ESTABLISHMENT OF NATIVE VEGETATION AT ST. JOHNS LANDFILL

Experimental Test Plot Monitoring

[TASK 10: 1999 Annual Report]

Prepared for:

REGIONAL ENVIRONMENTAL MANAGEMENT DIVISION
METROPOLITAN SERVICES DISTRICT
600 NE GRAND AVENUE
PORTLAND, OR 97232

Prepared by:

Mark Griswold Wilson, Restoration Ecologist
Laura Brophy, Green Point Consulting
Loverna Wilson, Environmental Consultant

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BACKGROUND: 1997-1998 EXPERIMENTAL PLOTS
The 1997-98 test plots were prepared during fall 1997 and spring 1998, and seeded in fall 1998. Experimental treatments applied in fall 1998 included:

Two seed mixtures:

1. Grasses only [California brome (*Bromus carinatus*) plus blue wild-rye (*Elymus glaucus*)]
2. Grasses (brome + wild-rye) plus Spanish clover (*Lotus purshianus*).

Two mycorrhizal treatments:

1. added mycorrhizal inoculum
2. no added mycorrhizal inoculum.

The combination of two seed treatments and two mycorrhizal treatments can be described as four separate experimental treatments:

1. Grass only (G)
2. Grass + legume (GL)
3. Grass + mycorrhizal inoculum (GM)
4. Grass + legume + mycorrhizal inoculum (GLM)

These four treatments were applied to three separate test plot locations (SA2, SA3N, and SA3S) in a strip-plot design.

VEGETATION COVER ANALYSIS: 1997-1998 EXPERIMENTAL PLOTS
Methods- Quantitative monitoring of vegetation cover in the 1997-98 test plots was designed to answer the question, "Which of the experimental treatments provides the best growth of native or native-dominant vegetation during the 5-year contract period?" Quantitative monitoring of vegetation in the test plots was conducted on July 16, 1999.

Despite good equipment performance, error-free planting, and successful application of mycorrhizal inoculum in fall 1998, establishment of seeded species (*Bromus carinatus, Elymus glaucus*, and *Lotus purshianus*) was very low in the test plots during 1998-99 (see **Results** below). Given the scarcity of the seeded species, we chose to sample observation areas of approximately 10 square meters rather than the 1 sq m quadrats originally planned. This maximized the chances of detecting any of the seeded species within the observation areas.

Four roughly circular 10 sq m observation areas were located within each subplot, spaced evenly along a line bisecting the subplot lengthwise. These four observation areas produced a total sampling area of approximately 10% of the subplot area, compared to less than 0.5% of each subplot that would have been sampled using 1 sq m quadrats. Within each 10 sq m observation area, we recorded percent cover for all plant species present at higher than 5% cover.

Results- Quantitative monitoring of vegetation cover in July 1999 showed no significant difference ($p>10\%$) in cover of native vegetation among the experimental treatments. In addition, there was no significant difference ($p>10\%$) in cover of native vegetation among the three experimental plot locations (SA2, SA3N, SA3S).

The most common species in the test plots was perennial ryegrass, *Lolium perenne* -- the same species that had been dominant in the test plot areas before initiation of the experiment (see **Discussion** below). Cover of *Lolium perenne* averaged 66%, and did not differ significantly between locations or experimental treatments ($p>10\%$). Several species of clover (*Trifolium dubium*, *Trifolium repens*, and *Trifolium subterraneum*) were common in the plots. Since it was difficult to distinguish between some of the *Trifolium* species due to plant senescence, cover of *Trifolium* species was analyzed for the genus as a whole rather than for individual species. Cover of *Trifolium* species averaged 11% and did not differ significantly between locations or experimental treatments.

Cover of seeded species (*Bromus carinatus*, *Elymus glaucus*, and *Lotus purshianus*) was very low. *Bromus carinatus* was not detected in any of the subplots. *Elymus glaucus* was detected in 45 of the 144 observation areas, but average cover was under 1% for every subplot. Individual *Elymus glaucus* plants were small and spindly, and were difficult to detect due to lack of seedheads (see **Discussion** below). *Lotus purshianus* was observed in only 10 of the 144 observation areas, and had average cover of less than 1% for every subplot.

Discussion- Herbicide applications during 1997-1998 did not effectively control *Lolium perenne*. Observation of test plots in fall 1997 and spring 1998 showed that each application of Roundup© herbicide killed most of the established ryegrass plants. But, a thick stand of new ryegrass plants sprouted because Roundup© does not have the residual soil activity necessary to control soil seedbanks.

Vigorous growth of *Lolium perenne* in the testplots may have prevented establishment of the seeded native species by shading the soil surface (light is necessary for germination of many seeds). In addition, individuals of the seeded species that did successfully germinate may have been killed by competition from the dense ryegrass sward. The *Elymus glaucus* plants that were observed were small, poorly tillered, and etiolated. This supports the idea that competition from ryegrass greatly affected the native plantings.

Despite low percent cover, the frequency of *Elymus glaucus* (present in 45 of 144 observation areas) shows that it established more successfully than *Bromus carinatus* in the test plots. It is possible that over several years, *Elymus glaucus* may become more prominent within the experimental plots. *Elymus glaucus* is present (though not dominant) on other portions of the landfill (see **Summer 1998 Vegetation Survey**, in the Appendices to the November 1998 report). Its presence increases the diversity of the perennial grass community, and may improve the resilience of the grass community over the years to come.

Quantitative monitoring of *Elymus glaucus* cover was made more difficult by the small size of the *Elymus glaucus* plants in the test plots, and by their lack of seedheads. Close observation of the plots showed that seed heads were present only on *Elymus glaucus* stems that were prostrate. These head-bearing stems appeared to have been knocked down or crushed -- possibly during the mowing conducted in spring 1999. It seems likely that many more seed heads of *Elymus glaucus* were present during mowing, but were removed by the mower blades. Since grasses receive a large part of their photosynthate from the leaves of the flowering stems, the mowing not only made *E. glaucus* harder to identify, but may also have reduced their vigor. Unfortunately, the best time of mowing to control the height of Lolium is not always the optimal time for native grasses. In the future, timing of mowing should be carefully planned in relation to the timing of seedhead development of native grasses.

Other factors besides heavy growth of *Lolium perenne* may have caused the poor establishment and low cover of seeded native species. Soil physical testing during 1998 showed soil characteristics that are very challenging for establishment of native species [see **Winter 1998 Soil Testing** in the Appendices to the November 1998 Final Report]. Soils on the test plots have surface layers of clay and sand that are poorly mixed, resulting in highly variable infiltration rates ranging from 0.5 cm/hr (poorly-drained) to over 150 cm/hr (excessively drained). Low infiltration rates can result in saturated surface soils, creating anaerobic conditions that prevent germination or kill new seedlings. High infiltration rates can produce droughty conditions that kill young plants during early summer, particularly if those plants have already been stressed by anaerobic conditions during the previous winter.

Table 1. Percent cover of dominant and seeded plant species in 97-98 experimental plots, measured in July 1999. NOTE: Differences in percent cover between treatments and locations were not significant.

		Treatment				
Location	Species	grass only	grass + legume	grass + legume + mycorrhizae	grass + mycorrhizae	mean % cover
SA2	*Lolium perenne*	71.25	73.75	63.33	51.67	65.00
	Trifolium spp.	14.58	16.17	18.33	22.08	17.79
	Elymus glaucus	0.20	0.18	0.00	0.29	0.17
	Lotus purshianus	0.00	0.02	0.00	0.25	0.07
SA3N	*Lolium perenne*	79.58	71.67	72.50	58.75	70.63
	Trifolium spp.	0.42	0.00	0.00	1.25	0.42
	Elymus glaucus	0.08	0.29	0.08	0.61	0.27
	Lotus purshianus	0.03	0.01	0.01	0.01	0.01
SA3S	*Lolium perenne*	54.17	62.08	67.08	68.33	62.92
	Trifolium spp.	22.08	16.25	5.83	12.08	14.06
	Elymus glaucus	0.00	0.00	0.00	0.00	0.00
	Lotus purshianus	0.00	0.00	0.00	0.01	0.00
ALL LOCATIONS	*Lolium perenne*	68.33	69.17	67.64	59.58	66.18
	Trifolium spp.	12.36	10.81	8.06	11.81	10.76
	Elymus glaucus	0.09	0.16	0.03	0.30	0.15
	Lotus purshianus	0.01	0.01	0.00	0.09	0.03

RECOMMENDATIONS FOR LONG TERM VEGETATION MANAGEMENT

A total of twelve native grass testplots were established at SJL between 1992 and 1998. Although the only testplot series scientifically replicated was in 1998, viable stands of native grasses have not been able to be successfully established on any of the testplots for longer than one year. The influence of a *Lolium* dominated soil seedbank and the degradation of physical soil characteristics are thought to be the primary causes of this failure to establish natives. [See the **Discussion** above and **Winter 1998 Soil Testing** in the Appendices to the November 1998 Final Report]. The potential significance of the *Lolium* contamination of the SJL soil seedbanks has been known since native vegetation establishment activities began in 1992. In the 1980's, during temporary closure work, *Lolium perenne* "Manhattan" (perennial ryegrass), and *Agrostis* spp. (bentgrass) were seeded throughout the areas subject to final closure. These soils (and sod and seedbank) were then recycled when final closure work was initiated in 1992. The following spring ryegrass was the primary component in all "closed" areas of SJL. In June of 1994, the Oregon State University Seedlab conducted analyses on 6 soil samples taken from Subareas 1 & 2 to determine soil-seedbank composition. In each 1 pound soil sample, the Seedlab identified between 22 and 67 viable *Lolium* seeds. As of December 1999, all former SJL testplot locations are again primarily composed of ryegrass which, in all likelihood, has germinated from the soil-seedbank.

Based on the results of 7 years of testing, the WBW Project Team makes the following recommendations for the establishment of vegetation at SJL:

- Concentrate on replanting the riparian woodland/wetland around the edges of the landfill. Consider closing or narrowing Road E in order to provide additional planting area. Beaver/nutria protection fencing will be required.
- Determine, through experimental plantings, whether native woody shrub/arborescent tree plant communities can be established in certain SJL locations where the topsoil is deepest. [Soil depths should be =/> 12".] Deer protection fencing will be required.
- Finally, in areas where soil depths are less than 12", manage [e.g. fertilize, lime and mow] the existing ryegrass as waterfowl feeding areas. Alternatively, seed with non-native fescues such as: F. longifolia (hard fescue) or F. commutata (chewings fescue).