COLORADO DIVISION OF MINERALS AND GEOLOGY

# *GUIDELINE REGARDING SELECTED COAL MINE BOND RELEASE ISSUES*

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## Introduction

This document is a guideline pursuant to Rule 1.15.4. The guideline is intended to assist coal operators by describing reclamation success demonstration approaches and techniques which the Division will accept as meeting the applicable regulatory requirements for bond release. In accordance with Rule 1.15.4(2), operators are free to demonstrate compliance with the Act and Regulations using procedures or information or an interpretation of the Act and Regulations different from that set forth in the guidelines. Operators are advised to consult with the Division well in advance of bond release application preparation and data collection activities, to insure that reclamation success demonstration approaches and procedures will be acceptable to the Division. Federal mine operators may wish to consult with OSM as well, since OSM may or may not concur with the Division's determination regarding acceptable approaches and techniques.

The guideline has been developed in response to requests from coal operators and consultants who have expressed frustration with various uncertainties regarding acceptable procedures for demonstrating compliance for bond release. Vegetation sampling approaches and methods of statistical evaluation associated with Phase II and Phase III bond release have been the focus of considerable concern, and these topics are addressed in detail in the guideline.

The guideline is somewhat transitional in nature in that certain rule changes for which the Board initiated rulemaking in December, 1994 but which have not been finally approved will have some bearing on the bond release process. The guideline is written with the assumption that the rules which are the subject of current rulemaking will be approved as proposed. In addition, anticipated 1995 revegetation rulemaking and associated changes in the Division's "Guidelines for Compliance with Land Use and Vegetation Requirements for Coal Mining" may specifically allow for the use of certain non-parametric statistical methods and alternative sample adequacy approaches which are not set forth in this document. The allowance for the use of "normal husbandry practices" during the liability period may also be affected by future rule changes. For some period of time, there will be certain inconsistencies between some of the methods and approaches set forth in this guideline, and those included in the "Guidelines for Compliance with Land Use and Vegetation Requirements for Coal Mining." In such instances, the approaches outlined in this guideline will take precedence.

## Part 1

## Application Requirements and Inspection Criteria for Bond Release on Permanent Program Areas

This section of the guideline is intended to provide assistance to Division staff and coal operators regarding the general procedural and format requirements of Section 34-33-125 of the Act and Rule 3.03, Release of Performance Bonds. The release of performance bonds is divided into three distinct phases, discussed separately below.

Part I of this section addresses the general requirements for all bond release applications and bond release inspections. Parts II, III and IV address the general criteria for release, specific information needed in the release application and what will be evaluated during the bond release inspection for Phases I, II and III.

I. General Requirements

A. Bond Release Application

An application for bond release shall contain the following information:

1. Date of request;
2. Permittee;
3. Permit number;
4. Date permit was approved;
5. Mine name;
6. Phase of bond release requested;
7. Number of acres;
8. Bond company;
9. Bond number;
10. Current total amount of bond;
11. Original total amount of bond (for area requested for release);
12. Dollar amount requested for release;
13. Legal description of area requested;
14. A permit area map with bond release request area delineated;
15. Dates reclamation work performed, including final grading, topsoiling (if applicable), and initial seeding (if applicable);
16. A description of the results achieved as they relate to the approved reclamation plan and the criteria used in the determination;

17. Copies of the written notice to seek release to parties identified in Rule 3.03.2(1). This includes: adjoining property owners, surface owners, local government bodies, municipalities, regional planning commissions, boards of county commissioners, county planning agencies, sewage and water treatment authorities, and water conservancy and water conservation districts in the locality of the mine; and

18. A copy of the newspaper advertisement required by Rule 3.03.2(1)(b) and the proof of publication required by Rule 3.03.2(1)(c).

The bond release application must contain all of the above information in order to be deemed complete.

B. Bond Release Inspection and Evaluation

The Division is required to conduct an inspection and an evaluation of the reclamation work involved in the area requested for bond release. The inspection is to be conducted within 30 days after the bond release application is deemed complete or as soon thereafter as the Division determines weather conditions permit. Notification of the inspection shall be given to the surface owner and agent or lessee, and the appropriate OSM Field Office (required for federal mines; courtesy notification for non-federal mines). They may accompany the Division on the inspection.

Bond release inspections will consider the following items as well as the specific items for each phase:

1. Results of past monthly inspections;
2. Surface and ground water monitoring data;
3. Whether pollution of surface or subsurface water is occurring, the probability of such future pollution and the estimated cost to abate pollution;
4. Stability of reclaimed surface lands; and
5. The degree of difficulty and estimated cost to complete any remaining reclamation.

II. Phase I Bond Release

Pursuant to Rule 3.03.1, a permittee may request Phase I Bond release upon successful completion of backfilling, regrading and drainage control in accordance with the approved reclamation plan. Up to 60 percent of the bond can be released. The timing of Phase I bond release will vary depending on the areas disturbed and reclaimed. For surface mines the disturbed and reclaimed areas continually progress with the mining and reclamation plan and bond release may begin during the life of the ongoing operation. For underground mines the disturbed area may be fairly constant, with little or no ongoing disturbance and reclamation, depending primarily on the nature and extent of any surface waste disposal sites. For underground mines with little or no ongoing disturbance, bond release may not be appropriate until mining ceases.

When Phase I bond release is requested, the release will apply only to those areas where backfilling and grading are completed. Backfilling and grading are considered completed upon the achievement of final post-mine topography in accordance with the permit, including establishment of the approved permanent drainage system. Areas which do not qualify for

bond release include long-term facilities such as sediment ponds, buildings, roads and other areas which will receive continued use in accordance with the approved plan.

The monetary amount from which the 60 percent release may be granted is the estimated cost of total reclamation of the area for which Phase I bond release is being requested. This estimated amount includes costs for facilities removal, backfilling, grading, topsoiling, seeding, mulching, etc. Up to 60 percent of the applicable amount can be released, provided sufficient funds are retained to cover remaining aspects of the reclamation.

A. Phase I Bond Release Application

In order for the Division to evaluate the success of reclamation for Phase I, the following information is needed in the bond release application:

1. An as-built post-mining topography map showing the regraded contours. The scale must be the same as the proposed post-mining topography map in the permit application. This regraded topography map will be overlain with the post-mining topography map approved in the permit application. Some deviations are to be expected, however major variations between the two must be explained in the bond release application;

2. Certified cross-sections of backfilled and graded area (representative);

3. Documentation that drainages have been reestablished, including drainage profiles; and

4. Documentation that drainage control has been established in accordance with the approved plan. All regraded areas must drain into the approved sediment control system.

B. Phase I Bond Release Inspection and Evaluation

Evaluation will be based on the specific requirements of the reclamation plan and the functional requirements of the post-mining land use. Inspections will evaluate the following, in addition to the items listed in Part I, Section I.B.:

1. Hillslope and drainage channel gradients and general design compliance;

2. Performance of the reconstructed topography. Symptoms of failures or instabilities such as slumping or exposed highwalls will be examined;

3. Hillslope design/function with regard to erosion;

4. Swales and depressions with regard to numbers of such features and effect on post-mining land use;

5. Blending of regraded land to undisturbed areas;

6. The functioning of drainages with regard to knickpoints, blending at disturbance boundaries and channel erosion. The evaluation of drainage function and erosional stability may not be possible within parcels which drain unreclaimed areas where final drainage systems have not been established. In such cases, Phase I bond release may

be precluded for permanent channel corridors until such time that the entire tributary drainage system has been reconstructed and is functioning.

7. Erosional features; and

8. Drainage control for the reclaimed area, including approved upslope diversions.

III. Phase II Bond Release

A permittee may request Phase II bond release upon the establishment of vegetation which supports the approved post-mining land use. For purposes of Phase II bond release, the Division will evaluate topsoil replacement, and, in most cases, vegetative cover and species composition (see Rule 3.03.1(2)(b)). The area cannot contribute suspended solids to stream-flow or runoff outside the permit area in excess of pre-mining levels or levels documented for comparable adjacent non-mined areas. On alluvial valley floors the essential hydrologic functions and agricultural productivity must be reestablished. Productivity must also be reestablished on cropland, including prime farmland.

Only those areas where Phase I has been released are eligible for Phase II release. In some cases a request for release of Phases I and II may be simultaneous. In either case the area must be clearly labeled on a map. Vegetation sampling for Phase II release may not be conducted prior to the second growing season, with the exception of annual cropland.

The Phase II application should summarize the reclamation and management history for the reclamation parcels included in the release request. The reclamation summary should include the date and thickness of topsoil application, topsoil source (stockpile or "live handle"), fertilizer type and application rate, seed mixture(s), rates applied and initial seeding dates, shrub planting species, methods, density, and planting dates, and type and method of mulch application. Any husbandry or management practices employed subsequent to initial revegetation, such as livestock grazing, interseeding, weed control, or rill and gully repair should be described.

The monetary amount which can be released at Phase II includes the costs for topsoiling and can be up to 85 percent of the total bond amount originally applicable to the reclaimed areas included in the bond release request. Sufficient bond must be retained to cover the costs of reestablishing vegetation by a third party during the remainder of the liability period, pursuant to Rule 3.03.1(3)(a) and Section 34-33-125(9)(b) of the Act. This amount will include material, labor, and other costs which would be incurred by having a third party access the site and reestablish vegetation required in the approved reclamation plan in the event that a complete vegetation failure should occur.

In addition to retaining bond for reestablishing vegetation, the estimated costs of any remaining reclamation work will also be accounted for in the bond retained following Phase II release. If these combined costs account for more than 15 percent of the applicable bond amount, more than 15 percent of the bond will be retained. If the revegetation and other remaining costs account for less than 15 percent of the applicable bond amount, 85 percent of the applicable bond amount may be released. However, at no time prior to final bond release shall the bond amount for an operation be reduced to less than $10,000.00. This minimum bond amount is required by Rule 3.03.1(4).

A. Phase II Bond Release Application

Operators are advised to contact the Division at least three months prior to any vegetation sampling associated with Phase II bond release, so that any uncertainties with regard to sampling approaches or methods can be resolved, and so that Division staff can arrange to be present during the sampling.

Operators are encouraged to submit Phase II bond release applications to the Division prior to mid-September of the year that vegetation data is collected, if possible, and in no case later than June 1 of the following year. Sampling should be timed to coincide as closely as possible with peak production of the primary reclamation species, and livestock grazing should in no case be allowed to interfere with data collection (i.e., grazing may need to be deferred until after sampling is completed).

It is highly recommended that requests for sediment pond removal pursuant to Rule 4.05.2(2), supported by applicable ground cover data and sedimentation demonstrations, be submitted either prior to or in conjunction with the Phase II bond release application. Sediment ponds and related collection and diversion ditches should be reclaimed promptly upon approval by the Division, and this reclamation should be completed at least two years prior to initiation of vegetation sampling for Phase III bond release.

In order for the Division to evaluate the success of reclamation for Phase II the following information is needed in the bond release application.

1. A map showing the revegetated areas, sample observation locations, and the reference area(s), if used.

2. A summary of the reclamation and management history for the bond release parcels, including maintenance and repairs of rills and gullies.

3. Documentation of successful establishment of vegetation. For reclaimed lands other than croplands and prime farmlands, a statistically adequate sample of vegetation cover collected during a single year from each reclaimed area and from the approved reference area or standard is required. The data should be presented in a table listing the percent absolute cover by species, rock, bare ground, and litter. Relative cover should be calculated and listed for each vegetation species.

   Vegetation establishment will be considered acceptable if the cover of the revegetated area is at least 90 percent of the cover from the reference area or other standard with 90 percent statistical confidence (Rule 4.15.8). Species composition will be evaluated using the species relative cover to determine whether the vegetation exhibits seasonality and species composition supportive of the approved post-mining land use. At a minimum, all species required to meet final diversity and seasonality requirements should be represented in the Phase II sampling data. Planting or seeding of woody species shall have been completed in accordance with the approved plan, and appropriate woody species should be represented in the reclaimed stand.

   The allowable relative cover contribution of annual and biennial species should not exceed 10 percent, or the relative cover of such species in the associated reference area or approved technical standard, whichever is higher. Annual or biennial cover in excess of this threshold should be deleted from the reclaimed area data prior to success

comparison. An acceptable alternative approach is to delete all annual and biennial cover from both the reference area data and reclaimed area data prior to success comparison. For purposes of runoff or sediment modeling, annual or biennial cover which is not counted toward the success standard should be converted to "bare ground," unless "second hit" cover data demonstrates that conversion to "litter" would be appropriate.

Under no condition will noxious weeds count toward the success standard. Phase II bond release will be denied if the reclaimed area has not been managed in compliance with the Division's "Guideline for the Management of Noxious Weeds on Coal Mine Permit Areas." The cover component provided by noxious weeds should be eliminated from both reclaimed and reference area data prior to success comparison.

The revegetation section of the release application should include a description of the sampling methods used, success standard comparisons, and statistical procedures (including sample adequacy calculations and statistical tests). Summarized transect data (total vegetation cover and absolute cover by species, rock, soil, or litter, for each transect) should be presented in addition to the sample statistics for total vegetation cover, and absolute and relative vegetation cover by species for the entire sampled area. The sample mean for litter, rock, and bare ground should also be presented. The cover contributed by noxious weed species and "excess" annuals and biennials should be discounted (i.e. subtracted from each sample observation) prior to success comparison and statistical evaluation.

4. For reclaimed alluvial valley floors (AVF), and croplands (other than prime farmlands), an adequate sample of production collected from the reclaimed area and the approved reference area during a single year is needed. Agricultural productivity will be considered acceptable if the crop production from the AVF or cropland is at least 90 percent of the production from the approved standard. Documentation must also be presented that the essential hydrologic functions have been restored, for alluvial valley floors. Vegetation cover and species diversity demonstrations are not applicable to croplands, but are applicable to non-cropland alluvial valley floors.

5. A map or description of topsoil replacement thickness, and replacement documentation methodology. This will be compared to the approved topsoil replacement plan. Some deviation is to be expected, but major differences will be of concern. DMG- collected data documented in bond compliance inspection reports may be substituted for operator-collected data. Pre-fertilizer application fertility sampling results should be reported, if required by the permit.

6. For prime farmlands, adjusted average annual crop production based on at least three cropping years immediately prior to submittal of the application must be demonstrated to be equivalent to, or higher than, the average reference crop yield, pursuant to Rules 3.03.1(2)(b), 3.03.1(3)(b), and 4.25.5(3)(a). Topsoil replacement requirements for prime farmlands as specified in Rule 4.25.4 are also more stringent than for non prime farmland reclaimed areas.

7. The levels of total suspended solids (TSS) contributed by the reclaimed area to runoff or streamflow outside the permit area must be less than or comparable to the pre-mining condition or levels documented for comparable adjacent areas. This condition can be demonstrated:

   a. By representative sampling through the peak of a pond discharge (permanent or temporary impoundments with discharge available), or pond inflow (where there is no available discharge), or

   b. If aberrant, polluting conditions exist in the receiving stream, then compare the peak pond inflow to peak levels of suspended solids as measured off like/adjacent land, or

   c. If sufficient data are available, a comparison using an appropriate predictive model of the suspended solids generated off the pre-mining land or comparable adjacent area, and the reclaimed area during a similar intensity storm event.

8. Documentation that permanent impoundments meet the applicable criteria of Rules 4.05.6 and 4.05.9. This shall include a P.E. certification and discussion of future maintenance.

B. Phase II Bond Release Inspection and Evaluation

Phase II bond release inspections will evaluate the following, in addition to the items listed in Part I, Section I.B.:

1. Topsoil replacement thickness may be checked to verify compliance with the approved plan. More detailed evaluation will be undertaken if replacement thickness has not previously been documented by the Division, or if apparent problems are noted.

2. Vegetative cover and "bare areas." Reclaimed parcels which contain areas substantially devoid of vegetation to an extent not observed on properly managed adjacent lands may warrant additional evaluation as to the possible reasons and implications with respect to the post-mining land use and potential for excessive contribution of suspended solids to streamflow outside the permit area.

3. Species composition will be visually evaluated, and should generally correspond to the sample data presented in the application. Perennial species supportive of the post-mining land use should predominate. If both warm season and cool season grasses are required components, both types of species should be present, as should perennial forbs and shrubs, if those life forms are specified for final reclamation. Completion of any approved revegetation treatments to achieve woody plant establishment or diversity (i.e., seedling transplants, mature transplants, "shrub establishment areas," etc.) will be evaluated.

4. Reestablishment of essential hydrologic functions on AVF's. Evaluation will depend on the nature of the AVF, and the type of disturbance which occurred. In general, factors including proper grading and soil replacement would be inspected. For surface irrigated lands, proper

installation and functioning of ditches, piping, or other water delivery systems would be evaluated. For subirrigated lands, the evaluation would include consideration of vegetative indicators of subirrigation (composition and/or apparent vigor and productivity) as compared to upland reclaimed areas, as well as consideration of seasonal alluvial water quality and depth monitoring data.

5. Erosional features. The presence and extent of rill and gully erosion will be evaluated pursuant to Rules 4.14.6, 4.15.1, and the rill and gully plan contained in the permit. In addition, erosional stability will be visually assessed in comparison to any sediment delivery modelling provided. The presence of erosional features which exceed the regulatory or permit criteria, or which indicate that established vegetation cover has not stabilized the soil surface to achieve erosion control equal to pre-mining levels, will disqualify the parcel from Phase II bond release approval. Repair of rills and gullies of limited areal extent may be allowed, upon approval of the Division, within the first five years of any ten-year liability period without reinitiating the ten-year liability period, pursuant to Rule 4.15.7(5).

6. The condition of the sediment pond or ponds and any needed maintenance. A sample of the pond effluent will be taken if it is discharging.

7. Construction and performance of permanent impoundments.

IV. Phase III Bond Release

A permittee may request Phase III or final bond release no sooner than ten years after initial revegetation, (see Rule 3.02.3) and the successful completion of the reclamation plan except for areas where industrial or commercial post-mining land use are implemented (Rule 4.15.10). With the exception of prime farmland, all revegetation success criteria must be achieved during the last two years of the liability period. One hundred percent of the bond amount can be released and the released area is to be removed from the permit area. For prime farmland, success is demonstrated based on comparison of average crop production data for, at a minimum, the three cropping years immediately prior to bond release application submittal, as set forth in Rule 4.25.5(3).

Final bond release applies to those areas where Phases I and II have been released and it has been a minimum of five years since the last seeding, fertilizing, rill and gully repair or other work has been conducted on the area. Reclaimed sediment pond sites and associated reclaimed temporary diversion and collection ditches must be included in the release request, if the entire disturbed area to which they apply is included. The ten year liability period requirement does not apply to reclaimed sediment control structures, but they are otherwise subject to the same reclamation criteria as adjacent areas. Reclaimed sediment control structure sites should be included in the vegetation sampling "universe" for bond release purposes, and the reclamation of such sites will be qualitatively evaluated along with adjacent reclaimed areas during the bond release inspection.

A. Phase III Bond Release Application

As with Phase II bond release, operators are advised to contact the Division at least three months prior to initiation of any vegetation sampling for bond release. To allow for the bond release inspection and evaluation to occur no later than the first growing season after vegetation sampling is completed, applications should be submitted no later than June 1, of the year following the final year during which vegetation data for final bond release is collected. The Division will accept applications submitted by this date as meeting the requirement of Rule 4.15.7(5), that "...revegetation success criteria...shall be met for at least the last two consecutive years of this period of responsibility." The Division may not be able to determine if revegetation success criteria have been met during the last two consecutive years of the liability period (Rule 4.15.7(5)) if applications are submitted at a later date. Submittal of first year sampling data as soon as it is summarized and evaluated is strongly encouraged. Sampling should be timed to coincide as closely as possible with peak production of the primary reclamation species, and livestock grazing should in no case be allowed to interfere with data collection (i.e., grazing may need to be deferred until after sampling is completed).

The Division will need the following information in the final bond release application:

1. Documentation that the ten-year minimum period of responsibility has been met for all reclamation parcels included in the release application, including a map showing the dates of the original and last seeding, fertilizing, rill and gully repairs or other work conducted on the area. A narrative summary of the reclamation and management history should be included.

2. A map showing the revegetated areas, each year's sampling observation locations, and the reference area(s), if used.

3. With the exception of certain designated categories of land, documentation that the revegetation success criteria as required by Rule 4.15.8 have been achieved for the last two consecutive years. For all lands except those designated as cropland, previously mined lands or areas to be developed for industrial or residential use, or prime farmlands; vegetation cover, herbaceous production, species diversity, seasonality, and woody plant density shall be evaluated as required by the approved permit. An adequate sample of each reclaimed area must be compared to an adequate sample of the approved reference area, or to the standard established in the permit application, for cover, production, and woody plant density, as applicable, using the methods approved in the permit. Data should be presented in tables showing estimates of absolute and relative cover by species and woody plant density by species. Production should be listed by life form (or as otherwise specified in the permit). Absolute cover estimates of rock, litter and bare ground should also be provided.

   The allowable relative cover and production contribution of annual and biennial species should not exceed 10 percent, or the relative cover and production of such species in the associated reference area or standard, whichever is higher. Annual or biennial cover or production in excess of this threshold should be deleted from the reclaimed area data prior to success comparison. An acceptable alternative is to delete

all annual/biennial cover and production from both reference area and reclaimed area data prior to success comparison.

Under no condition will noxious weeds count toward the success standard. The cover and production component provided by noxious weeds should be deleted from both reference and reclaimed area data prior to success comparison for those parameters. Final bond release will be denied if the reclaimed area has not been managed in compliance with the Division's "Guideline for the Management of Noxious Weeds on Coal Mine Permit Areas."

The revegetation section of the release application should include a description of the sampling methods used, success standard comparisons, and statistical procedures (including sample adequacy calculations and statistical tests). Summarized transect cover data (total vegetation cover, and absolute cover by species, rock, soil, and litter, for each transect) and woody plant density data should be included in addition to summary data tables. The revegetation will be considered successful if the criteria of Rule 4.15.8, and the standards set forth in the approved permit, have been achieved. For success comparison and statistical evaluation purposes, the cover and production contribution of any noxious weed species or "excess" annuals and biennials should be discounted (i.e. subtracted from the total for each sample observation) prior to success comparison for cover and production.

Cropland, previously mined lands or areas to be developed for industrial or residential use, and prime farmlands will be evaluated against the standards required by the approved permit. Refer to Rule 4.15.9 for cropland success criteria, 4.15.10 for previously mined lands and areas to be developed for industrial or residential use, and 4.25.5(3) for prime farmlands.

4. A discussion and documentation that the approved post-mining land uses have been achieved. If livestock grazing is a component of the post-mining land use, but grazing has not been conducted during the liability period, the application should include a discussion of the utility of the reclaimed land for livestock grazing (e.g. forage species composition, palatability and productivity, presence of poisonous or noxious plants, livestock access to forage areas, availability of water, etc.). If wildlife habitat is a component of the post-mining land use, the application should include a discussion of the utility of the reclaimed land as wildlife habitat (e.g., suitability for cover, food, winter or summer range, breeding grounds, water resources, etc.).

5. A surface and groundwater quantity and quality impact analysis. This analysis must include an assessment of available hydrology data relative to the impact projections contained within the approved Probable Hydrologic Consequences and the applicable Cumulative Hydrologic Analysis. The analysis must show that onsite impacts have been minimized, and that offsite impacts have been prevented. The analysis must include an evaluation of any impact trends which may exist in the available data.

6. For underground mines, the application should include an analysis of observed versus projected subsidence impacts, and a discussion of how any subsidence caused material damage was prevented or mitigated.

B. Phase III Bond Release Inspection and Evaluation

The final bond release inspection will evaluate the following items, in addition to those listed in Section I.B. To facilitate the inspection, it is suggested that the parcels to which the request applies be boundary flagged or otherwise delineated in the field prior to the inspection.

1. Revegetation success;

2. The functioning of the reclaimed land to serve the post-mining land use;

3. Erosional features; and "bare areas" as discussed for Phase II inspections;

4. Surface and groundwater impacts; and

5. Completion of all reclamation obligations.

## Part 2

## Bond Release Area Delineation

What factors should be considered in determining whether any particular area of reclaimed land can be evaluated as a single entity for bond release? This issue has resulted in frequent misunderstandings and differing interpretations among operators, OSM, and the Division. The Division's recommended approach is outlined herein. Three terms introduced in this section are used throughout the remainder of the document as specifically defined below.

### Terminology

Reclamation Parcel - A more or less contiguous area of uniform land use initially seeded during the same year and season, with the same reclamation practices (topsoil depth, seedmix and seeding/planting technique, fertilization rate, etc.).

Bond Release Block - One or more reclamation parcels comprising the area of land for which a single bond release application is made.

Logical Land Management Unit - An area of land which may include one or more bond release blocks, characterized by uniform land use, and which, due to physical, geographical, or biological characteristics, comprises a single unit with respect to the post-mining land use.

### Bond Release Block Delineation and Approval

Operators are strongly encouraged to submit appropriate reclamation maps depicting bond release blocks and parcels in advance of data collection in conjunction with bond release applications. Parcels should be identified by year of backfilling and grading, or year and season of seeding, as appropriate. These maps, along with any necessary refinement or modification of originally approved sampling plans and methods of statistical analysis, should be submitted for Division review as one of the initial planning steps in the preparation of a bond release application. It is also strongly recommended that the operator consult with affected landowners to consider any concerns or recommendations they might have regarding bond release block delineation and vegetation sampling approaches at this time. Where practicable, it may be logical and appropriate to consider land ownership as a factor in the delineation of bond release blocks.

### Bond Release Block Constraints

Under the approach described here, if the block consists of more than one parcel, the various parcels must together comprise or be contained within a single logical land management unit. Revegetation success standards for woody plant density and species diversity/seasonality should be consistent for different parcels within a bond release block. The weighted reference area comparison for cover and production described in Rule 4.15.7(4)(b) is in no way precluded by the approach outlined in this document, and such weighted area comparison is appropriate regardless of whether the block consists of one parcel or multiple parcels.

Watershed and drainage reestablishment considerations also enter into the delineation of bond release blocks. Reestablished drainage channels cannot be evaluated in isolation from their contributing watersheds. In most cases, reconstructed drainage channel segments will not be approved for final bond release until upstream portions of the channel have been completed, and upland portions of the watershed have been effectively reclaimed and stabilized, with all elements of the permanent drainage system in place.

Coal refuse piles for which reclamation practices (depth of cover material and/or topsoil) or topographic (slope or aspect) or physical characteristics (physical or chemical makeup) differ significantly from other reclaimed areas may need to be treated as separate reclamation blocks. Operators are encouraged to discuss sampling plans for coal refuse piles with the Division prior to sampling.

**Logical Land Management Units**

The definition of logical land management unit will vary depending on the land use and regionally accepted management practices. In general, for cropland, a management unit would be equivalent to a single "field" planted to a particular crop, defined by ownership boundaries, and natural or artificial barriers. For rangeland or pastureland, a management unit would generally consist of a single "pasture" or a small number of pastures utilized within a defined grazing system, delimited by natural or artificial barriers to livestock movement. For wildlife habitat, the definition of a logical unit would be based on habitat requirements and use patterns of the wildlife species of primary concern.

**Exclusion of Areas from Bond Release Blocks**

When approved by the Division pursuant to Rule 3.02.3(2)(d), a reclamation parcel or distinguishable and contiguous portion of a parcel requiring reinitiation of liability due to augmentation may be separated from a bond release block. A reinitiated liability period may be applied to such isolated and clearly defined areas while bond release for other portions of a bond release block is considered. Any such areas to be excluded from consideration for bond release need to be clearly identified in the bond release application and in subsequent Annual Reclamation Reports submitted to the Division. Scattered or intermittent areas of failed reclamation within a bond release parcel will not be excluded from consideration of bond release within a bond release block. When such areas exist, the entire reclamation parcel would be excluded from the bond release block under consideration.

When parcels are excluded from a bond release, those parcels shall be specifically discussed in the Division's findings regarding bond release. If a reinitiated liability period is required for the excluded area due to augmentive seeding or other work, the time frames of that extended period and the dollar amounts of liability associated with the excluded area shall be outlined in the Division's bond release findings.

## Part 3

## Vegetation Sampling Methods, Considerations and Design Approaches

Acceptable sampling techniques are set forth in the Division's "Guidelines for Compliance with Land Use and Vegetation Requirements of the Colorado Mined Land Reclamation Board for Coal Mining." Vegetation sampling methods are more comprehensively addressed in publications referenced in that document. More recent texts which review vegetation sampling methods include Cook and Stubbendieck (1986), and Bonham (1989). Sampling techniques will not be addressed in detail in this document. It is anticipated that the sampling technique section of the above referenced guidelines will be revised to some extent in conjunction with regulatory amendments during 1995.

Vegetation sampling design approaches acceptable to the Division include simple random sampling, and stratified random design modifications including proportional allocation and area weighted sampling. Although not addressed in detail in this document, multi-stage, or cluster sampling and systematic designs as discussed below may be adaptable to certain reclamation situations, and may meet regulatory requirements when design assumptions are met and specified procedures are followed. Double sampling approaches are not recommended by the Division.

The difficulty of attaining sample adequacy for woody plant density on reclaimed lands has been recognized as a significant concern by coal operators and the Division. Regulation changes which would provide additional options for statistical testing and sample adequacy determination are currently under consideration. Until the regulation changes are approved, operators are advised to give careful consideration to sampling approaches which minimize variation among sample observations. Such approaches might include within-parcel stratification and acreage weighting, if there is apparent variation in density on different sites within the parcel, and the use of longer than normal belt transects. Multistage or cluster sampling has also been suggested as an approach which might be of use in this respect. Cluster sampling and associated statistical techniques are described in Steel and Torrie (1980), and Cochran (1977).

In certain situations in which long belt transects are employed, systematic sampling may be more efficient than random sampling. In this approach, equidistant parallel transects would need to be run from boundary to boundary of the reclamation parcel or stratum (if the parcel is stratified into sub-areas for sampling purposes). Data summarization will be somewhat complicated in comparison to random sampling by the need to proportionally weight sampling units (belt transects) of unequal length which will result from irregularly shaped reclamation parcels or strata. If sample adequacy is not achieved initially, a complete additional set of systematic transects must be run, with an additional transect placed between each of the original transects, and this process is repeated until adequacy is achieved.

**Simple random sampling** results in data which satisfies the assumptions of parametric statistical theory. The sample design and statistical evaluation of the data is uncomplicated. The basic procedure, as applied to bond release sampling, requires the placement of a grid over a map encompassing the entire bond release block. Grid coordinates derived from sequential random numbers, which fall within the boundaries of the bond release block are selected as sample observation points, and marked on the map, numbered in the order that they were selected. In the field, sample observations are taken in the order that they were selected, until statistical sample adequacy is achieved. Observation points are located in the field by the use of a compass and pacing, along with some consistent procedure to insure unbiased placement (blind toss of a quadrat frame, for example) and transect orientation (random compass bearing). If an insufficient number of sample observation points were selected initially, the random selection procedure is repeated until sample adequacy is achieved. Parametric sample adequacy formulas recommended by the Division are set forth in Part 4 of this document.

Drawbacks associated with simple random sampling are that, in some situations it may be less efficient than a stratified design, and further, the completely random selection of sample observation points may result in a distribution in which the observations are not dispersed uniformly throughout the block in a manner which appears to be "representative." In instances where the distribution of sample observation points is skewed to such an extreme that the block as a whole is not adequately represented, additional sampling may be warranted.

**Proportional allocation** and acreage-weighted sampling are both stratified random designs which may be more efficient than simple random sampling in certain situations, and they provide a degree of assurance that designated strata will be representatively reflected in the data. A bond release block might be stratified on the basis of individual reclamation parcels or observed differences in "vegetation type" on different ecological sites within the block.

In proportional allocation, at least one sample observation is randomly located within each designated stratum, with the number of observations allocated to any particular stratum proportional to the percentage of the total bond release block acreage contributed by that stratum. The technique is self weighting, and thus for statistical purposes, the data for the entire block can be treated as if from a simple random design, and the sample mean, median, standard deviation, and degrees of freedom can be calculated, and sample adequacy can be evaluated, accordingly. If statistical sample adequacy is not achieved from the sample observations initially selected, some additional number of observations are allocated proportionally within the designated strata, and this process is repeated until adequacy is achieved. The implementation of this procedure is somewhat more complicated and subject to error which could bias the sample than simple random sampling, but if properly conducted it is a valid approach, and statistical evaluation is identical to simple random sampling. The proportional allocation design becomes relatively less efficient as the difference in acreage between the largest and smallest stratum within a bond release block increases, and as the differences among individual stratum sample mean values increase.

Therefore, the proportional allocation design is best suited to bond release blocks containing reclamation parcels or other designated strata which are of similar acreage, and where the differences among sample means are relatively small.

In **acreage-weighted sampling**, sample observations are randomly located within each designated stratum, and a sufficient sample size is obtained to achieve sample adequacy within each stratum. An acreage-weighted sample mean is calculated for the entire bond release block, based on the individual stratum sample means and their associated acreages. In order to perform statistical testing, it is necessary to calculate the standard error of the weighted sample mean as explained in the section on Statistical Testing for Demonstrations of Revegetation Success. Degrees of freedom for the individual strata are summed to obtain degrees of freedom for the weighted mean. In addition, acreage-weighted relative cover or production means for each species must be calculated to obtain species composition summary information for the entire bond release block. The approach described here for acreage-weighted sampling within the reclaimed area is essentially the same approach which is applied to the sampling of multiple reference areas to obtain a weighted average reference area standard pursuant to Rule 4.15.7(4)(b).

The acreage-weighted approach would be well suited to the situation in which the reclaimed area is essentially a grassland with scattered shrub establishment areas or mature transplant habitat "islands." If separate success standards have not been established for the two vegetation types, the scattered shrub habitat areas could be mapped and combined into a single "shrub habitat stratum" within the same bond release block as the grassland. The acreage-weighted approach, in this instance, might allow for the attainment of sample adequacy for the entire block with a smaller sample size than would the simple random or proportional allocation approach. Conversely, if success standards specific to each vegetation type have been established, the shrub habitat stratum would logically be mapped and sampled as a separate bond release block, distinct from the bond release block which would include only the grassland areas. In this situation, simple random sampling or proportional allocation might be more efficient.

Disadvantages of the acreage-weighted approach include the increased complexity of data reduction and statistical evaluation, and the problems of meeting sample adequacy and physically fitting a sufficient number of transects or quadrats into small parcels.

Situations may arise on occasion for which typical sampling approaches do not seem to fit. Examples might include isolated linear disturbances or multiple small disturbed sites scattered over a large area (e.g., exploratory drill sites). Site-specific modifications in sample design or technique may be warranted in such cases, and operators are encouraged to discuss proposed approaches with the Division prior to initiation of sampling.

## Part 4

## Statistical Testing for Demonstrations of Revegetation Success

For Phase III bond release on lands other than prime farmland, revegetation success for cover, production, or woody plant density is typically demonstrated when the parameter population mean for the bond release block is demonstrated to be not less than 90 percent of the approved standard, at the 90 percent statistical confidence level (alpha error probability = .10, for a one-tailed confidence interval) for two consecutive years. The mean (average) is the measure of central tendency which is used in parametric statistical testing commonly associated with tests of revegetation success and illustrated in the examples which follow. The approved standard might be the sample mean for a single reference area, a weighted reference area sample mean, or a technical standard approved by the Division. The two consecutive years for which data must be collected may not commence prior to the 9th growing season of the most recently seeded reclamation parcel included in a bond release block.

If the parameter sample mean for the bond release block is equal to or greater than 90 percent of the reference area or weighted reference area sample mean, or 90 percent of the approved technical standard, revegetation is considered successful for the parameter. Other than a demonstration of adequate sample size, no statistical calculations are required in this case to document success. If the parameter sample mean for the bond release block is less than 90 percent of the standard, an operator may employ hypothesis testing to demonstrate that the difference is not statistically significant.

For both reference area and technical standard comparisons, one-sample hypothesis tests are appropriate statistical tests of revegetation success. This is because the Division considers the reference area sample mean to be the "standard." An alternative approach would be to compare the reclaimed sample data to the reference area sample data in a two-sample hypothesis test, allowing for a confidence interval around the reference area sample mean. This approach would also be acceptable, but two sample hypothesis testing is considerably more complex, and may require the use of a test for equality of variances to determine whether a pooled variance is appropriate or whether some approximation must be employed to determine appropriate degrees of freedom. When either the reference area or the reclaimed area sampling involves stratification and acreage weighting, the variance terms can become rather complicated. The one-sample T-test is the parametric hypothesis test recommended by the Division, and demonstrated in the examples.

Due to the typically irregular distribution of shrubs on many reclaimed areas, non-normal data distributions may often result from woody plant density sampling, and the statistical procedures set forth in this document may be less efficient than alternative approaches which are not based on the assumption of normality. The median (mid-point value) is a more robust measure of central tendency (less influenced by extreme data values) than the mean and is used in non-parametric statistical testing. Use of the median and non-parametric statistical methods would appear to have potential as an alternative to parametric methods with respect to woody plant density sampling. Nonparametric statistical tests are described in Steel and Torrie (1980), Gilbert (1987), and Helsel and Hirsch (1992), but widely accepted sample adequacy approaches apparently are not available. For this reason, the Division is not currently recommending the use of non-parametric methods, but we are researching this issue, and regulation changes which would provide additional options for woody plant density success demonstrations and sample adequacy determinations are under consideration.

Provided below and on the following pages are the sample size adequacy approaches recommended by the Division along with the one-sample T-test and example data sets.

### Hypothesis Testing Based Sample Size Formula for Reclaimed Areas

The parametric sample size formula recommended by the Division for reclaimed area sampling when success demonstration requires hypothesis testing (i.e. when the sample mean is less than the standard) is distinct from the formula recommended when hypothesis testing is not required. The hypothesis test based formula incorporates both an alpha and a beta error probability factor and the concept of statistical power, so as to insure that sample size will be sufficient to allow for the detection of a difference between the reclaimed area parameter mean and the standard, when such difference does exist. The null hypothesis assumes there is no difference between the parameter being sampled on the reclaimed area and the same parameter in the reference area or technical standard.

The recommended formula for this instance is from Kupper and Hafner (1989). The concept of statistical power with respect to sample size determination pertinent to testing for differences is also discussed in Steel and Torrie (1980), p. 113 through 119.

$$N_m = \frac{(t_a + t_b)^2 (S^2)}{(d\ Q)^2}$$

*where:*

$s^2$ = Sample variance

$d$ = Desired level of precision (.1 for our purposes)

$Q$ = 90% of reference area sample mean, or 90% of technical standard

$t_a$ = the ($\alpha$ = .10) t table value for a single tailed t-test, with (n - 1) degrees of freedom

$t_b$ = the ($\alpha$ = .25) t table value for a single tailed t-test

Ames (1993) provides additional discussion regarding the differences between testing hypotheses and estimating parameters with respect to appropriate sample size determination. Ames in fact suggests that a more straightforward interpretation of the regulatory requirement would lead to a reversal of the null hypothesis, thus placing the burden on the operator to demonstrate success by rejection of the null hypothesis. This is a reversal of the standard approach in which the null hypothesis assumes that there is no difference between the parameter being sampled in the reclaimed area and the same parameter being sampled in the reference area or technical standard.

The "reverse null" approach would generally be viewed as more stringent than current OSM or State regulatory agency interpretations, but the logic of the argument reinforces the need for inclusion of a statistical power factor in the sample adequacy formula when hypothesis testing is employed. Theoretically, a beta error probability of .25 in the formula would insure that a reclaimed area true mean which falls just below the standard would result in proper rejection of the null hypothesis of equality at least 75 percent of the time. Conversely, the alpha error probability of .1 theoretically insures that a reclaimed area true mean which is exactly equal to the standard would result in proper failure to reject the null hypothesis at least 90 percent of the time.

**Sample Size Formula for Reference Areas and Reclaimed Area Parameter Estimation without Hypothesis Testing**

For reference area sampling, or reclaimed area sampling when parameter estimation is sufficient and hypothesis testing is not employed, the following sample size formula is recommended:

$$N_m = \frac{t^2 s^2}{(d\ \bar{x}\ )^2}$$

*where*:

$s^2$ = Sample variance

*d* = Precision (.10)

$\bar{x}$ = Sample mean

*t* = The ($\alpha$ = .10) t-table value for a single tailed t-test with (n - 1) degrees of freedom

Regardless of which formula is used, a minimum of 15 to 20 sample observations is recommended for each reference area, bond release block or designated stratum (in the case of acreage weighted sampling), depending on the size of the block or stratum, even if statistical sample adequacy is achieved with fewer samples.

**One-Sample T-Tests**

$$t_c = \frac{Q - \bar{x}}{s_{\bar{x}}}$$

The general form of a one-sample T-Test is as follows:

$Q = 90\%$ of the standard

$\bar{x}$ = Bond release block sample mean

$s_{\bar{x}}$ = Standard error of the mean ($s / \sqrt{n}$)

$s$ = Sample standard deviation

$n$ = Sample size

$t_c$ = Calculated t value

*where:*

The null hypothesis being tested is that the bond release block mean (u) is greater than or equal to 90% of the standard, and can be stated as $H_0$: $u \geq Q$.

If $t_c$ is less than or equal to the 1-tailed t table value for alpha error probability of .10, at the appropriate degrees of freedom, then $H_0$ is not rejected, and revegetation is deemed successful for the parameter tested.

**Example 1**
**Technical Standard or Simple Reference Area Comparison**
**Simple Random or Proportional Allocation in Bond Release Block**

In the example data set below, the cover data for the bond release block could have been derived from either a simple random sample or from sample observations proportionally allocated within two or more relatively homogenous reclamation parcels. The standard of comparison could be either a technical standard or a single reference area sample mean. The standard is assumed to be 70 percent.

| Sample No. | Bond Release Block Percent Cover | Sample No. | Bond Release Block Percent Cover |
|---|---|---|---|
| 1 | 78 | 9 | 68 |
| 2 | 52 | 10 | 62 |
| 3 | 64 | 11 | 62 |
| 4 | 60 | 12 | 74 |
| 5 | 74 | 13 | 52 |
| 6 | 64 | 14 | 64 |
| 7 | 56 | 15 | 38 |
| 8 | 50 | 16 | 66 |
| | | 17 | 56 |

$\bar{x}$ = 61.20
$s$ = 9.98
$s^2$ = 99.53
$s_{\bar{x}}$ = 2.42
$n$ = 17
$n_{min}$ = 11*

**T-Test**

$$t_c = \frac{Q - \bar{x}}{s_{\bar{x}}} = \frac{63.0 - 61.2}{2.42}$$

$$t_c = .74$$

$$t_t \ [\alpha = .10, n-1 \text{ d. f. }] = 1.337$$

Since .74 ≤ 1.337, $H_0$ is not rejected; the conclusion is that reclaimed area cover is not less than 90% of the standard.

* Required sample size for Hypothesis testing based sample size formula

**Example 2**
**Technical Standard or Simple Reference Area Comparison**
**Weighted Sampling in Bond Release Block**

In the example data set below, the cover data for the bond release block was derived from acreage-weighted sampling within two separate reclamation parcels. The standard remains 70 percent, and as in the first example, could be either a technical standard or a single reference area sample mean.

| Parcel A = 40 Acres | | Parcel B = 11 Acres | |
|---|---|---|---|
| Sample No. | % Cover | Sample No. | % Cover |
| 1 | 52 | 1 | 78 |
| 2 | 64 | 2 | 66 |
| 3 | 38 | 3 | 74 |
| 4 | 60 | 4 | 74 |
| 5 | 48 | 5 | 62 |
| 6 | 52 | 6 | 68 |
| 7 | 56 | 7 | 76 |
| 8 | 68 | | |
| 9 | 50 | | |
| 10 | 58 | | |
| $\bar{x}$ = | 54.60 | $\bar{x}$ = | 71.10 |
| s = | 8.59 | s = | 5.87 |
| $s^2$ = | 73.82 | $s^2$ = | 34.48 |
| $s_{\bar{x}}$ = | 2.72 | $s_{\bar{x}}$ = | 2.22 |
| n = | 10 | n = | 7 |
| $n_m$ = | 8 | $n_m$ = | 4 |

**Acreage-Weighted Bond Release Block Statistics**

Weighted Sample Mean ($\bar{x}$) = 40/51 (54.6) + 11/51 (71.1) = 58.2

Standard Error of Weighted Sample Mean ($s_{\bar{x}}$) =

$$\sqrt{\left(\frac{40}{51}\right)^2 \text{x} \frac{s_a^2}{n_a} + \left(\frac{11}{51}\right)^2 \text{x} \frac{s_b^2}{n_b}} = \sqrt{4.81} = 2.19$$

Sample Size (n) = 17

Degrees of Freedom (d.f.) = (10-1) + (7-1) = 15*

*Degrees of freedom = (n - 2) because the weighted mean was derived from two individual parcel sample means. One degree of freedom is lost for each additional sample mean which contributes to a weighted mean.

T-Test

$$t_c = \frac{Q - \bar{x}}{s_{\bar{x}}} = \frac{63.0 - 58.2}{2.19} = 2.19$$

$$t_t \; [\; \alpha = .10, (n - 2)\, d.\, f.\; ] = 1.341$$

Since **2.19** > 1.341, $H_0$ is rejected, and the conclusion is that the bond release block cover is less than 90% of the approved standard.

**Example 3**
**Acreage Weighted Reference Area Comparison**
**Acreage Weighting in Bond Release Block**

This example uses the acreage-weighted sampling data for the bond release block from Example 2. The weighted reference area standard against which the bond release block is compared is obtained from the acreage-weighted summation of sample means from three separate reference areas, representative of vegetation types "J," "K," and "L," and comprised of 25, 16, and 10 acres respectively.

| Reference Area J | | Reference Area K | | Reference Area L | |
|---|---|---|---|---|---|
| Sample No. | % Cover | Sample No. | % Cover | Sample No. | % Cover |
| 1 | 70 | 1 | 48 | 1 | 82 |
| 2 | 74 | 2 | 72 | 2 | 76 |
| 3 | 72 | 3 | 70 | 3 | 84 |
| 4 | 68 | 4 | 64 | 4 | 86 |
| 5 | 78 | 5 | 58 | 5 | 82 |
| 6 | 70 | 6 | 50 | 6 | 86 |
| 7 | 70 | 7 | 76 | 7 | 82 |
| 8 | 66 | 8 | 70 | | |
| 9 | 80 | 9 | 62 | | |
| 10 | 70 | 10 | 62 | | |
| | | 11 | 48 | | |
| | | 12 | 70 | | |
| | | 13 | 68 | | |
| | | 14 | 74 | | |
| $\bar{x}$ = | 71.80 | $\bar{x}$ = | 63.70 | $\bar{x}$ = | 82.60 |
| $s$ = | 4.40 | $s$ = | 9.50 | $s$ = | 3.40 |
| $s^2$ = | 19.10 | $s^2$ = | 91.00 | $s^2$ = | 11.00 |
| $n$ = | 10 | $n$ = | 14 | $n$ = | 7 |
| $n_m$* = | 1 | $n_m$* = | 4 | $n_m$* = | 1 |
| $s_{\bar{x}}$ = | 1.39 | $s_{\bar{x}}$ = | 2.54 | $s_{\bar{x}}$ = | 1.29 |

* Required sample size for Parameter Estimation without hypothesis testing.

| Bond Release Block Statistics | Weighted Reference Area Statistics |
|---|---|
| $\bar{x}_b$ = 58.2<br>$(s_{\bar{x}})$ = 2.19<br>$n_b$ = 17.0<br>d.f. = 15.0 | $\bar{x}_q$ = 25/51 (71.8) + 16/51 (63.7) + 10/51 (82.6) = 71.4 |

**T-Test**

$$t_c = \frac{Q^* - \bar{x}_b}{s_{\bar{x}_b}} = \frac{64.26 - 58.20}{2.19} = 2.77$$

$$t_t\,[\alpha = .10, 15\ d.f.] = 1.341$$

Since 2.77 > 1.341, $H_0$ is rejected and the conclusion is that the bond release block cover is less than 90% of the approved standard.

* $Q = \bar{x}_q \times .9 = 64.26$

## Part 5

## Hydrologic Considerations

### Sediment Demonstrations

Evaluation of reclaimed areas with respect to suspended solids demonstrations generally will entail modelling, or a combination of modelling and site specific runoff and sedimentation data for specific reclaimed watersheds within each bond release block. In some cases, such demonstrations may be required for multiple subwatersheds within a single reclamation parcel. As with vegetation, suspended solids demonstration methodologies, sampling locations, and standards should be established during the permitting process, and refined, if necessary prior to Phase II or Phase III bond release submittal. Sedimentation and runoff modelling for specific subwatersheds must be based on site specific ground cover data, soils, and slope conditions for the subwatershed of concern. Ground cover estimates (vegetation, rock, and litter) should be obtained using the sampling approaches recommended in this document.

Erosional stability will be evaluated by the Division during Phase II and Phase III bond release inspections. In order to minimize conflicts with regard to what constitutes "excessive erosion" with respect to the extent of rilling and gullying and the size of individual gullies, it is important that this issue be addressed with sufficient specificity in the rill and gully control plan contained in the permit application.

Sediment demonstration methodologies and erosional stability evaluation considerations applicable to each bond release phase will vary depending upon site-specific conditions. Operators are encouraged to develop a site-specific sediment delivery demonstration methodology in consultation with the Division, prior to implementation of any field or modelling studies. The extent to which temporary drainage and sediment control measures (e.g., diversions, check dams, sediment ponds, etc.) are allowed to contribute to such evaluations for each bond release phase will be determined on a site-specific basis. In general, the Division interprets the Rules to require increasing reliance on permanent topographic features and vegetation, and less reliance on temporary measures with succeeding bond release phases. To a large extent, temporary stabilization and sediment control measures should be unnecessary for reclaimed areas which qualify for Phase II release, and all such measures must be eliminated prior to Phase III release.

### Water Quantity and Quality Impacts

The Phase III bond release application must include a detailed water quantity and quality impact analysis to assess compliance with 4.05. This analysis will provide a summary of existing surface and groundwater data for the mine and adjacent areas. Adequate monitoring facilities must remain in place and functional through the bond liability period to ensure that this requirement can be met.

The submitted analysis and subsequent review will evaluate whether onsite impacts have been minimized to the extent predicted in the approved Probable Hydrologic Consequences section of the permit. The analysis will also evaluate whether offsite impacts and material damage have been prevented in accordance with the approved Probable Hydrologic Consequences section and existing Cumulative Hydrologic Impact Analysis.
Groundwater, spoil aquifer and surface water impacts will be considered within the context of site-specific hydrologic units. These units will not typically coincide with bond release blocks as defined above.

Trends which may be apparent in the monitoring data must be assessed. Spoil aquifer and other groundwater impact predictions typically encompass time periods much longer than 10 years. Accordingly, impact analysis will focus on trends which would support or refute long-term stability in quantity and quality data. Bond release might be delayed if the surface or groundwater quality data indicate trends towards hydrologic balance degradation.

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