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2002 Environmental Restoration Contractor Revegetation Monitoring Report

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2002 Environmental Restoration Contractor Revegetation Monitoring Report

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EXECUTIVE SUMMARY

This report documents the progress of the Environmental Restoration Contractor's (ERC's) revegetation monitoring on the Hanford Site for the period of April through August 2002. This is the fifth year of monitoring following revegetation of the 600-104 (2,4-D) Bioremediated site and the 300-FF-1 sagebrush (*Artemisia tridentata*) and bitterbrush (*Purshia tridentata*) mitigation areas. Data was collected for the fourth year of monitoring at the 316-5 Process Trenches and the 116-C-1 restoration site. Third-year monitoring was conducted at the 116-B-1, 116-B-11, and 116-C-5 revegetation sites, and first-year monitoring was conducted at the revegetated liquid waste sites in0 the 100-D/DR and 100-H Areas and the 600-23 and J. A. Jones sites in the 600 Area. Revegetation monitoring of these sites is conducted annually to ensure that the objectives of the ERC's revegetation efforts are accomplished, to note planting techniques that yield the greatest success, and to document successional recovery. It is important to note that it typically takes 3 to 5 years before revegetation efforts in arid regions show signs of success.

Broadcast seeding of the 600-104 (2,4-D) Bioremediated site was conducted in the fall of 1997. To promote additional shrubs in the recovering community, 900 sagebrush tublings were planted throughout the site in February 2001. All of the revegetation materials were collected from species on the Hanford site. Thirty-five species were observed on the site this year. Biotic crust measurements increased 38.2% from 2001 data collections. Sagebrush tublings on the site had an average height of 17.6 cm.

The 600-23 and J. A. Jones sites were backfilled in late summer 2001 and were revegetated in December 2001. Both areas were hydroseeded with a mixture of native seed collected from the Hanford Site. Triple-16 (16% each of nitrogen, phosphorous, and potassium) fertilizer was co-applied during seeding at 112 kg/ha and was irrigated with 0.62 cm/ha of water. The entire seeded area was mulched with grass straw, which was then crimped into the soil surface with a disk. The 600-23 site was planted with 140, 4 cubic inch ($in.^3$) sagebrush tublings and 150, 4-$in.^3$ bitterbrush tublings. The J. A. Jones site was planted with 100, 4-$in.^3$ sagebrush tublings and 130,

10-in.^{3} bitterbrush tublings. Initial vegetation surveys found 21 species on the 600-23 site and 29 species on the J. A. Jones site. Shrub survival data were collected from the 600-23 site in May 2002, with the shrub survival rate calculated at 83.6% for sagebrush and 78.2% for bitterbrush. Shrub survival data obtained from the J. A. Jones site were collected in August 2002, identifying sagebrush survival at 89.2% and bitterbrush survival at 39%. Data gathered after an entire growing season will provide a more accurate outlook for shrub survival.

The 300-FF-1 sagebrush and bitterbrush mitigation planting was measured for survival in early summer. Of the 50 bitterbrush planted in November 1999 and January 2001, only 18 plants remain alive. However, the survival rate of the sagebrush planted in 1997 was 36.6%, with 66% of the original planting locations still having at least one of the three plants still alive.

The 316-5 Process Trenches were remediated from mid-1997 through early 1998, with 80% of the remediated trench area being regraded and contoured with the surrounding soils. During the fall of 1998, the recontoured area was broadcast seeded with crested wheatgrass (*Agropyron cristatum*) at 50 kg/ha. Wheat (*Triticum sp.*) straw was used as mulch and was crimped into the soil. Fourth-year monitoring was conducted in June 2002 and 32 species were identified. The most abundant species on the trench was crested wheatgrass, with 20.9% canopy cover, which was an increase of 9.1% from measurements collected in the 2001 surveys. Cheatgrass (*Bromus tectorum*) canopy cover of 17.3% remains consistent with the 2001 data collections.

The 116-C-1 site revegetation was conducted as a demonstration project to evaluate practical methods for revegetating remediated sites with native species. The 116-C-1 site was backfilled with naturally occurring sand and cobble from a nearby borrow pit and was used as the planting medium for two of four planting treatment areas. The remaining two treatment areas used topsoil salvaged from the construction area of the Environmental Restoration Disposal Facility. In November 1998, a native seed mixture was distributed across the site. Cryptobiotic soil/dust was also spread on the eastern half of the site to inoculate the soil surface, and then wheat straw mulch was applied across the planted area at an approximate rate of 6.7 metric tons/ha, then crimped into the soil surface. Two hundred and one sagebrush tublings were planted across the

sites in groups of three and were then irrigated. Irrigation was applied over one-half the cobble substrate and one-half the topsoil substrate. Vegetation analysis conducted in May 2002 found 28 species across the site, 22 of which were native. The overall sagebrush survival rate remains high at 80%. Sagebrush seedling survival is the highest on the non-irrigated and irrigated cobble treatment areas at 93.9% and 88.8%, respectively.

The 116-B-1, 116-B-11, and 116-C-5 sites were seeded in December 1999. Three different fertilizer formulas were applied to the backfilled areas. The native seed mixture and fertilizer treatments were applied with a hydroseeder. The entire seeded area was mulched and then irrigated with water at 0.62 cm/ha. In December 2000, 2,600 sagebrush tublings were planted across the sites. Vegetation analysis conducted in June 2002 found 28 species across the sites, 16 of which were native. Sandberg's bluegrass (*Poa sandbergii*) continues to have the greatest canopy cover across all of the treatments. Species diversity is the highest at the 116-C-5 site, which received a combination of Triple-16 and micronutrient fertilizers. The sagebrush survival rate remains at 98.9% after an entire growing season.

The 100-D/DR and 100-H liquid waste sites were revegetated in November and December 2001. The entire backfilled area at the 100-D/DR and 100-H Areas, 27.9 ha and 22.3 ha respectively were broadcast seeded with a hydroseeder and irrigated with 0.62 cm/ha of water. The entire seeded area was mulched with grass straw that was crimped into the soil surface with a disk. A total of 21,700 sagebrush was planted across the revegetated area. Initial vegetation analysis at the 100-D/DR and 100-H Areas identified 29 and 24 species, respectively, across the sites.

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METRIC CONVERSION CHART

Into Metric Units

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

Out of Metric Units

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

1.0 INTRODUCTION

This report contains a compilation of the results of vegetation monitoring data that were collected in the spring and summer of 2002 from the Environmental Restoration Contractor's (ERC's) revegetation and mitigation areas on the Hanford Site. The monitoring sites included in this report are the 600-104 (2,4-D) Bioremediated site, the 300-FF-1 sagebrush (*Artemisia tridentata*) and bitterbrush (*Purshia tridentata*) mitigation areas, the 316-5 Process Trenches, the 116-C-1 restoration site, and the 116-B-1, 116-B-11, and 116-C-5 revegetation areas. First-year data were collected for the revegetated waste sites at the 100-D/DR and 100-H Areas, the 600-23 site, and the J. A. Jones site. The locations of these sites are shown in Figure 1.

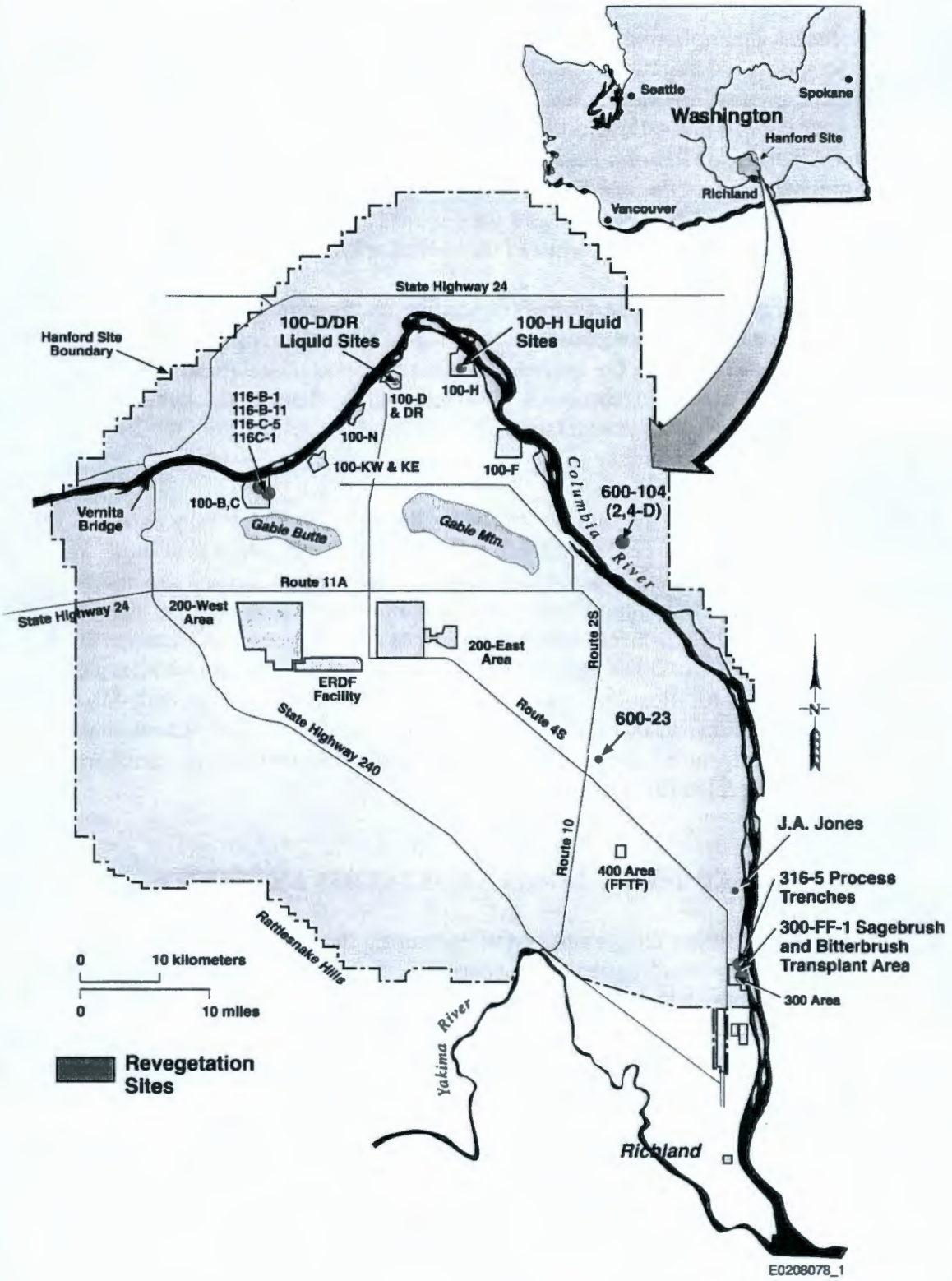
The extent of each revegetation effort varied depending on the surrounding habitat, existing conditions, and future land use designation of the area. The purpose of monitoring the revegetation efforts is to measure the progress of plant succession, and in some cases, to evaluate the success of different planting techniques. Each area will be discussed separately and will include a brief description of the revegetation activities and the results from the 2002 monitoring efforts and data collection activities.

This report provides fifth-year monitoring results for the 600-104 (2,4-D) site and presents the shrub survival rates of the 300-FF-1 sagebrush and bitterbrush mitigation plantings. Monitoring data were collected for the fourth year from the 116-C-1 restoration site and the 316-5 Process Trenches. Third-year vegetation monitoring and sagebrush survival results are included for the 116-B-1, 116-B-11, and 116-C-5 restoration areas. Data collection results from the first-year monitoring efforts of the 100-D/DR and 100-H Area liquid waste sites, the 600-23, and the J. A. Jones site are also included. Results from previous years' monitoring are provided in reports for each respective year (Johnson 2001, Johnson et al. 2000, Gano et al. 1999, Kemp et al. 1998). The measurement data from the previous revegetation monitoring reports are summarized in Appendices A, B, C, and D of this report.

1.1 METHODS USED TO EVALUATE VEGETATION RECOVERY

Vegetation monitoring during 2002 consisted of measuring the canopy cover of all plant species found on the Hanford Site, the frequency of occurrence, and the survival of transplanted sagebrush and bitterbrush. All values were then converted to percentages. Canopy cover and frequency measurements were obtained using the methods described in *Steppe Vegetation of Washington* (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 provides a measure of the amount of ground covered by each species. Because it is possible, in dense stands of vegetation for species to overlap one another, total measured vegetative cover can exceed 100%. Within each location, a series of plot frames were analyzed for the canopy cover 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 x 100 = 40%.

Figure 1. Hanford Site Showing Locations of Revegetation Sites.



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

This report uses taxonomic nomenclature from *Flora of the Pacific Northwest* (Hitchcock and Cronquist 1973). Some of the plant taxonomic names have been updated, and the revised names are provided in Appendix E of this report. Plant identification was conducted using the nomenclature in Hitchcock and Cronquist (1973) and *Vascular Plants of the Hanford Site* (Sackschewsky et al. 2001).

The type and extent of each revegetation effort is based on the location of the project and the future land designation of that area. The objective of revegetating the 600-104 (2,4-D) Bioremediated site was to stabilize the soils and to promote the establishment of native species, and the 300-FF-1 sagebrush and bitterbrush were planted to compensate for the loss of shrubs during initial remediation of the 618-4 Burial Ground. The results of the monitoring efforts indicate that these objectives have been met and that monitoring can be discontinued at these sites.

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

Success criteria differ for each site based upon the varying soil types and microclimatic conditions. For example, sandy areas promote different species with differing recovery rates and plant densities than those found in rocky soils; therefore, the criteria for judging success will be different. All sites will be evaluated based on the plant canopy cover, plant community composition, and survival and growth rates of the transplanted shrubs. These criteria are detailed in the *Revegetation Manual for the Environmental Restoration Contractor* (McLendon et al. 1997). A revegetation effort will be considered to be successful if the area is stabilized to prevent erosion and is dominated by recovering stands of native sagebrush, forbs, and grasses. Areas identified for future industrial use will be stabilized but will not likely be planted with native species. More likely they will be planted with wheatgrass (*Agropyron*) species due to the potential for future land disturbance.

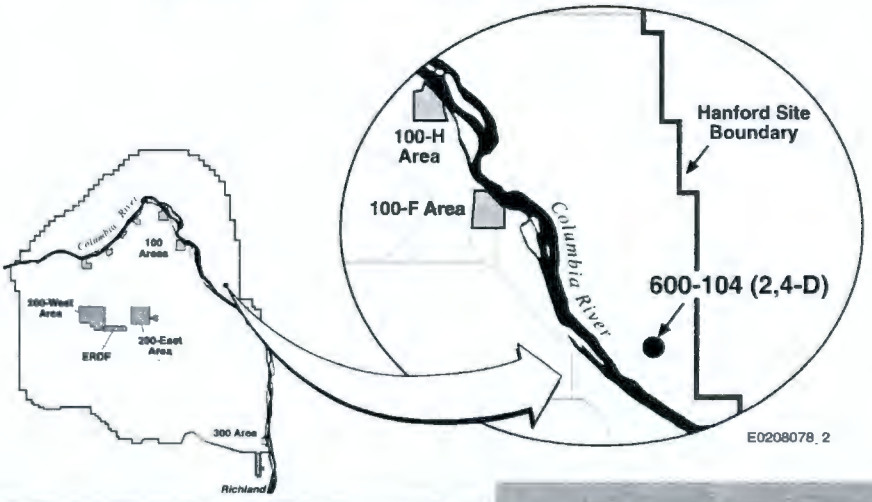
2.0 600 AREA REVEGETATION

2.1 600-104 (2,4-D) BIOREMEDIATION SITE

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

The annual vegetation survey was conducted on May 3, 2002. Thirty-five species were observed on the site this year, of which 28 were native. The number of species remains consistent with data collected in 2001; however, the observations made in 2002 noted a difference in six species across the site. Three new species (including bottlebrush squirreltail [*Sitanion hystrix*], thickspike wheatgrass [*Agropyron dasytachyum*], and sand beardtongue [*Penstemon acuminatus*]) were observed this year, while whitestem stickleaf (*Mentzelia albicaulis*), narrow-leaf collomia (*Collomia linearis*), and needle-and-thread grass (*Stipa comata*) were not noted. Total canopy cover across the site increased 53.5%, yielding a total measured cover across the site of 94.8% (see data provided in Table 1). The measurement of biotic crust also significantly increased from 1.1% cover in 2001 to 39.3% in 2002, with a corresponding reduction of bare ground decreasing from 48.9% in 2001 to 13.7% for 2002. The two most significant changes in canopy cover include Sandberg's bluegrass and cheatgrass, with increased covers of 8.2% and 23.9%, respectively, in 2002. The access road continues to demonstrate significant signs of recovery, as the undisturbed sagebrush community adjacent to the road has contributed its the recovery. Sagebrush and native forbs continue to move onto on the abandoned road. The sagebrush planted in February 2001 looked healthy and had noticeable foliar growth when compared to surveys conducted in 2001. The sagebrush had an average height of 17.6 cm, with an overall estimated survival rate of greater than 80%.

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



Preremediation Spring 1997

Access Road, May 2002

February 2001 Planted Sagebrush, May 2002

Postremediation, May 2002

Table 1. Percent Canopy Cover and Frequency of Occurrence at the 600-104 (2,4-D) Site in 2002. (2 Pages)

Species	% Cover	% Frequency
Bromus tectorum[a] (cheatgrass)	47.5	100
Salsola kali[a] (Russian thistle)	0.9	36
Sisymbrium altissimum[a] (tumblemustard)	2.5	60
Ambrosia acanthicarpa (bur ragweed)	1.1	44
Poa sandbergii (Sandberg's bluegrass)	11.3	68
Festuca octoflora (six-weeks fescue)	1.4	56
Rumex venosus (winged dock)	0.1	4
Lappula redowskii (western stickseed)	0.7	28
Amsinckia lycopsoides (tarweed fiddleneck)	1	40
Holosteum umbellatum[a] (jagged chickweed)	10.7	80
Draba verna (spring whitlow)	2	40
Achillea millefolium (yarrow)	1	40
Epilobium paniculatum (tall willowherb)	0.6	24
Lactuca serriola[a] (prickly lettuce)	0.6	24
Microsteris gracilis (annual phlox)	0.5	20
Artemisia tridentata (big sagebrush)	0.2	8
Machaeranthera canescens (hoary aster)	0.3	12
Phlox longifolia (long-leaf phlox)	0.7	8
Eriogonum niveum (snow buckwheat)	1.9	16
Lupinus pusillus (low lupine)	X	X
Oryzopsis hymenoides (Indian ricegrass)	X	X
Poa bulbosa[a] (bulbous bluegrass)	1.4	16
Balsamorhiza careyana (Carey's balsamroot)	X	X
Tragopogon dubius[a] (yellow salsify)	X	X
Astragalus caricinus (buckwheat milkvetch)	0.1	4
Astragalus sclerocarpus (stalked-pod milkvetch)	X	X
Chrysothamnus viscidiflorus (green rabbitbrush)	3.7	12
Chrysothamnus nauseosus (gray rabbitbrush)	2.4	20
Phacelia hastata (whiteleaf scorpionweed)	X	X
Plantago patagonica (Indian wheat)	1.7	12
Fritillaria pudica (yellow bell)	X	X
Sitanion hystrix (bottlebrush squirreltail)	X	X
Agropyron dasytachyum (thickspike wheatgrass)	0.1	4

Table 1. Percent Canopy Cover and Frequency of Occurrence at the 600-104 (2,4-D) Site in 2002. (2 Pages)

Species	% Cover	% Frequency
Descurainia pinnata (western tansymustard)	0.4	16
Penstemon acuminatus (sand beardtongue)	X	X
Biotic crust	39.3	100
Bare soil	13.7	84
Litter	57.6	100
Total cover (does not include biotic crust, bare soil, or litter)	**94.8**	

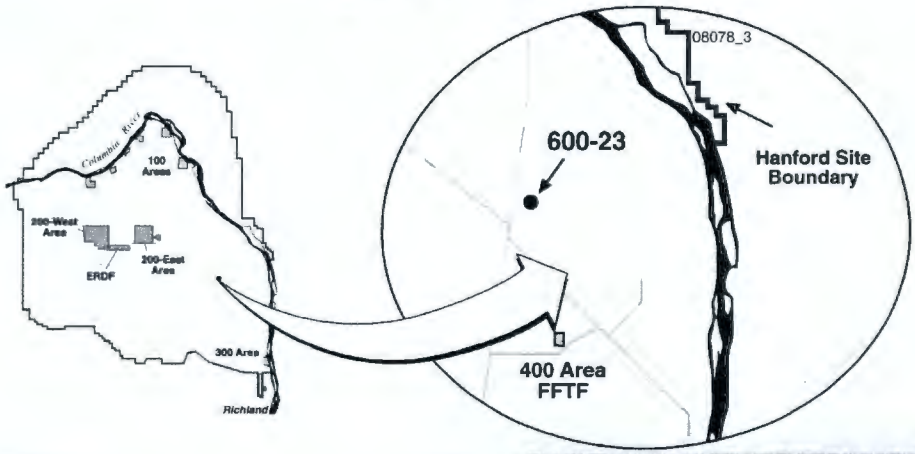
[a] Introduced species.
X = present but not counted in the plot frames

The continued increase in the number of native species, increased biotic crust development, and reduced bare ground indicate that this is site is continuing to recover and stabilize from the 1997 remedial action activities. Because the 600-104 (2,4-D) site has demonstrated increasing recovery, it will not require vegetation monitoring beyond the current fifth year of data collection.

2.2 600-23 AND J. A. JONES SITES

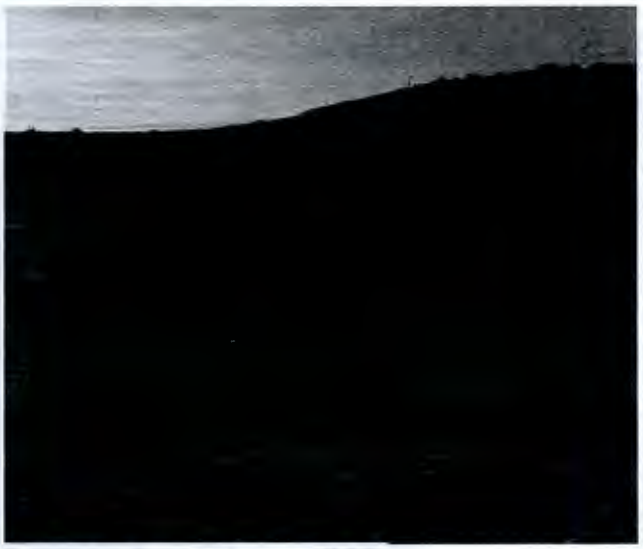
The 600-23 and J. A. Jones sites were remediated as part of the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units* (EPA et al. 1999). The 600-23 site is located north of the Hanford Site's Wye Barricade, along Route 2 South, and is within the Pit 11 boundary (Figure 3). The J. A. Jones site is located north of the 300 Area (Figure 4). Both sites were used for the disposal of construction waste and miscellaneous debris. Prior to remediation, the 600-23 site was dominated by cheatgrass and Russian thistle (*Salsola kali*), with occurrences of snow buckwheat and bitterbrush. The J. A. Jones site was dominated by cheatgrass and gray rabbitbrush (*Chrysothamnus nauseosus*) with some Sandberg's bluegrass and bitterbrush. The area surrounding the J. A. Jones site is mature sagebrush and is identified as a Level III resource in the *Hanford Site Biological Resources Management Plan* (BRMaP) (DOE-RL 2001). The goal of each revegetation effort was to stabilize the soils and initiate vegetative recovery.

Figure 3. 600-23 Site.



Preremediation, October 2000

Planted Bunchgrass Emerging from Beneath Straw Mulch, May 2002



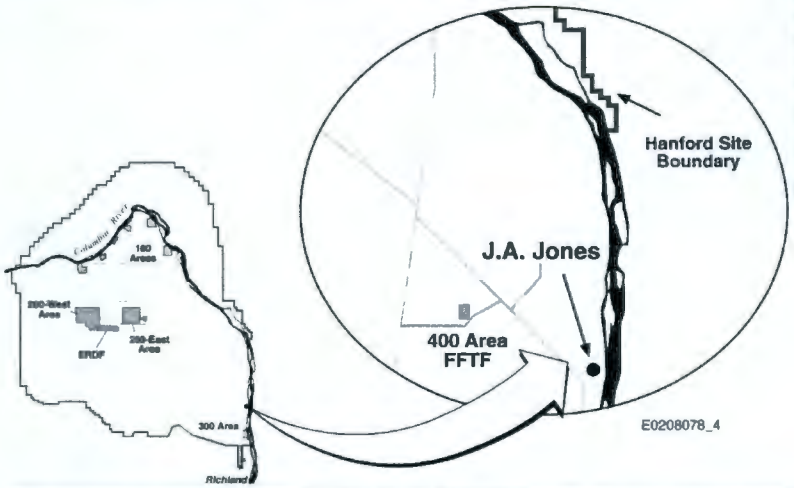
Revegetated Area, January 2002

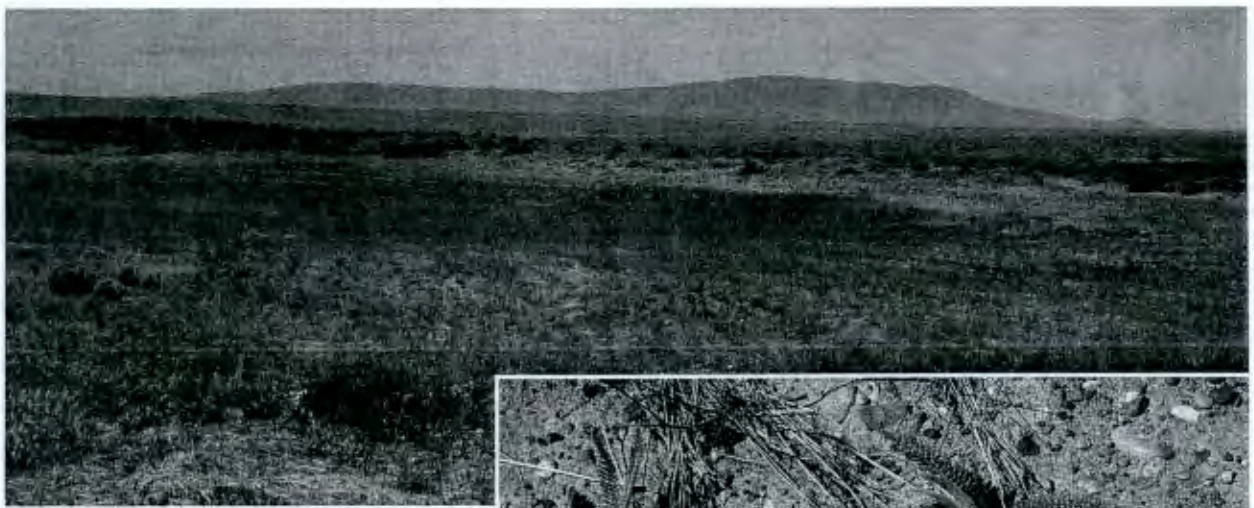
December 2001 Planted Sagebrush, May 2002

Figure 4. J. A. Jones Site.

Preremediation Looking West Over Site, September 2000

Planting Sagebrush, December 2001





Looking West Over Revegetation Area, May 2002

Prairie Clover and Yarrow Seedlings, May 2002

The areas disturbed by remedial action activities included 0.78 ha at the 600-23 site and 0.4 ha at the J. A. Jones site. Both sites were revegetated under *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1998) Milestone M-16-41C in mid-December 2001. Both sites were planted within just a few months of having been recontoured. The sites were hydroseeded with a mixture of native seeds collected from around the Hanford Site. The seeded areas had 112 kg/ha of Triple-16 (16% each of nitrogen, phosphorous, and potassium) fertilizer co-applied during seeding, and the areas were then irrigated with 0.62 cm/ha of water. The entire seeded area was mulched with grass straw at a rate of 4.5 metric tons/ha, which was then crimped into the soil surface with a disk. The 600-23 site was planted with 140, 4-cubic inch (in.^{3}) sagebrush tublings and 150, 4-in.^{3} bitterbrush tublings. The J. A. Jones site was planted with 100, 4-in.^{3} sagebrush tublings and 130,10-in.^{3} bitterbrush tublings. All bitterbrush tublings had biodegradable mesh tubes placed around the plants and anchored with bamboo stakes to prevent browsing by deer.

Initial vegetation surveys were conducted at the 600-23 site on May 9, 2002. The 600-23 site had 21 species present, of which 15 were native and 8 that had been planted. Sandberg's bluegrass was the dominant species on the site with 3.7% cover and 88% frequency, followed by Russian thistle with 2.4% cover and thickspike wheatgrass with 2.1% cover (see Table 2). Shrub survival data for the sagebrush and bitterbrush was gathered in early May from a representative plot within the revegetated area. Sagebrush survival was estimated at 83.6% and bitterbrush survival was 78.2% (Table 3). The survival rates of the planted shrubs will change after an entire growing season; therefore, the 2002 shrub survival rates should be viewed only as a baseline for comparison in future years.

Table 2. Percent Canopy Cover and Frequency of Occurrence at the 600-23 Site in 2002. (2 Pages)

Species	% Cover	% Frequency
Poa sandbergii (Sandberg's bluegrass)	3.7	88
Bromus tectorum[a] (cheatgrass)	0.4	16
Salsola kali[a] (Russian thistle)	2.4	76
Achillea millefolium (yarrow)	1.6	64
Melilotus alba[a] (sweetclover)	0.4	16
Eriogonum niveum (snow buckwheat)	0.2	8
Stipa comata (needle-and-thread grass)	0.2	8
Agropyron dasytacum (thickspike wheatgrass)	2.1	84
Artemisia tridentata (sagebrush)	0.1	4
Festuca octoflora (slender six-weeks)	0.1	4
Gilia leptomeria (Great Basin Gilia)	0.2	8
Sisymbrium altissimum[a] (tumble mustard)	0.1	4
Holosteum umbellatum[a] (jagged chickweed)	X	

Table 2. Percent Canopy Cover and Frequency of Occurrence at the 600-23 Site in 2002. (2 Pages)

Species	% Cover	% Frequency
Lactuca seriola[a] (prickly lettuce)	X	
Amsinckia lycopsoides (tarweed fiddleneck)	X	
Phacelia hastata (whiteleaf scorpionweed)	X	
Ambrisia acanthicarpa (bur ragweed)	X	
Poa bulbosa[a] (bulbous bluegrass)	X	
Chaenactis douglassii (hoary false yarrow)	X	
Purshia tridentata (bitterbrush)	X	
Mentzelia laevicaulis (blazing star)	X	
Bare soil	52.7	92
Litter (straw mulch)	25.3	96
Total cover (does not include bare soil or litter)	**11.5**	

[a] Introduced species.
X = present but not counted in plot frames

Table 3. Percent Survival Rate of Planted Shrubs. (2 Pages)

Site	1998	1999	2000	2001	2002
300-FF-1 Mitigation					
1997 sagebrush	70	54	--	42.3	36.6
1997 sagebrush and 1999 replacements	--	--	98.5	--	--
1999 sagebrush	--	--	--	1	0
1999 bitterbrush	--	--	100	2	0
2001 bitterbrush	--	--	--	--	37.5
116-C-1					
Non-irrigated cobble	--	100	95.5	95.4	93.9
Irrigated cobble	--	91.7	86.1	91.6	88.8
Non-irrigated topsoil	--	83.3	61.9	64.2	61.9
Irrigated topsoil	--	78.9	75.4	68.4	71.9
116-C-5					
Sagebrush	--	--	--	99	98.9

Table 3. Percent Survival Rate of Planted Shrubs. (2 Pages)

Site	1998	1999	2000	2001	2002
600-23					
Sagebrush	--	--	--	--	83.6
Bitterbrush	--	--	--	--	78.2
J. A. Jones					
Sagebrush	--	--	--	--	89.2
Bitterbrush	--	--	--	--	39
100-D/DR					
Sagebrush	--	--	--	--	93.8
100-H					
Sagebrush	--	--	--	--	59.8

Initial vegetation surveys were conducted on the J. A. Jones site in late May 2002. A total of 29 species were identified across the 0.4-ha site, 12 of which were included in the seed mix. (Table 4). The area is dominated by thickspike wheatgrass, tumble mustard, Russian thistle, cheatgrass, and Sandberg's bluegrass. The initial vegetation survey indicates good Sandberg's bluegrass and yarrow seed germination with 88% and 56% frequencies, respectively. The sandy soil at the J. A. Jones site is native to the surrounding area and, as such, the remediated area is likely to be dominated by weedy species such as Russian thistle and cheatgrass for the first few years while the native species become established and displace them. Sagebrush and bitterbrush survival was estimated across the site in early August 2002, with the initial counts indicating a sagebrush survival rate of 89.2% and bitterbrush survival rate of 39% (Table 3).

Table 4. Percent Canopy Cover and Frequency of Occurrence at the J. A. Jones Site in 2002. (2 Pages)

Species	% Cover	% Frequency
Argropyron dasytachum (thickspike wheatgrass)	32.1	100
Bromus tectorum[a] (cheatgrass)	6.2	72
Salsola kali[a] (Russian thistle)	11.7	100
Poa sandbergii (Sandberg's bluegrass)	2.2	88
Achillea millefolium (yarrow)	1.4	56
Amsinckia lycopsoides (tarweed fiddleneck)	1.2	48
Artemisia tridentata (big sagebrush)	X	X
Purshia tridentata (bitterbrush)	X	X
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	4

Table 4. Percent Canopy Cover and Frequency of Occurrence at the J. A. Jones Site in 2002. (2 Pages)

Species	% Cover	% Frequency
Eriogonum niveum (snow buckwheat)	X	X
Erodium cicutarium[a] (storksbill)	0.2	8
Lactuca serriola[a] (prickly lettuce)	X	X
Festuca octoflora (slender six-weeks)	0.4	16
Sisymbrium altissimum[a] (tumblemustard)	14	84
Machaeranthera canescens (hoary aster)	X	X
Chaenactis douglasii (hoary false yarrow)	0.3	12
Petalostemon ornatum (western prairieclover)	X	X
Microsteris gracilis (pink microsteris)	X	X
Penstemon acuminatus (sand beardtongue)	X	X
Balsamorhiza careyana (Carey's balsamroot)	0.1	4
Mentzelia laevicaulis (blazing star)	X	X
Plantago patagonica (Indian wheat)	X	X
Phlox longifolia (long-leaf phlox)	X	X
Oenothera pallida (pale evening primrose)	0.4	16
Ambrosia acanthicarpa (bur ragweed)	2.1	64
Draba verna (spring whitlowgrass)	0.3	12
Holosteum umbellatum[a] (jagged chickweed)	0.7	28
Melilotus officinalis[a] (sweetclover)	X	X
Amaranhus albus[a] (pigweed)	X	X
Bare soil	53.8	96
Litter	36.1	100
Total cover (does not include bare soil or litter)	**73.4**	

[a] Introduced species.
X = present but not counted in plot frames

3.0 300 AREA

3.1 300-FF-1 SAGEBRUSH AND BITTERBRUSH TRANSPLANT AREA

Several plantings were completed to mitigate the loss of mature shrubs during initial remediation of the 618-4 Burial Ground. In October 1997, 24 bitterbrush plants, ranging in height from 0.25

to 0.50 m , were salvaged from the perimeter of the 618-4 Burial Ground and transplanted 200 m to the east in groups of three. Each shrub was excavated using a 0.25-yd backhoe; however, the course sandy gravel fell from the root mass during extraction, consequently causing root damage. Just prior to planting each shrub, the transplant hole was filled with water and then allowed to drain. When the plants were observed a year later, all 24 of the bitterbrush plants had died.

In December 1997, 293 two-year old, one-gallon size, container-grown sagebrush were planted over a 3,100-m^2 area north of the bitterbrush planting area (Figure 5). This planting effort was conducted as additional mitigation for the loss of shrubs associated with the 618-4 Burial Ground remediation. Five rows of plants were placed in groups of three, spaced 0.5 to 1.0 m apart, with group spacing of 4.6 m. In November 1999, survivorship was determined to be 51%. All of the dead plants were replaced, and an additional 180 tublings from the Umatilla Native Plant Nursery of the Confederated Tribes of the Umatilla Indian Reservation in Umatilla, Oregon, were added to the plot. In addition to the sagebrush planting, 50 bitterbrush tublings were planted east of the 618-4 Burial Ground, in the previous 1997 transplant area that had failed. Each bitterbrush tubling was in excellent condition, with top growth ranging from ~ 15 to 25 cm. All of the plants were protected with biodegradable plastic mesh tubes to prevent browsing by deer. The bitterbrush plants were examined for survival in January 2001, and all but one of the bitterbrush plants had died. At that time, 50 additional bitterbrush tublings were planted in the same location with protective mesh tubes. Each plant had top growth ranging from approximately 15 to 25 cm. However, just prior to planting, each plant had the upper one-third of its top removed.

In June and August 2001, each bitterbrush was irrigated with 18.9 L of water. An 18.9 L bucket with a 2.5 mm. hole drilled in the bottom (to slowly release water, was placed at the base of each plant. The plants were then examined in June 2002 and 18 plants were alive, yielding a survival of 37.5% (Table 3).

Sagebrush survival was also estimated in June 2002. Survival of the November 1997 planting was 36.6%; however, the 180 sagebrush from the Umatilla Native Plant Nursery had all died. Despite the low survival rate of the 1999 planted shrubs, 66% of the original 1997 planting locations still have at least one of the three plants still alive.

The low shrub survival rates experienced in this area are attributed to competition from this established plant community dominated by Sandberg's bluegrass, cheatgrass, snow buckwheat, scufpea (*Psoralea lanceolata*), and rabbitbrush. The established root systems limit the available water needed for establishment of the newly planted seedlings. When available, future plantings should be planned in areas having less competition from the already-established vegetation.

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

2-Year-Old, Container-Grown Sagebrush Planted, December 1997

Irrigating Bitterbrush, June 2001

January 2001 Planted Bitterbrush, June 2002

1997 Planted Sagebrush, June 2002

3.2 316-5 PROCESS TRENCHES

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

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

On June 20, 2002, 32 species were observed on the trenches. Of the species observed, 19 were native (Table 5). Native species new to the process trenches during 2002 include slender six-weeks (*Fectuca octoflora*) and buckwheat milkvetch (*Astragalus caricinus*). Crested wheatgrass was the dominant species across the site, with 20.9% canopy cover and 92% frequency, and was closely followed by cheatgrass, with 17.3% cover and 100% frequency of occurrence (Table 5). Total cover and biotic crust increased 12.4% and 5.4%, respectively, across the sites compared to the measurements from 2001. Bitterbrush and rabbitbrush are continuing to volunteer onto the remediated area from adjacent, undisturbed areas. This site is demonstrating successful stabilization, as expected for the fourth year following revegetation.

Figure 6. 316-5 Process Trenches.

316-5 Process Trenches Remediation

Rabbitbrush Volunteering on the Site, June 2002

Looking South Over Revegetated Area, June 2002

Revegetated Area, June 2002

Table 5. Percent Canopy Cover and Frequency of Occurrence at the 316-5 Process Trenches in 2002. (2 Pages)

Species	% Cover	% Frequency
Bromus tectorum[a] (cheatgrass)	17.3	100
Salsola kali[a] (Russian thistle)	0.8	32
Ambrosia acanthicarpa (bur ragweed)	0.1	4
Microsteris gracilis (annual phlox)	0.1	4
Holosteum umbellatum[a] (jagged chickweed)	2.2	68
Draba verna (spring whitlow)	1.2	48
Lactuca seriola[a] (prickly lettuce)	X	X
Amsinckia lycopsoides (tarweed fiddleneck)	2	40
Sisymbrium altissimum[a] (tumble mustard)	0.1	4
Erodium cicutarium[a] (storksbill)	3.5	60
Machaeranthera canescens (hoary aster)	0.1	4
Plantago patagonica (Indian wheat)	0.4	16
Melilotus alba[a] (sweetclover)	X	X
Psoralea lancedata (dune scurfpea)	0.6	4
Agropyron cristatum[a] (crested wheatgrass)	20.9	92
Achillea millefolium (yarrow)	X	X
Phacelia hastata (whiteleaf scorpionweed)	0.1	4
Poa sandbergii (Sandberg's bluegrass)	X	X
Eriogonum niveum (snow buckwheat)	0.6	4
Oeothera pallida (evening primrose)	0.2	8
Chrysothamnus nauseosus (gray rabbitbrush)	0.6	24
Poa bulbosa[a] (bulbous bluegrass)	0.1	4
Tragopogon dubius[a] (yellow salsify)	0.1	4
Hymenopapus filifolius (Columbia cutleaf)	X	X
Centaurea diffusa[a] (diffuse knapweed)	X	X
Chaenactis douglassii (hoary false yarrow)	X	X
Purshia tridentata (bitterbrush)	0.6	4
Stipa comata (needle-and-thread grass)	0.2	8
Festuca octoflora (slender six-weeks)	0.7	8
Astragalus caricinus (buckwheat milkvetch)	X	X
Centaurea solstitialis[a] (yellowstar thistle)	X	X
Chondrilla juncea[a] (Rush skeletonweed)	X	X
Biotic crust	6.1	68

Table 5. Percent Canopy Cover and Frequency of Occurrence at the 316-5 Process Trenches in 2002. (2 Pages)

Species	% Cover	% Frequency
Bare soil	37.3	100
Litter	39.3	100
Total cover (does not include crust, bare soil, or litter)	**52.5**	

[a] Introduced species.
X = present but not counted in plot frames

4.0 100-B/C AREA REVEGETATION

4.1 116-C-1 SITE

The 116-C-1 site was remediated as a part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial action project for the 100-B/C Area (EPA et al. 1995). The goal of revegetating the remediated site was to stabilize the soils and initiate the establishment of native species. The restoration plan for the 116-C-1 site was developed as a demonstration project to evaluate the effects of soil type and supplemental irrigation on the establishment and success of native species.

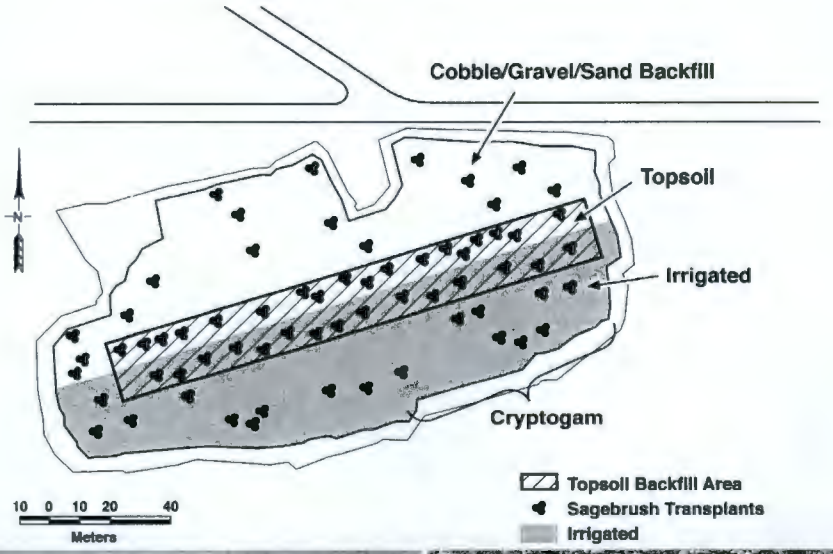
Four treatments were used on the backfilled site. The backfill material used for remediation was a course assortment of cobble, gravel, and sand from a near by borrow pit and was used as the planting medium for two of the four treatments. The cobble backfill material is representative of naturally occurring soils that were deposited by the Columbia River as it meandered over time and is similar to backfill material that will be used in future remediation projects. The two remaining treatments used topsoil grubbed from the Environmental Restoration Disposal Facility excavation in the summer of 1995. In November 1995, a seed mix of native species was planted across the four treatment areas (Weiss and Kemp 1998): irrigated cobble, irrigated topsoil, non-irrigated topsoil, and non-irrigated cobble (Figure 7). Sandberg's bluegrass (11.2 kg/ha), Indian ricegrass (2.2 kg/ha), and sagebrush (1.1 kg/ha) were planted using a range type drill. Snow buckwheat (0.56 kg/ha), balsamroot (0.56 kg/ha), yarrow (0.28 kg/ka), needle-and-thread grass (1.1 kg/ha), and additional Indian ricegrass (0.28 kg/ha) were distributed across the site with a hand operated broadcast seeder. To evaluate the effectiveness of promoting the early development of soil biotic crust, 9.1 kg of biotic soil/dust was hand cast over the eastern half of the site to inoculate the soil surface. Wheat straw was applied across the seeded area at a rate of 6.7 metric tons/ha and was then crimped with a disk. A total of 201 sagebrush tublings were planted in groups of three across the four treatments. Irrigation was applied to one half the cobble and one half the topsoil substrate from March 15 through June 4, 1999, and from May 11 through June 26, 2000. Water was applied in 30,283-L increments, with applications equivalent to approximately 5 cm/ha (Table 6).

Table 6. Precipitation and Irrigation Received at the 116-C-1 Site Through 2002.

Month	Water (in.)					
	Irrigation 1999	Monthly Rainfall 1999	Irrigation 2000	Monthly Rainfall 2000	Monthly Rainfall 2001	Monthly Rainfall 2002
March	0.37	0.06	0	0.94	0.67	0.19
April	0.83	Trace	0	0.57	0.83	0.29
May	0.67	0.34	0.98	0.77	0.08	0.16
June	0.44	0.31	1.18	0.25	1.27	0.65
Totals	**2.31**	**0.71**	**2.16**	**2.53**	**2.85**	**1.29**

In May 2002, 28 species were observed across the site, which is 7 fewer species than were identified in the 2001 survey. However, spring whitlow (*Draba verna*), annual phlox (*Microsteris gracilis*), and thickspike wheatgrass (*Agropyron dasytachyum*) were seen for the first time on the site in 2002. Species diversity was the highest on the non-irrigated topsoil and cobble treatments with 21 and 20 species, respectively, while the irrigated topsoil and cobble treatments had 18 and 14 species, respectively (Table 7). Canopy cover remained the highest on the topsoil treatments, in both the irrigated and non-irrigated areas with 39% and 38.2% covers, respectively, which were significantly lower than the 86.7% and 87.1% respective covers observed in 2001. The reduction of canopy cover across all of the treatment areas can be attributed to the reduction of cheatgrass cover, with the largest decreases of 45.7% and 57.9% covers observed on the irrigated and non-irrigated topsoil treatments, respectively. Canopy cover for needle-and-thread grass and Indian ricegrass was recorded on all treatment areas, with both grasses producing seed this year. Snow buckwheat cover and frequency of occurrence increased across all of the treatment areas, except for the non-irrigated topsoil area, where it was recorded as present but not counted in the plot frame (Table 8). Biotic crust was recorded for the first time across all areas, with the greatest development on the topsoil treatments with 8.3% and 3.9% on the irrigated then non-irrigated areas, respectively. Sagebrush survival remains the highest on the non-irrigated and irrigated cobble treatments with 93.9% and 88.8%, respectively, followed by the irrigated and non-irrigated topsoil treatments at 71.9% and 61.9%, respectively. The site had an overall survival rate of 80%, which is within expectations for the site.

Figure 7. 116-C-1 Site Revegetation.



Soil Preparation

Sagebrush on Nonirrigated Cobble, August 2002

Snow Buckwheat Blooming on Nonirrigated Cobble, August 2002

Indian Ricegrass, Needle-and-Thread, and Sandberg's Bluegrass on Irrigated Topsoil, August 2002

Table 7. Percent Canopy Cover at the 116-C-1 Site in 2002. (2 Pages)

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irrigated Topsoil	Non-Irrigated Cobble
Bromus tectorum[a] (cheatgrass)	2.9	9.2	7.3	10.8
Salsola kali[a] (Russian thistle)	0.3	0.1	0.3	0.7
Poa sandbergii (Sandberg's bluegrass)	6.4	15.3	16.5	7.5
Stipa comata (needle-and-thread grass)	1.8	0.1	0.1	1
Achillea millefolium (yarrow)	0.1	--	X	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	1	2.3	--
Artemisia tridentata (big sagebrush)	0.1	1.6	0.2	X
Chrysothamnus nauseosus (gray rabbitbrush)	2.6	2.8	2.7	2.1
Descurania pinnata (western tansymustard)	--	0.3	0.3	--
Epilobium paniculatum (tall willowherb)	--	--	--	0.3
Eriogonum niveum (snow buckwheat)	0.3	0.6	X	0.5
Erodium cicutarium[a] (storksbill)	--	0.1	0.1	X
Lactuca serriola[a] (prickly lettuce)	--	0.1	0.3	X
Oryzopsis hymenoides (Indian ricegrass)	1	0.2	0.2	1.4
Sisymbrium altissimum[a] (tumblemustard)	0.4	5.9	7.5	0.3
Tragopogon dubius[a] (yellow salsify)	--	--	X	X
Machaeranthera canescens (hoary aster)	0.1	X	--	X
Centaurea diffusa[a] (diffuse knapweed)	0.1	X	--	0.1
Balsamorhiza careyana (Carey's balsamroot)	X	--	--	X
Erigeron poliospermus (cushion fleabane)	--	--	--	X
Erigeron piperianus (Piper's daisy)	--	--	--	X
Agropyron cristatum (crested wheatgrass)	0.4	0.1	0.1	0.4
Oenothera pallida (pale eveningprimrose)	--	--	--	0.2
Ambrosia acanthicarpa (bur ragweed)	--	--	X	--
Holosteum umbellatum[a] (jagged chickweed)	--	0.5	0.4	--
Draba verna (spring whitlow)	--	0.3	0.6	--

Table 7. Percent Canopy Cover at the 116-C-1 Site in 2002. (2 Pages)

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irrigated Topsoil	Non-Irrigated Cobble
Microsteris gracilis (annual phlox)	--	--	0.1	--
Agropyron dasytachyum (thickspike wheatgrass)	--	--	X	--
Crust	0.1	8.3	3.9	0.5
Bare soil	61.3	36.3	37.4	42.9
Litter	19.2	34.5	27.6	34.4
Total cover (does not include crust, bare soil, or litter)	16.5	38.2	39	25.3

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

Table 8. Percent Frequency of Occurrence at the 116-C-1 Site in 2002. (2 Pages)

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irrigated Topsoil	Non-Irrigated Cobble
Bromus tectorum[a] (cheatgrass)	76	96	100	100
Salsola kali[a] (Russian thistle)	12	4	12	28
Poa sandbergii (Sandberg's bluegrass)	96	92	100	88
Stipa comata (needle-and-thread grass)	16	4	4	20
Achillea millefolium (yarrow)	4	--	X	--
Amsinckia lycopsoides (tarweed fiddleneck)	--	20	32	--
Artemisia tridentata (big sagebrush)	4	8	8	X
Chrysothamnus nauseosus (gray rabbitbrush)	64	16	12	44
Descurania pinnata (western tansymustard)	--	12	12	--
Epilobium paniculatum (tall willowherb)	--	--	--	12
Eriogonum niveum (snow buckwheat)	12	4	X	20
Erodium cicutarium[a] (storksbill)	--	4	4	X
Lactuca serriola[a] (prickly lettuce)	--	4	12	X
Oryzopsis hymenoides (Indian ricegrass)	40	8	8	56
Sisymbrium altissimum[a] (tumblemustard)	16	96	100	12
Tragopogon dubius[a] (yellow salsify)	--	--	X	X
Machaeranthera canescens (hoary aster)	4	X	--	X
Centaurea diffusa[a] (diffuse knapweed)	4	X	--	4
Balsamorhiza careyana (Carey's balsamroot)	--	--	--	--
Erigeron poliospermus (cushion fleabane)	X	--	--	X
Erigeron piperianus (Piper's daisy)	--	--	--	X
Agropyron cristatum (crested wheatgrass)	--	--	--	X

Table 8. Percent Frequency of Occurrence at the 116-C-1 Site in 2002. (2 Pages)

Species	Irrigated Cobble	Irrigated Topsoil	Non-Irrigated Topsoil	Non-Irrigated Cobble
Oenothera pallida (pale eveningprimrose)	16	4	4	16
Ambrosia acanthicarpa (bur ragweed)	--	--	--	8
Holosteum umbellatum[a] (jagged chickweed)	--	--	X	--
Draba verna (spring whitlow)	--	20	16	--
Microsteris gracilis (annual phlox)	--	12	24	--
Agropyron dasytachyum (thickspike wheatgrass)	--	--	4	--
Crust	--	--	X	--
Bare soil	4	92	96	20
Litter	100	96	96	100
Total cover (does not include crust, bare soil, or litter)	100	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

4.2 116-B-1, 116-B-11, AND 116-C-5 REVEGETATION SITES

The 116-B-1, 116-B-11, and 116-C-5 sites were also remediated as part of the CERCLA remedial action project for the 100-B/C Area (EPA et al. 1995). Initial revegetation efforts for these sites were completed December 6 through 9, 1999. The objective of revegetating these sites was to stabilize the soils while establishing a plant community dominated by native species, while minimizing the influence of introduced species within the community after establishment.

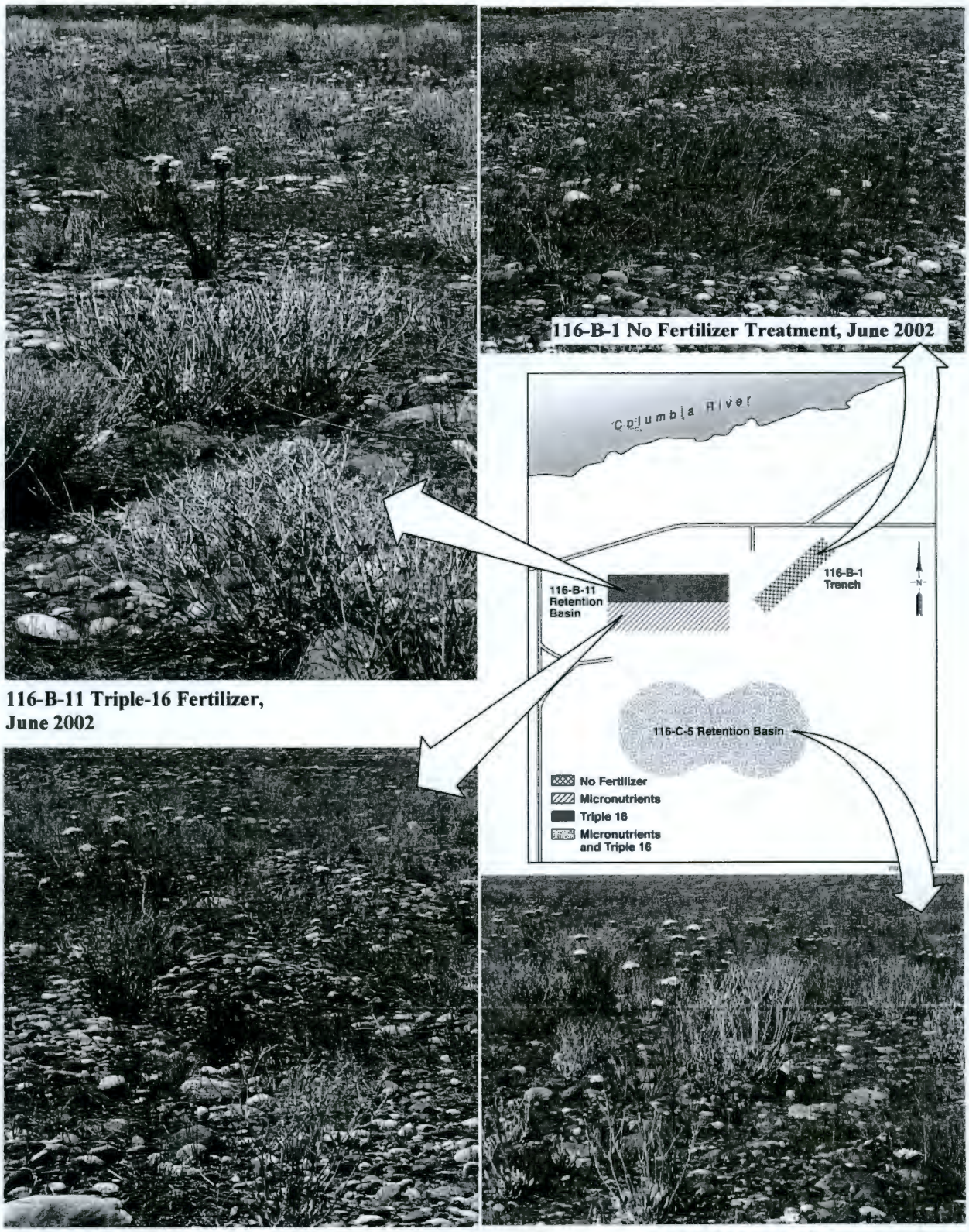
The material used to backfill the remediated waste sites was excavated from the nearby Pit 24. The backfill material is representative of naturally occurring soils in these areas and consists of rocky sand and gravel. The material placed as the top horizon of the remediated sites, and consequently the planting medium, was excavated from subsoil horizons within the pit, which was very nutrient-deficient. To compensate, one of three fertilizer treatments was applied to each of the backfilled sites to evaluate the results of the varying fertilizer applications and the establishment of the planted native species.

On the southern half of the 116-B-11 site, a micronutrient fertilizer formula containing sulfur (22.36%), soluble pot ash (1.6%), nitrogen (1.24%), magnesium (0.08%), zinc (0.24%), and boron (0.04%) was applied at a rate of 112 kg/ha. The northern half of 116-B-11 site received Triple-16 (16% each of nitrogen, phosphorous, and potassium) fertilizer applied at a rate of 112 kg/ha. The 116-C-5 site received a combination of Triple-16 and micronutrient fertilizers applied to the entire site at a rate of 112 kg/ha each. As a control site, no fertilizer was applied to the 116-B-1 site (Figure 8).

A native seed mixture was broadcast with a hydroseeder across each of the sites. The seed mixture and seeding rates included Sandberg's bluegrass (22.4 kg/ha), needle-and-thread grass (2.24 kg/ha), sagebrush (1.12 kg/ha), snow buckwheat (1.12 kg/ha), Carey's balsamroot (1.12 kg/ha), and yarrow (0.28 kg/ha). Small amounts of cushion fleabane (*Erigeron poliospermus*) and Piper's daisy (*Erigeron piperianus*) were also mixed in the hydroseeder and applied to the 116-C-5 site, but due to the small size and amount of seed, the quantities were not measured. Following the seeding, grass straw was applied as mulch across all of the sites at a rate of 4.5 metric tons/ha. The entire seeded area was then irrigated with 0.62 cm/ha of water. Half of the water was applied through the hydroseeder during the application of seed and fertilizer mix, and the remaining irrigation was applied after the distribution of the straw mulch.

In December 2000, 2,600 sagebrush tublings were planted across the sites. Because of the rocky plant bed, holes were augured into the ground and then filled with moist sand. Each tubling was then planted in the center of the sand (Figure 9).

Figure 8. Fertilizer Treatments.



116-B-11 Triple-16 Fertilizer, June 2002

116-B-11 Micronutrient Fertilizer, June 2002

116-C-5 Combination Triple-16 and Micronutrient Fertilizers, June 2002

Figure 9. 116-B-1, 116-B-11, and 116-C-5 Revegetation Sites.

Hydroseeding 116-C-5, December 1999

Moist Sand to Plant Sagebrush into, December 2000

Aerial of 100-B/C, November 2001

December 2000 Planted Sagebrush with Flower Buds, June 2002

Sagebrush, Snow Buckwheat, and Rabbitbrush Seedlings, June 2002

Table 10. Percent Frequency of Occurrence at 100-B/C Revegetation Sites in 2002.

Species	116-C-5	116-B-11 (Triple-16)	116-B-11 (Micro)	116-B-1
Poa sandbergii (Sandberg's bluegrass)	100	100	100	88
Eriogonum niveum (snow buckwheat)	90	52	48	60
Salsola kali[a] (Russian thistle)	22	4	16	16
Achillea millefolium (yarrow)	36	24	8	12
Sisymbrium altissimum[a] (tumblemustard)	2	12	4	8
Descurainia pinnata (western tansymustard)	18	X	--	12
Centaurea diffusa[a] (diffuse knapweed)	X	4	X	X
Artemisia tridentata (big sagebrush)	16	12	8	X
Chrysothamnus nauseosus (gray rabbitbrush)	22	36	8	32
Chrysothamnus viscidiflorus (green rabbitbrush)	6	--	--	X
Balsamorhiza careyana (Carey's balsamroot)	8	4	X	4
Bromus tectorum[a] (cheatgrass)	40	48	48	96
Oryzopsis hymenoides (Indian ricegrass)	--	X	4	--
Melilotus officinalis[a] (sweetclover)	X	--	--	--
Lactuca serriola[a] (prickly lettuce)	X	--	4	--
Machaeranthera canescens (hoary aster)	2	--	X	4
Epilobium paniculatum (tall willowherb)	10	20	--	16
Poa bulbosa[a] (bulbous bluegrass)	--	--	--	4
Draba verna (spring whitlow)	--	4	--	4
Medicago sativa (alfalfa)	X	--	4	X
Agropyron dasytachyum (thickspike wheatgrass)	46	56	68	20
Stipa comata (needle-and-thread grass)	8	--	8	4
Tragopogon dubius (yellow salsify)	2	4	4	X
Erigeron poliospermus (cushion fleabane)	2	8	--	--
Erigeron piperianus (Piper's daisy)	4	--	--	--
Holosteum umbellatum[a] (jagged chickweed)	2	--	--	4
Agropyron cristatum[a] (crested wheatgrass)	X	12	4	4
Erodium cicutrium[a] (storksbill)	2	8	--	--
Chaenactis douglasii (hoary false yarrow)	X	--	--	--
Agastachea occidentalis[a] (western horsemint)	X	--	--	--
Bare soil	98	100	96	100
Litter	98	100	100	100

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

5.0 100-D/DR AND 100-H AREAS REVEGETATION

The 100-D/DR and 100-H liquid waste sites were remediated under the direction of the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units (EPA et al. 1995). Remediation and backfill were completed at the 100-D/DR and 100-H Areas in the spring and summer of 2001. The remediated sites were revegetated in November and December 2001 in accordance with Tri-Party Agreement Milestone M-16-26B. Twenty-four sites at the 100-D/DR Area (27.2 ha) and 12 sites, including the borrow area at the 100-H Area (21.7 ha), were planted. The primary objective of this revegetation effort was to stabilize the soils while promoting the establishment of a vegetative community dominated by native species. Several species were added to the native seed mix for distribution across the sites. The establishment of these species will be observed in the annual vegetation monitoring program, and the results will be documented and used to develop seed mixes that will be successful in future revegetation efforts.

The backfill work at 100-D/DR was completed in the spring of 2001. A majority of the backfilled area was dominated by Russian thistle by the time the area was planted in December. Backfill operations for the 100-H Area sites were not completed until mid-summer and, as a result, the weedy species did not have an opportunity to become established on the remediated areas prior to seeding.

The backfill material for the 100-D/DR and 100-H Areas was obtained from nearby borrow pits. As with most borrow areas, the material is excavated from several feet below grade and was nutrient deficient. To help establish vegetation in these soils, a fertilizer mix of Triple-16 was co-applied at a rate of 112 kg/ha during seeding. A native seed mixture was broadcast across the sites with a hydroseeder. The seed mixture included 22.4 kg/ha of Sandberg's bluegrass, 2.24 kg/ha of needle-and-thread grass, and small amounts of yarrow (*Achillea millefolium*), prairie clover (*Petalostemon ornatum*), sagebrush, rabbitbrush, Indian ricegrass, Carey's balsamroot, snow buckwheat, milkvetch, mariposa lily (*Calochortus macrocarpus*), grayball sage (*Salvia dorrii*), false yarrow (*Chaenactis douglasii*), slender hawksbeard (*Crepis atrabarba*), sand dropseed (*Sporobolus cryptandrus*), fleabane, globe mallow (*Sphaeralcea munroana*), squirreltail grass, Cusick's sunflower (*Helianthus cusickii*), wallflower (*Erysimum asperum*), blazingstar (*Mentzelia laevicaulis*), springparsely (*Cympopterus terebinthinus*), sand beardtongue, and long-leaf phlox (*Phlox longifolia*). The entire seeded area was irrigated with 0.62 cm/ha of water. One-half of the irrigation was applied during initial seeding, with the remaining irrigation applied immediately after seeding. Grass straw mulch was distributed across the entire seeded area at a rate of 4.5 metric tons/ha and was then crimped with a disk. Following the mulch application, 21,700 4-in.^{3} sagebrush tublings were planted across the sites.

5.1 100-D/DR AREA SITES

Initial vegetation surveys were conducted in May 2002. Twenty-nine species were seen on the revegetated areas at the 100-D/DR Area, 21 of which were native (Table 11), including 8 of the planted species. The revegetated area was dominated by Russian thistle with 13.1% cover and

98% frequency, followed by thickspike wheatgrass, with 5.6% cover, residual from the straw used as mulch, and Sandberg's bluegrass with 3.2% cover and 76% frequency (Figure 10). As the native species become established on the site within the next 3 to 5 years, the Russian thistle influence within the vegetative community will become less dominant.

Table 11. Percent Canopy Cover and Frequency of Occurrence at the 100-D/DR Sites in 2002.

Species	% Cover	% Frequency
Poa sandbergii (Sandberg's bluegrass)	3.2	76
Salsola kali[a] (Russian thistle)	13.1	98
Achillea millefolium (yarrow)	0.4	16
Sisymbrium altissimum[a] (tumblemustard)	1.7	48
Descurainia pinnata (western tansymustard)	0.5	10
Amsinckia lycopsoides (tarweed fiddleneck)	0.3	12
Centaurea diffusa[a] (diffuse knapweed)	X	X
Artemisia tridentata (big sagebrush)	0.1	4
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	2
Chrysothamnus viscidiflorus (green rabbitbrush)	X	X
Erodium cicutrium[a] (storksbill)	X	X
Bromus tectorum[a] (cheatgrass)	2.9	58
Phaelia linearis (threadleaf scorpionweed)	X	X
Melilotus officinalis[a] (sweetclover)	X	X
Lactuca serriola[a] (prickly lettuce)	0.3	12
Machaeranthera canescens (hoary aster)	X	X
Epilobium paniculatum (tall willowherb)	0.1	2
Senecio vulgaris[a] (common groundsel)	X	X
Poa bulbosa[a] (bulbous bluegrass)	0.1	2
Draba verna (spring whitlow)	0.2	8
Agropyron dasytachyum (thickspike wheatgrass)	5.6	64
Stipa comata (needle-and-thread grass)	X	X
Lepidium perfoliatum (clasping pepperweed)	X	X
Holosteum umbellatum (jagged chickweed)	0.5	20
Mentzelia albicaulis (whitestem stickleaf)	X	X
Ranunculus testiculatus (bur buttercup)	0.3	12
Sphaeralcea munroana (globemallow)	0.1	2
Chaenactis douglasii (hoary false yarrow)	X	X
Ambrosia acanthicarpa (bur ragweed)	0.1	2
Bare soil	48.5	90
Litter	31.8	100
Total cover (does not include bare soil or litter	**29.3**	

[a] Introduced species.
X = present but not counted in plot frames
-- = not present on site

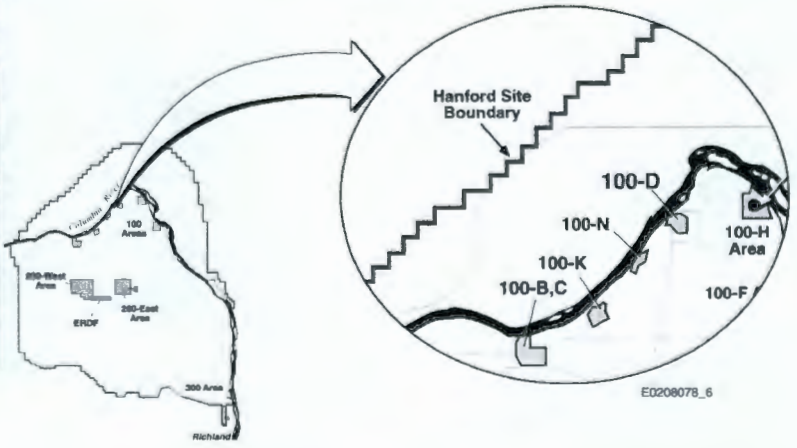
Figure 10. 100-D/DR Revegetation Sites.

Hydroseeding at 100-D/DR Area, December 2001

Looking East Over Revegetated Area, August 2002

December 2001 Planted Sagebrush, August 2002

100-D/DR Revegetation Area, February 2001



The sagebrush survival rate was estimated on a representative plot within the planted area on August 8, 2002. Of the sagebrush plants that were counted, 93.8% were still alive. Most of the seedlings have not grown since they were planted in December 2002. Sagebrush survival data gathered the first year following planting does not provide an adequate estimate to judge the success of the effort; rather the information gathered should be used as a baseline for future counts at the site. Estimates gathered after an entire growing season will provide a more accurate depiction of the survival rate.

5.2 100-H AREA SITES

Initial vegetation surveys were conducted in mid-May 2002. Twenty-six species were identified across the revegetated area, of which 16 were native. Eight of the planted species including Sandberg's bluegrass, snow buckwheat, yarrow, sagebrush, rabbitbrush, needle-and-thread grass, bottlebrush squirreltail, false yarrow, and sand beardtongue were recorded on the sites. Sandberg's bluegrass (18.9% cover, 94% frequency) dominated the planted area, followed by wheatgrass with 4.1% cover and cheatgrass with 2.3% cover (Figure 11). The entire area had a total cover of 31.3 %.

The sagebrush survival rate was evaluated within a representative plot on August 12, 2002. Of the seedlings counted, 59.8% were still alive. The material used as backfill at the 100-H Area consists of cobble rock and course sand and, as a result, does not have a good moisture-holding capacity. The young seedlings that survive the first growing season and establish roots deeper in the soil will be more likely to survive through subsequent years.

Table 12. Percent Canopy Cover and Frequency of Occurrence at the 100-H Sites in 2002.

Species	% Cover	% Frequency
Poa sandbergii (Sandberg's bluegrass)	18.9	94
Eriogonum niveum (snow buckwheat)	X	X
Salsola kali[a] (Russian thistle)	1.9	74
Achillea millefolium (yarrow)	1.0	38
Sisymbrium altissimum[a] (tumblemustard)	1.5	30
Descurainia pinnata (western tansymustard)	0.1	2
Centaurea diffusa[a] (diffuse knapweed)	X	X
Artemisia tridentata (big sagebrush)	0.1	2
Chrysothamnus nauseosus (gray rabbitbrush)	0.1	4
Bromus tectorum[a] (cheatgrass)	2.3	44
Lactuca serriola[a] (prickly lettuce)	0.1	4
Machaeranthera canescens (hoary aster)	X	X
Epilobium paniculatum (tall willowherb)	0.1	2
Senecio vulgaris[a] (common groundsel)	X	X
Poa bulbosa[a] (bulbous bluegrass)	0.7	8
Draba verna (spring whitlow)	0.5	18
Agropyron sp. (wheatgrass)	4.1	60
Stipa comata (needle-and-thread grass)	0.1	4
Holosteum umbellatum[a] (jagged chickweed)	0.2	6
Hordeum murinum[a] (smooth barley)	X	X
Erodium cicutrium[a] (storksbill)	X	X
Amsinckia lycopsoides (tarweed fiddleneck)	X	X
Lepidium perfoliatum[a] (clasping pepperweed)	0.1	2
Sitanion hystrix (bottlebrush squirreltail)	0.1	2
Penstemon acuminatus (sand beardtongue)	X	X
Chaenactis douglasii (hoary false yarrow)	X	X
Bare soil	49.9	96
Litter	26.7	98
Total cover (does not include bare soil or litter)	**31.3**	

[a] Introduced species.
X = Present but not counted in plot frames

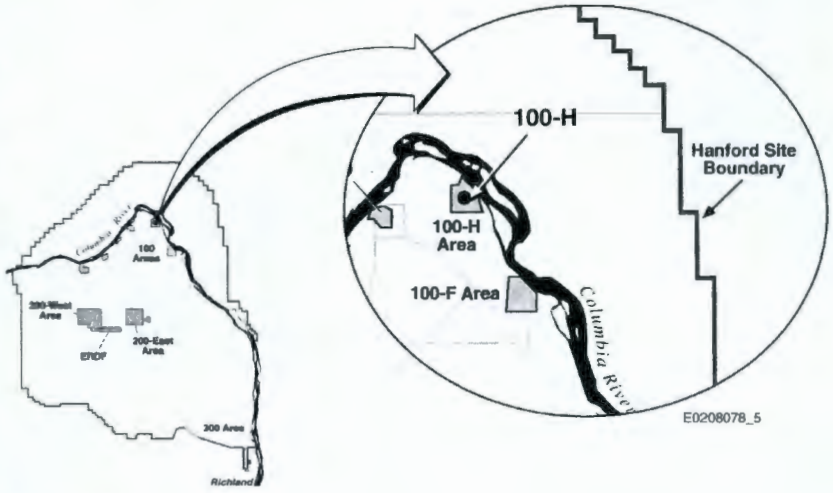
Figure 11. 100-H Revegetation Sites.

100-H Area Remediation, June 2001

100-H Area Revegetation Area Being Mulched, November 2001

Seeding 100-H Area, November 2001

November 2001 Planted Sagebrush, August 2002



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APPENDIX A

2001 REVEGETATION MONITORING RESULTS

Appendix A – 2001 Revegetation Monitoring Results

Table A-1. Percent Canopy Cover and Frequency of Occurrence on the 600-104 (2,4-D) Site in 2001.

Species	% Cover	% Frequency
*Bromus tectorum** (cheatgrass)	23.6	96
*Salsola kali** (Russian thistle)	3.1	64
*Sisymbrium altissimum** (tumblemustard)	0.2	8
Ambrosia acanthicarpa (bur ragweed)	0.8	32
Poa sandbergii (Sandberg's bluegrass)	3.1	28
Festuca octoflora (six-weeks fescue)	0.5	20
Rumex venosus (winged dock)	0.2	8
Lappula redowskii (western stickseed)	0.2	8
Amsinckia lycopsoides (tarweed fiddleneck)	0.2	8
*Holosteum umbellatum** (jagged chickweed)	0.7	28
Draba verna (spring whitlow)	0.4	16
Achillea millefolium (yarrow)	1.1	24
Epilobium paniculatum (tall willowherb)	0.6	24
*Lactuca serriola** (prickly lettuce)	0.1	4
Microsteris gracilis (annual phlox)	0.1	4
Artemisia tridentata (big sagebrush)	0.3	12
Machaeranthera canescens (hoary aster)	0.2	8
Phlox longifolia (longleaf phlox)	1.5	4
Eriogonum niveum (snow buckwheat)	0.7	8
Mentzelia albicaulis (whitestem stickleaf)	X	X
Lupinus pusillus (low lupine)	0.1	4
Oryzopsis hymenoides (Indian ricegrass)	0.1	4
*Poa bulbosa** (bulbous bluegrass)	X	X
Balsamorhiza careyana (Carey's balsamroot)	X	X
*Tragopogon dubius** (yellow salsify)	X	X
Astragalus caricinus (buckwheat milkvetch)	X	X
Astragalus sclerocarpus (stalked-pod milkvetch)	2.5	4
Chrysothamnus viscidiflorus (green rabbitbrush)	0.6	4
Chrysothamnus nauseosus (gray rabbitbrush)	0.2	8
Collomia linearis (narrow leaf collomia)	X	X
Phacelia hastata (whiteleaf scorpionweed)	X	X
Plantago patagonica (Indian wheat)	0.2	8
Fritillaria pudica (yellow bell)	X	X
Stipa comata (needle-and-thread grass)	X	X
Erigeron filifolius (threadleaf fleabane)	X	X
Biotic crust	1.1	44
Bare soil	48.9	100
Litter	23	100
Total cover (does not include biotic crust, bare soil or litter)	**41.3**	

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

Table A-2. Percent Canopy Cover and Frequency of Occurrence on the 316-5 Process Trenches in 2001.

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

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

Table A-3. Percent Frequency of Occurrence on the 116-C-1 Site in 2001.

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

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

Table A-4. Percent Canopy Cover on the 116-C-1 Site in 2001.

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

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

Table A-5. Percent Canopy Cover on 100-B/C Revegetation Sites in 2001.

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

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

Table A-6. Percent Frequency of Occurrence on 100-B/C Revegetation Sites in 2001.

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

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

APPENDIX B

2000 REVEGETATION MONITORING RESULTS

Appendix B – 1999 Revegetation Monitoring Results

Table B-1. Percent Canopy Cover and Frequency of Occurrence on 600-104 (2,4-D) Site in 2000.

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

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

Table B-2. Percent Canopy Cover and Frequency of Occurrence on the 316-5 Process Trench in 2000.

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

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

Table B-3. Percent Canopy Cover on the 116-C-1 Site in 2000.

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

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

Table B-4. Percent Frequency of Occurrence on the 116-C-1 Site in 2000.

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

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

Table B-5. Percent Canopy Cover on 100-B/C Revegetation Sites in 2000.

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

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

Appendix C – 1999 Revegetation Monitoring Results

Table C-1. Percent Canopy Cover and Frequency of Occurrence on 600-104 (2,4-D) Site in 1999.

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

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

Table C-2. Percent Canopy Cover and Frequency of Occurrence on 316-5 Process Trench in 1999.

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

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

Table C-3. Percent Canopy Cover on 116-C-1 in 1999.

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

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

Table C-4. Percent Frequency of Occurrence on 116-C-1 in 1999.

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

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

APPENDIX D

1998 REVEGETATION MONITORING RESULTS

Appendix D – 1998 Revegetation Monitoring Results

Table D-1. Percent Canopy Cover and Frequency of Occurrence on 600-104 (2,4-D) Site in 1998.

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

* Introduced species.

APPENDIX E

NAME CHANGES INCLUDED IN THE 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*
Agropyron dasytachyum = *Elymus lanceolatus spp. lanceolatus*
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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