

MONTANA'S FRAMEWORK FOR ESTABLISHING TECHNICAL VEGETATION STANDARDS¹

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Abstract. In order to achieve Phase III bond release, vegetation on reclaimed surface mines must be compared with unmined reference areas or technical vegetation standards. Technical standards may be developed from historical data or from USDA, USDI, or other relevant government or academic publications. The reference areas or standards used must represent lands with “good ecological integrity,” and cover and production must equal the comparison within specified tolerances. Other requirements include that the vegetation be “diverse, effective, and permanent,” primarily native (except for improved pastureland), and have similar seasonality to unmined vegetation.

One of the impediments to Phase III bond release in Montana has been the difficulty in developing a metric for such factors as diversity and ecological integrity. Exact comparisons with reference areas were problematic in a practical as well as a theoretical sense. In the interests of moving forward with bond release on reclaimed lands that were well past the 10-year responsibility period, the Montana Department of Environmental Quality established a framework for mine operators to use in developing technical vegetation standards. The framework is based on the use of Ecological Site Descriptions from USDA Natural Resources Conservation Service and the methodology presented in *Interpreting Indicators for Rangeland Health* (TR 1734-6 USDI Bureau of Land Management). We describe the framework and provide an example of vegetation standards consistent with the framework that were developed for the Absaloka Mine in southeastern Montana.

Additional Key Words: mine reclamation, Phase III bond release, ecological site descriptions, rangeland health.

¹ Paper was presented at the 2009 National Meeting of the American Society of Mining and Reclamation, Billings, MT, *Revitalizing the Environment: Proven Solutions and Innovative Approaches* May 30 – June 5, 2009. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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DOI: 10.21000/JASMR09010359
<http://dx.doi.org/10.21000/JASMR09010359>

Introduction

This paper is intended to 1) discuss some of the ecological problems associated with developing technical performance standards for Phase III bond release; 2) describe the existing statutory and regulatory requirements, including tightly specified criteria and more vague objectives; 3) present Montana's recently completed guidance for developing performance standards; and 4) provide a real-world example of such development.

Important criteria that are necessary to meet at Phase III bond release are explicitly described in the Montana Surface and Underground Mining and Reclamation Act (MSUMRA) and the federal Surface Mining Control and Reclamation Act (SMCRA). The specific sections of MSUMRA are found in the Montana Code Annotated (MCA), Title 82, Chapter 4, Part 2. The rules that implement MSUMRA and SMCRA are found, respectively, in the Administrative Rules of Montana (ARM) Title 17, Chapter 24, Sub-Chapters 3 - 13 and the Code of Federal Regulations (CFR) Title 30. The Montana Department of Environmental Quality (MDEQ) and the Office of Surface Mining (OSM) implement, respectively, the state and federal rules.

Cover, production, and woody plant density (or stocking) of reclaimed vegetation must generally equal or exceed that of the reference area or the technical standard. The rules that were developed to implement SMCRA state that "cover, production, or stocking shall be considered equal to the approved success standard when they are not less than 90% of the success standard." The rules further require that "sampling techniques for measuring success shall use a 90-percent statistical confidence interval (i.e., one-sided test with a 0.10 alpha error)" (30 CFR 816.116(a) (2)). These instructions, combined with other directions as to what types of post-mining land uses the three parameters should be applied, specify very precisely how to measure some of the success criteria for meeting Phase III bond release. When unmined reference areas are used as the standard for comparison, determining bond release should, in theory, be a fairly straightforward process.

However, additional criteria are required for bond release. The vegetation must be diverse, effective, and permanent, and it must be composed of native species or desirable introduced species (82-4-233 MCA). However, specific definitions, methods of measurement, or minimum thresholds for these criteria are not provided in the law. Nor is there any explicit requirement for comparison with a reference area or technical standards,

though one would certainly seem implied. Much of this gray area was left to be worked out by regulators, mine operators, consultants, and interested citizens. The framework created by MDEQ provides guidance for developing site-specific technical vegetation standards, which will be acceptable to MDEQ and may then be incorporated into mining permits. The complete document, *Framework for Technical Vegetation Standards*, along with other vegetation sampling and reclamation guidance may be found at <http://www.deq.mt.gov/CoalUranium/guidelines.asp>.

General Intent and Requirements for Phase III Bond Release

MSUMRA and the federal Surface and Mining Control and Reclamation Act (SMCRA) clearly intend that land be reclaimed to a state that fully supports the post-mining land uses that are approved in the mining permit. Such post-mining land uses are predicated on the uses that existed prior to mining, unless an alternative post-mining land use is proposed and approved. Loosely speaking, the intent is that the land be functionally equivalent to its pre-mining state. The law clearly recognizes that “duplication of pre-mining topography, soils, and vegetation composition is not practicable” (MCA 82-4-201(3)(d)).

Two different approaches are allowed by law to determine if revegetation criteria have been met and that reestablished vegetation is “good enough.” The first approach specifies the use of a reference area as a control (in the experimental context) for determining quantitative and qualitative parameters and descriptors for the expected vegetation. In this case, the reestablished vegetation is considered adequate when it matches the reference area. Such reference areas have historically been unmined areas within the permit boundary. They must be under management control of the operator and representative of the “geology, soil, slope and vegetation in the permit area” (MCA 82-4-203(44)). Typically, they would be matched to a particular reclaimed area according to specific environmental variables such as slope, aspect, soil type, etc.

The second approach specifies the use of technical standards. Rather than comparing measures of the reclaimed vegetation against similar measures on a specific plot of ground, monitoring results are compared against quantitative or descriptive performance standards. Such standards may be derived from historical data, from previously revegetated areas that are compared to historical data, or from data and information provided by U.S. Department

of Agriculture or U.S. Department of Interior that may be relevant to the geographic area and the post-mining land use (ARM 17.24.724(3)).

However the vegetation success standards are derived, they “must be representative of vegetation and related site characteristics occurring on lands exhibiting good ecological integrity” (ARM 17.24.724(3)).

Theoretical Basis for Reference Areas

The basic concept behind using a reference area for setting vegetation success standards is appealing from perspectives of both ecological theory and practicality. In the context of ecological theory, the approach is firmly rooted in a deterministic concept of plant succession towards a climax community: given comparable environmental factors and similar management and disturbance (or lack thereof), over time two plant communities will become indistinguishable (Clements, 1936; Borman and Pyke, 1994). As long as disturbance and other impacts are held constant, the primary (or even solely) determining factor in plant community composition and productivity is assumed to be the environment. Theoretically, any difference in vegetation between the reference area and the reclaimed area must be due to a difference in environment between the two areas, or specifically, that the reclamation inputs (e.g. soil lay-down, slope, etc.) were inadequate to recreate the same environment.

From a practical standpoint, reference areas would seem to provide a tracking mechanism for seasonal weather variations. Unusual drought, cold or other yearly factors are assumed to have equal impact on both the reference and reclaimed areas, and their respective vegetation would be assumed to respond to such factors in a similar manner. Thus, the success standard should change with yearly weather variables and will serve as a more appropriate performance measure for the reclaimed vegetation.

Several problems exist with these theories. They include: drawbacks to deterministic theories of vegetation, initial floristic composition, temporal and spatial variability, stage of succession, and environmental comparability. Discussion of these issues follows.

Conceptual and Practical Weaknesses of Reference Areas

Alternative theories of plant succession have existed for some time, being generally more prevalent in the eastern half of the U.S. (Gleason, 1926; Whittaker, 1951). In the past three decades, recognition of the importance of perturbations as organizing or defining elements in

plant communities has grown (Westoby, 1989; White, 1979). Perturbations may be mild and fairly constant or include relatively rare, but cataclysmic events.

Frequent, relatively benign events include impacts such as grazing and trampling by animals, background level insect infestation, etc. Such disturbances may serve to order the plant community, prolonging a relatively steady state of fluctuation about a mean. Less frequent, more extensive or cataclysmic impacts such as fire, flooding, mass wasting, severe drought, epidemic insect infestations, etc. often result in a transition to a different state in which the plant community persists, fluctuating around a different mean than that of the previous state. Recognition has also grown that the *absence* of background perturbations, such as grazing or animal trampling, in communities that previously contained such phenomena, can also result in a state change (Savory, 1998).

The recognition that discrete incidents of disturbance and the removal of background disturbance can result in a long term change in vegetation has lead ecologists to develop “state and transition” theories (Bestelmeyer et al., 2003, 2004; Stringham et al., 2001), recognizing that environment alone is not the organizing principle of vegetation, and that multiple steady states within a given environment are possible.

In similar fashion, the impacts of initial floristic composition can have enormous influence on a plant community. For instance, if a fire burns through grassland dominated by cheatgrass, the post-fire community is predictably dominated by cheatgrass, as the seed is numerous and little else exists to compete. In contrast, post-fire vegetation in a perennial grass community will be dominated by perennial grasses, even with cheatgrass present, unless the fire burns hot enough to kill perennial root crowns. A similar situation is found in reclamation when salvaged topsoil contains viable seed, and is hauled directly to the reclamation site, after which the vegetation is influenced (or even dominated) by plants established from such residual seed.

Temporal and spatial variability is especially pronounced in the complex topography and semi-arid environments common in eastern Montana. Total herbaceous production is greatly affected by annual and seasonal precipitation, seasonal temperature variation, and the timing of precipitation relative to temperature and plant phenological stage. The relative abundance of species in a plant community also varies greatly from year to year, and some species of herbaceous perennials may be absent in any given year due to climate fluctuations such as

prolonged drought, unusual cold, or extreme heat. Spatial variations may occur as a result of factors such as extremely localized precipitation events, differences in insolation and complex interactions with microtopography, and the inherent substrate variability of steep and/or rugged terrain.

By definition, reference areas are presumed to represent relatively mature stages of vegetation and soil development. A purely herbaceous community might possibly reach full development in as little as ten years, assuming that good management and favorable, steady weather patterns have prevailed. However, woody plant communities often take longer to fully develop after disturbance (Cooper et al., 2007). To complicate matters, growing conditions in the northern Great Plains favorable may vary greatly from year to year (Fig. 1).

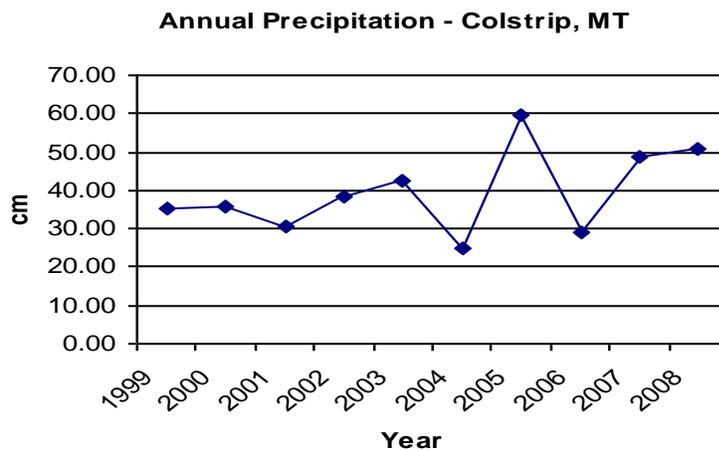


Figure 1. Total annual precipitation in Colstrip, MT over a ten-year period (1999-2008).

The coal mines of southeastern Montana are located within a working landscape, and plant communities in unmined reference areas are as much a function of past management and disturbance as of their environment. Thus, reference and reclaimed areas must generally be expected to be at different stages of plant succession and community development. Unless the time for bond release was extended to several decades, one would not necessarily expect enormous similarity between reference and reclaimed areas.

With regards to environmental comparability, edaphic factors are often critical. However, soil characteristics are determined not only by the texture, composition and depth of the topsoil, but also by biological and chemical activity that occurs *in situ* and greatly

influences the type and amount of vegetation that will grow on a given site. Even though topsoil is salvaged and replaced, the structure, chemistry and biota of the replaced soil will not equate to an undisturbed area. Mixing of different soil types and textures, which occurs to a greater or lesser degree in any operation, further exaggerates the environmental differences between reclaimed and undisturbed substrates and tends to undermine the assumption of environmental comparability.

In this regard, reclaimed mine lands and adjacent unmined lands are similar to glaciated areas: One site starts over with a similar but highly altered substrate, which is now devoid of biological activity. The adjacent reference area continues in an uninterrupted trajectory with its vegetation and soil biota intact.

All of these issues have a certain degree of validity in a wide range of environments. In environments with moderate precipitation, constant moderate to high humidity, and long growing seasons that coincide with favorable moisture regimes, high biological activity will tend to dampen the effects of past disturbance and environmental variation. None of these conditions prevails in eastern Montana, and, consequently, different conditions (historical or environmental) may result in very divergent, yet stable, plant communities.

Information Supporting the Development of Technical Standards

Technical standards must be based on reasonable understandings and expectations of plant communities in the area. The reclaimed areas should retain the general characteristics of the area (this is the ultimate goal of reclamation), even if they do not match any specific location in the unmined landscape. Therefore, vegetation performance standards should ideally be based on generalized characteristics and descriptions that have been derived from the landscape of concern.

These characteristics and descriptions for southeastern Montana are available through existing sources. A primary source for native rangeland can be found in the Ecological Site Descriptions developed by USDA Natural Resources Conservation Service (NRCS). Most of the current coal mines fall within Major Land Resource Areas 58A (Northern Rolling Plains, Northern Part) and 58B (Northern Rolling Plains, Southern Part). A map showing the Major Land Resource Areas within Montana is available at <http://www.mt.nrcs.usda.gov/technical/ecs/range/ecolsites>. The individual Ecological Site Descriptions are available through the Electronic Field Office Technical Guides (EFOTG) at

<http://www.nrcs.usda.gov/technical/efotg>; 58A files are accessed through Montana counties, while 58B files are accessed through Wyoming counties.

These site descriptions cover a broad range of information, some qualitative and some quantitative. Physiographic features, climate and soils data are provided, along with lists of representative soils for each county. Data are provided for plant community and species composition, relative dominance, and production for native grasses, shrubs and forbs. Cover is provided for plant growth forms and soil surface. Also provided is a discussion of the successional dynamics, including descriptions of seral stages, historic climax plant community, and state and transition models between stages.

Information for improved pastures is available through the NRCS EFOTG in the form of Forage Suitability Guides. These guides provide data on forage species suitability and expected production levels for native and introduced grasses and forbs for specific soil, climate, and site combinations.

Characterization of forests may be needed to derive technical standards for forestry post-mining land uses. In this case, forest productivity and stockability data are available from a number of sources (Jain et al., 2007; Pfister et al., 1977). The Custer National Forest also has extensive data on forest stand structure for the area (DiBenedetto, 2007).

All of the above-referenced existing sources of data can provide the basis for developing reasonable and appropriate vegetation technical standards for coal mine reclamation.

Important Requirements and Definitions

In general, reclamation requirements focus primarily on the post-mining land use, with the requirement that reclaimed vegetation support that land use, rather than focusing on the vegetation per se. Categories of land use include cropland, pastureland, grazing land, fish and wildlife habitat, forestry, developed water resources, industrial or commercial, pastureland, recreation, or residential. In Montana, wildlife habitat is extremely important to the state as a whole, so wildlife habitat enhancement features must be incorporated into reclamation even where the approved post-mining land use is something other than fish and wildlife habitat.

Definitions

Definitions provided by MSUMRA, CFR, and ARM provide specificity and clarity for reclamation goals. Some of the more pertinent ones are provided below. All come from MCA, unless otherwise noted.

Land uses. Many of the definitions for land uses are obvious and straight forward. Two that deserve greater scrutiny are “pastureland” and “grazing land.” Pastureland is defined as land that is used for the long-term production of *domesticated forage plants*. In contrast, grazing land is defined as grasslands and forest lands where the *indigenous vegetation* is actively managed for livestock grazing or browsing. This is one instance where vegetation composition is a defining component of post-mining land use. Both pastureland and grazing land may occasionally be hayed.

Reclamation vs. restoration. Much discussion occurs in the ecological community regarding the difference between “reclamation” and “restoration.” Montana law-makers have simplified the discussion and, for the purposes of coal mining, equated both terms to mean making lands capable of supporting those uses that existed prior to mining, or “higher and better” uses. (Of course, whether one use, say a golf course, is higher and better than another, say wildlife habitat, depends on one’s perspective.)

Ecological terms. All but the last of these terms come from the Federal Register (1982).

- Diverse: sufficiently varied amounts and types of vegetation to achieve ground cover and support the post-mining land uses... diversity does not necessarily mean that every species of grass, shrub, or trees be reestablished in identical numbers and ratios after mining.
- Permanent: the plant community *as a whole* must be capable of providing the necessary amount of ground cover over time through natural succession – not that every plant species will propagate itself in identical numbers and ratios.
- Same seasonal characteristics of growth as the original vegetation: the major season of growth for herbaceous species; in general this refers to cool-season and warm-season.
- Good ecological integrity: the complex of the community of organisms and its environment functioning as an ecological unit possesses components and processes in good working order (ARM 17.24.301(46)).

Vegetation Standards for Various Post-Mining Land Uses

Vegetation standards for reclamation must provide for stability and prevent excessive erosion irrespective of land use. Beyond this requirement, MSUMRA and SMCRA and the rules dictate that the criteria for success standards vary according to the approved post-mining land use. For instance, species and functional group diversity would be expected to be higher in grazing land than in pastureland. In addition, different measures of success apply to different uses. A discussion of the variation between categories of post-mining land use, along with the associated standards and measures, follows.

Cropland

Cropland is used for harvested crops, whether annual crops such as small grains, or perennial, such as alfalfa hay, orchards or tree nurseries. As these lands may include plowing and fallow periods when no vegetative cover is present, a cover standard is not applicable. (Erosion control and stability must therefore be provided by characteristics such as limitations on slope, drainage design, shelterbelts, etc.) Likewise, a vegetation community standard is also not applicable. The only plant species requirement is desirable agricultural species.

The primary performance standard for cropland is annual production or yield, measured in units typical for the crop (e.g. pounds/acre, bushels/acre, etc.) Quantitative standards may be developed based on data from USDA Natural Resources Conservation Service, Farm Services Administration, the Montana Department of Agriculture and/or historic data from a comparable reference area.

Pastureland

Pastureland is used “for the long-term production of domesticated forage plants to be grazed by livestock or occasionally hayed” (82-4-203(28) MCA). Vegetation must be composed of primarily perennial herbaceous plants that may include or even be dominated by introduced species. The emphasis is on desirable forage plants, whether native or introduced. Relative dominance of the established species need not conform precisely to proportions in the seed mix, and introduced grasses such as smooth brome, that were not deliberately seeded, may be present. Important criteria are that established species are

perennial and possess adequate forage value; vegetative composition will be assessed on that basis.

Vegetative cover and production are the primary performance standards for pastureland. The cover assessment will include total desirable perennial vegetation, including all native and desirable introduced herbaceous species, plus woody plants (if any). Production will be measured as total herbaceous perennial plant production. Quantitative standards may be developed based on data from USDA Natural Resources Conservation Service, specifically from the applicable Forage Suitability Groups of the Field Office Technical Guides and/or historic data in the vicinity of the reclaimed area.

Standards for ecological integrity (discussed below) will be used to assess reclamation areas as a whole for soil/site stability, hydrologic function, and biotic integrity. Standards for ecological integrity in pastureland will be based on Ecological Site Descriptions for native rangeland, with appropriate modification based on information from the Forage Suitability Groups.

The primary use of pastureland is focused on forage for domestic livestock. However, pastureland is also specifically mentioned as a post-mining land use where wildlife enhancement features should be incorporated. The presence and effectiveness of such features can be documented and assessed by looking at diversity across the landscape. In assessing biotic integrity of pastureland, the arrangement and variety of wildlife habitat enhancement sites across the landscape will be considered.

Grazing Land

Grazing land is comprised of grasslands, shrublands and forested areas “where the indigenous vegetation is actively managed for livestock grazing or browsing or occasional hay production” (82-4-203(28) MCA). The emphasis in this definition is native plant species that are useful for grazing or browsing. Introduced species, if present, should be a minor component of the plant community, comprising not more than 15% of the vegetation (based on percent composition). Generally speaking, they should not be included in the reclamation seed mix, though direct-hauling of topsoil will often result in an abundance of annual or perennial introduced species, if they were prevalent in pre-mining vegetation. Fields in which introduced perennial grasses exceed 15% relative composition should be designated as pastureland and subjected to pastureland production and cover standards.

Because of the focus on native species and communities, vegetative diversity is an important characteristic for this land use type. The plant community must include a representative assemblage of species and life forms that would be expected in undisturbed areas, though given the mid-seral nature of reclaimed land by Phase III bond release, one would not expect the same proportions or relative dominance as would be found in undisturbed, late-seral (or even post-climax) plant communities. Every species of pre-mining grass, shrub, or tree need not be reestablished throughout the reclaimed area, but a variety of species from the natural vegetation should be present, so the community has the same general character as the pre-mining vegetation. Such diversity within a given ecological site is important to ensure a fully functioning plant community, including its functionality for wildlife use.

By law, quantitative standards for cover and production must be applied to grazing land. Cover standards will be based on perennial vegetation at peak development. The cover assessment will include total desirable perennial vegetation, including all native and desirable introduced herbaceous species, plus woody plants. Noxious weeds and annual species, whether native or introduced, will not count toward meeting cover requirements.

Production standards and assessment will be based on total perennial herbaceous production. Production must focus primarily on herbaceous species, as trees and shrubs growing in the harsh conditions of southeastern Montana generally do not reach full production levels in ten years. In addition, clipping to measure annual woody plant production is detrimental to plants and counterproductive to achieving the desired results. The important criteria for woody plants is that they are present in the community and adequately vigorous to maintain that presence, mature, and contribute to further succession and community development.

Standards for ecological integrity (see next section) will be used to assess reclamation as a whole for soil/site stability, hydrologic function, and biotic integrity. These three attributes together address the requirement that reclaimed vegetation be “diverse, effective, and permanent” and have “good ecological integrity.”

Grazing land, by definition, is primarily focused on forage for domestic livestock. However, as with unmined, private ranch lands and livestock grazing allotments on public lands, these areas, to a greater or lesser extent, provide an important component of wildlife

habitat. Grazing land is specifically mentioned as a post-mining land use where wildlife enhancement features should be incorporated. The presence and effectiveness of such features can be documented and assessed by looking at diversity across the landscape. In assessing the biotic integrity of grazing land, vegetation diversity within a given ecological site, as well as the variety of sites and wildlife habitat enhancement features across the landscape, will be considered.

Fish and Wildlife Habitat

Fish and wildlife habitat is defined as land that is “dedicated wholly or partially to the production, protection, or management of species of fish or wildlife” (82-4-203(28) MCA). A gray area exists, in that croplands, pasturelands, and grazing lands are required to incorporate wildlife habitat enhancement features, and the requirement for native vegetation in grazing land implies some level of wildlife utility. Thus, all of these lands are expected to at least partially support use by wildlife.

However, in order to apply the appropriate vegetation standards, the designation of land use as fish and wildlife habitat must be clear, and should be a primary purpose of the post-mining land use, even if such use is limited to or concentrated in certain seasons. Examples include land that has been recognized as critical mule deer winter range or sage grouse breeding and rearing habitat prior to mining, and that has the requirement to replace pre-mining utility.

Shrub and/or tree density is the primary quantitative vegetation standard required by law for fish and wildlife habitat. Such a standard must take into account the early stage of development of the woody vegetation and must insure that the vegetation is on a trajectory toward the desired state. Thus, woody plant vigor, as well as density, needs to be considered. The standard must be developed in consultation with and approved by Montana Fish Wildlife and Parks.

The statutory requirement for the vegetation cover standard is that which is adequate to provide stability and prevent undue erosion, while supporting the approved post-mining land use. Specific quantitative standards for cover will be set according to the vegetation desired to provide habitat for the targeted wildlife species.

Standards for ecological integrity will also apply to fish and wildlife habitat. However, the end state for the desired vegetation will often differ from that applied to grazing land. As

such, different successional states will be used for assessing ecological integrity for fish and wildlife habitat than those applied to grazing land, and different states may be specified depending on whether utility for a particular wildlife species is desired.

Forestry

Forestry is defined as land used or managed for the long-term production of wood or wood-derived products. Given the environmental limitations for tree growth in the eastern Montana coal fields, land is not generally dedicated solely to forestry in the pre-mining state. However, much private and public land is managed for forestry under a multiple-use scenario.

Tree density is the primary quantitative vegetation standard required by law for lands classified as primarily forestry for post-mining land use. The vast majority of forested lands in eastern Montana currently have an altered structure resulting from decades of fire exclusion and selective logging; this current forest structure is not sustainable (see Jain and Graham, 2007; Jain et al., 2007; Biswell 1972; Covington 1993, 2000). Therefore, a vegetative standard for tree density in lands designated for forestry will be based on a sustainable tree density and forest structure that contributes to long-term forest health. The end goal will be based on approximations of presettlement forest structure.

As is the case for fish and wildlife habitat, the statutory requirement for vegetation cover on forestry lands is that which is adequate to provide stability and prevent undue erosion, while supporting the approved post-mining land use. Thus, the requirement for stability must be balanced with the need to limit moisture competition enough to ensure that the desired forest structure will develop over time without replanting.

Standards for ecological integrity will also apply to forestry. The desired end state for forestry land is the potential natural vegetation under a pre-Euro American disturbance regime. Vegetation diversity and structure will be measured against an appropriate mid-seral stage that would be expected to eventually succeed to the historical climax plant community.

Recreation or Residential

Recreation land is that used for public or private leisure-time activities, including developed recreational facilities, such as campgrounds. Residential land is used for single or multiple-family housing, mobile home parks or other lodging.

None of these post-mining land uses have direction for vegetation success specified in the law or the rules with the exception that vegetation must be adequate to prevent excessive soil erosion and achieve the post-mining land use. Given the nature of recreation land as typically dominated by native vegetation, standards for ecological integrity will be applied as appropriate. Likewise, with residential land, standards for ecological integrity will be applied insofar as native vegetation is the desired matrix around anticipated housing development. Any desired forests must be of a structure and density that sustains forest health and does not pose an undue risk to life-safety or home ignitions during a wildland-urban interface fire.

Approval for these land uses can only be made upon submission of an alternative post-mining land use plan. Specific vegetation standards to ensure land stability, drainage and aesthetics will be developed in the course of that approval process, based on the specific design for the alternative post-mining land use. The standard for cover is that the vegetation must be adequate to provide stability and prevent excessive erosion.

Industrial or Commercial

Industrial or commercial lands are those used for manufacturing facilities, warehousing and distribution, or retail trade. The expectation for these lands is full development, and no vegetation standards for production or diversity apply. However, the vegetation cover combined with hardscaping must be adequate to provide stability and prevent excessive erosion.

Standards for Ecological Integrity

The general goal for reclaimed mine lands in eastern Montana is to establish healthy rangeland vegetation that has good ecological integrity. The National Range and Pasture Handbook (USDA, 1997) defines rangeland health as “the degree to which the integrity of the soil, vegetation, water, and air, as well as the ecological processes of the rangeland ecosystem are balanced and sustained.” It defines integrity as “the maintenance of the functional attributes characteristic of a locale, including normal variability.” More specifically the goal is to reestablish native vegetation that is diverse, effective and permanent. On cropland and pastureland desirable introduced species are allowed.

The Act and Rules specify only production, cover, and density as quantitative vegetation standards that must be met. However, assessments based on single traits are inadequate to determine rangeland health because they do not reflect the complexity of the ecological processes (Pellant et al., 2005) and, therefore, do not serve as adequate assessments of rangeland health.

A method for assessing rangeland health has been developed over the last decade by an interagency team of range ecologists from the Agricultural Research Service, the Bureau of Land Management, the Natural Resources Conservation Service, and the U.S. Geological Survey. This method will form the basis for assessing the required qualitative standards for revegetation success (diverse, effective, and permanent) for the Montana Department of Environmental Quality.

This methodology has grown out of questions regarding appropriate rangeland monitoring, the difference between assessment and monitoring, successional dynamics in rangeland environments, and ecological theories of state and transition dating back to the early 1990's. This paper is not designed to cover the scientific underpinnings of the methodology. Readers who are unfamiliar with such work should visit the website of the Agricultural Research Service's Jornada Experimental Range where much of the work was completed, and the assessment tool is presented in a broader context. The basic concept of assessment (as opposed to monitoring) is defined as "the process of estimating or judging the value or functional status of ecological processes (e.g., rangeland health)" (http://usda-ars.nmsu.edu/monit_assess/monitoring.php). Assessment is appropriate for one-time judgments, but should not be used for establishing trend with repeated measurements. An explanation of the basic approach of the methodology follows.

Interpreting Indicators of Rangeland Health

Interpreting Indicators of Rangeland Health, Version 4 (Pellant et al., 2005) is published as Technical Reference 1734-6 by the National Science and Technology Center of the Bureau of Land Management.¹ The methodology is a qualitative assessment of three major

¹ The document is available online at www.blm.gov/nstc/library/techref.htm. A hard copy may be ordered from:

BLM National Business Center
Printed Materials Distribution Service, BC-652
P.O. Box 25047
Denver, CO 80225-0047

By FAX: 303.236.0845
By E-Mail: BLM_NCS_PMDS@blm.gov

attributes: soil/site stability, hydrologic function, and biotic integrity reflecting the basic ecological process of nutrient cycle, water cycle, and energy flow. Soil/site stability assesses the capacity of an area to limit redistribution or loss of soil resources. Hydrologic function reflects the capacity of an area to capture, store, and safely release water, plus the resilience and recoverability of that capacity. Biotic integrity is the capacity of plants, animals, and microorganisms to support ecological processes within the normal range of variability, plus the resilience and recoverability of that capacity.

Seventeen indicators make up the assessment of the major attributes. Of these indicators, ten apply to soil/site stability, ten apply to hydrologic function, and nine apply to biotic integrity. Thus many of the indicators are used in assessing two or more of the major attributes.

The methodology has been adopted as the standard for determining rangeland health by most of the federal agencies concerned with rangeland management: the Natural Resources Conservation Service, the Bureau of Land Management, and the Bureau of Indian Affairs. It is also used to a lesser degree by the U.S. Fish and Wildlife Service and the National Park Service.

Though the overall assessment is qualitative in nature, information can be supplemented with quantitative data for many of the indicators. A few indicators have no quantitative equivalent because some ecosystem properties are more accurately reflected by qualitative indicators (Rapport, 1995). Where it is desirable to augment the qualitative data with quantitative measures, one should select the best quantitative indicators for each of the three *attributes*, rather than selecting an equivalent quantitative measure for each qualitative indicator (Pellant et al., 2005).

Interpreting Indicators of Rangeland Health is predicated on a classification system that identifies distinct sites based on the type and amounts of vegetation that can potentially grow there. The existing Ecological Site Descriptions for eastern Montana provide such a classification system. These descriptions also provide the basis for developing Reference Sheets that describe the indicator characteristics of healthy vegetation for that site. Evaluations of the indicators are then based on the observed departure from the expected characteristics provided in the Reference Sheet for each Ecological Site Description.

Reference Sheets have already been developed for most Ecological Site Descriptions. However, even where Reference Sheets already exist, they may need to be modified for assessing reclaimed vegetation. Two reasons exist for this:

1. Many of the Reference Sheets already developed for the Ecological Site Descriptions are descriptive of the historic climax plant community and, as discussed earlier, one would not necessarily expect full development of the vegetation in as little as ten years. A different community within the threshold that includes the historic climax plant community may be more appropriate.
2. In some cases, such as pastureland or fish and wildlife habitat, the desired plant community does not coincide with the historic climax plant community. In the first case, introduced species may be a prevalent component of the community, and thus the expected plant functional/structural groups and annual production would likely be modified, though most other indicators would apply directly. In the second case, greater dominance by shrubs might be important, which is typically associated with reduced grasses and increased bare ground. In order to assure that the post-mining land use goals are met, the Reference Sheet should be tailored to those goals.

The Ecological Site Descriptions include extensive plant species lists (all of which are not expected to occur at any one locale), ranges for annual production, and detailed discussions of successional dynamics, along with state and transition models. This information, along with data from the mine sites and local expert knowledge, should allow for adequate development of applicable Reference Sheets.

In summary, indicator characteristics described in the NRCS Ecological Site Descriptions will provide the basis for qualitative standards for ecological integrity for pastureland, grazing land, fish and wildlife habitat, forestry, recreation, and residential post-mining land uses. For many of these uses, Reference Sheets will need to be modified or developed from scratch. Information from the NRCS Forage Suitability Groups will be combined with the Ecological Site Descriptions for use in assessing improved pastureland. The qualitative standards do not apply to cropland.

Outline of the Methodology

The basic steps in the Rangeland Health Assessment protocol are described below. This description is not intended to be complete and instructional, but rather an outline to

familiarize the reader with the basic elements of the approach. **Important concepts and details of the methodology must be obtained through a thorough study of Technical Reference 1734-6.**

Steps in the Process. Technical Reference 1734-6 postulates five steps in the Rangeland Health Assessment protocol:

Step 1 is to identify the evaluation area and to **determine the soil and ecological site**. In the case of a bond release application, the evaluation area will be the acreage described in the application. Ideally, soil and ecological site determinations will be completed before the application for bond release has been submitted. Identification of site characteristics early in the reclamation process will allow operators to fine tune management practices over the period of responsibility, so as to increase the operators' ability to achieve the desired vegetation. If the vegetation is on a different track than expected, such lead time will allow for ground-truthing and correction of misidentified sites or management adjustments to achieve the desired state before application for Phase III bond release.

Step 2 is to obtain or **develop the Reference Sheet** that will be used in the assessment. For the most part, these Reference Sheets will be developed by MDEQ personnel, with advice and assistance from NRCS, BLM, USFS, FWP and other local experts. The existing Reference Sheets from the Ecological Site Descriptions will be used as a starting point. Alternatively, Reference Sheets may be developed based on examination of the approved reference areas existing on a given mine. Vegetation monitoring data and local weather data from the mines will serve as additional input. Mine personnel and vegetation consultants who have years of familiarity with pre- and post-mining soils and vegetation will also have an important role to play in the development of Reference Sheets, insuring that realistic expectations are established.

A corollary step to developing the Reference Sheet is to **develop the Evaluation Matrix** that will accompany the Reference Sheet. The Evaluation Matrix provides descriptions for each indicator for the five states of departure from what is expected for the site: None to Slight, Slight to Moderate, Moderate, Moderate to Extreme, and Extreme to Total. The development of the Evaluation Matrix will follow that of the Reference Sheet, described above.

Step 3 is to **collect supplementary information**. This step is designated as optional in the technical reference. However, at a minimum, operators will need to collect the quantitative information that is required for bond release (cover, production, and/or density). Additional quantitative information to directly support the rangeland health assessment is suggested in Table 2 and in Appendix 6 of Technical Reference 1734-6. Operators should consult with MDEQ to insure applicability of additional quantitative or other supplementary data that they propose to collect in support of Phase III bond release.

Step 4 is to **rate the 17 indicators** on the Evaluation sheet and to justify those ratings with written comments. These field ratings are to be conducted only by trained professionals with a good understanding of the ecological processes, vegetation, and soils of the area being evaluated (Pellant et al., 2005). Ratings of bond release areas will be completed by MDEQ personnel, with a minimum of two people representing at least two disciplines (vegetation plus soils and/or hydrology). Ideally, they will be completed with all three disciplines represented.

Step 5 is to **determine the functional status of the three rangeland health attributes** based on the ratings of the 17 indicators. The ratings of the three attributes (soil/site stability, hydrology, and biotic integrity) must be justified with written comments. The appropriate departure category for each attribute is based on a preponderance of evidence from the indicator ratings that make up that attribute (see below). **In order to achieve the standard for ecological integrity for the purposes of Phase III bond release, a departure from expected of no more than “slight to moderate” must be achieved for each of the three attributes.**

Descriptions of the 17 Indicators. Table 1 lists the 17 indicators used in the attribute evaluation process and denotes the attributes to which each applies.

Each of these indicators is given a rating for the departure from expected from “none to slight” to “extreme to total.” If a particular indicator is not present (e.g. no gullies exist) it is rated as “none to slight.” The ratings for each indicator are then tallied under the attributes to which they apply, and attribute ratings are determined. **The attribute ratings are not simply a numerical average of their respective indicator ratings. Interpretation of the relative importance of each indicator is required.**

Table 1. Relationship of range health indicators to the three functional attributes (adapted from Pellant et al., 2005).

Indicator	Functional Attributes		
	Soil/Site Stability	Hydrology	Biotic Integrity
1. Rills	X	X	
2. Water-flow patterns	X	X	
3. Pedestals and/or terracettes	X	X	
4. Bare ground (%)	X	X	
5. Gullies	X	X	
6. Wind-scoured, blowouts or deposition areas	X		
7. Litter movement	X		
8. Soil surface resistance to erosion	X	X	X
9. Soil surface loss or degradation	X	X	X
10. Plant community composition and distribution relative to infiltration		X	
11. Compaction layer	X	X	X
12. Functional/structural groups			X
13. Plant mortality/decadence			X
14. Litter amount		X	X
15. Annual production			X
16. Invasive plants			X
17. Reproductive capability of perennial plants			X

The meaning for many of the indicators is apparent. Some of the more obscure indicators are described below. Definitions and/or explanations for the indicators come from Pellant et al. (2005).

- **Pedestals and/or terracettes:** Pedestals refer to rocks or plants that appear elevated as a result of soil loss by wind or water erosion. Similar effects can also be caused by non-erosional processes such as frost heaving, thus evaluators must be able to distinguish such processes from erosional ones. Terracettes are benches of soil deposition caused by water movement (not wind). Terracettes caused by livestock and wildlife movements on hillsides are not considered erosional terracettes, though they may affect erosion or alter infiltration.
- **Bare ground** refers to exposed mineral or organic soil. Anything covered by rock, litter, standing dead vegetation, biological crust or plant basal and/or canopy cover is not considered bare ground.

- **Litter movement** refers to whether the redistribution of litter occurs within a small area or is transferred offsite. The size of litter moved by wind or water is also an indicator of the degree of litter redistribution. The greater the distance and the larger the size of litter moved, the more the site is subject to erosion.
- **Soil surface resistance to erosion** depends on soil stability and its spatial variability, relative to vegetation and microtopographic features. Biological crusts, decomposing organic matter, and soil organic matter aggregates all contribute to stabilizing the soil surface.
- **Soil surface loss or degradation** refers not only to loss through erosion, but also to degradation of the surface horizon. Loss of soil structure (i.e., aggregates) and/or surface organic matter reflect a degraded soil surface.
- **Plant community composition and distribution relative to infiltration and runoff** is an assessment of how plant rooting patterns, litter production, basal area, foliar cover, and plant spatial distribution affect infiltration and/or runoff. An example of a composition change that reduces infiltration is the conversion of desert grasslands to shrub-dominated communities.
- **Compaction layer** refers to a soil structural change, as opposed to a textural change.
- **Functional/Structural groups** are species that are grouped together because they share a characteristic influence on the community. They are species with similar shoot and root structures, photosynthetic pathways, nitrogen fixing ability, and/or life cycle. Examples include warm-season tall perennial grasses, leguminous shrubs, or perennial forbs. Functional composition and functional diversity are principal factors in plant productivity, plant percent nitrogen, plant total nitrogen and light penetration (Tilman et al., 1997). These characteristics in turn have effects on the utility of a community and the habitat niches available for animals, birds and insects. A diverse assemblage of functional and structural groups thus supports wildlife diversity.
- **Litter amount** refers to dead plant material that is detached from the base of the plant and lying on the soil surface. Standing dead plant material is not considered litter.
- **Invasive plants** include native and introduced plants that are absent from or a minor component of the reference plant community that have the potential to become

dominant or co-dominant species on the site if not actively controlled by management interventions. This indicator, by definition, includes noxious weeds. Species that become dominant for only one to several years are not invasive plants.

The information presented here is a brief and excerpted summary of *Interpreting Indicators of Rangeland Health*. Extensive information regarding the assessment protocol, the 17 indicators, the three functional attributes, and the ecological theory and supporting evidence behind this methodology is provided in Technical Reference 1734-6. More information can also be found at the Jornada Experimental Range website under monitoring and assessment: http://usda-ars.nmsu.edu/monit_assess/monitoring.php

Implementation for Phase III Bond Release

The Rangeland Health Assessment protocol will be applied during Phase III bond release field inspections. The assessments must be carried out by at least two inspectors, including one vegetation specialist and either a surface water hydrologist or a soil scientist, or both. As is the case for all bond release inspections, mine personnel and members of the public may attend. Ratings will be made only by inspectors who have been trained in the use of the protocol.

The threshold for acceptability will be that no one of the three attributes of rangeland health is rated with more than a slight to moderate departure from the associated Reference Sheet (i.e., “slight to moderate,” and “slight to none” are acceptable). Individual indicators may receive less favorable ratings; however, such ratings would be expected to be few and relatively insignificant for the site as a whole. The preponderance of evidence must indicate no more than slight to moderate departure from the Reference Sheet for soil/site stability, hydrologic function, and biotic integrity. See the discussion under “Step 5” in “Instructions for Using the Rangeland Health Assessment Protocol” in Technical Reference 1734-6.

Mine operators are encouraged to complete training in the use of the protocol and to use it to assess reclaimed vegetation prior to application for Phase III bond release. They are also encouraged to submit any supplementary data that have been collected in support of the bond release application. See the discussion under “Step 3” and Appendix 6 in Technical Reference 1734-6. Any data that are submitted will be considered in the ratings. However, data collected in years prior to the application and inspection may or may not agree with

current conditions on the ground, and thus may or may not reasonably be used to supplement the ratings at the time of the bond release inspection.

Because the Rangeland Health Assessment protocol is qualitative in nature, some fear that it is completely subjective and therefore unpredictable and susceptible to personal bias. If the mine operator, land owner, or a member of the public who was in attendance at the bond release field inspection disputes the conclusions of the assessment, an independent assessment using the same protocol may be conducted by NRCS personnel who have been trained in the methodology and are familiar with local plant communities. If Montana DEQ believes that an independent assessment is warranted and if NRCS personnel are not available, the independent assessment may be conducted by a Certified Professional in Rangeland Management (as designated by the Society for Rangeland Management). Although the final determination for bond release rests with Montana DEQ, the independent assessment will be considered in the final determination.

Wildlife Habitat Enhancements

MSUMRA requires that wildlife habitat enhancement features be incorporated into cropland, pastureland and grazing land. Generally speaking, such areas will incorporate different plant communities and/or different ecological sites. Examples of the former include dense shrub or tree plantings; examples of the latter include wetlands (permanent impoundments), woody draws, or rock outcrops. A minimum of 5% of these land use areas should consist of wildlife habitat enhancement features.

Standards for Production, Cover, and Density

Quantitative measurements are required by law for production in cropland, production and cover in pastureland and grazing land, for cover in all other land uses, and for woody plant density in wildlife habitat and forestry. Discussion of the derivation of the standards for each of these land uses is provided below. For all comparisons, the reclaimed vegetation must equal at least 90% of the comparison level, assessed at the 90% confidence interval with a one-tailed test. (Note that the statistic may be derived from a t-test or a nonparametric test, as appropriate. For further information on sampling and statistical treatments, see Vegetation Sampling at <http://www.deq.mt.gov/CoalUranium/guidelines.asp>. For all land uses where cover measurements are required, cover will be measured as the percent of the

ground surface that is covered by the vertical projection of live vegetation, litter, and/or standing dead plant matter from perennial species. This measure must be greater than or equal to 90% of the cover standard at the 90% confidence interval. If the standard is derived from plant community descriptions that provide a range for total cover, reclaimed vegetation must have cover levels greater than or equal to the lower value in the range provided, or at least 90% of the mid-range, both at the 90% confidence interval.

Cropland

The ideal comparison for cropland production is an adjacent unmined area that is under the same management, if one is available and comparison measurements can easily be made. Reference areas work well for cropland because intense and repeated management keeps the reference area in a similar state as the reclaimed area, without successional induced changes in soils and vegetation.

In the absence of such a reference area, local production data from NRCS or the Farm Services Administration may be used for the crop in question. Whenever possible such data should be matched according to soil type. If the current year's data are not available, comparisons will be made with average annual production for the extant record.

Pastureland

Production standards for pastureland may be derived from the NRCS Forage Suitability Groups, matched according to soils and climate. "Low" and "High" levels will be applied according to the favorability of the growing season. The Forage Suitability Groups provide data for native and introduced, as well as warm- and cool-season species. Production standards for pastureland may also be derived from historic data from the vicinity of the reclaimed area.

Forage Suitability Groups do not provide data for cover. Therefore, cover standards for pastureland will be based on total vegetative canopy cover expected in the historic climax plant community for the climate and soil type as given in the applicable Ecological Site Description. Cover values from the historic climax plant community will be used as the technical standard because improved pastureland would be expected 1) to be strongly dominated by perennial grasses, and 2) to be at least as dense as native vegetation (at least in the first two decades after establishment). Cover standards for pastureland may also be derived from historic data from the vicinity of the reclaimed area.

Grazing Land

Production and cover standards for grazing land will be derived from the applicable NRCS Ecological Site Description matched according to mean annual precipitation. They may also be derived from historic data from the vicinity of the reclaimed area. Production will be measured as total herbaceous perennial production (less any noxious weeds) and must equal at least 90% of the average total annual production listed in table 7a of the appropriate Ecological Site Description (or the historically derived standard).

Wildlife Habitat

Shrub and/or tree density requirements for designated wildlife habitat areas will be established on a site-specific basis in consultation with and approval from Montana Fish Wildlife and Parks personnel.

Cover must be adequate to achieve the post-mining land use, provide soil stability, and prevent undue erosion. Specific quantitative standards will be set according to the vegetation required to provide habitat for targeted wildlife species. For instance, cover requirements for a waterfowl nesting area will obviously be different from those for big-game winter range. The primary goal for the cover standard is soil stability and erosion control.

Forestry

Tree density requirements for designated forestry areas will be established on a site-specific basis in consultation with and approval from Montana Department of Natural Resources and Conservation personnel. Additional information regarding appropriate stocking levels for forest species is available in *Forest Habitat Types of Montana* (Pfister et al., 1977) and for selected sites in the Ecological Site Descriptions.

Cover must be adequate to achieve the post-mining land use, soil stability, and erosion control. Specific quantitative standards will be based on comparable forest habitat descriptions (Pfister et al., 1977; Jain et al., 2007).

A Real World Example

Absaloka Mine used this framework to develop vegetation technical standards. Those standards were approved for use in January 2009 and have now been incorporated into the mining permit. Absaloka Mine is east of Hardin, MT on the northern boundary of the Crow

Indian Reservation. The mine is under permit from both MDEQ and OSM because the surface ownership is private, but the coal is held in federal trust for the Crow Tribe.

Approved post-mining land uses for Absaloka Mine are cropland, grazing land and pastureland, with the commitment to provide wildlife habitat enhancements on a minimum 3% of reclaimed acres. Seed mixes utilized since the early 1990s have included solely native species, and no pastureland has been deliberately established. However, prior to mining large portions of the permit area consisted of degraded pasture, dominated by crested wheatgrass (*Agropyron cristatum*) and broom snakeweed (*Gutierrezia sarothrae*) (Scow, 1992). Many roadside ditches were also dominated by smooth brome (*Bromus inermis*) (Myran, 2008). The presence of such concentrated areas of introduced cool-season grasses has resulted in localized reclamation areas where these species, especially smooth brome, now dominate. Such areas typically occur when salvaged soil with significant propagules of introduced grasses is directly hauled to reclamation areas, rather than being stockpiled. Once established the introduced perennial grasses are difficult to remove. Rather than attempting to extirpate the introduced grasses, Absaloka, MDEQ, and OSM have agreed to classify these areas as pastureland allowing a predominance of introduced perennial grasses.

Wildlife enhancement areas on Absaloka Mine include permanent ponds and associated riparian areas, shrub and tree plantings, and rock piles. Wildlife enhancement areas, because of their variety and small individual size, have no quantitative performance standards. Their utility for wildlife will be visually assessed during inspections.

Quantitative standards for grazing land and pastureland were developed from historical, pre-mining baseline vegetation data collected in 1991 (Scow, 1992). Normally, a number of years of historical data would be required to develop quantitative standards, however, spring precipitation records from 1991 showed good conformance with the long-term average for the site. Therefore, MDEQ and OSM accepted the proposition that vegetation characteristics for 1991 were an adequate proxy for long-term averages, and the proposed standards for cover and production were deemed acceptable (Table 2). Crop production standards were developed from predicted yields in the Big Horn County, MT Soil Survey (USDA, 1977).

Following the principles of rangeland health assessment, the demonstration of adequate diversity is based on the relative composition of plant functional groups. In this case, forbs, shrubs, and sub-shrubs were combined into one functional group because individually they

exhibit very low cover in the native grassland vegetation and shrubs are generally limited to specialized sites (i.e., drainages) in the unmined landscape. Recording all species present within plots is critical, but reporting the cover of individual species is not required. Species diversity within each functional group is required to achieve at least the threshold level.

The Silty Ecological Site Description from MLRA 58A, which applies to most of the reclamation on Absaloka, lists nine species of native cool-season grasses, two species of sedges, and nine species of native warm-season grasses that could be included to makeup the requisite minimum. Similarly, 28 species (or sometimes genera) of forbs are listed for the historic climax plant community and 14 species of shrubs and sub-shrubs. Therefore, providing at least four species of native cool-season grasses, two of native warm-season grasses, and at least six forbs, shrubs, and/or sub-shrubs in any given bond release area ensures broad comparability with the native landscape.

Phase III bond release field inspections have yet to occur utilizing these standards. However, at this point we expect to use the Reference Sheet from the Silty Ecological Site Description to assess the qualitative measures of rangeland health. Mine personnel, Absaloka's vegetation consultant, and MDEQ personnel have all agreed that the indicator descriptions provided there seem appropriate for the reclaimed grassland areas at the mine. Collection of data for a Phase III bond release application will begin in summer 2009, with a bond release field inspection expected to occur during summer 2011.

Acknowledgements

Thanks go to the following individuals for their thoughtful review and comment and their generous discussion of the concepts here applied,: Pat Shaver, Jon Siddoway, Robert Killian, and Bruce Waage of the USDA Natural Resources Conservation Service; Bob Postle and Rick Williamson of the USDI Office of Surface Mining, Reclamation, and Enforcement; Pat Plantenburg of the Montana Department of Environmental Quality, Hard Rock Mining Program.

Much of the approach presented here is based on the document *Interpreting Indicators of Rangeland Health, Version 4* (Technical Reference 1734-6), authored by Mike Pellant, David Pyke, Patrick Shaver, and Jeffrey Herrick. The ground-breaking work of these authors in developing useful concepts and methodologies for assessing ecological integrity in rangeland environments is gratefully acknowledged.

Table 2. Approved vegetation technical standards by land use category for Absaloka Mine, Hardin, MT.

PARAMETER	LAND USE		
	GRAZING LAND	PASTURELAND	CROPLAND
Non-stratified Cover (excluding trees)	Total: 53 % Perennial: 48 %	Total: 49 % Perennial: 40 %	Not Applicable
Herbaceous Production	Total: 967 lbs/ac Perennial: 823 lbs/ac	Total: 1490 lbs/ac Perennial: 1328 lbs/ac	Alfalfa: 0.93 tons/ac Wheat: 19.5 bu/ac Barley: 29.2 bu/ac
Diversity/Seasonality	<p>Native perennial cool-season grasses: relative cover $\geq 25\%$ # species ≥ 4</p> <p>Native perennial warm-season grasses: relative cover $\geq 3\%$ # species ≥ 2</p> <p>Native perennial forbs, shrubs and/or sub-shrubs: relative cover $\geq 11\%$ # species ≥ 6</p> <p>Introduced perennial cool-season grasses: relative cover $\leq 15\%$</p> <p>Introduced perennial forbs: relative cover $\leq 3\%$</p>	Adapted forage plants (native or introduced)	Not Applicable

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