Project Summary
Rocky Mountains Cooperative Ecosystem Studies Unit

Project Title: Assessment of effects of amendments on vegetation performance at a bentonite minesite.

Type of Project: Research

Project Discipline: Natural

Funding Agency: Bureau of Land Management

Other Partners/Cooperators: Not Applicable

Effective Dates: February 1, 2005 to September 30, 2005

Funding Amount: $23,544

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Project Abstract: A total of 135 experimental plots [15 treatments with 3 fertilized rates nested within each treatment and replicated three times] were implemented on bentonite spoils in the 1980s by staff of the Reclamation Research Unit at Montana State University. Treatments varied from physical manipulations to additions of chemical and biological amendments. The plots were seeded with mixes of plant species. Effects of these amendments and treatments on spoil chemistry and vegetation were documented in several early RRU reports (Dollhopf et al. 1979, 1988, 1990). In April, 2005, a reconnaissance team from the Reclamation Research Unit conducted a qualitative assessment of the vegetation status of the experimental reclamation plots. The purpose of this assessment was to determine which of the treatments support the "best" vegetation. Based on this assessment (Neuman 2005), soils and vegetation from these "best" plots were then evaluated in July. These treatments were as follows:

- Treatment #7 – Manure at 112 Mg/ha + H_2SO_4 at 20 Mg/ha
- Treatment #9 – Gypsum at 6.7 Mg/ha + $CaCl_2$ at 17.2 Mg/ha
- $MgCl_2$ Brine

Quantitative evaluation of the vegetation growing on these experimental plots in 2005 revealed the following:

1. The mean vegetation cover values for each treatment, across all replications, were not significantly different among the three chosen treatments. Mean canopy cover values were 21.1% for spoils treated with gypsum and $CaCl_2$, 24.4% for spoils treated with H_2SO_4 and manure, and 27.3% for spoils amended with a brine of $MgCl_2$. These cover values were markedly lower than those measured in previous years. In 1987 and 1989, the mean percent canopy cover of vegetation growing on the $MgCl_2$ brine treated plots was 39.3% and 46.0%, respectively (Dollhopf et al. 1990). These cover values are greater than the mean value of 27.3% found in 2005. In 1986, mean vegetation cover values measured on the spoils treated with gypsum/$CaCl_2$ and those treated with H_2SO_4 and manure were 54.0 and 77.6%,
2. Community composition did vary significantly ($P < 0.05$) among the treatments. Perennial grasses, specifically Alkali sacaton (*Sporobolus airoides)*, dominated the vegetation community growing on the spoils treated with $MgCl_2$ brine (Image 2). Perennial forbs, chiefly Prostrate summercypress *(Kochia prostrata)* accounted for the majority of the vegetation growing on the materials initially treated with H_2SO_4 and manure.
3. Few of the seeded species were found growing on the experimental plots. Many other species have colonized the plots, but they contributed little to vegetation cover or biomass.
4. Mean Aboveground biomass varied from 494 g/m^2 for plant of the acid/manure plots to 968 g/m^2 for vegetation on the plots treated with $CaCl_2$ and gypsum. Like vegetation cover, the composition of plants contributing to aboveground biomass varied among the three treatments.
5. Level of soil pH across all treatment and depths were very similar with a range of 6.78 to 8.04.
6. The electrical conductivity (EC) of spoil (top 20 cm) treated with H_2SO_4 and manure was markedly reduced compared to either the control samples or the soils collected from the other treated plots. Correspondingly, the soluble concentrations of calcium, magnesium, and sodium as well as the sodium absorption ratios of the top 20 cm of the acid/manure treated spoils are less than all other samples.
7. The EC and SAR values for the $MgCl_2$ brine-treated spoils have not changed since they were last measured in 1989 (Dollhopf et al. 1990).

8. In 1980, the SAR levels of spoils treated with $CaCl_2$ and gypsum ranged from 16.8 to 47.7 (Dollhopf et al. 1988). Slightly lower SAR levels were found in 2005.
9. The manure incorporated into this treatment (H_2SO_4 and manure) was clearly visible in the soils profile. However, much of the manure had not decomposed since it was added to the spoils 25 years ago. Roots were abundant to a depth of 45 cm.
10. The depth of the amended zone (gypsum and $CaCl_{2)}$ was clearly defined at 45 cm, and copious roots were found in the soil profile to this depth. The amended zone was visible to a depth of approximately 56 cm. Roots were abundant to 20 cm with fewer observed below this depth in the profile.

Outcomes with completion dates (reports, publications, workshops, videos, etc.):
1) Technical Memorandum of May 3, 2005 regarding reconnaissance of Bentonite vegetation research plots.
2) Final Report of October 20, 2005.
3) Results of this work will be presented at the 10 Billings Land Reclamation Symposium in June 2006.

Keywords: Bentonite reclamation, vegetation cover and production,

Attach any appropriate supporting materials.