheatgrass)	--	1.6	--	--	--	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.7	0.1	X	2.3	0.2	0.4
<i>Cymopterus terebinthinus</i> (turpentine springparsley)	2.7	--	X	X	X	--
<i>Descurainia pinnata</i> (western tansymustard)	0.4	2	0.4	--	--	0.6
<i>Epilobium paniculatum</i> (tall willowherb)	0.5	X	1.6	0.3	0.6	0.7
<i>Eriogonum niveum</i> (snow buckwheat)	X	0.7	2.6	--	--	5.4
<i>Festuca octoflora</i> (six-weeks fescue)	1.8	1.9	0.3	0.2	0.3	1.4
<i>Holosteum umbellatum</i> * (jagged chickweed)	6.8	6	14.3	19.1	21	4.8
<i>Draba verna</i> (spring whitflow)	16.8	0.1	1.4	1.7	8.7	1.3
<i>Lactuca serriola</i> * (prickly lettuce)	--	0.1	1.1	--	0.1	--
<i>Machaeranthera canescens</i> (hoary aster)	0.7	0.1	6.2	0.1	1.4	0.3
<i>Microsteris gracilis</i> (annual phlox)	3.4	0.1	0.4	9	2.5	3.1
<i>Oenothera pallida</i> (evening primrose)	1.2	1	X	0.1	--	--
<i>Phlox longifolia</i> (longleaf phlox)	--	X	0.1	--	1.5	--
<i>Comandra umbellatum</i> (bastard toadflax)	3.2	--	X	--	--	--
<i>Achillea millefolium</i> (yarrow)	1.2	0.7	1.7	1.8	5.9	0.1
<i>Tragopogon dubius</i> * (yellow salsify)	X	--	X	0.1	--	X
<i>Psoralea lanceolata</i> (dune scurfpea)	--	--	--	3.3	--	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	2.8	--	X	--	--	0.2
<i>Lappula redowskii</i> (Western stickweed)	--	--	--	--	--	0.1
<i>Poa scabrella</i> (pine bluegrass)	--	0.6	--	--	--	--
<i>Koeleria cristata</i> (prairie junegrass)	--	X	--	--	--	--
<i>Brodiaea douglasii</i> (Douglas' clusterlily)	X	--	--	X	--	--
<i>Astragalus carcinus</i> (buckwheat milkvetch)	--	--	X	--	--	2.5
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	--	X	--	--	--	--
<i>Fritillaria pudica</i> (yellow bell)	0.1	X	X	--	--	--
<i>Cryptantha circumscissa</i> (matted cryptantha)	--	0.3	--	0.1	--	--
<i>Plantago patagonica</i> (Indian wheat)	--	--	--	--	--	0.3
<i>Phacelia linearis</i> (threadleaf scorpionweed)	--	X	X	--	--	X
<i>Erysimum asperum</i> (rough wallflower)	0.2	0.2	--	--	--	0.2
<i>Erodium cicutarium</i> * (storksbill)	--	--	--	--	--	1
<i>Layia grandulosa</i> (white-daisy tidytips)	--	--	X	--	--	--
Cryptobiotic crust	65.2	0.3	52.9	19.6	63.5	20.8
Bare soil	25.9	68.9	30	30.9	37.1	67.3
Litter	66.7	21.1	64.9	62.5	59.3	22.1
Total cover (does not include crust, soil, or litter)	143.5	44.9	100.2	125.4	118.6	54.2

* Introduced species.

X = Present but not counted in plot frames.

-- = Not occurring on the plot.

North Slope Sites

Table 4-6. Percent Frequency of Occurrence on PSN 12/14 Sites in 2000.

Species	Reference	Plot 5	Plot 4	Plot 2	Plot 1	Road
<i>Bromus tectorum</i> * (cheatgrass)	100	96	100	100	100	100
<i>Ambrosia acanthicarpa</i> (bur ragweed)	16	76	48	40	20	96
<i>Sisymbrium altissimum</i> * (tumblemustard)	16	16	40	88	48	4
<i>Salsola kali</i> * (Russian thistle)	12	12	36	28	16	8
<i>Artemisia tridentata</i> (big sagebrush)	48	4	24	8	40	12
<i>Purshia tridentata</i> (antelope bitterbrush)	4	--	--	--	--	--
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	16	X	X	X	--	8
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	X	X	X	12	36	36
<i>Poa sandbergii</i> (Sandberg's bluegrass)	64	X	88	44	32	52
<i>Stipa comata</i> (needle-and-thread grass)	--	64	40	60	28	--
<i>Oryzopsis hymenoides</i> (Indian Ricegrass)	--	16	X	X	4	--
<i>Agropyron dasytachyum</i> (thickspike wheatgrass)	--	24	--	--	--	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	8	4	X	16	8	16
<i>Cymopterus terebinthinus</i> (turpentine springparsley)	12	--	X	X	X	--
<i>Descurainia pinnata</i> (western tansymustard)	16	60	16	--	--	24
<i>Epilobium paniculatum</i> (tall willowherb)	20	X	44	12	24	28
<i>Eriogonum niveum</i> (snow buckwheat)	X	8	8	--	--	44
<i>Festuca octoflora</i> (six-weeks fescue)	12	36	12	8	12	56
<i>Holosteum umbellatum</i> * (jagged chickweed)	80	64	96	92	96	92
<i>Draba verna</i> (spring whitlow)	80	4	16	28	44	52
<i>Lactuca serriola</i> * (prickly lettuce)	--	4	44	--	4	--
<i>Machaeranthera canescens</i> (hoary aster)	8	4	56	4	16	12
<i>Microsteris gracilis</i> (annual phlox)	56	4	16	92	60	84
<i>Oenothera pallida</i> (pale evening primrose)	8	20	X	4	--	--
<i>Phlox longifolia</i> (longleaf phlox)	--	X	4	--	4	--
<i>Comandra umbellatum</i> (bastard toadflax)	28	--	X	--	--	--
<i>Achillea millefolium</i> (yarrow)	8	8	12	16	8	4
<i>Tragopogon dubius</i> * (yellow salsify)	X	--	X	4	--	X
<i>Psoralea lanceolata</i> (dune scurfpea)	--	--	--	16	--	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	16	--	X	--	--	8
<i>Lappula redowskii</i> (Western stickweed)	--	--	--	--	--	4
<i>Poa scabrella</i> (pine bluegrass)	--	4	--	--	--	--
<i>Koeleria cristata</i> (prairie junegrass)	--	X	--	--	--	--
<i>Brodiaea douglasii</i> (Douglas' clusterlily)	X	--	--	X	--	--
<i>Astragalus caricimus</i> (buckwheat milkvetch)	--	--	X	--	--	4
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	--	X	--	--	--	--
<i>Fritillaria pudica</i> (yellow bell)	4	X	X	--	--	--
<i>Cryptantha circumscissa</i> (matted cryptantha)	--	12	--	4	--	--
<i>Plantago patagonica</i> (Indian wheat)	--	--	--	--	--	12
<i>Phacelia linearis</i> (threadleaf scorpionweed)	--	--	X	--	--	X
<i>Erysimum asperum</i> (rough wallflower)	8	8	--	--	--	8
<i>Erodium cicutarium</i> * (storksbill)	--	--	--	--	--	20
<i>Layia grandulosa</i> (white-daisy tidytips)	--	--	X	--	--	--
Cryptobiotic crust	100	12	96	84	96	100
Bare soil	100	100	84	72	92	100
Litter	100	100	100	100	100	100

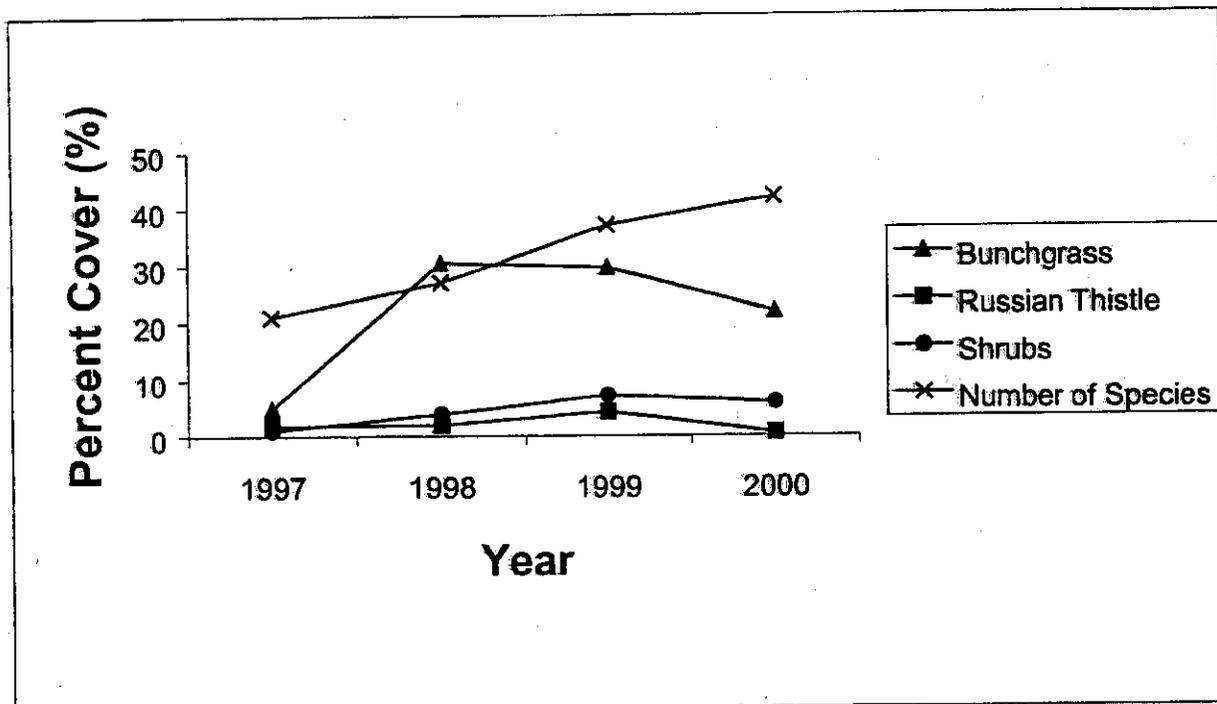
* Introduced species.

X = Present but not counted in plot frames.

-- = Not occurring on the plot.

North Slope Sites

Figure 4-5. Comparison of Canopy Cover Trends on PSN 12/14 Sites, 1997-2000.



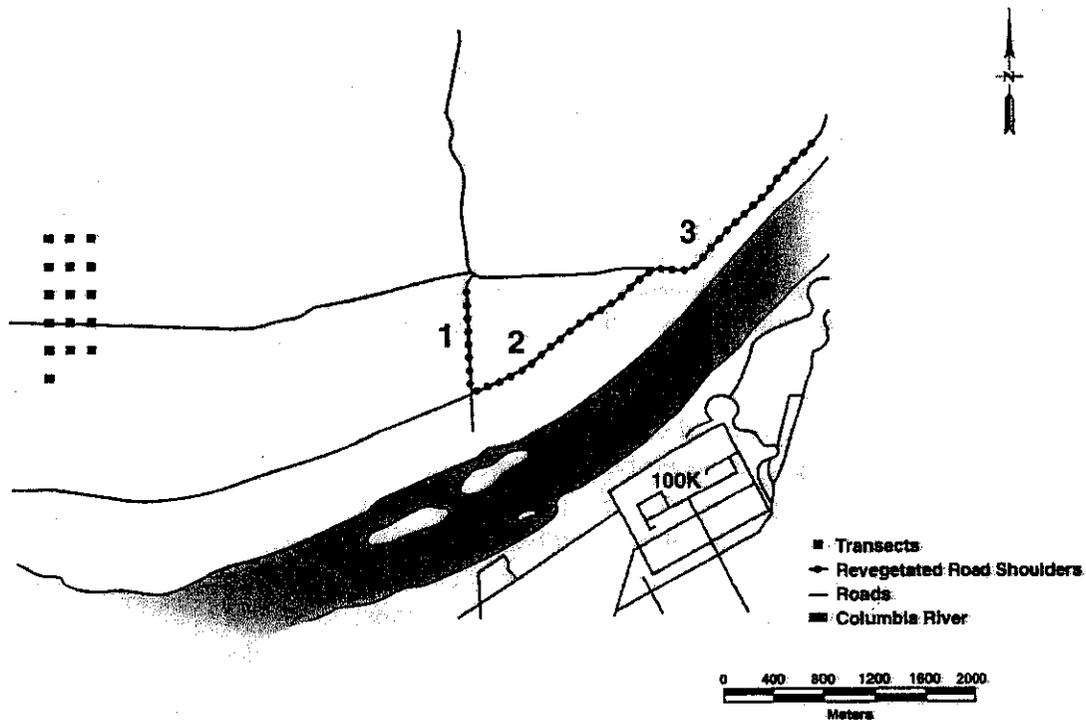
4.5 NORTH SLOPE CHEATGRASS AREA

Sagebrush seedlings were planted in August and October, 1996 in a burned area on the Saddle Mountain Wildlife Refuge (Figures 1-1 and 4-6). These burned areas have had the sagebrush component removed due to repeated wildfires. The objective of this planting was to provide a seed source in the area to promote sagebrush regeneration.

Approximately 3,000 sagebrush were planted in groups of 3 along an access road in August 1996. These sagebrush were salvaged as seedlings from gravel pits at the junction of the access road and Highway Route 24. Different planting methods were used during the August 1996 transplanting. All of the sagebrush were planted directly in the ground and watered. In one treatment, sagebrush were surrounded by black plastic to help control weed competition. Sagebrush in another treatment were planted with Dri-Water™, a commercial product composed of a vegetable gel that slowly releases water into soil over an extended period of time. The survival of these sagebrush was extremely poor; only 5.5% after the first year. Therefore, these two treatment areas were not monitored in 2000.

™ Dri-Water is a trademark of Dri-Water, Inc., Petaluma, California.

Figure 4-6. Sagebrush Transplant Sites on the North Slope Cheatgrass Area.



E99060692

Approximately 2,700 sagebrush were planted in October 1996. These sagebrush were salvaged from an area south of the Hanford Site's 300 Area. The plantings were done in groups of three along the access road (road transect) and in small transect plots that were established perpendicular to the access road. The road transect was divided into three sections (Figure 4-6) and surveyed for survivorship in May 2000. Sagebrush survival for sections 1, 2, and 3 were 80%, 74.5%, and 78.8%, respectively, with an average survival of 77.4%. The average height of the sagebrush for all three sections was 39 cm and ranged from 11 cm to 60 cm. Sagebrush survival did not change in the last year. The survival counts were nearly identical with 79.9%, 74.2%, and 76% for sections 1, 2, and 3 respectively in 1999. Some of the sagebrush in sections 2 and 3 have begun producing seed, resulting in several sagebrush seedlings growing in the road area, demonstrating that the planted sagebrush have initiated regeneration to the area. In addition, sagebrush survivorship measured this year is still considered very good and is beginning to meet the objectives of this planting by providing a seed source to reestablish sagebrush in this area.

The dramatic improvement in survivorship of sagebrush planted in October versus August shows that late summer planting may not be a successful approach. High average daily temperatures (92.6° F) (Hoitink and Burk 1997) and injury to root systems while salvaging sagebrush from gravelly soils were primary factors in the low survivorship of the August 1997 plantings.

North Slope Sites

4.6 WASTE SITE 600-104

Waste site 600-104 (2,4-D site) is located approximately 9.7 km south of PSN 12/14 and approximately 1 km east of the Columbia River (Figure 1-1). The 1 hectare site was used by the Bureau of Reclamation to dispose of 11 empty tanks and soil contaminated with 2,4-D. In 1997, prior to remediation the site was dominated primarily by cheatgrass and tumbled mustard. In August 1997, the tanks were exhumed and bio-remediation of 2,4-D contaminated soils took place. On September 28, 1997, the site was broadcast seeded by hand with 1 kg/ha of uncleaned big sagebrush seed, 0.75 kg/ha of snow buckwheat, 5 kg/ha of Sandberg's bluegrass, 1 kg/ha of Indian ricegrass, and 20 kg/ha of balsamroot. After hand broadcasting the seed using a fertilizer spreader, the planted area was watered with 5 cm of water (approximately 100,000 L of water over the entire site).

A total of 22 species were observed on 600-104 site on April 17, 2000, of which 18 were native species. The number of species observed on the site this year was down from 32 in 1999, not likely due to a decrease in species occurrence but rather the timing of data collections. This year vegetation surveys were conducted 4 to 5 weeks earlier than in previous years. Surveys determined cheatgrass and yarrow to be the dominant species with 18.1% and 5.8% canopy covers (Table 4-7). Cheatgrass canopy cover remained consistent from last year, and yarrow cover increased by 4%. Yarrow demonstrated good growth with evidence of last year's plants producing seed heads, contributing to the success and regeneration of seedlings observed this year. Russian thistle cover fell dramatically from 45.6% in 1999 to only 2% this year. The decrease in Russian thistle cover can be attributed to increased competition from native species and the time of year the collections were gathered. This site's native species diversity suggests that this area is beginning to recover from the 1997 remedial action disturbance.

North Slope Sites

Table 4-7. Percent Canopy Cover and Frequency of Occurrence on 600-104 Site in 2000.

Species	% Cover	% Frequency
<i>Bromus tectorum</i> * (cheatgrass)	18.1	92
<i>Salsola kali</i> * (Russian thistle)	2	60
<i>Sisymbrium altissimum</i> * (tumblemustard)	0.3	12
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.6	24
<i>Descurainia pinnata</i> (western tansymustard)	0.1	4
<i>Poa sandbergii</i> (Sandberg's bluegrass)	0.9	16
<i>Festuca octoflora</i> (six-weeks fescue)	X	X
<i>Rumex venosus</i> (winged dock)	X	X
<i>Lappula redowskii</i> (Western stickweed)	X	X
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.1	4
<i>Holosteum umbellatum</i> * (jagged chickweed)	0.5	20
<i>Achillea millefolium</i> (yarrow)	5.8	24
<i>Oenothera pallida</i> (evening primrose)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	X	X
<i>Machaeranthera canescens</i> (hoary aster)	X	X
<i>Phlox longifolia</i> (longleaf phlox)	1.2	8
<i>Astragalus caricinus</i> (buckwheat milkvetch)	X	X
<i>Astragalus sclerocarpus</i> (stalked-pod milkvetch)	X	X
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	X	X
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	X	X
<i>Collomia linearis</i> (narrowleaf collomia)	X	X
<i>Phacelia hastata</i> (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.

5.0 SAGEBRUSH PLANTINGS IN THE 200 AND 300 AREAS

5.1 216-A-25 EMERGENCY EXTENSION SITE

On February 11, 1998, a total of 1,000 sagebrush tubelings were planted in groups of 3 to mitigate for interim stabilization of the 216-A-25 emergency extension site. The sagebrush were planted using a small straight crowbar to create a hole for planting the tubelings. The soil was then gently pushed in to fill any void spaces around the roots. The soil moisture during planting conditions was ideal.

On March 24, 2000, sagebrush survival was estimated at the 216-A-25 emergency extension site. Some of the plants were marked during planting using pin flags for future identification and survival counts. As a result of weathering, some of these flags are no longer in place. Therefore, a qualitative count was made and the estimated survival appears to be close to that seen in 1999 around 65%. The surviving plants are in good condition ranging in height from approximately 20 to 50 cm.

5.2 300-FF-1

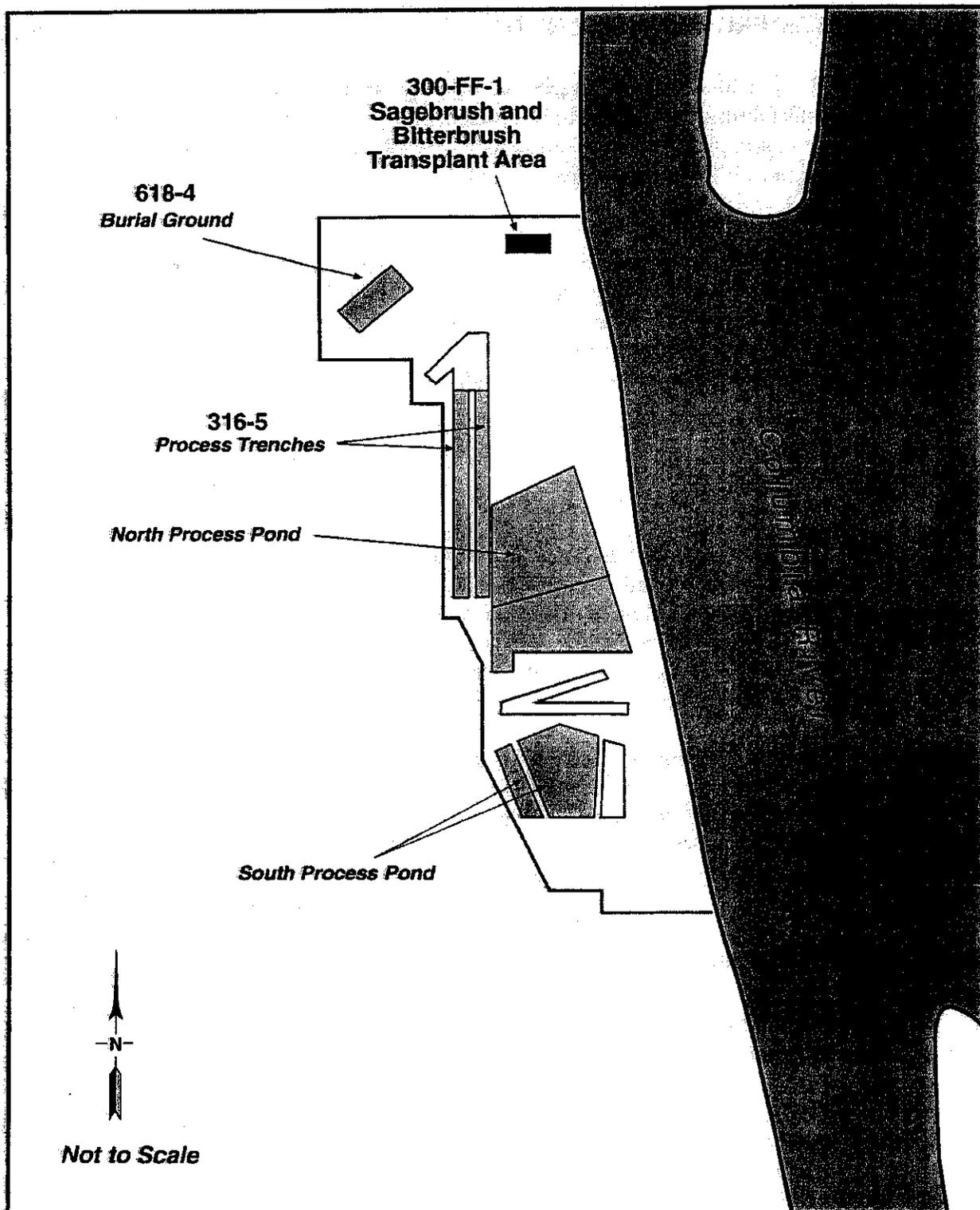
On October 16 - 17, 1997, a total of 24 antelope bitterbrush were salvaged from the perimeter of the 618-4 Burial Ground and moved 200 m east. The salvaging effort was conducted to mitigate for the loss of mature shrubs on the 618-4 Burial Ground during grubbing and remediation of the site (Weiss 1996). The salvaged plants averaged 0.25 to 0.5 m in height and were replanted in groups of three over a 500 m² area. The plants were removed with a "1/4 yard backhoe" and moved directly to the planting hole with a minimum of handling.

The soil around the burial ground where the shrubs were salvaged had a thin veneer of fine soil covering coarse, sandy gravel. Using extreme care, the shrubs were lifted from the ground, taking as much soil as possible to reduce damage to the root systems. However, because the soil was so coarse, most of it fell apart during the extraction, breaking most of the fine roots. Before planting, the hole in which the salvaged plant was to be placed was filled with water and allowed to drain.

On August 31, 1998, the transplanted bitterbrush were examined for survival and all 24 plants had died. The loss of the fine roots during excavation of the plants is likely the major cause of the failure. A contributing factor may also have been the dry sandy soil at the transplant sites, even though water was provided during transplanting.

On December 2, 1997, a total of 293 2-year old container grown sagebrush plants were planted over an area of 3,100 m² just north of the bitterbrush planting area (Figure 5-1). This planting was additional mitigation for the loss of shrubs on the 618-4 Burial Ground. Five rows of plants were placed in clusters of three, spaced 0.5 to 1.0 m apart, with each cluster approximately 4.6 m apart.

Figure 5-1. 300 Area Process Trench and 300-FF-1 Sagebrush and Bitterbrush Transplant Area.



E9908046

Sagebrush Plantings in the 200 and 300 Areas

On June 22, 1999, the planted area was examined to determine survivorship. A total of 164 live plants were counted, yielding a survivorship of 54%, notably lower than 70% found in 1998. The plant height ranged from about 15 to 30 cm. Some plants were very healthy and beginning to form flower buds, while others showed signs of stress, including yellowing leaves. However, only 11 of the 98 planting locations had all 3 sagebrush plants dead.

On November 19, 1999, the planted area was again examined for survivorship. One hundred and fifty live plants were observed, yielding a 51% survivorship. All dead sagebrush plants were replaced with sagebrush tubelings acquired from the Umatilla Native Plant Nursery of the Confederated Tribes of the Umatilla Indian Reservation in Umatilla, Oregon. An additional 180 sagebrush tubelings were added to the plot bringing the total on the plot to 480 over an area of approximately 0.4 ha. The tubelings had good root systems, all reaching the bottom of the tubes and top growth ranging from 4 to 10 cm.

In addition to planting sagebrush tubelings, 50 bitterbrush tubelings were planted east of the 618-4 Burial Ground in the area of failed transplanted bitterbrush. 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 into the ground to prevent browsing by deer. Plants were placed in seven rows, spaced at approximately 7 m. The soil was sandy and moist to about 20 to 23 cm. On March 22, 2000, the sagebrush and bitterbrush areas were examined for survivorship. All 50 of the bitterbrush seedlings were still alive with a noticeable increase in top height and foliar growth. One of the protective mesh tubes had been knocked loose; as a result, the plant had been browsed but was still alive, confirming the need for protective barriers for bitterbrush seedlings. The average height of the bitterbrush seedlings ranged from 20 to 30 cm. Survivorship of the sagebrush seedlings was high at 98.5%, including the seedlings planted in November 1999. All the bitterbrush and sagebrush plants appeared to be doing very well and demonstrated active growth since being planted on November 19, 1999.

5.3 200-ZP-1 INJECTION WELL PIPELINE

The 200-ZP-1 Injection Well Pipeline is located on the western edge of the 200 West Area (Figure 1-1). On September 28, 1997, a total of 600 sagebrush tubelings were planted in the 200-ZP-1 pipeline corridor to replace habitat that was lost during construction of the 200-ZP-1 injection well system. After planting, the tubelings were watered because of dry soil conditions. Sandberg's bluegrass and snow buckwheat were also seeded at 5 kg/ha and 1.5 kg/ha, respectively.

The June 27, 2000, fire that burned through the area consumed the entire vegetative community. Prior to the fire, monitoring efforts conducted on March 16, 2000, found 33 sagebrush of the 200 originally planted still alive on the east-west section of the pipeline and 177 sagebrush recruited into the road area. On the north-south section leading to the injection wells, 125 of the 400 original plants were still alive with 100 sagebrush recruited into the area. The combined survivorship of the two areas was 21%. The site had areas with good establishment of Sandberg's bluegrass and other native species including rabbitbrush, annual phlox, snow buckwheat, turpentine springparsley, balsamroot, and spring whitlow, further demonstrating that the site was recovering very well.

Sagebrush Plantings in the 200 and 300 Areas

6.0 300 NORTH PROCESS TRENCH

6.1 316-5 PROCESS TRENCH

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 5-1). The trenches received 300 Area process effluent from the uranium fuel fabrication facilities. In addition, liquid waste from the 300 Area laboratories that was determined to be below discharge limits was also discharged into the trenches. The 316-5 Process Trenches consisted of two parallel, unlined trenches approximately 468 m long, 3 m wide, and 3.7 m deep, spaced 15 m apart. The trenches were covered with screens 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 the contaminated soil and debris were excavated and loaded into containers for shipment to ERDF. A majority of the bulk tonnage was uranium-contaminated soils; however, a concrete headwork structure at the inlet to the two trenches and bird screens comprised of wood framing and wire mesh were also demolished and sent to ERDF (Lerch 1998b).

Upon completion of remediation, the majority of the 316-5 Process Trenches was regraded and contoured with the surrounding soils immediately adjacent to the trench in mid- to late 1998. A small portion of one of the trenches was not regraded due to its close proximity to the North Process Pond work area, but will be completed with the North Process Pond work. In long range planning, the 300 Area has been designated as an industrial use area (EPA 1996). Therefore, the area of the regraded trench was broadcast seeded with approximately 50 kg/ha of crested wheatgrass. Straw mulch was blown over the seeded area at a rate of 4.5 metric tons per hectare, and then crimped into the soil using a disk.

On April 18, 2000, 29 species were found at the 316-5 Process Trench site. Of the 29 species observed, 19 were native (Table 6-1). As anticipated, domestic wheat, residual from the straw mulch applied to the site, significantly decreased from 10% cover in 1999 to only a limited occurrence in 2000, partly due to consumption of residual wheat by Canada geese (*Branta canadensis*) last fall. Crested wheatgrass canopy cover increased slightly from last year but remains low at 5%; however, frequency of occurrence within the plot frames was moderate at 64%, indicating successful germination and suggesting an initial stage of stabilization. Dune scurfpea, a rhizomatous native legume that stabilizes sandy areas, was also observed on the site, as well as several other early successional species including jagged chickweed, spring whitlow, and storksbill.

300 North Process Trench

Table 6-1. Percent Canopy Cover and Frequency of Occurrence on the 316-5 Process Trench in 2000.

Species	% Cover	% Frequency
<i>Triticum spp.</i> * (Wheat)	X	X
<i>Bromus tectorum</i> * (cheatgrass)	14.4	76
<i>Salsola kali</i> * (Russian thistle)	6.7	72
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.2	8
<i>Microsteris gracilis</i> (annual phlox)	0.4	16
<i>Holosteum umbellatum</i> * (jagged chickweed)	15.3	80
<i>Draba verna</i> (spring whitlow)	6.6	36
<i>Lactuca serriola</i> (prickly lettuce)	0.2	8
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	3	44
<i>Sisymbrium altissimum</i> * (tumble mustard)	1.2	28
<i>Erodium cicutarium</i> * (storksbill)	4.8	76
<i>Machaeranthera canescens</i> (hoary aster)	0.1	4
<i>Plantago patagonica</i> (Indian wheat)	0.2	8
<i>Melilotus alba</i> * (sweetclover)	X	X
<i>Psoralea lanceolata</i> (dune scurfpea)	X	X
<i>Agropyron cristatum</i> * (crested wheatgrass)	5	64
<i>Epilobium paniculatum</i> (tall willowherb)	0.1	4
<i>Phacelia hastata</i> (whiteleaf scorpionweed)	0.1	4
<i>Poa sandbergii</i> (Sandberg's bluegrass)	X	X
<i>Eriogonum niveum</i> (snow buckwheat)	X	X
<i>Oenothera pallida</i> (evening primrose)	X	X
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	0.1	4
<i>Descurainia pinnata</i> (western tansymustard)	0.1	4
<i>Poa bulbosa</i> * (bulbous bluegrass)	X	X
<i>Brodiaea howellii</i> (Howell's clusterlily)	X	X
<i>Layia grandulosa</i> (white-daisy tidytips)	X	X
<i>Astragalus caricinus</i> (buckwheat milkvetch)	X	X
<i>Centaurea diffusa</i> * (diffuse knapweed)	X	X
<i>Agoseris heterophylla</i> (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.

7.0 ENVIRONMENTAL RESTORATION DISPOSAL FACILITY MITIGATION SITES

In November 1998, 73,800 sagebrush seedlings were planted as compensatory mitigation for 20.25 hectares (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 hectare (2.47 acres) of this habitat is destroyed, then compensatory mitigation must take place at a rate of 3:1. The planting of the 73,800 sagebrush took place in shrubless areas on the ALE Reserve. The plants were distributed at a rate of approximately 988 plants/ha (400 plants/ac) over a total of 77 hectares (191 acres). This resulted in a compensation ratio of approximately 4:1.

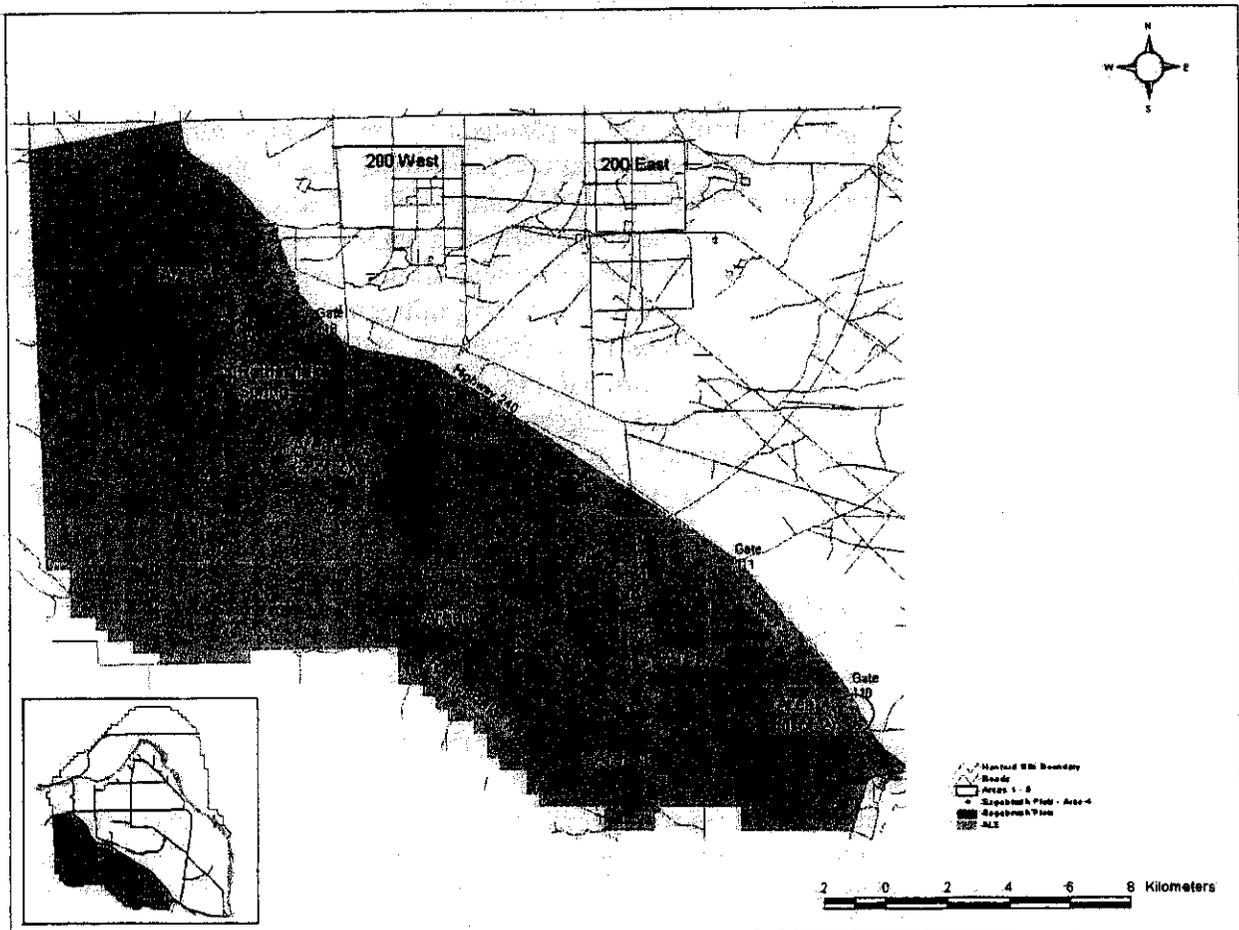
The goal of this mitigation project was to replace the habitat lost to the two bird species listed above. It was anticipated that when the shrubs matured, the habitat would also support sage thrashers (*Oreoscoptes montanus*) and potentially sage grouse (*Centrocercus urophasianus*).

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, which 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 tubelings 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 (Figure 1-1) on the ALE Reserve were selected for revegetation and habitat enhancement through the planting of tubelings and bare-root sagebrush. The criteria for selecting the plots to be planted were to locate sites with north facing slopes of draws, and to include areas dominated with cheatgrass, areas of mixed cheatgrass/bunchgrasses, and pure bunchgrass areas. The intent was to take advantage of more favorable soil moisture conditions that exist in such 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. Tubelings and bare-root seedlings were planted in rows, with individuals spaced approximately 3.4 m apart.

Area 1 consisted of two, 2-hectare (5-acre) plots located to the east of the "1200-Foot Road" along north-facing draws. One was planted with bare-root plants from Lucky Peak, and the second plot planted with tubelings from Plants of the Wild (Figure 7-1).

Figure 7-1. Environmental Restoration Disposal Facility Mitigation Areas.



Area 2 consisted of twenty 0.8-hectare (2-acre) plots planted with bare-root tubelings from Lucky Peak. Plots were established to the east and west of the ALE Powerline road that leads toward gate 113 on State Highway 240 (Figure 7-1).

Area 3 consisted of nineteen 0.8-hectare (2-acre) plots planted with tubelings from Plants of the Wild. Plots were located in north-facing draws on alternating north and south sides of the "1200-Foot Road" (Figure 1-1).

Area 4 was split into subareas A and B. Subarea A, located near gate 110, consisted of three 1.6-hectare (4-acre) plots planted with bare-root sagebrush from Lucky Peak. Subarea B, located near Benson Ranch, consisted of three 0.8-hectare (2-acre) plots planted with tubelings. Both areas contain three small, 0.2-hectare (0.5-acre) student plots that are a mixture of bare-root and tubelings (Figure 7-1).

Area 5 was 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-hectare (10-acre) plots and one 2-hectare (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 (Figure 7-1).

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.

Sagebrush survival was estimated in February and March 2000 within the monitoring plots of each area (Table 3-3). Area 2, planted with bare-root stock from Lucky Peak, had the highest overall survival, with 86.6%, down from 97.8% in 1999. Area 1 had 73.9%, which was down from 93% in 1999, and Area 3 had 65.9% survival, a reduction from 91.6% in 1999. These two areas were both planted with tubelings from Plants of the Wild. Area 5 had the lowest average survival at only 48.6%, down from 57.8% in 1999. Of the five plots in Area 5, three plots had survival above 60%, but low survival was encountered on the remaining two plots with 17.3% at the tubeling site and 15% at the Umatilla Native Plant Nursery bare-root site. Factors that could have contributed to the lack of success on these two plots include below normal precipitation; above-normal wind immediately following planting causing soil desiccation; and shallow soil with an underlying compacted zone approximately 10 to 20 cm below the surface, which restricts percolation of water. With the exception of the two plots within Area 5, the survival rates were within expected and acceptable ranges following the second year of monitoring.

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 in this area. The tubelings had good root systems, all reaching the bottom of the tubes, and top growth ranging from 4 to 10 cm.

On June 27, 2000, a wildfire resulted 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 hectares (164,000 acres) covering all of ALE and a large portion of the southwestern section of Hanford Site proper (Figure 1-1). Only small islands of vegetation on ALE were spared. Initial surveys of the areas indicate that all of the plots in Areas 1 through 4 were burned in the fire. Portions of Area 5 burned in the fire as a result of obvious backfire attempts. This area burned in 1997 and had little fuel to carry the fire. The low intensity mosaic burn pattern may have spared some of the shrubs. Typically, when wildfires burn through native communities of sagebrush/bunchgrass habitat, the perennial grasses and forbs return the following year along with many of the annual species. The sagebrush, however, do not resprout from the crowns and can be very slow to return, depending on whether viable seeds remain in the soil and sufficient precipitation falls in the following winter.

Environmental Restoration Disposal Facility Mitigation Sites

BHI-01406

Rev. 0

8.0 116-C-1 REVEGETATION

The 116-C-1 site was remediated as a part of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) Remedial Action Project for the 100-B/C Area (EPA 1995). Revegetation at the 116-C-1 site was done as a demonstration project to evaluate the effects of two different soil types on revegetation success on remediated sites with native species. Additional objectives of the revegetation are to stabilize the site and encourage growth of native vegetation.

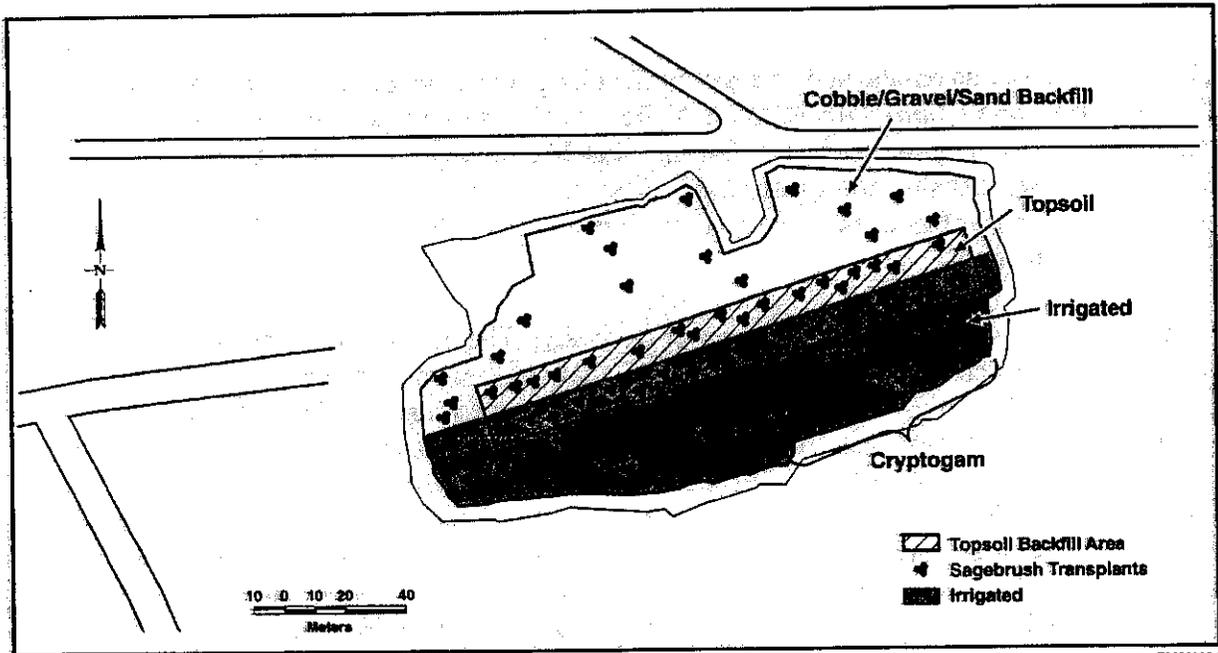
Four treatments were employed on the remediated site. The backfill material used for remediation was a coarse assortment of cobble, gravel, and sand from a nearby borrow pit and served as the soil planting medium for two of the four treatments. The backfill material is representative of naturally occurring soils that were deposited as the Columbia River changed course over time. 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, nonirrigated topsoil, and nonirrigated cobble (Figure 8-1). 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 by hand-broadcasting the seed. Cryptobiotic soil/dust (9.1 kg) was also hand-cast over the eastern half of the site to inoculate the soil surface and stimulate the growth of this important soil component. Following the seeding, wheat straw mulch was applied at the rate of 6.7 metric tons per hectare, then crimped. After the straw was crimped into the soil, 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 (Table 8-1).

The second year of irrigation was initiated 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), (333,115 L [88,000 gal] total) to one-half of the cobble substrate, and one-half of the topsoil substrate (Table 8-1). This concludes the last application of water to this site.

In April 2000, 23 plant species were identified on the 116-C-1 site. Fourteen of the 23 species were native. Species diversity was greatest on the nonirrigated cobble with 18 species, followed by 15 on the irrigated cobble, 13 on the irrigated topsoil, and 11 species on the nonirrigated topsoil treatment. Conversely, canopy cover was greatest on the topsoil treatments but dominated by cheatgrass with 38.2% on the irrigated treatment and 47.7% on the nonirrigated topsoil treatment followed by Sandberg's bluegrass with 24.7% and 13.9%, respectively (Table 8-2).

116-C-1 Revegetation

Figure 8-1. 116-C-1 Treatment Areas.



E9908089.3

Table 8-1. Irrigation Applied to 116-C-1 in 2000.

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

116-C-1 Revegetation

Table 8-2. Percent Canopy Cover on the 116-C-1 Site in 2000.

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irr. Topsoil	Non-Irr. Cobble
<i>Bromus tectorum</i> * (cheatgrass)	2.2	38.2	47.7	6.1
<i>Salsola kali</i> * (Russian thistle)	0.7	0.6	1.1	1
<i>Poa sandbergii</i> (Sandberg's bluegrass)	6.8	24.7	13.9	2.4
<i>Stipa comata</i> (needle-and-thread grass)	0.3	--	--	--
<i>Triticum spp.</i> * (wheat)	0.1	X	X	0.3
<i>Achillea millefolium</i> (yarrow)	--	X	--	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	--	X	X	X
<i>Artemisia tridentata</i> (big sagebrush)	X	--	--	--
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	--	0.1	X	0.2
<i>Descurania pinnata</i> (western tansymustard)	--	0.1	0.9	0.1
<i>Epilobium paniculatum</i> (tall willowherb)	--	--	--	X
<i>Eriogonum niveum</i> (snow buckwheat)	1.2	X	--	X
<i>Erodium cicutarium</i> * (storksbill)	--	--	--	X
<i>Lactuca serriola</i> * (prickly lettuce)	X	--	--	X
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	X	0.1	X	1.5
<i>Sisymbrium altissimum</i> * (tumblemustard)	0.3	3	3.6	0.3
<i>Tragopogon dubius</i> * (yellow salsify)	X	X	X	X
<i>Machaeranthera canescens</i> (hoary aster)	0.1	--	--	X
<i>Astragalus caricinus</i> (buckwheat milkvetch)	X	--	--	--
<i>Layia grandulosa</i> (white-daisy tidytips)	--	--	X	X
<i>Poa bulbosa</i> * (bulbous bluegrass)	--	--	--	X
<i>Centaurea diffusa</i> (diffuse knapweed)	X	X	--	X
<i>Medicago sativa</i> * (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.

The two cobble treatments had the greatest species diversity but lowest total canopy cover, just below 12% on both treatments. The irrigated cobble treatment was dominated by Sandberg's bluegrass with 6.8% cover followed by 2.2% cheatgrass cover. The nonirrigated cobble area was dominated by cheatgrass with 6.1% cover followed by Sandberg's bluegrass with 2.4% canopy cover.

The percent frequency of cheatgrass in 2000 was significantly higher across all treatments than last year. The cobble areas had 72% frequency on the nonirrigated treatment and 68% on the irrigated cobble, compared to 12% and 20% in 1999. Frequency of cheatgrass increased from 1999 from 68% to 100% on nonirrigated topsoil and 88% to 96% on the irrigated topsoil treatments (Table 8-3). At the same time, Russian thistle frequency decreased drastically, ranging from 28% to 44% in 2000 across all treatments, compared to 48% to 88% in 1999. As expected, cryptobiotic crust has not yet begun to develop on this site. Normally, cryptobiotic crust is not observed until the third growing season.

116-C-1 Revegetation

Table 8-3. Percent Frequency of Occurrence on the 116-C-1 Site in 2000.

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

Survival of sagebrush seedlings at 116-C-1 was high, with survival of 163 out of 201 tubelings, yielding an overall survival of 81.1%. Sagebrush seedling survival remains highest at 95.5% on the nonirrigated cobble treatment. Survival is above average across all treatments with 86.1% on the irrigated cobble, 75.4% on the irrigated topsoil, and 61.9% on the nonirrigated topsoil treatment (Table 8-4).

Table 8-4. Sagebrush Seedling Survival on 116-C-1 in 2000.

	Irrigated Backfill		Nonirrigated Backfill		Irrigated Topsoil		Nonirrigated Topsoil	
	1999	2000	1999	2000	1999	2000	1999	2000
Sagebrush survival (ratio alive:dead)	33:3	31:5	66:0	63:3	45:12	43:14	35:7	26:16
Percent Survival	91.7%	86.1%	100%	95.5%	78.9%	75.4%	83.3%	61.9%

9.0 100-B/C REVEGETATION

The 116-B-1, 116-B-11, and 116-C-5 sites were remediated as part of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) Remedial Action Project for the 100-B/C Area (EPA 1995). Revegetation of these three waste sites was performed December 6-9, 1999. The goal of revegetation at these sites is to stabilize the soils and establish a plant community consisting of native species with a minimum number of introduced species.

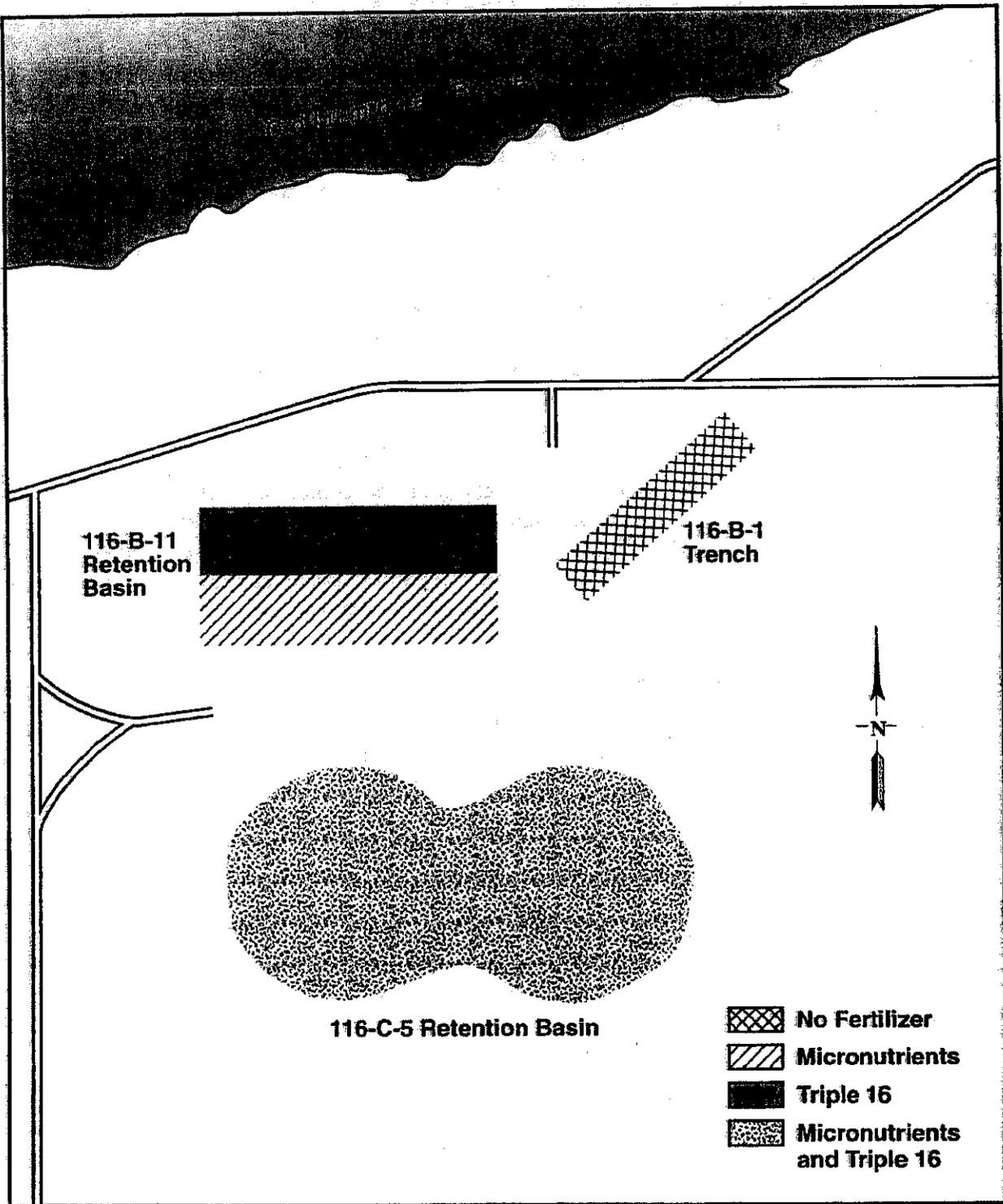
The material used to backfill the remediated wastes sites was excavated from a nearby borrow pit (pit 24). The backfill material is representative of naturally occurring soils in the area deposited by the Columbia River and consists of rocky sand and gravel. The top horizon of the remediated sites consisted of backfill material excavated from subsoil horizons in the pit, which provided a very nutrient deficient soil. 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 116-B-11, a mixture of micronutrients 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 (Figure 9-1). The northern half of 116-B-11 received triple-16 (16% each of nitrogen, phosphorous, and potassium) applied at a rate of 112 kg/ha. On 116-C-5, a combination of triple-16 and micronutrients was applied to the entire site at a rate of 112 kg/ha each. No fertilizer was applied to the 116-B-1 site.

A seed mixture of native species was broadcast by 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, but due to the small size and amount of seed, they were not measurable quantities. Following the seeding, grass straw mulch was blown across all sites at a rate of 4.5 metric tons per hectare.

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

Figure 9-1. Fertilizer Treatments at 100-B/C Revegetation Sites.



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100-B/C Revegetation

Initial vegetation surveys were conducted on April 20, 2000. Twenty-two species were observed on the sites, 12 of which were native (Table 9-1). Species diversity was highest (19 species) on the 116-C-5 site, which was treated with a fertilizer combination of triple-16 and micronutrients. Fourteen species were observed on the northern and southern treatments of 116-B-11, which were treated with only triple-16 or micronutrients respectively. Twelve species were present on 116-B-1, which had no fertilizer applied.

Table 9-1. 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
<i>Poa sandbergii</i> (Sandberg's bluegrass)	11.9	9	5.7	3.3
<i>Eriogonum niveum</i> (snow buckwheat)	0.55	0.3	X	0.3
<i>Salsola kali</i> * (Russian thistle)	1	2	0.8	2
<i>Achillea millefolium</i> (yarrow)	1.6	0.8	0.4	X
<i>Sisymbrium altissimum</i> * (tumblemustard)	1	0.3	0.3	1.1
<i>Descurainia pinnata</i> (western tansymustard)	7.6	4.7	4	10.3
<i>Centaurea diffusa</i> * (diffuse knapweed)	0.05	X	--	--
<i>Artemisia tridentata</i> (big sagebrush)	0.15	0.4	0.1	1.6
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	0.15	0.2	--	X
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	0.05	X	X	--
<i>Poa spp.</i> * (residual from straw)	1.4	2.7	1.4	3.9
<i>Bromus tectorum</i> * (cheatgrass)	X	--	0.2	7.7
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	--	--	0.1	--
<i>Melilotus officinalis</i> * (sweetclover)	X	--	--	--
<i>Lactuca serriola</i> * (prickly lettuce)	X	X	X	X
<i>Machaeranthera canescens</i> (hoary aster)	X	--	X	--
<i>Epilobium paniculatum</i> (tall willowherb)	X	0.1	X	X
<i>Microsteris gracilis</i> (annual plox)	X	--	--	--
<i>Amaranthus albus</i> * (pigweed)	X	--	--	--
<i>Senecio vulgaris</i> * (common groundsel)	X	--	--	--
<i>Draba verna</i> (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.

Five of eight species planted were observed on the sites, Sandberg's bluegrass, snow buckwheat, yarrow, sagebrush, and Carey's balsamroot. Sandberg's bluegrass had the greatest canopy cover across all treatments with 11.9% on 116-C-5, the triple-16 and micronutrient site and lowest on 116-B-1, no fertilizer at 3.3%. Frequency of occurrence across all treatments for Sandberg's bluegrass ranged from 76% to 90%, suggesting good seed germination (Table 9-2).

100-B/C Revegetation

Table 9-2. 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
<i>Poa sandbergii</i> (Sandberg's bluegrass)	90	84	88	76
<i>Eriogonum niveum</i> (snow buckwheat)	22	12	X	12
<i>Salsola kali</i> * (Russian thistle)	40	40	32	60
<i>Achillea millefolium</i> (yarrow)	16	12	16	X
<i>Sisymbrium altissimum</i> * (tumblemustard)	20	12	12	24
<i>Descurainia pinnata</i> (western tansymustard)	34	16	28	64
<i>Centaurea diffusa</i> * (diffuse knapweed)	2	X	--	--
<i>Artemisia tridentata</i> (big sagebrush)	6	16	4	8
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	6	8	--	X
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	2	X	X	--
<i>Poa spp.</i> * (residual from straw)	26	48	36	20
<i>Bromus tectorum</i> * (cheatgrass)	X	--	8	56
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	--	--	4	--
<i>Melilotus officinalis</i> * (sweetclover)	X	--	--	--
<i>Lactuca serriola</i> * (prickly lettuce)	X	X	X	X
<i>Machaeranthera canescens</i> (hoary aster)	X	--	X	--
<i>Epilobium paniculatum</i> (tall willowherb)	X	4	X	X
<i>Microsteris gracilis</i> (annual plox)	X	--	--	--
<i>Amaranthus albus</i> * (pigweed)	X	--	--	--
<i>Senecio vulgaris</i> * (common groundsel)	X	--	--	--
<i>Poa bulbosa</i> * (bulbous bluegrass)	--	--	--	--
<i>Draba verna</i> (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.

Results from first-year monitoring at any site are seldom sufficient to predict the final outcome of any revegetation effort. Comparison of canopy cover can be misleading in the first few years of a revegetation project due to lower growth rates of native perennials and high percent canopy covers of undesirable species, including mustards and Russian thistle. Observance of 5 of 8 species planted suggests good germination, but success in the future will be assessed on the plant community's progression through succession and recruitment. The rate at which a native plant community proceeds through succession is dependent on several environmental factors including soil type, local precipitation, wind, and competition from nonnative species. Therefore, comparisons and judgements of succession rates and success between different locations should be made with caution.

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References

APPENDIX A
1999 REVEGETATION MONITORING RESULTS

APPENDIX A

1999 REVEGETATION MONITORING RESULTS

Table A-1. Percent Canopy Cover on Horn Rapids Landfill for 1999.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
<i>Agropyron spp*</i> (wheatgrasses)	22.1	31.8	19	22.4	19.1	29.8
<i>Salsola kali*</i> (Russian thistle)	0.1	0.1	0.1	0.1	0.01	0.1
<i>Bromus tectorum*</i> (cheatgrass)	30.3	18.4	30.1	11.5	14.5	20.1
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.7	X	X	X	--	0.1
<i>Sisymbrium altissimum*</i> (tumblemustard)	--	X	0.1	0.1	X	--
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.2	0.1	--	--	0.1	0.2
<i>Convolvulus arvensis*</i> (field bindweed)	X	X	X	X	X	X
<i>Holosteum umbellatum*</i> (jagged chickweed)	21.4	24.5	25	18.5	12.8	20.4
<i>Lactuca serriola*</i> (prickly lettuce)	X	--	--	--	--	--
<i>Draba verna</i> (spring whitlow)	7.3	9.7	13.6	16	6.4	4.5
<i>Descurainia pinnata</i> (tansymustard)	0.1	--	--	--	X	--
<i>Epilobium paniculatum</i> (tall willowherb)	0.1	--	0.2	--	--	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	X	--	2.1	--	X	X
<i>Plantago patagonica</i> (Indian wheat)	--	--	--	--	--	0.1
<i>Erodium cicutarium*</i> (storksbill)	0.1	--	0.2	X	0.1	--
<i>Tragopogon dubius*</i> (yellow salsify)	X	0.1	X	--	--	X
<i>Agoseris grandiflora</i> (mountain dandelion)	--	--	X	--	--	--
<i>Eriogonum niveum</i> (snow buckwheat)	X	X	X	--	--	X
<i>Astragalus caricinus</i> (buckwheat milkvetch)	--	--	X	--	--	--
<i>Machaeranthera canescens</i> (hoary aster)	X	X	--	X	--	X
<i>Achillea millefolium</i> (yarrow)	--	X	--	--	--	--
<i>Medicago sativa*</i> (alfalfa)	X	--	X	X	X	X
<i>Chondrilla juncea*</i> (rush skeletonweed)	X	--	--	X	--	X
<i>Cardaria draba*</i> (whitetop)	X	--	--	--	X	--
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	--	0.6	X	X	X	X
<i>Oenothera pallida</i> (evening primrose)	X	--	--	--	--	--
<i>Microsteris gracilis</i> (annual phlox)	--	--	0.1	0.1	--	0.4
<i>Agastache occidentalis*</i> (western horsemint)	--	--	--	X	--	--
<i>Sphaeralcea munroana</i> (globemallow)	--	--	--	--	X	--
<i>Centaurea diffusa*</i> (diffuse knapweed)	--	--	--	--	--	X
Bare soil	19.5	29.5	27.7	40.8	42	20.1
Litter	63.6	58.4	57.6	35.5	36.7	63.6
Total (does not include bare soil or litter)	82.4	85.3	90.5	68.7	53.1	75.7

* Introduced Species.

X = Present but not counted in plot frames.

-- = Not occurring on plot.

Appendix A – 1999 Revegetation Monitoring Results

Table A-2. Percent Frequency of Occurrence on Horn Rapids Landfill for 1999.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
<i>Agropyron spp*</i> (wheatgrasses)	80	96	88	92	88	88
<i>Salsola kali*</i> (Russian thistle)	4	4	4	4	4	4
<i>Bromus tectorum*</i> (cheatgrass)	92	96	92	80	80	100
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	8	X	X	X	--	4
<i>Sisymbrium altissimum*</i> (tumblemustard)	--	X	4	4	X	--
<i>Ambrosia acanthicarpa</i> (bur ragweed)	8	4	--	--	4	8
<i>Convolvulus arvensis*</i> (field bindweed)	X	X	X	X	X	X
<i>Holosteum umbellatum*</i> (jagged chickweed)	100	100	100	100	100	100
<i>Lactuca serriola*</i> (prickly lettuce)	--	--	--	--	--	--
<i>Draba verna</i> (spring whitlow)	80	80	96	100	100	80
<i>Descurainia pinnata</i> (tansymustard)	4	--	--	--	X	--
<i>Epilobium paniculatum</i> (tall willowherb)	4	--	8	--	--	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	X	--	4	--	X	X
<i>Plantago patagonica</i> (Indian wheat)	--	--	--	--	--	4
<i>Erodium cicutarium*</i> (storksbill)	4	--	8	X	4	--
<i>Tragopogon dubius*</i> (yellow salsify)	X	4	X	--	--	X
<i>Agoseris grandiflora</i> (mountain dandelion)	--	--	X	--	--	--
<i>Eriogonum niveum</i> (snow buckwheat)	X	X	X	--	--	X
<i>Astragalus carcinus</i> (buckwheat milkvetch)	--	--	X	--	--	--
<i>Machaeranthera canescens</i> (hoary aster)	X	X	--	X	--	X
<i>Achillea millefolium</i> (yarrow)	--	X	--	--	--	--
<i>Medicago sativa*</i> (alfalfa)	X	--	X	X	X	X
<i>Chondrilla juncea*</i> (rush skeletonweed)	X	--	--	X	--	X
<i>Cardaria draba*</i> (whitetop)	X	--	--	--	X	--
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	--	4	X	X	X	X
<i>Oenothera pallida</i> (evening primrose)	X	--	--	--	--	--
<i>Microsteris gracilis</i> (annual phlox)	--	--	4	4	--	16
<i>Agastache occidentalis*</i> (western horsemint)	--	--	--	X	--	--
<i>Sphaeralcea munroana</i> (globemallow)	--	--	--	--	X	--
<i>Centaurea diffusa*</i> (diffuse knapweed)	--	--	--	--	--	X
Bare soil	96	92	88	100	100	96
Litter	100	100	100	100	100	100

* Introduced Species.

X = Present but not counted in plot frames.

-- = Not occurring on plot.

Appendix A – 1999 Revegetation Monitoring Results

Table A-3. Percent Canopy Cover on the Horseshoe Landfill in 1999.

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

* Introduced Species

X = Present but not counted in the plot frames

-- = Not occurring on site

Appendix A – 1999 Revegetation Monitoring Results

Table A-4. Percent Frequency on the Horseshoe Landfill in 1999.

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

Appendix A – 1999 Revegetation Monitoring Results

Table A-5. Percent Survival of Transplanted Bunchgrasses and Sagebrush Plants in 1999.

Site Name	Sagebrush			Bunchgrass		
	1997	1998	1999	1997	1998	1999
PSN 12/14						
Plot 1	91.3	59		54	66	
Plot 2	75	58		96.8	82	62.9
Plot 3	76.5	73		62.5	74	
Plot 4	93.8	69		66.7	61	46.2
Plot 5	58.1	43		72	76	80.9
Plot 6	57.8	59		74.4	88	69.4
Plot 7	57.3	57		81.3	88	64.2
Bridge Overlook				94		
NS Cheatgrass Area						
Small Plots (Aug)	5.5					
Small Plots (Oct)	92.7					
Road Transect	85.7	81.8	76.7			
Horseshoe Landfill				68	70	70.6
Nike Landfill						
Plot 1				83		
Plot 2				92		
Plot 3				86		
300-FF-1		70	54			
200-ZP-1		54	29			
216-A-25		84	65			
ERDF Mitigation Sagebrush Planting						
Area 1			93			
Area 2			97.8			
Area 3			91.6			
Area 4			70.5			
Area 5			57.8			
116-C-1						
Nonirrigated backfill			100			
Irrigated backfill			91.7			
Nonirrigated Top Soil			83.3			
Irrigated Top Soil			78.9			

Appendix A – 1999 Revegetation Monitoring Results

Table A-6. Percent Canopy Cover on Bridge Overlook Sites in 1999.

Species	Waste Site	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	17.8	20.5
<i>Salsola kali</i> * (Russian thistle)	4.2	0.2
<i>Ambrosia acanthicarpa</i> (bur ragweed)	1.1	--
<i>Psoralea lanceolata</i> (dune scurfpea)	16.4	0.7
<i>Stipa comata</i> (needle-and-thread-grass)	1.9	0.7
<i>Gilia leptomeria</i> (great basin gilia)	1.1	0.1
<i>Mentzelia albicaulis</i> (whitestem stickleaf)	--	0.4
<i>Oenothera pallida</i> (evening primrose)	1.2	0.6
<i>Descurainia spp</i> (tansymustard)	3.8	0.4
<i>Cryptantha circumscissa</i> (matted cryptantha)	0.8	0.7
<i>Eriogonum niveum</i> (snow buckwheat)	2.3	8.4
<i>Artemisia tridentata</i> (big sagebrush)	3.4	10.9
<i>Purshia tridentata</i> (antelope bitterbrush)	--	5.4
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	--	0.6
<i>Grayia spinosa</i> (spiny hopsage)	X	5.5
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	X	0.6
<i>Festuca octoflora</i> (six-weeks fescue)	--	0.3
<i>Cymopterus terebinthinus</i> (turpentine parsley)	X	1.6
<i>Layia grandulosa</i> (white-daisy tidytips)	0.6	0.3
<i>Comandra umbellatum</i> (bastard toadflax)	--	1.5
<i>Microsteris gracilis</i> (annual phlox)	0.1	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	2.7
<i>Machaeranthera canescens</i> (hoary aster)	2.5	0.1
<i>Cryptantha pterocarya</i> (winged cryptantha)	1	0.2
<i>Melilotus alba</i> * (sweetclover)	X	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	--	0.1
<i>Koeleria cristata</i> (prairie junegrass)	X	X
<i>Sisymbrium altissimum</i> * (tumblemustard)	0.1	--
Biotic crust	5.9	24.8
Bare soil	52.5	34.5
Litter	50.8	56.5
Total (does not include crust, soil or litter)	58.2	60.1

* Introduced Species.

X = Present but not counted in plot frames.

-- = Not occurring on site.

Appendix A – 1999 Revegetation Monitoring Results**Table A-7. Percent Frequency of Occurrence on Bridge Overlook Sites in 1999.**

Species	Waste Site	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	68	96
<i>Salsola kali</i> * (Russian thistle)	72	8
<i>Ambrosia acanthicarpa</i> (bur ragweed)	24	--
<i>Psoralea lanceolata</i> (dune scurfpea)	60	8
<i>Stipa comata</i> (needle-and-thread-grass)	16	8
<i>Gilia leptomeria</i> (great basin gilia)	24	4
<i>Mentzelia albicaulis</i> (whitestem stickleaf)	--	16
<i>Oenothera pallida</i> (evening primrose)	8	4
<i>Descurainia</i> spp (tansymustard)	52	16
<i>Cryptantha circumscissa</i> (matted cryptantha)	12	32
<i>Eriogonum niveum</i> (snow buckwheat)	16	48
<i>Artemisia tridentata</i> (big sagebrush)	4	20
<i>Purshia tridentata</i> (antelope bitterbrush)	--	8
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	--	4
<i>Grayia spinosa</i> (spiny hopsage)	--	12
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	--	4
<i>Festuca octoflora</i> (six-weeks fescue)	--	12
<i>Cymopterus terebinthinus</i> (turpentine parsley)	X	24
<i>Layia grandulosa</i> (white-daisy tidytips)	4	12
<i>Comandra umbellatum</i> (bastard toadflax)	--	40
<i>Microsteris gracilis</i> (annual phlox)	4	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	12
<i>Machaeranthera canescens</i> (hoary aster)	4	4
<i>Cryptantha pterocarya</i> (winged cryptantha)	20	8
<i>Melilotus alba</i> * (sweetclover)	X	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	--	4
<i>Koeleria cristata</i> (prairie junegrass)	X	X
<i>Sisymbrium altissimum</i> * (tumblemustard)	4	--
Biotic crust	44	56
Bare soil	100	100
Litter	100	100

* Introduced Species.

X = Present but not counted in plot frames.

-- = Not occurring on site.

Appendix A – 1999 Revegetation Monitoring Results

Table A-8. Percent Canopy Cover on PSN 72/82 Well Mound Sites in 1999.

Species	Waste Site	Road	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	13	34.7	29.3
<i>Salsola kali</i> * (Russian thistle)	1.3	0.1	0.3
<i>Ambrosia acanthicarpa</i> (bur ragweed)	1.2	1.6	--
<i>Oenothera pallida</i> (pale evening primrose)	X	--	--
<i>Artemisia tridentata</i> (big sagebrush)	2.8	1.8	18.3
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	6.5	X	X
<i>Koeleria cristata</i> (prairie junegrass)	X	--	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	0.2	0.3	1.3
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	0.2	--	--
<i>Stipa comata</i> (needle-and-thread grass)	1.3	--	--
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	1.2	--	--
<i>Festuca octoflora</i> (six-weeks fescue)	2.8	12.8	1.5
<i>Microsteris gracilis</i> (annual phlox)	0.8	1.7	1.5
<i>Holosteum umbellatum</i> * (jagged chickweed)	0.8	4.1	1.2
<i>Draba verna</i> (spring whitlow)	6.7	10.2	1.7
<i>Lactuca serriola</i> * (prickly lettuce)	0.2	X	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	0.6	X
<i>Sisymbrium altissimum</i> * (tumblemustard)	1	1.4	X
<i>Descurainia spp</i> (tansymustard)	--	0.2	0.3
<i>Erodium cicutarium</i> * (storksbill)	1.3	0.1	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	2.5	5.2
<i>Machaeranthera canescens</i> (hoary aster)	1.7	3.1	X
<i>Cryptantha circumscissa</i> (matted cryptantha)	--	2.6	X
<i>Eriogonum niveum</i> (snow buckwheat)	--	3.9	--
<i>Plantago patagonica</i> (Indian Wheat)	--	0.4	--
<i>Gilia leptomeria</i> (great basin gilia)	--	0.3	--
<i>Cryptantha pterocarya</i> (winged cryptantha)	--	0.1	--
<i>Astragalus spp.</i>	X	--	--
<i>Agropyron cristatum</i> * (crested wheatgrass)	--	--	X
<i>Phlox longifolia</i> (longleaf phlox)	--	--	1.0
<i>Epilobium paniculatum</i> (tall willowherb)	--	--	0.7
Biotic Crust	19.8	3.1	40.7
Bare soil	31.3	58.6	9.0
Litter	55.5	40.1	83.2
Total (does not include crust, soil or litter)	43	86.2	62.3

* Introduced Species.

X = Present but not counted in plot frames.

-- = Not occurring on site.

Appendix A – 1999 Revegetation Monitoring Results

Table A-9. Percent Frequency of Occurrence on PSN 72/82 Well Mound Sites in 1999.

Species	Waste Site	Road	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	100	92	93.3
<i>Salsola kali</i> * (Russian thistle)	53.3	4	13.3
<i>Ambrosia acanthicarpa</i> (bur ragweed)	46.7	44	--
<i>Oenothera pallida</i> (pale evening primrose)	X	--	--
<i>Artemisia tridentata</i> (big sagebrush)	20	12	40
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	6.7	X	X
<i>Koeleria cristata</i> (prairie junegrass)	X	--	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	6.7	12	20
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	6.7	--	--
<i>Stipa comata</i> (needle-and-thread grass)	20	--	--
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	13.3	--	--
<i>Festuca octoflora</i> (six-weeks fescue)	46.7	84	26.7
<i>Microsteris gracilis</i> (annual phlox)	33.3	68	26.7
<i>Holosteum umbellatum</i> * (jagged chickweed)	33.3	48	46.7
<i>Draba verna</i> (spring whitlow)	80	64	66.7
<i>Lactuca serriola</i> * (prickly lettuce)	6.7	X	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	4	X
<i>Sisymbrium altissimum</i> * (tumblemustard)	40	36	X
<i>Descurainia spp</i> (tansymustard)	--	8	13.3
<i>Erodium cicutarium</i> * (storksbill)	53.3	4	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	4	20
<i>Machaeranthera canescens</i> (hoary aster)	33.3	84	X
<i>Cryptantha circumscissa</i> (matted cryptantha)	--	64	X
<i>Eriogonum niveum</i> (snow buckwheat)	--	20	--
<i>Plantago patagonica</i> (Indian Wheat)	--	16	--
<i>Gilia leptomeria</i> (great basin gilia)	--	12	--
<i>Cryptantha pterocarya</i> (winged cryptantha)	--	8	--
<i>Astragalus spp.</i>	X	--	--
<i>Agropyron cristatum</i> * (crested wheatgrass)	--	--	X
<i>Phlox longifolia</i> (longleaf phlox)	--	--	6.7
<i>Epilobium paniculatum</i> (tall willowherb)	--	--	26.7
Biotic Crust	67	44	73
Bare Soil	100	100	100
Litter	100	100	100

* Introduced Species.

X = Present but not counted in plot frames.

-- = Not occurring on site.

Appendix A – 1999 Revegetation Monitoring Results

Table A-10. Percent Canopy Cover on PSN 12/14 Sites in 1999.

Species	Reference	Plot 5	Plot 4	Plot 2	Plot 1	Road
<i>Bromus tectorum</i> * (cheatgrass)	63.3	19.8	34.3	28	37.3	11.1
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.6	1.7	1.6	1.4	0.7	4.1
<i>Sisymbrium altissimum</i> * (tumblemustard)	1.7	0.5	6.3	2.6	4.3	0.2
<i>Salsola kali</i> * (Russian thistle)	0.6	2.2	3.4	10	4.8	0.9
<i>Artemisia tridentata</i> (big sagebrush)	13.3	0.1	1.4	1.7	1.5	2.2
<i>Purshia tridentata</i> (antelope bitterbrush)	4.7	--	--	0.1	--	--
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	4	X	--	--	--	3.8
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	--	--	--	--	2.7	1.2
<i>Poa sandbergii</i> (Sandberg's bluegrass)	15.4	1.9	6.9	3.6	6.5	0.1
<i>Poa bulbosa</i> * (bulbous bluegrass)	0.7	--	--	--	--	0.1
<i>Stipa comata</i> (needle-and-thread grass)	--	12.6	3.1	8.1	5.7	--
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	2.5	6.5	X	--	X	--
<i>Agropyron dasytachyum</i> (thickspike wheatgrass)	--	11.7	--	--	--	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	--	0.1	0.2	--	--
<i>Cymopterus terebinthinus</i> (turpentine parsley)	2.2	--	--	X	--	--
<i>Descurainia spp</i> (tansymustard)	1.4	0.7	2.3	--	X	0.1
<i>Epilobium paniculatum</i> (tall willowherb)	0.6	--	0.7	0.1	1.3	0.1
<i>Eriogonum niveum</i> (snow buckwheat)	1.6	3.8	--	--	--	3.1
<i>Festuca octoflora</i> (six-weeks fescue)	--	0.4	0.1	--	--	--
<i>Holosteum umbellatum</i> * (jagged chickweed)	26.9	1.1	21.3	18.2	30.2	3.6
<i>Draba verna</i> (spring whitlow)	10.1	--	--	2	3.8	1.1
<i>Lactuca serriola</i> * (prickly lettuce)	0.2	--	2.7	0.4	2.8	--
<i>Machaeranthera canescens</i> (hoary aster)	0.1	X	0.8	0.1	0.7	0.2
<i>Microsteris gracilis</i> (annual phlox)	2.4	--	0.1	11.3	0.5	--
<i>Oenothera pallida</i> (pale evening primrose)	0.2	0.9	--	0.5	--	--
<i>Phlox longifolia</i> (longleaf phlox)	3.6	--	--	0.1	--	--
<i>Comandra umbellatum</i> (bastard toadflax)	2.1	--	--	--	--	--
<i>Achillea millefolium</i> (yarrow)	X	0.6	0.1	0.3	0.2	3.5
<i>Tragopogon dubius</i> * (yellow salsify)	--	X	0.1	X	0.3	--
<i>Psoralea lanceolata</i> (dune scurfpea)	--	--	--	4.4	--	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	X	--	--	--	--	0.2
<i>Lappula redowskii</i> (Western stickweed)	--	--	--	--	0.2	0.3
<i>Poa scabrella</i> (pine bluegrass)	--	X	--	--	--	--
<i>Koeleria cristata</i> (prairie junegrass)	--	X	--	--	--	--
<i>Brodiaea douglasii</i> (Douglas' clusterlily)	0.7	--	--	--	--	--
<i>Rumex venosus</i> (winged dock)	--	--	--	--	--	0.2
<i>Astragalus caricinus</i> (buckwheat milkvetch)	--	--	0.1	--	--	0.2
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	--	X	X	--	--	--
<i>Fritillaria pudica</i> (yellow bell)	0.1	--	--	--	--	--
<i>Crepis atrabarba</i> (slender hawkbeard)	X	--	--	--	--	--
<i>Cryptantha circumscissa</i> (matted cryptantha)	X	--	--	--	--	--
Biotic crust	66.3	--	46.4	4.4	41.3	--
Bare soil	17.2	66.8	30.1	30.9	27.0	78
Litter	83.5	27.4	65.6	57.5	55.3	1.2
Total cover (does not include crust, soil, or litter)	159	64.5	85.4	93.1	103.5	36.3

* Introduced species.

X = Present but not counted in plot frames.

-- = Not occurring on the plot.

Appendix A – 1999 Revegetation Monitoring Results

Table A-11. Percent Frequency of Occurrence on PSN 12/14 Sites in 1999.

Species	Reference	Plot 5	Plot 4	Plot 2	Plot 1	Road
<i>Bromus tectorum</i> * (cheatgrass)	100	100	100	96	100	84
<i>Ambrosia acanthicarpa</i> (bur ragweed)	24	68	44	56	27	68
<i>Sisymbrium altissimum</i> * (tumblemustard)	12	20	44	48	73	8
<i>Salsola kali</i> * (Russian thistle)	24	88	76	92	67	36
<i>Artemisia tridentata</i> (big sagebrush)	36	4	16	12	60	12
<i>Purshia tridentata</i> (antelope bitterbrush)	16	--	--	4	--	--
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	8	X	--	--	--	32
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	--	--	--	--	13	28
<i>Poa sandbergii</i> (Sandberg's bluegrass)	56	16	64	28	60	4
<i>Poa bulbosa</i> * (bulbous bluegrass)	8	--	--	--	--	4
<i>Stipa comata</i> (needle-and-thread grass)	--	64	44	40	33	--
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	4	12	X	--	X	--
<i>Agropyron dasytachyum</i> (thickspike wheatgrass)	--	28	--	--	--	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	--	4	8	--	--
<i>Cymopterus terebinthinus</i> (turpentine parsley)	12	--	--	X	--	--
<i>Descurainia spp</i> (tansymustard)	16	8	16	--	X	4
<i>Epilobium paniculatum</i> (tall willowherb)	24	--	28	4	53	4
<i>Eriogonum niveum</i> (snow buckwheat)	8	20	--	--	--	28
<i>Festuca octoflora</i> (six-weeks fescue)	--	16	4	--	--	--
<i>Holosteum umbellatum</i> * (jagged chickweed)	88	44	92	92	93	68
<i>Draba verna</i> (spring whitlow)	68	--	--	40	27	44
<i>Lactuca serriola</i> * (prickly lettuce)	8	--	68	16	80	--
<i>Machaeranthera canescens</i> (hoary aster)	4	X	32	4	27	8
<i>Microsteris gracilis</i> (annual phlox)	76	--	4	72	20	--
<i>Oenothera pallida</i> (pale evening primrose)	8	36	--	20	--	--
<i>Phlox longifolia</i> (longleaf phlox)	12	--	--	4	--	--
<i>Comandra umbellatum</i> (bastard toadflax)	24	--	--	--	--	--
<i>Achillea millefolium</i> (yarrow)	X	4	4	12	7	8
<i>Tragopogon dubius</i> * (yellow salsify)	--	X	4	X	13	--
<i>Psoralea lanceolata</i> (dune scurfpea)	--	--	--	24	--	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	X	--	--	--	--	8
<i>Lappula redowskii</i> (Western stickweed)	--	--	--	--	7	12
<i>Poa scabrella</i> (pine bluegrass)	--	X	--	--	--	--
<i>Koeleria cristata</i> (prairie junegrass)	--	X	--	--	--	--
<i>Brodiaea douglasii</i> (Douglas' clusterlily)	8	--	--	--	--	--
<i>Rumex venosus</i> (winged dock)	--	--	--	--	--	8
<i>Astragalus caricinus</i> (buckwheat milkvetch)	--	--	4	--	--	8
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	--	X	X	--	--	--
<i>Fritillaria pudica</i> (yellow bell)	4	--	--	--	--	--
<i>Crepis atrabarba</i> (slender hawksbeard)	X	--	--	--	--	--
<i>Cryptantha circumscissa</i> (matted cryptantha)	X	--	--	--	--	--
Biotic crust	92	--	100	100	100	0
Bare soil	92	96	100	100	100	100
Litter	100	100	100	96	100	28

* Introduced species.

X = Present but not counted in plot frames.

-- = Not occurring on the plot.

Appendix A – 1999 Revegetation Monitoring Results

Table A-12. Percent Canopy Cover and Frequency of Occurrence on 600-104 (2,4-D).

Species	% Cover	% Frequency
<i>Bromus tectorum</i> * (cheatgrass)	20.8	96
<i>Salsola kali</i> * (Russian thistle)	45.6	100
<i>Sisymbrium altissimum</i> * (tumblemustard)	0.7	28
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.6	24
<i>Descurainia spp</i> (tansymustard)	0.2	8
<i>Poa sandbergii</i> (Sandberg's bluegrass)	0.7	8
<i>Festuca octoflora</i> (six-weeks fescue)	0.5	20
<i>Rumex venosus</i> (winged dock)	0.2	8
<i>Lappula redowskii</i> (Western stickweed)	0.2	8
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.3	12
<i>Holosteum umbellatum</i> * (jagged chickweed)	0.7	28
<i>Draba verna</i> (spring whitlow)	0.2	8
<i>Achillea millefolium</i> (yarrow)	1.8	32
<i>Oenothera pallida</i> (pale evening primrose)	0.1	4
<i>Epilobium paniculatum</i> (tall willowherb)	0.4	16
<i>Lactuca serriola</i> * (prickly lettuce)	0.6	24
<i>Microsteris gracilis</i> (annual phlox)	0.2	8
<i>Artemisia tridentata</i> (big sagebrush)	0.1	4
<i>Machaeranthera canescens</i> (hoary aster)	0.1	4
<i>Phlox longifolia</i> (longleaf phlox)	0.7	8
<i>Eriogonum niveum</i> (snow buckwheat)	0.1	4
<i>Mentzelia albicaulis</i> (whitestem stickleaf)	0.1	4
<i>Lupinus pusillus</i> (low lupine)	X	
<i>Oryzopsis hymenoides</i> (Indian Rice grass)	X	
<i>Poa bulbosa</i> * (bulbous bluegrass)	X	
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	X	
<i>Tragopogon dubius</i> * (yellow salsify)	X	
<i>Astragalus spp.</i>	X	
<i>Chaenactis douglasii</i> (hoary falseyarrow)	X	
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	X	
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	X	
<i>Thelypodium laciniatum</i> (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.

Appendix A – 1999 Revegetation Monitoring Results

Table A-13. Percent Canopy Cover and Frequency of Occurrence on 300 North Process Trench in 1999.

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

* Introduced species.

X = Present but not counted on plot frames.

Table A-14. Irrigation Applied to 116-C-1 in 1999.

	Water (inches)		Average Monthly Rainfall (1947 to Present)
	Irrigation	Monthly Rainfall 1999	
March 15-31	0.37	0.06	0.47
April	0.83	Trace	0.41
May	0.67	0.34	0.51
June 1-4	0.44	0.31	0.38
Total	2.3	0.71	1.77

Appendix A – 1999 Revegetation Monitoring Results

Table A-15. Percent Canopy Cover on 116-C-1 in 1999.

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

* Introduced species.

X = Present but not counted in plot frames.

-- = Not present on site.

Appendix A – 1999 Revegetation Monitoring Results

Table A-16. Percent Frequency of Occurrence on 116-C-1 in 1999.

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

Table A-17. Sagebrush Seedling Survival on 116-C-1.

	Irrigated Backfill	Irrigated Topsoil	Nonirrigated Topsoil	Nonirrigated Backfill
Sagebrush survival (ratio alive:dead)	33:3	45:12	35:7	66:0
Percent survival	91.7%	78.9%	83.3%	100%

Appendix A – 1999 Revegetation Monitoring Results

APPENDIX B
1998 REVEGETATION MONITORING RESULTS

APPENDIX B

1998 REVEGETATION MONITORING RESULTS

Table B-1. Percent Canopy Cover on Horn Rapids Landfill for 1998.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
<i>Agropyron spp</i> (wheatgrasses)	15.9	24	23.5	21.6	24.7	26.7
<i>Salsola kali</i> (Russian thistle)	0.2	0.3	0.6	1.1	0.9	0.1
<i>Bromus tectorum</i> (cheatgrass)	23.4	18.6	25.8	9.5	7	34.8
<i>Amsinckia lycopsoides</i> (tarweed)	0.3	0.1	2.2	--	--	0.7
<i>Sisymbrium altissimum</i> (tumblemustard)	--	0.3	0.1	0.3	0.2	--
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.2	0.5	--	0.2	0.3	0.4
<i>Convolvulus arvensis</i> (field bindweed)	--	--	--	0.1	--	--
<i>Holosteum umbellatum</i> (jagged chickweed)	10.1	25.9	16.4	20.8	10.6	8.3
<i>Lactuca serriola</i> (prickly lettuce)	--	--	0.5	0.1	--	--
<i>Draba verna</i> (spring whitlow)	2.1	9.7	3.8	24	8.8	4.2
<i>Descurainia pinnata</i> (tansymustard)	0.1	0.1	--	--	--	--
<i>Epilobium paniculatum</i> (tall willowherb)	--	0.4	0.2	0.6	0.4	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	--	--	0.6	--	X	0.1
<i>Plantago patagonica</i> (Indian wheat)	0.1	--	--	--	--	--
<i>Erodium cicutarium</i> (storksbill)	0.3	0.7	0.2	0.2	--	0.1
<i>Tragopogon dubius</i> (yellow salsify)	0.1	--	--	--	--	--
<i>Agoseris grandiflora</i> (mountain dandelion)	--	0.1	--	0.1	--	--
<i>Stipa comata</i> (needle and thread grass)	--	--	--	--	--	X
<i>Chaenactis douglasii</i> (hoary falseyarrow)	--	--	--	--	--	X
<i>Phacelia hastata</i> (whiteleaf scorpionweed)	--	--	--	--	--	X
<i>Eriogonum niveum</i> (snow buckwheat)	--	--	--	--	--	X
<i>Astragalus caricinus</i> (buckwheat milkvetch)	--	--	--	--	--	X
<i>Machaeranthera canescens</i> (hoary aster)	--	--	--	--	X	X
<i>Achillea millefolium</i> (yarrow)	--	--	X	--	--	--
<i>Medicago sativa</i> * (alfalfa)	--	--	X	--	--	--
<i>Melilotus officinalis</i> * (yellow sweet clover)	--	--	X	--	--	--
<i>Convolvulus arvensis</i> * (field bindweed)	--	--	X	--	--	--
<i>Chondrilla juncea</i> * (skeletonweed)	--	--	X	--	--	--
<i>Cardaria draba</i> * (whitetop)	--	--	--	--	X	--
Bare Soil	59.8	53.4	46	84.3	85.3	58.5
Litter	38.9	36.7	51.4	14.3	9.4	34.8
Crust	--	--	0.1	--	--	--
• Total *	52.8	80.7	73.9	78.6	52.9	75.4

* Does not include bare soil, litter, or crust.

X = Present but not counted in plot frames.

Appendix B – 1998 Revegetation Monitoring Results

Table B-2. Percent Frequency of Occurrence on Horn Rapids Landfill for 1998.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
<i>Agropyron spp</i> (wheatgrasses)	68	88	84	88	100	80
<i>Salsola kali</i> (Russian thistle)	8	12	24	24	36	4
<i>Bromus tectorum</i> (cheatgrass)	100	76	100	88	88	100
<i>Amsinckia lycopsoides</i> (tarweed)	12	4	12	--	--	8
<i>Sisymbrium altissimum</i> (tumblemustard)	--	12	4	12	8	--
<i>Ambrosia acanthicarpa</i> (bur ragweed)	8	20	--	8	12	16
<i>Convolvulus arvensis</i> (field bindweed)	--	--	--	4	--	--
<i>Holosteum umbellatum</i> (jagged chickweed)	96	96	96	100	100	84
<i>Lactuca serriola</i> (prickly lettuce)	--	--	20	4	--	--
<i>Draba verna</i> (spring whitlow)	68	92	92	100	100	48
<i>Descurainia pinnata</i> (tansymustard)	4	4	--	--	--	--
<i>Epilobium paniculatum</i> (tall willowherb)	--	16	8	24	16	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	--	--	4	--	--	4
<i>Plantago patagonica</i> (Indian wheat)	4	--	--	--	--	--
<i>Erodium cicutarium</i> (storksbill)	12	8	8	8	--	4
<i>Tragopogon dubius</i> (yellow salsify)	4	--	--	--	--	--
<i>Agoseris grandiflora</i> (mountain dandelion)	--	4	--	4	--	--
Bare Soil	100	100	96	100	100	96
Litter	100	100	100	100	100	100
Crust	--	--	4	--	--	--

Appendix B – 1998 Revegetation Monitoring Results

Table B-3. Percent Canopy Cover on the Horseshoe Landfill in 1998.

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

* Introduced species.

X = Present but not counted in plot frames.

Appendix B – 1998 Revegetation Monitoring Results

Table B-4. Percent Frequency on the Horseshoe Landfill in 1988.

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

* Introduced species.

Appendix B – 1998 Revegetation Monitoring Results

Table B-5. Percent Canopy Cover on Bridge Overlook Sites in 1998.

Species	Waste Site	Control Site
<i>Bromus tectorum</i> * (cheatgrass)	24.4	50.1
<i>Salsola kali</i> * (Russian thistle)	2.5	0.7
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.5	0.1
<i>Psoralea lanceolata</i> (duné scurfpea)	13.6	0.6
<i>Stipa comata</i> (needle-and-thread grass)	0.5	X
<i>Gilia leptomeria</i> (great basin gilia)	11.3	8.5
<i>Mentzelia albicaulis</i> (whitestem stickleaf)	0.1	--
<i>Oenothera pallida</i> (pale evening primrose)	X	1.2
<i>Descurainia sp.</i> (tansymustard)	7	3.4
<i>Cryptantha circumscissa</i> (matted cryptantha)	0.6	0.4
<i>Eriogonum niveum</i> (snow buckwheat)	0.6	3.9
<i>Artemisia tridentata</i> (big sagebrush)	X	16.3
<i>Purshia tridentata</i> (antelope bitterbrush)	X	2.5
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	--	X
<i>Grayia spinosa</i> (spiny hopsage)	--	7.4
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	X	X
<i>Festuca octoflora</i> (six-weeks fescue)	0.4	0.5
<i>Cymopterus terebinthinus</i> (turpentine parsley)	X	2.5
<i>Layia glandulosa</i> (white-daisy tidytips)	0.1	0.1
<i>Comandra umbellata</i> (bastard toadflax)	--	2.9
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	X
<i>Microsteris gracilis</i> (annual phlox)	0.1	--
<i>Poa scabrella</i> (pine bluegrass)	X	X
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	X	--
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	X	--
<i>Abronia mellifera</i> (white sandverbena)	X	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	X
<i>Erysimum asperum</i> (rough wallflower)	--	X
<i>Tragopogon dubius</i> (yellow salsify)		X
<i>Poa sandbergii</i> (Sandberg's bluegrass)	--	X
Biotic crust	1.5	29.1
Bare soil	58.4	31.4
Total (does not include crust or soil)	61.7	101.1

* Introduced species

X = Present but not counted in plot frames.

Appendix B – 1998 Revegetation Monitoring Results**Table B-6. Percent Frequency of Occurrence on Bridge Overlook Sites in 1998.**

Species	Waste Site	Control Site
<i>Bromus tectorum</i> * (cheatgrass)	80	92
<i>Salsola kali</i> * (Russian thistle)	80	28
<i>Ambrosia acanthicarpa</i> (bur ragweed)	20	4
<i>Psoralea lanceolata</i> (dune scurfpea)	52	4
<i>Stipa comata</i> (needle-and-thread grass)	20	--
<i>Gilia leptomeria</i> (great basin gilia)	72	52
<i>Mentzelia albicaulis</i> (whitestem stickleaf)	4	--
<i>Oenothera pallida</i> (pale evening primrose)	--	8
<i>Descurainia sp.</i> (tansymustard)	48	40
<i>Cryptantha circumscissa</i> (matted cryptantha)	4	16
<i>Eriogonum niveum</i> (snow buckwheat)	4	20
<i>Artemisia tridentata</i> (big sagebrush)	--	24
<i>Purshia tridentata</i> (antelope bitterbrush)	--	4
<i>Grayia spinosa</i> (spiny hopsage)	--	12
<i>Festuca octoflora</i> (six-weeks fescue)	16	20
<i>Cymopterus terebinthinus</i> (turpentine parsley)	--	4
<i>Layia glandulosa</i> (white-daisy tidytips)	4	4
<i>Comandra umbellata</i> (bastard toadflax)	--	20
<i>Microsteris gracilis</i> (annual phlox)	4	--
Biotic crust	4	88
Bare soil	100	80

* Introduced species.

Appendix B – 1998 Revegetation Monitoring Results

Table B-7. Percent Canopy Cover at PSN 72/82 Well Mound Sites in 1998.

Species	Waste Site	Road	Control Site
<i>Bromus tectorum</i> * (cheatgrass)	29.5	26.7	43.5
<i>Salsola kali</i> * (Russian thistle)	0.6	0.2	0.1
<i>Ambrosia acanthicarpa</i> (bur ragweed)	1.4	2.9	0.3
<i>Oenothera pallida</i> (pale evening primrose)	1.5	0.6	0.2
<i>Artemisia tridentata</i> (big sagebrush)	7.3	3.2	13.2
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	3.0	0.1	--
<i>Grayia spinosa</i> (spiny hopsage)	0.1	--	1.5
<i>Koeleria cristata</i> (prairie junegrass)	0.1	--	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	1.3	0.1	3.2
<i>Poa bulbosa</i> * (bulbous bluegrass)	0.1	0.3	--
<i>Poa scabrella</i> (pine bluegrass)	0.1	--	--
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	1.3	--	--
<i>Stipa comata</i> (needle-and-thread grass)	5.1	0.1	--
<i>Festuca octoflora</i> (six-weeks fescue)	5.6	6.6	1.7
<i>Microsteris gracilis</i> (annual phlox)	1.3	1.4	0.3
<i>Holosteum umbellatum</i> (jagged chickweed)	4.5	3.8	1.9
<i>Draba verna</i> (spring whitlow)	2.4	7	3.5
<i>Rumex venosus</i> (winged dock)	--	--	0.7
<i>Lactuca serriola</i> * (prickly lettuce)	--	--	0.1
<i>Amsinckia tessellata</i> (devil's lettuce)	0.4	0.2	0.3
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.3	0.3	0.3
<i>Sisymbrium altissimum</i> * (tumblemustard)	0.5	0.3	--
<i>Descurainia spp</i> (tansymustard)	1.5	0.2	0.9
<i>Erodium cicutarium</i> * (storksbill)	4.5	3.2	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	0.7	0.3	3.6
<i>Comandra umbellata</i> (bastard toadflax)	0.2	--	--
<i>Machaeranthera canescens</i> (hoary aster)	3.8	6.4	1
<i>Cryptantha circumscissa</i> (matted cryptantha)	--	1.1	--
<i>Eriogonum niveum</i> (snow buckwheat)	--	0.8	--
<i>Tragopogon dubius</i> * (yellow salsify)	--	0.1	--
<i>Plantago patagonica</i> (Indian wheat)	--	0.8	--
Biotic crust	0.6	--	8.4
Bare soil	90.3	81.3	42.3
Litter	7.8	9.6	35.7
Total (does not include crust , soil, or litter)	77.1	66.7	76.3

* Introduced species.

X = Present but not counted in plot frames.

Appendix B – 1998 Revegetation Monitoring Results

Table B-8. Percent Frequency of Occurrence at PSN 72/82 Well Mound Sites in 1998.

Species	Waste Site	Road	• Control Site
<i>Bromus tectorum</i> * (cheatgrass)	96	96	84
<i>Salsola kali</i> * (Russian thistle)	24	8	4
<i>Ambrosia acanthicarpa</i> (bur ragweed)	56	56	12
<i>Oenothera pallida</i> (pale evening primrose)	20	4	8
<i>Artemisia tridentata</i> (big sagebrush)	28	28	36
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	8	4	--
<i>Grayia spinosa</i> (spiny hopsage)	4	--	4
<i>Koeleria cristata</i> (prairie junegrass)	4	--	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	12	4	28
<i>Poa bulbosa</i> * (bulbous bluegrass)	4	12	--
<i>Poa scabrella</i> (pine bluegrass)	4	--	--
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	12	--	--
<i>Stipa comata</i> (needle-and-thread grass)	48	4	--
<i>Festuca octoflora</i> (six-weeks fescue)	32	68	28
<i>Microsteris gracilis</i> (annual phlox)	52	36	12
<i>Holosteum umbellatum</i> (jagged chickweed)	84	72	36
<i>Draba verna</i> (spring whitlow)	76	68	24
<i>Rumex venosus</i> (winged dock)	--	--	8
<i>Lactuca serriola</i> * (prickly lettuce)	--	--	4
<i>Amsinckia tessellata</i> (devil's lettuce)	16	8	12
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	12	12	12
<i>Sisymbrium altissimum</i> * (tumblemustard)	20	12	--
<i>Descurainia sp</i> (tansymustard)	40	8	36
<i>Erodium cicutarium</i> * (storksbill)	64	48	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	8	12	12
<i>Comandra umbellata</i> (bastard toadflax)	8	--	--
<i>Machaeranthera canescens</i> (hoary aster)	36	44	20
<i>Cryptantha circumscissa</i> (matted cryptantha)	--	24	--
<i>Eriogonum niveum</i> (snow buckwheat)	--	12	--
<i>Tragopogon dubius</i> * (yellow salsify)	--	4	--
<i>Plantago patagonica</i> (Indian wheat)	--	32	--
Biotic crust	4	--	52
Bare soil	100	96	80
Litter	100	72	96

* Introduced species.

Appendix B – 1998 Revegetation Monitoring Results

Table B-9. Percent Canopy Cover for PSN 12/14 in 1998.

Species	Control	Plot 5	Plot 4	Plot 2	Plot 1	Road
<i>Bromus tectorum</i> * (cheatgrass)	46.6	21.6	26.8	42.5	28.5	45.2
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.6	0.4	7.6	2.0	4.0	3.5
<i>Sisymbrium altissimum</i> * (tumblemustard)	0.7	0.4	21.3	0.5	16.5	0.3
<i>Salsola kali</i> * (Russian thistle)	0.3	1.9	4.4	0.5	2.0	1.2
<i>Artemisia tridentata</i> (big sagebrush)	9.4	0.6	3.9	X	8.5	1.6
<i>Purshia tridentata</i> (antelope bitterbrush)	3.9	--	--	--	--	--
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	1.7	--	--	--	--	0.1
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	--	--	--	--	--	0.2
<i>Poa sandbergii</i> (Sandberg's bluegrass)	7.7	--	16	11	0.5	0.2
<i>Poa bulbosa</i> * (bulbous bluegrass)	--	--	--	--	--	0.2
<i>Stipa comata</i> (needle-and-thread grass)	--	7.6	7.5	30.5	3.5	--
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	0.1	5.4	--	--	--	X
<i>Agropyron dasytachyum</i> (thickspike wheatgrass)	--	5.0	--	--	--	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	--	--	--	0.5	--	0.1
<i>Cymopterus terebinthinus</i> (turpentine parsley)	4.8	--	--	--	--	--
<i>Descurainia pinnata</i> (tansymustard)	--	0.1	--	--	--	--
<i>Epilobium paniculatum</i> (tall willowherb)	--	0.2	0.9	--	1.5	1.3
<i>Eriogonum niveum</i> (snow buckwheat)	1.6	--	0.1	--	--	0.9
<i>Festuca octoflora</i> (six weeks fescue)	--	--	--	--	--	0.9
<i>Holosteum umbellatum</i> (jagged chickweed)	16.3	0.6	6.3	15.5	26.5	3.3
<i>Draba verna</i> (spring whitlow)	13.5	--	--	--	--	0.7
<i>Lactuca serriola</i> * (prickly lettuce)	--	--	2.3	--	2.5	0.4
<i>Machaeranthera canescens</i> (hoary aster)	0.2	--	0.3	0.5	--	0.1
<i>Microsteris gracilis</i> (annual phlox)	1.6	--	--	6.5	--	2.6
<i>Oenothera pallida</i> (pale evening primrose)	0.9	3.0	0.1	3.0	0.5	X
<i>Phlox longifolia</i> (longleaf phlox)	1.3	--	--	--	--	--
<i>Comandra umbellatum</i> (bastard toadflax)	0.8	--	--	--	--	--
<i>Achillea millefolium</i> (yarrow)	0.7	0.1	0.3	--	--	X
<i>Tragopogon dubius</i> * (yellow salsify)	--	--	0.1	--	--	X
<i>Psoralea lanceolata</i> (dune scurfpea)	--	--	--	20	--	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	--	--	--	--	0.1
<i>Lappula redowskii</i> (Western stickseed)	--	--	--	--	--	X
<i>Plantago patagonica</i> (Indian wheat)	--	--	--	--	--	X
<i>Poa scabrella</i> (pine bluegrass)	--	X	--	--	--	--
<i>Koeleria cristata</i> (prairie junegrass)	--	X	--	--	--	--
<i>Phacelia linearis</i> (threadleaf scorpionweed)	--	--	--	--	--	X
<i>Brodiaea douglasii</i> (Douglas' clusterlily)	--	--	--	--	--	X
biotic crust	36.3	--	8.5	0.5	7.5	--
bare soil	40.3	78.8	32.5	40.5	54	60.9
Litter	37.6	14.1	58.1	57.5	59.5	5.4
Total cover (not including crust, bare soil, or litter)	112.7	46.9	97.9	133	94.5	62.9

* Introduced species.

X = Present but not counted in plot frames.

Appendix B – 1998 Revegetation Monitoring Results

Table B-10. Percent Frequency of Occurrence on PSN 12/14 Sites in 1998.

Species	Control	Plot 5	Plot 4	Plot 2	Plot 1	Road
<i>Bromus tectorum</i> * (cheatgrass)	100	100	95	100	100	100
<i>Ambrosia acanthicarpa</i> (bur ragweed)	24	16	70	80	60	60
<i>Sisymbrium altissimum</i> * (tumblemustard)	28	16	70	20	80	12
<i>Salsola kali</i> * (Russian thistle)	12	76	30	20	80	48
<i>Artemisia tridentata</i> (big sagebrush)	16	4	10	--	60	8
<i>Purshia tridentata</i> (antelope bitterbrush)	4	--	--	--	--	--
<i>Chrysothamnus viscidiflorus</i> (green rabbitbrush)	12	--	--	--	--	4
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	--	--	--	--	--	8
<i>Poa sandbergii</i> (Sandberg's bluegrass)	60	--	45	60	20	8
<i>Poa bulbosa</i> * (bulbous bluegrass)	--	--	--	--	--	8
<i>Stipa comata</i> (needle-and-thread grass)	--	56	40	80	40	--
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	4	28	--	--	--	--
<i>Agropyron dasytachyum</i> (thickspike wheatgrass)	--	8	--	--	--	--
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	--	--	--	20	--	4
<i>Cymopterus terebinthinus</i> (turpentine parsley)	36	--	--	--	--	--
<i>Descurainia pinnata</i> (tansymustard)	--	4	--	--	--	--
<i>Epilobium paniculatum</i> (tall willowherb)	--	8	35	--	60	32
<i>Eriogonum niveum</i> (snow buckwheat)	8	--	5	--	--	16
<i>Festuca octoflora</i> (six weeks fescue)	--	--	--	--	--	16
<i>Holosteum umbellatum</i> (jagged chickweed)	96	24	55	60	100	72
<i>Draba verna</i> (spring whitlow)	76	--	--	--	--	28
<i>Lactuca serriola</i> * (prickly lettuce)	--	--	65	--	100	16
<i>Machaeranthera canescens</i> (hoary aster)	8	--	10	20	--	4
<i>Microsteris gracilis</i> (annual phlox)	44	--	--	60	--	44
<i>Oenothera pallida</i> (pale evening primrose)	16	40	5	20	20	--
<i>Phlox longifolia</i> (longleaf phlox)	8	--	--	--	--	--
<i>Comandra umbellatum</i> (bastard toadflax)	12	--	--	--	--	--
<i>Achillea millefolium</i> (yarrow)	8	4	10	--	--	--
<i>Tragopogon dubius</i> * (yellow salsify)	--	--	5	--	--	--
<i>Psoralea lanceolata</i> (dune scurfpea)	--	--	--	40	--	--
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	--	--	--	--	4
biotic crust	84	--	35	20	20	--
bare soil	92	100	95	100	80	96
Litter	100	96	100	100	100	8

* Introduced species.

Appendix B – 1998 Revegetation Monitoring Results

Table B-11. Percent Canopy Cover and Frequency of Occurrence on 2,4-D Site.

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

* Introduced species.

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APPENDIX C
1997 REVEGETATION MONITORING RESULTS

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1997 REVEGETATION MONITORING RESULTS

Table C-1. Percent Canopy Cover on Horn Rapids Landfill for 1997.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
<i>Agropyron spp</i> (wheatgrasses)	7.5	9.5	10.1	6.4	11.5	11.1
<i>Salsola kali</i> (Russian thistle)	2.2	2.6	1.6	8.6	13.3	1.5
<i>Bromus tectorum</i> (cheatgrass)	6	7.8	5.5	1.6	1.2	22.9
<i>Amsinckia lycopsoides</i> (tarweed)	--	--	--	--	--	0.6
<i>Sisymbrium altissimum</i> (tumblemustard)	0.2	0.1	0.4	0.5	0.9	0.1
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.2	1.4		0.3	0.4	1.8
<i>Chenopodium sp</i> (lambsquartern)	0.2	0.1	0.3	1.0	1.1	--
<i>Convolvulus arvensis</i> (field bindweed)	--	--	--	0.2	--	--
<i>Holosteum umbellatum</i> (jagged chickweed)	4.0	4.8	2.3	0.9	0.3	0.4
<i>Lactuca serriola</i> (prickly lettuce)	0.2	0.3	0.3	--	--	--
<i>Draba verna</i> (spring whitlow)	0.2	2.9	2.1	0.6	1.1	0.2
<i>Medicago sativa</i> (alfalfa)	--	0.1	--	--	--	--
<i>Descurainia pinnata</i> (tansymustard)	0.1	0.3	0.2	--	--	--
<i>Epilobium paniculatum</i> (tall willowherb)	--	--	0.2	0.2	--	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	--	--	0.1	--	--	--
<i>Plantago patagonica</i> (Indian wheat)	--	--	--	0.2	--	--
<i>Erodium cicutarium</i> (storksbill)	--	--	--	0.2	0.1	0.2
<i>Agastache occidentalis</i> (western horsemint)	--	--	--	0.2	--	--
<i>Tragopogon dubius</i> (yellow salsify)	0.8	0.1	--	--	--	--
<i>Cardaria draba</i> * (whitetop)	--	--	--	--	3 plants	--
Total	21.6	30	23.1	20.9	29.9	38.8

* Not counted in plot frames.

Appendix C – 1997 Revegetation Monitoring Results

Table C-2. Percent Frequency of Occurrence on Horn Rapids Landfill for 1997.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
<i>Agropyron spp</i> (wheatgrasses)	80	92	84	100	92	80
<i>Salsola kali</i> (Russian thistle)	68	84	64	96	96	40
<i>Bromus tectorum</i> (cheatgrass)	84	80	80	64	48	96
<i>Amsinckia lycopsoides</i> (tarweed)	--	--	--	--	--	4
<i>Sisymbrium altissimum</i> (tumblemustard)	8	4	16	20	36	4
<i>Ambrosia acanthicarpa</i> (bur ragweed)	8	36	--	12	16	52
<i>Chenopodium sp</i> (lambsquarter)	8	4	12	40	44	--
<i>Convolvulus arvensis</i> (field bindweed)	--	--	--	8	--	--
<i>Holosteum umbellatum</i> (jagged chickweed)	80	72	52	16	12	16
<i>Lactuca serriola</i> (prickly lettuce)	8	12	12	--	--	--
<i>Draba verna</i> (spring whitlow)	8	40	44	24	44	8
<i>Medicago sativa</i> (alfalfa)	--	4	--	--	--	--
<i>Descurainia pinnata</i> (tansymustard)	4	12	8	--	--	--
<i>Epilobium paniculatum</i> (tall willowherb)	--	--	8	8	--	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	--	--	4	--	--	--
<i>Plantago patagonica</i> (Indian wheat)	--	--	--	8	--	--
<i>Erodium cicutarium</i> (storksbill)	--	--	--	8	4	8
<i>Agastache occidentalis</i> (western horsemint)	--	--	--	8	--	--
<i>Tragopogon dubius</i> (yellow salsify)	12	4	--	--	--	--

Appendix C – 1997 Revegetation Monitoring Results

Table C-3. Percent Canopy Cover on the Horseshoe Landfill in 1997.

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

* Introduced species.

Appendix C – 1997 Revegetation Monitoring Results

Table C-4. Percent Frequency of Occurrence on the Horseshoe Landfill in 1997.

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

* Introduced species.

Appendix C – 1997 Revegetation Monitoring Results

Table C-5. Percent Canopy Cover on Bridge Overlook Sites in 1997.

Species	Waste Site	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	5.8	32.4
<i>Salsola kali</i> * (Russian thistle)	1.4	0.2
<i>Ambrosia acanthicarpa</i> (bur ragweed)	1.8	0.6
<i>Psoralea lanceolata</i> (dune scurfpea)	1.4	1.2
<i>Koeleria cristata</i> (prairie junegrass)	0.1	--
<i>Stipa comata</i> (needle-and-thread grass)	0.7	--
<i>Gilia leptomeria</i> (great basin gilia)	0.2	0.2
<i>Mentzelia albicaulis</i> (whitestem stickleaf)	0.2	--
<i>Oenothera pallida</i> (pale evening primrose)	0.1	0.1
<i>Descurainia sp.</i> (tansymustard)	1.7	--
<i>Cryptantha circumscissa</i> (matted cryptantha)	0.1	0.2
<i>Eriogonum niveum</i> (snow buckwheat)	--	12.1
<i>Artemisia tridentata</i> (big sagebrush)	--	4.2
<i>Purshia tridentata</i> (antelope bitterbrush)	--	6.5
<i>Chrysothamnus viscidiflorus</i> (gray rabbitbrush)	--	1.5
<i>Grayia spinosa</i> (spiny hopsage)	X	3.5
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	X	1.5
<i>Festuca octoflora</i> (six-weeks fescue)	--	0.1
<i>Cymopterus terebinthinus</i> (spring turpentine parsley)	X	0.6
<i>Layia glandulosa</i> (white-daisy tidytips)	--	0.1
<i>Comandra umbellata</i> (bastard toadflax)	--	0.9
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	0.1
Biotic crust	--	21.8
Total (biotic crust not included)	13.5	66

* Introduced species.

X = Present but not counted in plot frames.

Appendix C – 1997 Revegetation Monitoring Results

Table C-6. Percent Frequency of Occurrence on Bridge Overlook Sites in 1997.

Species	Waste Site	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	60	84
<i>Salsola kali</i> * (Russian thistle)	36	8
<i>Ambrosia acanthicarpa</i> (bur ragweed)	32	24
<i>Psoralea lanceolata</i> (dune scurfpea)	16	8
<i>Koeleria cristata</i> (prairie junegrass)	4	--
<i>Stipa comata</i> (needle-and-thread grass)	8	--
<i>Gilia leptomeria</i> (great basin gilia)	8	8
<i>Mentzelia albicaulis</i> (whitestem stickleaf)	8	--
<i>Oenothera pallida</i> (pale evening primrose)	4	4
<i>Descurainia sp.</i> (tansymustard)	12	--
<i>Cryptantha circumscissa</i> (matted cryptantha)	4	8
<i>Eriogonum niveum</i> (snow buckwheat)	--	28
<i>Artemisia tridentata</i> (big sagebrush)	--	16
<i>Purshia tridentata</i> (antelope bitterbrush)	--	12
<i>Chrysothamnus viscidiflorus</i> (gray rabbitbrush)	--	4
<i>Grayia spinosa</i> (spiny hopsage)	--	8
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	--	4
<i>Festuca octoflora</i> (six-weeks fescue)	--	4
<i>Cymopterus terebinthinus</i> (turpentine parsley)	--	4
<i>Layia glandulosa</i> (white-daisy tidytips)	--	4
<i>Comandra umbellata</i> (bastard toadflax)	--	16
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	--	4
Biotic crust	--	56

* Introduced species.

Appendix C – 1997 Revegetation Monitoring Results

Table C-7. Percent Canopy Cover at PSN 72/82 Well Mound Sites in 1997.

Species	Waste Site	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	23.1	40.8
<i>Salsola kali</i> * (Russian thistle)	2.5	6.4
<i>Ambrosia acanthicarpa</i> (bur ragweed)	2.0	0.1
<i>Oenothera pallida</i> (pale evening primrose)	0.5	0.1
<i>Artemisia tridentata</i> (big sagebrush)	3.6	16
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	0.1	0.6
<i>Grayia spinosa</i> (spiny hopsage)	--	1.5
<i>Koeleria cristata</i> (prairie junegrass)	0.1	--
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	0.3	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	0.2	--
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	0.1	--
<i>Stipa comata</i> (needle-and-thread grass)	0.5	--
<i>Amsinckia tessellata</i> (devil's lettuce)	0.2	0.1
<i>Sisymbrium altissimum</i> * (tumblemustard)	0.5	0.1
<i>Descurainia pinnata</i> (tansymustard)	0.3	1.4
<i>Fritillaria pudica</i> (yellowbell)	0.1	0.8
<i>Erodium cicutarium</i> (storksbill)	0.1	0.2
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	0.8
<i>Comandra umbellata</i> (bastard toadflax)	--	0.6
<i>Machaeranthera canescens</i> (hoary aster)	--	0.1
Biotic crust	0.1	29.4
Total cover (biotic crust not included)	34.2	69.6

* Introduced species.

Appendix C – 1997 Revegetation Monitoring Results

Table C-8. Percent Frequency of Occurrence at PSN 72/82 Well Mound Sites in 1997.

Species	Waste Site	Reference Site
<i>Bromus tectorum</i> * (cheatgrass)	88	96
<i>Salsola kali</i> * (Russian thistle)	80	28
<i>Ambrosia acanthicarpa</i> (bur ragweed)	80	4
<i>Oenothera pallida</i> (pale evening primrose)	20	4
<i>Artemisia tridentata</i> (big sagebrush)	28	52
<i>Chrysothamnus nauseosus</i> (gray rabbitbrush)	4	4
<i>Grayia spinosa</i> (spiny hopsage)	--	4
<i>Koeleria cristata</i> (prairie junegrass)	4	--
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	12	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	8	--
<i>Sitanion hystrix</i> (bottlebrush squirreltail)	4	--
<i>Stipa comata</i> (needle-and-thread grass)	20	--
<i>Amsinckia tessellata</i> (devil's lettuce)	8	4
<i>Sisymbrium altissimum</i> * (tumblemustard)	20	4
<i>Descurainia pinnata</i> (tansymustard)	12	36
<i>Fritillaria pudica</i> (yellowbell)	4	32
<i>Erodium cicutarium</i> (storksbill)	4	8
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	--	12
<i>Comandra umbellata</i> (bastard toadflax)	--	4
<i>Machaeranthera canescens</i> (hoary aster)	--	4
Biotic crust	4	72

* Introduced species.

Appendix C – 1997 Revegetation Monitoring Results

Table C-9. Percent Canopy Cover for PSN 12/14 in 1997.

Species	Reference	Plot 5	Plot 4	Plot 2	Plot 1	Road
<i>Bromus tectorum</i> * (cheatgrass)	52.3	13.7	42.9	14.5	56.5	32.3
<i>Ambrosia acanthicarpa</i> (bur ragweed)	0.4	3.2	6.0	4.5	0.5	3.4
<i>Sisymbrium altissimum</i> * (tumblemustard)	0.4	--	16	1.0	1.5	1.1
<i>Salsola kali</i> * (Russian thistle)	--	0.9	4.0	1.5	2.0	0.7
<i>Artemisia tridentata</i> (big sagebrush)	15.6	--	1.5	0.5	--	--
<i>Purshia tridentata</i> (antelope bitterbrush)	2.1	--	--	--	--	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	14.6	0.1	0.3	--	--	--
<i>Stipa comata</i> (needle-and-thread grass)	--	6.8	3.0	3.5	3.0	--
<i>Koeleria cristata</i> (prairie junegrass)	--	0.1	--	--	--	--
<i>Amsinckia tessellata</i> (devil's lettuce)	--	--	0.1	--	--	--
<i>Cymopterus terebinthinus</i> (turpentine parsley)	0.7	--	--	--	--	--
<i>Descurainia pinnata</i> (tansymustard)	0.1	0.9	--	--	--	--
<i>Draba verna</i> (spring whitlow)	2.5	--	--	--	--	--
<i>Epilobium paniculatum</i> (tall willowherb)	--	--	0.3	0.5	1.5	0.1
<i>Eriogonum niveum</i> (snow buckwheat)	--	0.6	--	--	--	--
<i>Festuca octoflora</i> (six weeks fescue)	--	--	--	--	--	0.5
<i>Holosteum umbellatum</i> (jagged chickweed)	0.8	--	--	--	--	0.3
<i>Lactuca serriola</i> * (prickly lettuce)	--	--	0.8	--	1.0	0.2
<i>Machaeranthera canescens</i> (hoary aster)	--	--	0.3	--	--	--
<i>Microsteris gracilis</i> (annual phlox)	1.1	--	--	--	--	0.3
<i>Oenothera pallida</i> (pale evening primrose)	--	0.2	0.3	3.5	--	--
<i>Phlox longifolia</i> (longleaf phlox)	0.1	--	0.1	--	--	--
<i>Rumex venosus</i> (winged dock)	--	--	--	0.5	--	--
Biotic crust	52.5	--	38.5	--	0.5	--
Bare soil	20.2	86.3	20.9	80.5	30	--
Total cover (not including crust or bare soil)	90.7	26.5	75.6	30	66	38.9

* Introduced species.

Appendix C – 1997 Revegetation Monitoring Results

Table C-10. Percent Frequency of Occurrence on PSN 12/14 Sites in 1997.

Species	Reference	Plot 5	Plot 4	Plot 2	Plot 1	Road
<i>Bromus tectorum</i> * (cheatgrass)	100	96	95	100	80	96
<i>Ambrosia acanthicarpa</i> (bur ragweed)	16	88	45	80	20	56
<i>Sisymbrium altissimum</i> * (tumblemustard)	16	--	70	40	60	24
<i>Salsola kali</i> * (Russian thistle)	--	36	65	60	80	28
<i>Artemisia tridentata</i> (big sagebrush)	32	--	10	20	--	--
<i>Purshia tridentata</i> (antelope bitterbrush)	8	--	--	--	--	--
<i>Poa sandbergii</i> (Sandberg's bluegrass)	48	4	10	--	--	--
<i>Stipa comata</i> (needle-and-thread grass)	--	56	20	40	20	--
<i>Koeleria cristata</i> (prairie junegrass)	--	4	--	--	--	--
<i>Amsinckia tessellata</i> (devil's lettuce)	--	--	5	--	--	--
<i>Cymopterus terebinthinus</i> (turpentine parsley)	8	--	--	--	--	--
<i>Descurainia pinnata</i> (tansymustard)	4	36	--	--	--	--
<i>Draba verna</i> (spring whitlow)	60	--	--	--	--	--
<i>Epilobium paniculatum</i> (tall willowherb)	--	--	10	20	60	4
<i>Eriogonum niveum</i> (snow buckwheat)	--	4	--	--	--	--
<i>Festuca octoflora</i> (six weeks fescue)	--	--	--	--	--	20
<i>Holosteum umbellatum</i> (jagged chickweed)	12	--	--	--	--	12
<i>Lactuca serriola</i> * (prickly lettuce)	--	--	30	--	40	8
<i>Machaeranthera canescens</i> (hoary aster)	--	--	10	--	--	--
<i>Microsteris gracilis</i> (annual phlox)	44	--	--	--	--	12
<i>Oenothera pallida</i> (pale evening primrose)	--	8	10	40	--	--
<i>Phlox longifolia</i> (longleaf phlox)	4	--	5	--	--	--
<i>Rumex venosus</i> (winged dock)	--	--	--	20	--	--
Biotic crust	72	--	70	--	20	--
Bare soil	64	100	70	100	60	--

* Introduced species.

APPENDIX D

**1996 REVEGETATION MONITORING RESULTS FOR
HORN RAPIDS LANDFILL AND HORSESHOE LANDFILL**

APPENDIX D

1996 REVEGETATION MONITORING RESULTS FOR
HORN RAPIDS LANDFILL AND HORSESHOE LANDFILL

Table D-1. Percent Canopy Cover on Horn Rapids Landfill in 1996.

Plant Name	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
<i>Agropyron spp</i> (wheatgrasses)	11	5.2	9.3	25.9	12.8	12
<i>Salsola kali</i> (Russian thistle)	22.7	9.8	12.2	6.0	8.4	14.7
<i>Bromus tectorum</i> (cheatgrass)	1.8	1.1	1.7	0.3	0.1	2.8
<i>Amsinckia lycopsoides</i> (tarweed)	0.3	0.6	0.1	0.1	0.3	0.4
<i>Sisymbrium altissimum</i> (tumblemustard)	1.3	0.4	0.1	0.2	0.3	0.4
<i>Triticum sp</i> (wheat)	2.6	0.3	0.7	0	0	5.6
<i>Ambrosia acanthicarpa</i> (bur ragweed)	1.2	0.7	0.1	0.8	0.9	2.0
<i>Chenopodium sp</i> (lambsquarter)	1.0	4.8	2.4	1.7	1.2	0.1
<i>Lactuca serriola</i> (prickly lettuce)	0.1	0.2	0	0.1	0.1	0
<i>Erodium cicutarium</i> (storksbill)	0.2	0	0	0.1	0	0
Total	41.9	23.2	26.8	35	24.2	38.1

Table D-2. Percent Frequency of Occurrence on Horn Rapids Landfill in 1996.

Plant Name	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
<i>Agropyron spp</i> (wheatgrasses)	92	88	100	100	100	92
<i>Salsola kali</i> (Russian thistle)	100	100	100	100	100	100
<i>Bromus tectorum</i> (cheatgrass)	16	24	12	12	4	36
<i>Amsinckia lycopsoides</i> (tarweed)	12	4	4	4	12	16
<i>Sisymbrium altissimum</i> (tumblemustard)	32	16	4	8	12	16
<i>Triticum sp</i> (wheat)	44	12	28	0	0	32
<i>Ambrosia acanthicarpa</i> (bur ragweed)	28	8	4	12	36	60
<i>Chenopodium sp</i> (lambsquarter)	20	76	76	48	28	4
<i>Lactuca serriola</i> (prickly lettuce)	0	4	8	4	4	4
<i>Erodium cicutarium</i> (storksbill)	0	8	0	0	4	0

**Appendix D – 1996 Revegetation Monitoring Results for
Horn Rapids Landfill and Horseshoe Landfill**

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Table D-3. Percent Canopy Cover on the Horseshoe Landfill in 1996.

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

* Introduced species.

Table D-4. Percent Frequency of Occurrence on the Horseshoe Landfill in 1996.

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

* Introduced species.

**Appendix D – 1996 Revegetation Monitoring Results for
Horn Rapids Landfill and Horseshoe Landfill**

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APPENDIX E

**NAME CHANGES INCLUDED IN
INTEGRATED TAXONOMIC INFORMATION SYSTEM**

APPENDIX E

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*
Koeleria cristata = *Koeleria macrantha*
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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