TETRA TECH

851 Bridger Drive, Ste. 6
Bozeman, MT 59715
Tel 406-582-8780 Fax 406-582-8790
www.tetratech.com

TECHNICAL MEMORANDUM

To: Mary Beth Marks
From: Vicki Regula/Thad Jones
Company: Region 1, Gallatin National Forest
Date: January 12, 2009
Re: New World Revegetation Monitoring: Review and Recommendations
Project #: 1157561506A
CC:

The objectives of revegetating disturbed areas in the New World Mining District is to minimize erosion and to produce a self-sustaining vegetation community that approaches that of native vegetation communities on undisturbed sites. Long-term vegetation monitoring is implemented to ensure that these objectives are being met. Vegetation monitoring consists of collecting annual data on reclaimed areas; documenting trends in vegetation parameters over time; identifying areas where revegetation may be failing; and providing recommendations for maintaining revegetated areas.

The original Long-Term Revegetation Monitoring Plan (1999) developed for the New World Project states that monitoring transects would be established to document vegetative cover density and diversity and, in areas where transects were not established, area-wide monitoring would occur. Cover sampling transects were to be sited randomly within each of the reclaimed areas. Similar transects were to be established in reference areas based on criteria presented in Chambers and Brown (1983) to provide baseline conditions for comparison with revegetated areas. To account for transect data variability reclamation areas were stratified to reduce the effects of physical site characteristics such as slope, aspect, moisture regime, and elevation. Original strata were identified for the Como Basin, the McLaren Pit Cap Area, McLaren Triangle, Upper Elevation Roads, Middle Elevation Roads, and Low Elevation Roads. More recently, transects were established for the Borrow Area, Black Warrior, and Little Daisy reclamation areas.

Three cover sampling methods are listed in the original long-term revegetation monitoring report (1999) and are described in Chambers and Brown (1983). They include the Point Quadrat Method, 35 mm Slide Method, and Bitterlich's Variable Radius Method.

Bitterlich's Variable Radius Method was never used in yearly monitoring in the New World reclamation areas because it is used only on sites where trees have reached a measurable diameter at breast height (DBH). The Point-Quadrat Method for cover sampling has been used since 1999 on the New World Project site to report percent cover, species composition, and species diversity. The 35 mm Slide Method has been used intermittently to document transect location and provide a reference for vegetation cover on reclaimed transects. Historically, use of the 35 mm Slide Method has been inconsistent in that the method was not applied or reported every year of the monitoring period. For example, in the 1999 and 2000 revegetation reports, 35mm Slide results are recorded; however, results are not reported for the 2002, 2003, or 2004 revegetation reports. Results are included once again in annual revegetation reports for 2005, 2006, and 2007.

As stated in the Long-term Vegetation Monitoring Report (1999), the 35mm Slide Method will be used as a quality assurance/quality control measure that provides a second method of determining the aerial vegetative cover and the precision of field Point-Quadrat sampling (Maxim 1999). For this method, one 35mm Slide plot is photographed for each transect, representing only 10 percent of the total field transects sampled. Due to variability in field samplers and photo interpreters accuracy and precision, and the method's original intent, it is recommended for future reports that 35mm slide values within ± 20 percent of those generated by the Point-Quadrat Method be considered within the acceptable range of variation, whereas values exceeding 20 percent would require further review and justification as to the discrepancy in cover estimates.

Area-wide vegetation monitoring uses a series of criteria to determine if reclaimed areas require maintenance. Monitoring activities include: ocular estimates of the number, size, and location of areas void of vegetation; the presence, size, and extent of erosional features such as rills and gullies; and, an assessment of the cause(s) of barren or unproductive areas. Criteria used to define barren areas are: 1) areas that are approximately 10 percent or more of the overall monitoring strata; and 2) areas where the reclamation treatment has clearly failed. No minimum requirements were established for reporting erosional features; rather they are recorded if they were a dominant feature of the reclamation site and had the potential to result in additional erosion, to the detriment of the site.

A summary of past monitoring activities including a list of all monitored reclamation areas, their strata, reference sites, years of monitoring, and type of monitoring is presented in the table below. The summary indicates that established reference sites have not been revisited since 1999, and that reference sites have not been established or identified for other revegetation areas. Repeated monitoring of reference sites is critical to establish cover trends

and variability over time. For example, if 1999 was a very wet or very dry year, sample data would be skewed and comparisons with reclaimed sites would not be representative some nine or more years later. In addition, if invasive species are an issue in the reclaimed area it would also be beneficial to know if those same invasive species have become an issue in the reference area. Establishment of a reference site is an important component of reclamation to determine a percent cover by native species, percent cover by weeds, species diversity, and other information relevant to establishing success criteria for the proposed reclamation sites or areas.

The 2005 Revegetation Monitoring Report (Maxim 2005) reported a revegetation cover goal of 20 percent. This goal was not justified in any District reports or work plans and is not the preferred cover goal proposed by Chambers and Brown (1983).

In an effort to standardize revegetation monitoring and set a meaningful percent cover objective the following monitoring protocol is recommended: 1) follow-up area-wide observational monitoring will be done on sites originally visited in 2000 and 2003 to visually record these areas for lack of vegetation, erosion, and presence of exotics. This type of monitoring will be done to identify areas in need of maintenance. Four cover monitoring sites (multiple transects) with corresponding reference sites will be established in Como Basin, Glengarry Waste Dump, Gold Dust, and New World Repository. Follow-up cover monitoring will occur on the remaining reclamation sites using the Point-Quadrat Method. If reference sites in Como Basin, Glengarry Waste Dump, Gold Dust, and New World Repository are representative of the geology, soil, slope/aspect, and vegetation in the reclamation sites no additional reference sites will be established.

To determine reclamation success, ground cover of the revegetated area and the appropriate reference area will be monitored for three consecutive years to verify the continued success (Chambers and Brown 1983). Established reference areas will be revisited and additional reference areas, if needed, will be identified and sampled. In the event past reference areas cannot be located new reference areas will be established. Other superfund sites in Montana have established acceptable cover goals of 30-45 percent. Chambers considered these values to be too low (Chamber pers. comm., June 30, 2008). Instead of using these arbitrary values, it is recommended that Chambers and Brown cover goal of 90 percent of that of the reference area be used. Once a reclaimed site reaches these determined goals, sites will be monitored at year 5 intervals. If ground cover goals are not met following three consecutive years or during follow-up monitoring at 5 years, site evaluations and corrective recommendations will be made. It should be recognized that Monitoring by the US Forest Service at intervals greater than the initial 5 years may not be feasible at the New World Project

site because of man-power or funding restrictions. However, longer-term monitoring results (as suggested here) could contribute greatly to increased knowledge and understanding of the science of high elevation disturbed soil reclamation and plant succession patterns.

Historical and Recommended Vegetation Monitoring
New World District Reclamation Sites

Reclamation Sites	Monitoring Strata	Years Monitored	Historic Monitoring Type	2008 Recommended Monitoring
McLaren Pit Cap Area	McLaren Upper	1999, 2000, 2005, 2006, 2007	Cover	Cover
	McLaren Lower	1999, 2000, 2005, 2006, 2007	Cover	Cover
	McLaren Upper (Reference)	1999	Cover	Cover
	McLaren Lower (Reference)	1999	Cover	Cover
	McLaren Triangle	1999, 2000, 2002, 2003, 2005, 2006, 2007	Cover	Cover
	McLaren Triangle (Reference)	1999	Cover	Cover
	Borrow Area	2005, 2006, 2007	Cover	Cover
Como Basin	Como Basin	1999, 2000	Cover	Cover
	Como Basin (Reference)	1999	Cover	Cover
	Como Dump Area	2003	Area Wide	Cover
	Como Basin	2007	Area Wide	Cover
Reclaimed Roads	Upper Reclaimed Roads	1999, 2000	Cover	Area Wide
	Middle Reclaimed Roads	1999, 2000	Cover	Area Wide
	Reclaimed Roads Upper and Middle Monitoring Stratum (Reference)	1999	Cover	Area Wide
Fisher Creek	Fisher Dumps Monitoring Stratum	2000	Cover	Area Wide
	Fisher Trench Monitoring Stratum	2000	Cover	Area Wide
	Fisher Trench Monitoring Stratum (Reference)	2000	Cover	Area Wide
	Glengarry Waste Dump	2007	Area Wide	Cover
	Gold Dust	2007	Area Wide	Cover
	New World Repository	2007	Area Wide	Cover
Tredennic Dump	Tredennic Dump 1	2003	Area Wide	Area Wide
	Upper Tredennic Dump 2	2003	Area Wide	Area Wide
	Middle Tredennic Dump 1	2003	Area Wide	Area Wide
	Lower Tredennic Dump 1	2003	Area Wide	Area Wide
Miller Creek	Miller Creek Area	2006	Cover	Cover
	Little Daisy	2007	Cover	Cover
	Black Warrior	2007	Cover	Cover
Other	Middle Spalding Dump	2003	Cover	Area Wide
	Spalding Access Road Lower	2003	Cover	Area Wide
	Spalding Dump Small	2003	Cover	Area Wide
	Rommel Tailings	2003	Area Wide	Area Wide
	Soda Butte Tailings	2003	Area Wide	Area Wide
	Como Dump Area	2003	Area Wide	Area Wide

REFERENCES

Chambers, J.C. and R.W. Brown. 1983. Methods for Vegetation Sampling and Analysis on Revegetated Mined Lands. United States Department of Agriculture Forest Service. Intermountain Forest and Range Experiment Station. Ogden, Utah. General Technical Report INT-151.

Chambers, J.C. June 2008. Personal Communication.

Maxim Technologies. 1999. Long-Term Revegetation Monitoring Plan. New World Mining District Response and Restoration Project. Prepared for the USDA Forest Service Northern Region. Missoula, MT. Pg. 14.

Maxim Technologies. 2005. McLaren Pit Area. Revegetation Monitoring Report. New World Mining District Response and Restoration Project. Prepared for the USDA Forest Service Northern Region. Helena, MT. Pg. 55.