

**NORTH DAKOTA  
PUBLIC SERVICE COMMISSION**

**RECLAMATION DIVISION**

**STANDARDS FOR EVALUATION OF  
REVEGETATION SUCCESS  
AND  
RECOMMENDED PROCEDURES  
FOR  
PRE- AND POSTMINING  
VEGETATION ASSESSMENTS**

**REVISED MARCH 2022**

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## GENERAL NOTATIONS

### Abbreviations

PSC	ND Public Service Commission
OSM	US Dept. of Interior (USDI), Office of Surface Mining and Regulation
NRCS	US Dept. of Agriculture (USDA), Natural Resources Conservation Service [formerly known as the Soil Conservation Service (SCS)]
FR	Federal Register
USFWS	US Fish and Wildlife Service
ARS	USDA, Agricultural Research Service
NDCC	ND Century Code
SMCRA	Federal Surface Mining Control and Reclamation Act
NDASS	ND Agricultural Statistic Service
NDAC	ND Administrative Code
LRA	Land Resource Area as defined by the NRCS
GPS	Global Positioning System

### Mathematical Symbols

CF	Climatic correction factor
PI	NRCS Productivity Index for a soil series based on a rating of 1 to 100
X <sub>AD</sub>	Adjusted yield standard (bu/ac, t/ac, lbs/ac, etc)
X <sub>UA</sub>	Unadjusted yield standard developed using NRCS PI values
X <sub>C</sub>	Annual county small grain yield as reported by NDASS
X <sub>CLT</sub>	Long term average (minimum 15 years) NDASS hayland yield
X <sub>PI</sub>	NRCS PI average county yield for cropland or a minimum of an average of the last 15 years of the NDASS-reported hayland yields
X <sub>est</sub>	Estimated annual county yield using NDASS-reported X <sub>C</sub> and correcting for the prior year's management of either fallow or continuous cropping
X <sub>ca</sub>	Control area yield
X <sub>cw</sub>	Unadjusted control area standard yield developed using NRCS PI values
PR	Productivity ratio found by dividing X <sub>UA</sub> by X <sub>PI</sub>
s	Sample standard deviation [various subscripts denote weighting (w), sampling strata (h), etc.]
s <sup>2</sup>	Sample variance (subscripts denote the same indicator as for standard deviations)
	Indicates the absolute value (always positive) should be used
√	Indicates a square root should be calculated
t <sub>calc</sub>	Calculated Student's t value
d.f.	Degrees of freedom
n	Number of samples used to calculate a mean, etc.
t	Student's t distribution value for a given level of confidence
d	Arbitrary level of accuracy desired (i.e. 10% of a sample mean)
p	Percent surface cover

$q$	Percent bare ground or $100-p$
SEM	Standard error of the mean
$x_i$	Individual sample value
$\bar{x}$	Sample mean [subscripts denote sampling grouping (i.e. 1, 2), strata (h), weighting (w), etc.]
$h$	Levels of strata in a stratified sampling system
$N_h$	Number of sampling units (i.e. acres) in the $h^{\text{th}}$ stratum where $N$ equals the total number of sampling units
$W_h$	Proportion of sampling units in the $h^{\text{th}}$ stratum
$\Sigma$	Indicates a summation of values

**I. OBJECTIVES OF STANDARDS AND PROCEDURES AND  
OVERVIEW OF REGULATORY REQUIREMENTS**

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## A. INTRODUCTION

This policy document contains requirements and standards for evaluating revegetation success and recommended procedures for vegetation sampling and data analysis. These standards and procedures are approved by the North Dakota Public Service Commission (PSC) and the Office of Surface Mining (OSM) for use by surface coal mining companies operating in North Dakota. Use of standards or sampling procedures other than those contained herein will require prior approval by PSC and OSM. However, standards and sampling procedures previously approved by the PSC will not be affected by this policy document, unless mid-term reviews or permit renewal reviews indicate they are inconsistent with the standards and procedures contained in this document.

The standards and sampling procedures have been developed using research conducted by Cook and Bonham (1977), Chambers and Brown (1983), Hofmann et al. (1983), Ries and Hofmann (1984), Natural Resources Conservation Service (NRCS) which was formerly known as the Soil Conservation Service (SCS) (2012, 2004, 2000, 1997, 1988, 1987a, 1987b, 1984a, 1984b, 1982, 1979, 1976, 1975a, 1975b, and 1974), Van Dyne et al. (1984), and others (see Bibliography). This research has been combined with the professional experience of PSC staff, industry representatives, and state and federal scientists and resource managers.

Several agencies were consulted in the development of the standards and methods used in this document. Standards for fish and wildlife habitat were developed in consultation with the North Dakota Game and Fish Department, U.S. Fish and Wildlife Service (USFWS), and staff at North Dakota State University. The NRCS was consulted in the development of standards for prime farmland, cropland, native grassland, tame pastureland, woodlands, and shelterbelts. The USDA-Agricultural Research Service (ARS) was consulted in the development of standards and methods used for native grassland and tame pastureland. In developing these guidelines, a concerted effort has been made to incorporate recent developments in reclamation technology and innovative methods of evaluation of reclamation success. This effort will continue with future research and technological development.

## B. OBJECTIVES

The objectives of this document are twofold. First, this document provides requirements and approved standards for assessing revegetation success for bond releases (Chapter II). These standards, and their associated pre- and postmining data requirements, have been approved by both the PSC and OSM, as part of the state's regulatory program. Therefore, the use of these standards by mining companies will require no further approval by the PSC or OSM. However, specific standards to be used by the operator must be included in the approved mining permit. If a mining company proposes to use standards other than those contained in this document, these will require prior approval by the PSC and OSM, on a case-by-case basis.

Second, this document provides recommended procedures for sampling, measurement, and statistical analysis of vegetation parameters (Chapter III). Their use will ensure consistent and objective collection and analysis of vegetation data. Mining companies may propose alternative procedures for sampling and data analysis, but their use will require prior approval by the PSC and OSM.

The standards and the sampling and statistical procedures for various land use categories contained in this document apply to all areas where mining activities occurred after July 1, 1979. Assessment of revegetation success for lands mined between July 1, 1979 and August 1, 1980, may be made in any two years of the ten-year responsibility period. The requirement that revegetation assessment must be made in the last two growing seasons came into effect on August 1, 1980 and that rule was in effect until April 1, 2007. The PSC adopted rules changes effective April 1, 2007, allow mining companies to demonstrate that standards have been met using any two years of data collected after year six of the responsibility period. However, final bond release cannot be granted until the ten-year responsibility period has elapsed.

For lands where mining activities occurred between May 3, 1978 and July 1, 1979, the standards and sampling and statistical procedures need to be applied for the assessment of cover and productivity. For lands where mining activities occurred between July 1, 1975 and May 3, 1978, only productivity standards are required to be met, without any statistical requirements.

### C. REGULATORY REQUIREMENTS

The current regulatory requirements for revegetation of surface mined lands in North Dakota are based on the environmental protection performance standards contained in Subsections 17 and 18 of North Dakota Century Code (NDCC) Section 38-14.1-24, which went into effect on July 1, 1979. With the exception of some changes in the wording, these Subsections have remained, in essence, unchanged since 1979, and in their latest revised form they mandate the following:

#### **NDCC 38-14.1-24(17)**

Restore lands affected by the surface coal mining operation which have been designated for postmining agricultural purposes to the level of productivity equal to or greater than non-mined agricultural lands of similar soil types in the surrounding area, under equivalent management practices. For those lands which are to be rehabilitated to native grasslands, a diverse, effective and permanent vegetative cover shall be established of the same seasonal variety native to the area to be affected and capable of self-regeneration, plant succession, and at least equal in extent of cover and productivity to the natural vegetation of the area. The level of productivity and cover attained on disturbed lands within the permit area shall be demonstrated by the permittee using comparisons with similar lands in the surrounding area having equivalent historical management practices and that are undisturbed by mining, or comparable disruptive activities.

#### **NDCC 38-14.1-24(18)**

Assume the responsibility for successful revegetation, as required by subsection 17, for a period of ten full years after the last year of augmented seeding, fertilizing, irrigation, or other work, provided that, when the commission approves a long-term intensive agricultural postmining land use, the ten-year period of responsibility for revegetation shall commence at the date of initial planting. However, for previously mined areas that are affected by remining, the operator's responsibility for successful revegetation will extend for a period of five full years after the last year of augmented seeding, fertilizing, irrigation, and other work in order to assure compliance with the applicable standards. For the purposes of this subsection, "previously mined areas" are lands that were affected by coal mining activities prior to January 1, 1970, and "augmented seeding, fertilizing, irrigation, or other work" does not include normal conservation practices recognized locally as good management for the postmining land use. (Conservation and management practices that may or may not reinitiate the 10-year liability period are discussed in Appendix A.)

The above-mentioned Subsections of North Dakota laws are in conformity with Subsections 515(b)(19) and 515(b)(20) of the Surface Mining Control and Reclamation Act (SMCRA) that went into effect on August 3, 1977. In fact, the North Dakota law exceeds in its scope the Federal law in that it is explicit with respect to the restoration of productivity, whereas the Federal law makes no mention of it. Productivity requirements are, however, addressed in Federal regulations, but the level of stringency does not match that of North Dakota requirements



because the Federal regulations require at minimum 90% equivalency (except for prime farmlands), whereas North Dakota rules require 100% equivalency between the reclaimed area and the reference area or yield standard. The same difference between Federal and North Dakota rules exists for cover requirements.

The rules that address the current regulatory requirements for pre- and postmining vegetation inventories and procedures for assessment of revegetation success for areas that were disturbed by mining activities after July 1, 1979, are discussed in subsequent sections. For areas disturbed prior to July 1, 1979, the applicable revegetation requirements are summarized in Appendix B.

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<sup>1</sup>*Detailed contents are found at the beginning of each section.*

## A. INTRODUCTION

This section contains procedures for collecting and submitting pre- and postmining vegetation information and describes the standards that must be used in demonstrating the success of revegetation for different land use categories. The procedures for vegetation assessment include those mandated by the North Dakota law and rules as well as those recommended for the correct application of the approved success standards. Some of these procedures may not apply if other acceptable assessment methods or standards are used.

The revegetation success standards described for different land use categories are based on both reference area and technical standard concepts. The premises and general assumptions made in developing these success standards are:

1. That in establishing the success standards for revegetation “[SMCRA] specifically focuses on the extent of the cover of the natural vegetation in the general area and not on the premining productivity levels of the specific mined areas” (48FR, 40142), while North Dakota Law (NDCC) mandates that the productivity of the reclaimed lands must be equal to or greater than that of the similar soil types in the surrounding areas under equivalent management;
2. That both Federal and North Dakota rules permit the use of USDA or USDI or other available data for the development of standards that reflect the capability of local soils and the influence of climatic conditions;
3. That Federal rules allow the use of appropriately developed or derived variable standards based on average county yields by soil types (48FR, 40151);
4. That Federal rules allow the use of average county yields adjusted for local yield variations for the evaluation of revegetation success on prime farmlands (48FR, 21460); and,
5. That OSM recognizes that it is the States' obligation to develop, identify, and use the success standards which are appropriate for the conditions existing in each state (48FR, 40152).

## **B. DATA SOURCES FOR DEVELOPMENT OF STANDARDS**

The data sources used to develop the revegetation success standards contained in this document were chosen on the basis of the land uses involved. Standards for woodland and fish and wildlife land uses were developed using recommendations of Federal and State agencies along with other requirements specific to those land uses.

Standards for cropland, tame pastureland, and native grassland are based on agricultural data sources, including reference areas on surrounding lands and published technical data. These data sources are used to represent mapping units (e.g., soil series, soil mapping units, range sites/ecological sites) that existed in the reclaimed tracts prior to mining. This enables evaluation of reclaimed tracts by comparison with their premining characteristics and the characteristics of similar lands in the area. Because technical data usually consist of long-term averages or estimates, their use requires correction for annual climatic variations. Several climatic correction methods are provided which include the use of selective reference or control areas, and annual county yield averages.

The data sources used are briefly discussed below.

### **Reference Areas**

Data from reference areas can be used for direct comparisons with the reclaimed tract when all premining mapping units, which existed in the tract are represented by reference areas. A direct comparison also can be made if one reference area has been established on a mapping unit that represents the entire reclaimed tract. However, if reference areas are established for only some of the premining mapping units, then the other units must be represented by published technical data. Data collected from these reference areas must be combined with the technical data to derive a climatically adjusted standard.

### **Control Areas**

A control area is similar to a reference area, as it contains one or more representative premining mapping units that formerly existed in the reclaimed tract. However, data obtained from a control area will not be used for direct comparison with the reclaimed tract; instead, they are used to develop a climatic correction factor. The correction factor is used to adjust established yield estimates of the premining mapping units that existed in the reclaimed tract. Thus, control areas, like some reference areas, will be used to develop a climatically adjusted standard.

### **NRCS Cropland Productivity Indices**

The Natural Resources Conservation Service or NRCS (formerly known as the Soil Conservation Service or SCS) has published productivity indices for each soil series in North Dakota (Cropland Table 1, NRCS 2000). The productivity indices array the soils from most productive to least productive based on soil properties and qualities using the Major Land Resource Areas of North Dakota as the area of interest. An index of 100 is ascribed to the most

productive soil series in a given area. The indices are based on actual field trials and other experiments conducted at agricultural experiment stations, and are therefore reasonably accurate yield ratings for these soils.

The crop productivity index (PI) can be used to rate the potential yield one soil (or soil map unit) against that of another soil map unit over time. The productivity indices based on soil properties are expected to remain relatively constant in relation to one another over time. The predicted average yields will change with time due to changes in technology and climatic conditions. The PI is calculated for a given tract based on premine soil mapping unit acreages. The annual yield of the tract is compared to a standard that is adjusted annually using the PI and measured crop yields.

### **Average County Cropland Productivity Index (PI)**

An average county cropland PI, based on soil mapping units within the county and NRCS productivity indices, was calculated for each county. The NRCS Web Soil Survey was used to obtain the acreages and corresponding productivity indices of each soil mapping unit within the county (Soil Survey Staff, 2015-2017, <https://websoilsurvey.nrcs.usda.gov>). The soil map units with non-irrigated capability classes of 1, 2, 3 or 4 within the county web soil survey area of interest were selected for this calculation. PI ratings were then weighted by the appropriate soil mapping unit acreages and divided by the total acres to obtain an average cropland PI. Average county cropland PI's are shown in Cropland Table 2. The average county PI can be used to develop a climatic correction factor when correlated with the annual county yield reported in North Dakota Agricultural Statistics (NDAS).

### **North Dakota Agricultural Statistics (NDAS) County Cropland Yields**

NDAS county yield data collected and published annually by North Dakota State University, North Dakota Department of Agriculture and the USDA-National Agricultural Statistics Service (NDAS 1956- current year) can be used to represent the annual average yield for a county. NDAS county yields are based on reports from a large number of farmers randomly selected from each county. Information on acreages and yields for different crops grown in a given year by individual farmers is collected and reviewed by statisticians, who calculate the average yield by dividing the reported total production by the acreage harvested for that crop in a given county. Since NDAS reports actual county yields annually, these data can be used with the average county PI rating (Cropland Table 2) to obtain a correction for climatic variability.

### **NRCS Pasture and Hayland Forage Suitability Group (FSG) Yields**

NRCS has developed yield estimates for groups of soils suitable for pasture and hayland in each Major Land Resource Area in North Dakota. This information was used to develop Tame Pastureland Tables 1 and 2, (NRCS 2003). These estimated yields can be used to develop pasture and hayland productivity standards when adjusted for climatic variation.

### **NRCS Native Grassland Data**

NRCS has established ecological site descriptions for each soil series in North Dakota (Native Grassland Table 1) and published production estimates for the site each Major Land Resource Area in North Dakota (Native Grassland Table 2, NRCS 2003-2012). These estimates are based on long-term averages, and can be used to develop productivity standards for reclaimed native grasslands if they are corrected for climatic variation. The NRCS data are used to represent some of ecological sites which existed in the reclaimed tract prior to mining. These estimates are corrected for climatic variation using data from reference areas established for the predominant ecological sites that existed in the tract. Data from both sources are combined to derive a climatically adjusted standard.

### **ARS Perennial Grassland Cover Data**

Research data generated by the USDA-ARS Northern Great Plains Research Center, at Mandan, North Dakota (Hofmann et al. 1983 and Ries and Hofmann 1984) have been used to develop minimum standard values for basal and first-hit cover. These values will be used as standards for third-stage (and in some instance fourth-stage) bond release. In other instances these values may be used only in conjunction with cover data from reference areas to develop a standard.

### **Updating NRCS Data**

Current NRCS data have been provided in tabular form at the end of each land use section. When new data are published by the NRCS that would substantially affect the procedures outlined herein, updated tables will be forwarded to the mining companies and the OSM. The Web Soil Survey is the official source of NRCS soil survey data and these data are refreshed/updated annually. The productivity indices are relatively stable, however small variations may occur as new soil series are recognized, and the NRCS continues to improve the soil survey information. The NRCS also offers services on their website that will provide notification of updates to Web Soil Survey data.

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## **C. CROPLAND**

### **Definition**

Cropland, as defined in NDAC 69-05.2-01-02, means land which is used for the production of adapted crops for harvest, alone or in rotation with grasses and legumes, and includes row crops, small grain crops, hay crops, nursery crops, orchard crops and other specialty crops. Land used for facilities in support of cropland farming operations is also considered as cropland. Cropland also includes hayland, which was considered as a separate sub-category prior to June 1, 1983.

### **Requirements for Successful Revegetation**

For third-stage bond release on reclaimed croplands, “vegetation shall be considered established after the successful seeding of the crop being grown or a precropland mixture of grasses and legumes” [NDAC 69-05.2-22-07(3)(b)]. For prime farmland, productivity on the permit area must be equal to or greater than that of the approved reference area or standard with 90% statistical confidence for a minimum of three crop years [NDAC 69-05.2-22-07(3)(c)]. For fourth-stage bond release on cropland, productivity (crop yield) is the only vegetation parameter that must be assessed. According to NDAC 69-05.2-22-07(4)(c) and (l), “crop production from the permit area shall be equal to or greater than that of the approved reference area or standard with ninety percent statistical confidence for any two years after year six of the responsibility period.” For prime farmlands, North Dakota rules require that third stage bond release standards have been met and that the ten-year responsibility period has elapsed [NDAC 69-05.2-22-07(4)(d)].

Reclaimed tracts that remain in precropland vegetation following bond release must be assessed using annual small grain or row crops if the area had been annually cropped prior to mining. However, only representative portions of these tracts need be cropped for bond release assessment as described in Section III (D), Methods for Measuring Productivity, Cover, and Density. On cropland areas where the land after mining will be managed for perennial hay, yields of hay crops may be used to determine revegetation success during the years that yield measurements are taken for final bond release purposes. The productivity standards for hayland must be used for these areas. However, this will apply only to areas specifically approved in the reclamation plan as perennial hayland, or to areas where the premine land was perennial hayland.

### **Premining Assessment**

The following information is required as a part of the permit application in accordance with NDAC 69-05.2-08:

1. Delineate and identify on a map or aerial photograph of 1:4800 scale [NDAC 69-05.2-08-08(l)(a)(1)]:
  - a. All cropland tracts within the proposed permit area; and,
  - b. Each soil-mapping unit for each tract of cropland.



2. Tabulate total acreage of each soil mapping unit for each surface owner within the proposed permit area [NDAC 69-05.2-08-08(1)(c)(1)].
3. Provide an assessment of the production of the principal crop(s) grown on the cropland within the permit area. [NDAC 69-05.2-08-08(1)(c)(2)]. Evaluation of premining production of cropland may be based on:
  - a. NRCS yield estimates for the various soil mapping units;
  - b. Historical yield averages for the area, if available; or,
  - c. The most recent actual yields from the area.
4. If a cropland reference area or control area will be used to determine revegetation success, provide a map showing the location, size, and the soil mapping units of the proposed reference or control area. Also include a discussion that demonstrates that the proposed area adequately represents the conditions in the permit area [NDAC 69-05.2-08-08(2)].

### **Postmining Assessment**

#### **Third-Stage Bond Release**

The following information should be submitted for each reclaimed cropland tract with third-stage bond release requests:

1. An aerial photo of adequate scale that delineates the reclaimed cropland tract(s) proposed for bond release.
2. A narrative that includes methods used for seedbed preparation and seeding and describes all management practices used prior to the bond release request [NDAC 69-05.2-12-12(10)].
3. A demonstration of adequate establishment of vegetation under NDAC 69-05.2-22-07(3) (b), or NDAC 69-05.2-22-07(3) (c) for prime farmland, using the approved standard for third-stage bond release.
4. All other information as required by NDAC 69-05.2-12-12.

## **Revegetation Success Standards for Third-Stage Bond Release**

### **Precropland or hayland seed mix:**

The vegetation will be considered successfully established when the stand consists primarily of grass and legume species. This evaluation will be conducted by PSC field inspection no sooner than the end of the first growing season.

### **Annual Crops:**

The vegetation will be considered successfully established when the stand appears similar to those normally found on undisturbed lands and a harvestable crop is produced. The evaluation will be conducted by PSC field inspection near the end of the growing season, when the crop is mature.

### **Prime Farmland:**

The vegetation will be considered successfully established when the annual production of the reclaimed tract is equal to or greater than the reference area, or standard (as described for fourth-stage bond release success standards for other cropland), with 90% statistical confidence for a minimum of three years, not necessarily consecutive. A separate success standard must be calculated for prime farmland tracts unless a single yield standard has been approved as allowed by NDAC 69-05.2-22-07(4)(1). The PSC recommends that spring wheat be used for this demonstration for at least one of the three years that productivity measurements are taken. Wheat or other field crops commonly grown in the area may be used for the other years.

## **Fourth-Stage Bond Release**

The following information should be submitted for each reclaimed cropland tract with fourth-stage bond release requests:

1. An aerial photo of adequate scale that delineates the reclaimed cropland tract(s) proposed for bond release. The aerial photo must depict ownership boundaries if separate landowners are involved and, within each land ownership, any site type unit if a stratified sampling procedure was used. Provide in tabular form the acreages of site type units for each landowner within the reclaimed tract.
2. An aerial photo of adequate scale that delineates the area and soil mapping units that were used to develop the standard.
3. An aerial photo of adequate scale that delineates any corresponding reference or control areas and their soil mapping units, if used to develop the standard.
4. A narrative that includes soil replacement thicknesses and a complete management history of the reclaimed cropland tract(s) and reference or control areas. The narrative should include seed mix and rate, fertilizer program, pesticide control, tillage practices, and any other management techniques used during the liability period [NDAC 69-05.2-12-12(08)].
5. Data and calculations which demonstrate that productivity of each landowner's non-prime reclaimed tract is equal to or greater than the approved standard (with 90% statistical

confidence) in each of the two growing seasons where data is collected to prove reclamation success after year six of the responsibility period.

For reclaimed prime farmland, a separate yield standard must be calculated for each tract and three years (not necessarily consecutive) of data must be submitted that demonstrates that the productivity is equal to or greater than the approved standard with 90% statistical confidence. Alternatively, if a single standard has been approved and calculated for a reclaimed tract containing a mixture of prime and non-prime farmlands as allowed by NDAC 69-05.2-22-07(4)(1), data must be submitted which demonstrates that productivity is equal to or greater than the approved standard (with 90% statistical confidence) in any three years with at least two years being after year six of the responsibility period. The PSC recommends that spring wheat be used for this demonstration for at least one of the three years when productivity measurements are taken for final bond release. Wheat or other field crops commonly grown in the area may be used for the other years.

Sampling locations must also be shown on an appropriate map.

6. All other information as required by NDAC 69-05.2-12-12.

### **Revegetation Success Standards for Fourth-Stage Bond Release**

For assessment of revegetation success on surface mined lands reclaimed to cropland or hayland use, the permittee may use either a reference area standard, or a technical standard based on NRCS data. Each of these standards provides a procedure for climatic correction of yields. If a tract is owned by more than one landowner, production on each landowner's property must be assessed separately. A separate yield must be obtained, and a separate standard developed, for each landowner's property.

Crops most commonly grown prior to mining in the area must be used to measure productivity to determine reclamation success on areas being returned to cropland. Spring wheat (hard red spring wheat or durum wheat) is recommended for at least one of the years that measurements are taken on cropland for final bond release assessments. Other crops that may be grown during the other year on non-prime cropland include but are not limited to oats, barley, corn, canola, field peas, dry edible beans, soybeans, flax and sunflowers.

For fourth-stage release on prime farmlands, the ten-year responsibility period must have elapsed and productivity standards for third-stage bond release must have been met.

#### **Method 1: Cropland Reference Area Standard**

This standard combines a reference area with NRCS productivity indices for soil mapping units. It is particularly recommended for reclaimed prime farmland and reclaimed cropland tracts which subtend only a few map units.

A cropland reference area is established for soil mapping units which were predominant in the reclaimed tract prior to mining. The reference area must include one or two reference soils which singly or together occupy more than 50% of the reclaimed tract. The reference area must

be topographically similar to the reclaimed tract and must be established in the vicinity of the mine area. The proposed location of the reference area must be identified in the permit application, and must be inspected and approved by PSC staff.

The reference area must be established at least two years before the first year in which the reclaimed tract will be evaluated for bond release. Beginning at this time, the reference area must be managed using practices which may be site-specific, but equal in effect to those used on the reclaimed tract. The reference area and the reclaimed tract must be planted at the same time and with the same crop species and variety in the years when yields will be compared. An exemption from this two-year requirement may be granted if documentation is submitted to the Reclamation Division that demonstrates that the management of the reference area for the previous two years has been equivalent in effect to that of the reclaimed area.

In each of the years that data is collected to prove reclamation success, the yield from each soil mapping unit in the reference area must be separately harvested or sampled. The crop yield of one of the reference soils must be used, along with NRCS soil productivity indices from Cropland Table 1 (NRCS 2000) for row crops or median yield from Hayland Table 1 for hayland crops (NRCS 2015), to calculate the expected yields for the other premining soil mapping units not represented in the reference area. The expected yields are derived by dividing the index value (or median hayland yield) for each soil series by the index value (or median hayland yield) of the reference soil and multiplying by the current year's yield for the reference soil. The actual yields of the reference soils and the expected yields of the other soils are weighted by the acreage each soil mapping unit occupied in the tract prior to mining. The weighted yields are summed and divided by the total acreage of the reclaimed tract to derive the current year's yield standard for the tract. The current year's actual yield from the reclaimed tract is then compared to the derived standard. The yield standard must be derived for each year that the reclaimed tract is evaluated for bond release.

Since the yield standard is calculated by sampling and obtaining an average, there is a variance associated with the value. Therefore, when the reclaimed tract and reference area are sampled to obtain yields, appropriate statistical tests must be applied as necessary to determine if the yields are significantly different. If the yield of the reclaimed tract is obtained by a random or stratified (site type) sampling procedure, a standard deviation can be calculated which will enable statistical comparison with the yield standard. However, if the entire reclaimed tract is harvested to obtain a yield, a standard deviation cannot be calculated. In this case, special formulas must be used to enable statistical comparison with the standard. Further discussion of sampling and statistical procedures is given in Chapter III. The following example, using small grain data, may be used in a similar manner for hayland determinations using the median hayland yield values.

### **Example**

Assume there is a 50 acre reclaimed cropland tract in Mercer County which, according to the premining soils inventory, contained 30 acres of Bowbells soil, 15 acres of Arnegard soil and 5 acres of Williams soil. Since Bowbells constituted more than 50% of the reclaimed tract, a reference area was established on a Bowbells unit in the vicinity of the mine area. In each of the years that yield comparisons are made for final bond release purposes, the following steps should

be taken:

Step 1:

Determine the yield of the reference soil. Assume that the Bowbells reference soil yielded 28 bu/ac in the given year of comparison.

Step 2:

Determine the productivity index for all soil mapping units which were present in the reclaimed tract prior to mining, from Cropland Table 1 (NRCS 2000). The index values for these soils are:

<u>Map Unit Component</u>	<u>Slope Group</u>	<u>Productivity Index Value</u>
Arnegard	A	100%
Bowbells	B	95%
Williams	A	90%

Step 3:

The Bowbells soil is used as a reference soil, and has a productivity index (PI) of 95. A correction factor (CF) is calculated by dividing the index value for each mapping unit by the index value of the Bowbells soil. The CF is multiplied by 28.0 bu/ac (produced by the Bowbells soil in the given year) to derive the expected yields of the other soils for that year. The weighted yield is then calculated for the reclaimed tract by multiplying the expected yield of a soil by the acres of that soil. Finally, an average yield for the tract can be calculated by dividing by total acres.

<u>Soil</u>	<u>Soil PI</u>		<u>Bowbells PI</u>		<u>CF</u>		<u>Bowbells Production</u>		<u>Expected Yield</u>		<u>Acres</u>		<u>Total Bushels</u>
Arnegard	100	÷	95	=	1.05	x	28.0 bu/ac	=	29.4 bu/ac	x	15 ac	=	441 bu
Bowbells	95	÷	95	=	1.00	x	28.0 bu/ac	=	28.0 bu/ac	x	30 ac	=	840 bu
Williams	90	÷	95	=	0.95	x	28.0 bu/ac	=	26.6 bu/ac	x	5 ac	=	133 bu
Total:											50 ac		1414 bu

$$\text{Weighted average yield} = 1410 / 50 \text{ ac} = 28.28 \text{ bu/ac}$$

After rounding, the weighted average yield of 28.3 bu/ac is the current year's adjusted standard yield for the reclaimed tract.

Step 4:

Compare the current year's actual yield from the reclaimed tract with the adjusted yield standard using the appropriate statistical procedures.

## Method 2: NRCS Cropland Technical Standard

NRCS productivity indices may be used to calculate a productivity ratio for cropland or an unadjusted yield standard for hayland. The productivity ratio along with annual yield data are used to calculate an adjusted yield standard corrected for annual climatic variation. The annual adjusted yield standard must be determined using one of the two methods discussed later in this section.

Productivity index values for all premining soil mapping unit components which existed in the reclaimed cropland tract are obtained from Cropland Table 1 (NRCS 2000). As of February 2000, the NRCS has assigned productivity index values to nearly all soil series. However, in the event of a non-rated soil (such as a channeled mapping unit), the soil must be assigned a productivity index of 20%. Index values may be converted to relative yield values using the assigned county yield for the Productivity Index of 100%. For haylands, the median yield values for each soil are obtained by selecting the suitability group in Hayland Table 1 and finding the appropriate yield value in Hayland Table 2.

The ratio of the weighted productivity indices (PI) values from the reclaimed and control areas may be used with the control area yield to calculate the adjusted yield standard for the reclaimed area. The productivity indices are a relative measure of a soil's capacity to produce crops based on soil properties. Soils with the same PI are expected to have the same crop yield under the same management and climate conditions.

NRCS yield ratings for productivity indices and suitability groups are based on long-term average data which do not account for annual climatic effects. Therefore the yield standard for a reclaimed area is determined annually using crop yields from an area with a known PI using one of the following two methods (examples use cropland PI values but hayland median yield values may be used for hayland):

### Climatic Correction Factors for NRCS Technical Standard:

#### Correction Method A – Control Area:

A control area, which contains some of the predominant premining soil series, or similar soil series (including similar productivity), which existed in the reclaimed tract, can be used to calculate a climatically adjusted yield standard. A weighted average PI value is calculated for the control area using the same method that was used to calculate the PI value for the reclaimed tract (i.e., using soil mapping units from a professional soil classifiers survey, and NRCS productivity indices or hayland suitability group median yields). The control area is harvested in the same years that the reclaimed tract is harvested for comparison with the standard. The actual yield from the control area is multiplied by a productivity ratio correlating the reclaimed area PI to control area PI to obtain the adjusted yield standard for the current year.

$$\text{Productivity Ratio (PR)} = \text{Reclaimed area PI (PI}_{\text{RA}}) / \text{Control area PI (PI}_{\text{CA}})$$

$$\text{Adjusted standard (X}_{\text{AD}}) = \text{Control area yield (X}_{\text{CA}}) \times \text{Productivity Ratio (PR)}$$

This method assumes that the difference in yield for the control area and the reclaimed tract is a function of soil characteristics. The control area yield is used to adjust for the function of climate on the yield for a given year. The adjusted standard for the reclaimed tract is derived by combining the two equations shown above:

$$X_{AD} = X_{CA} \times (PI_{RA} / PI_{CA})$$

Where:

- $X_{AD}$  = adjusted yield standard;
- $X_{CA}$  = actual yield from the control area for the current year; and,
- $PI_{RA}$  = weighted average NRCS productivity indices (or hayland suitability median yields) for reclaimed tract.
- $PI_{CA}$  = weighted average NRCS productivity indices (or hayland suitability median yields) for the control area.

The proposed location of the control area must be identified in the permit application. Establishment of the control area must occur at least two years prior to the first year that the reclaimed tract is harvested for comparison with the standard. An exemption from this two-year requirement may be granted if documentation is submitted to the Reclamation Division that demonstrates that the management of the control area for the previous two years has been equivalent in effect to that of the reclaimed area. Prior to establishment, the permittee must provide the PSC with information on the control area, including soils descriptions, fertility levels, and management history. The PSC will review this information and inspect the control area prior to approval. Management of the control area and the reclaimed tract may be site specific, but must be equal in effect during the years in which comparisons with the standard will be made. (The example below uses small grain values but hayland values could be substituted and used).

### Example using Correction Method A:

Assume there is a 50-acre tract of land in Mercer County that will be reclaimed to cropland following mining disturbance. Let us further assume that the premining soils inventory has indicated that this area contains 15 acres of Bowbells soil, 25 acres of Williams soil and 10 acres of Zahl soil.

Step 1:

Based on the NRCS productivity indices for these soils, calculate the weighted average productivity index ( $PI_{RA}$ ) for the tract by the following procedure:

Soil	Slope Group	Productivity Index Value	x	Premine Acres	=	Weighted Index
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Bowbells	A	100%	15.0	1500
Williams	A	90%	25.0	2250
Zahl	B	57%	10.0	570
<b>Total</b>			50.0	4320

The PI for the reclaimed tract ( $PI_{RA}$ ) =  $4320 / 50.0 = 86.4$

**Step 2:**

Following the same procedure, calculate the expected yield of the control area. Assume there is a 29-acre control area in Mercer County. Let us further assume that a detailed soil survey, prepared by a professional soil classifier, has indicated that this area contains 8 acres of Sen soil, 18 acres of Williams soil and 3 acres of Zahl soil.

**Control Area:**

Soil	Slope Group	Productivity Index Value	X	Acres	=	Weighted Index
Sen	A	80%		8.0		640
Williams	A	90%		18.0		1620
Zahl	B	57%		3.0		171
				29.0		2431

The PI for the control area ( $PI_{CA}$ ) =  $2431 / 29.0 = 83.8$

**Step 3:**

Calculate the productivity ratio for the reclaimed tract and control area:

$$\text{Productivity Ratio (PR)} = 86.4 / 83.8 = 1.03$$

**Step 4:**

The current year's actual yield from the control area ( $X_{ca}$ , assumed to be 24.5 bu/ac) is multiplied by the productivity ratio to obtain an adjusted standard:

$$\text{Adjusted standard (X}_{AD}) = 24.5 \text{ bu/ac} \times 1.03 = 25.3 \text{ bu/ac}$$

**Step 5:**

Compare the current year's actual yield from the reclaimed tract to the adjusted yield standard (25.3 bu/ac) using the appropriate statistical procedures (repeat Steps 3 and 4 for each year).

**Correction Method B – County-Wide Average:**

When the entire reclaimed field is harvested or when representative strips are entirely harvested to obtain the yield for the reclaimed area, this reclaimed yield may be compared to the annual county yield reported in the North Dakota Agricultural Statistics (NDAS). A measured yield from the reclaimed tract equal to or exceeding the adjusted yield standard will demonstrate success for the given year.



The annual county yield reported in the North Dakota Agricultural Statistic (NDAS) may be compared to the reclaimed area yield obtained using entire field harvest or combine sampling methods. Under this method, a weighted average productivity index (PI) for the reclaimed area must be calculated according to the example provided in Method 2A described earlier (i.e., using soil mapping units from a professional soil classifiers survey, and NRCS productivity indices or hayland suitability group median yields). A productivity ratio correlating the reclaimed area PI to the average county PI is determined using the average cropland PI for the county from Cropland Table 2 in this document. The reported annual county yield is multiplied by the productivity ratio correlating the reclaimed area PI to the average county PI to obtain the adjusted yield standard for the current year:

The productivity ratio of the reclaimed area to the average county cropland (from Cropland Table 2) is calculated as follows:

$$\text{Productivity Ratio (PR)} = \text{Reclaimed area PI} / \text{Average county PI}$$

An adjusted yield standard for the reclaimed area for the particular year is then calculated by multiplying the PR (shown above) by the annual county yield obtained from NDAS.

$$\text{Adjusted standard (X}_{AD}\text{)} = \text{Annual county yield} \times \text{Productivity Ratio (PR)}$$

For hayland, the annual county hay yields reported by NDAS must be used to calculate an annual climatic correction factor (CF) as described in tame pastureland section. First a measurement of whether the forage consists of 25% or more by weight of alfalfa must be made in order to determine if the alfalfa or grass NDAS hay yield information is to be used. The average county hayland yield from the previous 14 years plus the current year yield is calculated to obtain a long-term average county hay yield. The correction factor is derived by dividing the NDAS county yield for the current year by the long-term average yield for the county. This correction factor is then multiplied by the unadjusted yield standard for the hayland tract to derive the adjusted yield standard for the current year hay crop.

During some years NDAS does not report an individual county's average yield for a particular crop. In the event that a county yield is not reported for a crop grown on a reclaimed tract, the following reported yield values may be available for determining the annual climatic correction:

The average yield reported for another county containing a portion of the permitted area or bordering (within a few miles) the mining permit containing the reclaimed tract may be used; or

The average yield reported for the agricultural district containing the county where the reclaimed tract is located should be available in most years when the county yield cannot be reported and may be used to determine the climatic correction.

When the reported yield for an alternate county or the agricultural district is used for determining the annual climatic correction, the appropriate corresponding average cropland productivity

index must also be used. The average cropland PI rating for the Southwest and West Central reporting districts along with the pertinent counties are provided in Cropland Table 2.

### **Example using Correction Method B**

Assume that the reclaimed tract is in Mercer County, hard red spring wheat is grown, and the following factors apply in a particular year:

The wieghted average PI for the reclaimed tract = 53.5%  
 Average Cropland PI for Mercer County from Cropland Table 2 = 73.5%  
 Annual county yield = 28.0 bu/ac  
 Annual yield for the reclaimed tract = 20.0 bu/ac

Step 1:

Calculate the Productivity Ratio (PR):  

$$PR = 53.5 / 73.5 = 0.728$$

Step 2:

Calculate the adjusted yield standard for the reclaimed area based on the current year's annual county yield using the PR obtained in Step 1:

Adjusted yield standard =  

$$X_{AD} = \text{Annual county yield} \times PR$$

$$= 28.0 \text{ bu/ac} \times 0.728$$

$$= 20.4 \text{ bu/ac}$$

Step 3:

The yield from the reclaimed tract of 20.0 bu/ac is below the adjusted yield standard for the current year. Plan to collect annual yield information for the reclaimed tract for an additional year.

### **Example using multiple crops grown on a reclaimed tract:**

When several different crops are grown on multiple field strips within a bond release tract, a weighted production approach may be necessary to determine whether the productivity requirements were met for the years of interest. The weighted production is calculated by dividing the actual yield of each crop by its adjusted standard for that year, multiplying that ratio by the acres actually planted to that crop, and then summing those production weighted acres for all crops. If the sum of all the production weighted acres exceeds the actual number of acres, then the productivity standard is met for that year.

Assume there is a 400-acre tract of reclaimed cropland in Bowman County that during 2007 was used to grow alfalfa on 200 acres, wheat on 100 acres and field peas on 100 acres. In this example we are using the County-Wide Average method for climatic adjustment and the average county cropland PI for Bowman County found in Cropland Table 2. The following tract and yield information also apply:

Cropland productivity standard PI for the reclaimed tract = 61.2%

Hay productivity standard for the reclaimed tract = 1.05 t/ac

Reclaimed tract yields: Wheat = 24.8 bu/ac; peas = 2300 lb/ac; and hay = 1.45 t/ac

Annual county yields: Wheat = 27.8 bu/ac; peas = 2230 lb/ac; and hay = 1.44 t/ac

The long-term average county hay yield for this example = 1.31 t/ac

Step 1:

Calculate the adjusted yield standards for each of the crops grown on the reclaimed tract.

Climatic Correction – Annual Crops										
Year	Crop	Reclaimed Cropland PI	÷	County Cropland PI	=	Productivity Ratio	×	County Yield	=	Adjusted Yield Standard
2007	Wheat	61.2		63.8		0.959		27.8 bu/ac		26.7 bu/ac
2007	Peas	61.2		63.8		0.959		2230 lb/ac		2139 lb/ac
Climatic Correction – Hay Crops										
Year	Crop	County Yield	÷	County 15-yr Avg	=	Correction Factor	×	Reclaimed Unadjusted Standard	=	Adjusted Yield Standard
2007	Alfalfa	1.44 t/ac		1.31 t/ac		1.099		1.05 t/ac		1.15 t/ac

Step 2:

Calculate the overall production weighted acres for reclaimed tract.

Year	Crop	Reclaimed Cropland Yield	÷	Adjusted Yield Standard	=	Production (Yield) Ratio	×	Actual Acres	=	Production Weighted Acres
2007	Wheat	24.8 bu/ac		26.7 bu/ac		0.929		100		92.9
2007	Peas	2300 lb/ac		2139 lb/ac		1.075		100		107.5
2007	Hay	1.45 t/ac		1.15 t/ac		1.256		200		251.3
						<b>Total</b>		<b>400</b>		<b>451.7</b>

Step 3:

The total production weighted acres exceed the total for the actual planted acres and thus the reclaimed tract meets the revegetation productivity standard for this year.

**Cropland Table 1.** Spring wheat productivity indexes (NRCS Soils Interpretive Guide, January, 2000 and NRCS eFOTG Soils Interpretive Tables, 2015.)

This table lists the productivity indexes for soil series and phases. The list was prepared by assigning a productivity index for spring wheat to map unit components in soil surveys and technical guides. Where two values are given for one series (e.g., Tonka, 40-85), the first value refers to an undrained soil, the second value refers to a drained soil. If no surface textural phases are listed, assume that the PI's listed are for all textural phases associated with that soil series. If a surface textural phase is listed (e.g., Amor 1, cl), the PI's listed are only for that surface textural phase. Usually, the most common or likely surface textural phases are provided on Table 1. In addition, some stony and saline phases are provided for those soils likely to have stony or saline phases. The PI's provided for the stony and saline phases represent very stony and moderately saline phases, respectively. For textural, salinity, or stony phases or soil series not listed on the table, please consult with Reclamation Division staff. Productivity indexes are provided for E (15-25%) and F (>25%) slope groups. If the map unit has a 15 to 25% slope, then the PI for the E slope phase should be used. However, it is common practice to group the E and F slopes together into a single map unit (e.g., Cabba loam, 15-35% slopes). In this case the midpoint between the E and F slope groups should be used. For example, a map unit of Cabba loam, 15 to 35% slopes would have a PI of 13.5, the midpoint between PI for E slope (16) and F slope(11). The representative value (RV) for slope may be used to determine the slope group if provided for map unit components in the pre-mine soil survey.

### SERIES MODIFIERS

Drainage	
ed	excessively drained
wd	well drained
mwd	moderately well drained
spd	somewhat poorly drained
pd	poorly drained
vpd	very poorly drained

Slope Group	
A	0-3%
B	3-6%
C	6-9%
D	9-15%
E	15-25%
F	>25%

Stoniness	
st	stony
stv	very stony
stx	extremely stony

Texture					
cos	coarse sand	lvfs	loamy very fine sand	si	silt
s	sand	cosl	coarse sandy loam	scl	sandy clay loam
fs	fine sand	sl	sandy loam	cl	clay loam
vfs	very fine sand	fsl	fine sandy loam	sicl	silty clay loam
lcos	loamy coarse sand	vfsl	very fine sandy loam	sc	sandy clay
ls	loamy sand	l	loam	sic	silty clay
lfs	loamy fine sand	sil	silt loam	c	clay

## PRODUCTIVITY INDICES (%)

Soil Series	Slope Group				
	A	B	C	D	E-F
Absher	30	28	22	17	12/8
Amor l, cl	80	76	61	46	32/22
Amor fsl	70	67	54	41	28/20
Amor, very stony	40	38	30	23	16/11
Arnegard	100	95	76	57	40/28
Arnegard, saline	50	48	-	-	-
Arveson sl, fsl - pd	30-55	-	-	-	-
Aquolls	20	-	-	-	-
Banks fsl, vfsl	45	43	-	-	-/-
Banks lfs, ls	35	33	-	-	-/-
Bearpaw	90	85	68	51	36/25
Beisigl ls, lfs	35	33	26	20	14/10
Beisigl sl, fsl	45	43	34	26	18/12
Beisigl, very stony	18	17	13	10	7/5
Belfield l, sil	75	71	57	43	30/21
Belfield, saline	38	36	-	-	-/-
Benz	25	24	19	0	0/0
Bowbells	100	95	76	-	-/-
Bowbells, saline	50	47	38	-	-/-
Bowdle	60	57	46	-	-/-
Boxcut	90	85	68	-	-
Boxwell	80	76	61	-	-/-
Boxwell, extremely stony	12	11	9	-	-/-
Brandenburg l, ch-l	30	28	22	17	12/8
Breien fsl	40	38	-	-	-/-
Brisbane l, cl	85	80	64	48	34/24
Bryant	90	85	68	51	30/25
Cabba l, sil, cl, sicl	40	38	30	23	16/11
Cabba, very stony	20	19	15	11	8/6
Cabbart, l, sil, cl	40	38	30	23	16/11
Cabbart, very stony	20	19	15	11	8/6
Chama	70	67	54	41	28/20
Chanta	60	57	46	35	24/17
Cherry sil, l, sicl, cl	75	71	57	43	30/21
Chinook	65	63	50	33	26/18
Cohagen	30	28	22	17	12/8
Coleharbor	85	80	64	-	-
Colvin sil, sicl, vpd	10-60	-	-	-	-/-
Colvin, sil, sicl, pd	40-70	-	-	-	-/-
Colvin, channeled	20	-	-	-	-/-
Colvin, saline, pd	35	-	-	-	-/-
Daglum cl, sil, l, sil	45	43	34	26	18/12
Daglum l, sil, cl-mod. deep	40	38	30	23	16/11
Daglum, saline	23	22	17	13	9/6
Daglum, very stony	20	18	15	11	8/6
Desart fsl, sl, vfsl	55	52	42	32	22/15
Dilts	30	28	22	17	12/8
Dimmick c, sic	30-70	-	-	-	-/-
Divide l. sil, cl, scl	65	63	-	-	-/-
Divide, saline	33	32	-	-	-/-
Dogtooth	25	24	19	14	11/7
Dragline	60	-	-	-	-
Dragline, vpd	20	-	-	-	-
Ekalaka fsl, vfsl, sl	40	38	30	23	16/11
Falkirk	90	85	68	51	36/25
Falkirk, saline	45	42	34	25	18/12
Fargo, saline	45	43	-	-	-/-
Farland	90	85	68	51	36/25
Farnuf	90	85	68	51	36/25
Felor fsl, sl	80	76	61	46	32/22

Soil Series	Slope Group				
	A	B	C	D	E-F
Flasher ls, lfs	25	24	19	14	11/7
Flasher sl, fsl	35	33	26	20	14/10
Flasher, very stony	13	12	10	7	5/4
Flaxton fsl	70	67	54	41	28/20
Flaxton lfs	55	52	42	32	22/15
Flaxton l	75	71	57	43	30/21
Fleak fsl, sl	35	33	26	20	14/10
Fossum	50	-	-	-	-
Golva	90	85	68	51	36/25
Grail	100	95	76	57	40/28
Grail, saline	50	48	38	-	-/-
Grassna	100	95	76	57	40/28
Grassna, saline	50	48	38	-	-/-
Hamerly	85	80	-	-	-/-
Hamerly, saline	43	40	-	-	-/-
Hamerly, very stony	43	40	-	-	-/-
Hanly fsl, sl	45	43	-	-	-/-
Harriet	25	-	-	-	-/-
Havre	85	80	-	-	-/-
Havre, channeled	20	20	-	-	-/-
Havrelon, l, sil, sicl	85	80	-	-	-/-
Havrelon, channeled	20	20	-	-	-/-
Havrelon, fsl, vfsl	75	71	-	-	-/-
Heil sicl, sil	35	-	-	-	-/-
Janesburg l, sil, sicl, cl	40	38	30	23	16/11
Kniferiver	78	73	-	-	-
Korchea fsl, sl, vfsl	80	76	-	-	-/-
Korchea cl, sicl, l, sil	90	85	-	-	-/-
Korchea, channeled	20	20	-	-	-/-
Krem fs	35	33	26	20	14/10
Krem ls, lfs	50	48	38	29	20/14
Kremlin	85	80	64	48	34/24
LaMoure	40-70	-	-	-	-/-
Lawther sicl	85	80	64	48	34/24
Lawther c, sic	80	76	61	46	32/22
Lefor	60	57	46	35	24/17
Lehr l, sl	45	43	34	26	18/12
Lihen fsl, sl	55	52	42	32	22/15
Lihen lfs, ls	45	43	34	26	18/12
Linton	85	80	64	48	34/24
Lisam	30	28	22	17	12/8
Livona fsl, sl	70	67	54	41	28/20
Livona lfs, ls	50	48	38	29	20/14
Lohler sic, c	80	76	-	-	-/-
Magnus sicl	85	80	-	-	-/-
Makoti	95	90	72	54	38/26
Mandan	95	90	72	54	38/26
Manning fsl, sl	40	38	30	23	16/11
Marysland	30-60	-	-	-	-/-
Max	85	80	64	48	34/24
Max, very stony	45	43	34	26	18/12
McKenzie, pd	25-45	-	-	-	-/-
Moreau sic	65	63	50	38	26/18
Moreau sicl, cl	70	67	54	41	28/20
Moreau, saline	32	32	25	19	13/9
Morton	85	80	64	48	34/24
Morton, very stony	45	43	34	26	18/12
Mott	60	57	46	35	24/17
Niobell	75	71	57	43	30/21
Noonan l, sil	45	43	34	26	18/12

## PRODUCTIVITY INDICES (cont.)

Soil Series	Slope Group				
	A	B	C	D	E-F
Nutley sic, c	90	85	68	51	36/25
Oburn	30	28	22	17	12/8
Omio	85	80	64	48	34/24
Parnell sic, sil, sicl	20-75	-	-	-	-/-
Parshall	70	67	54	41	28/20
Parshall, saline	35	33	27	-	-/-
Parshall, wet	80	76	61	-	-/-
Patent l, sil, cl, sicl	50	48	38	29	20/14
Reeder	85	80	64	48	34/24
Reeder, very stony	45	43	34	26	18/12
Regan, pd	35-65	-	-	-	-/-
Regan, vpd	20-55	-	-	-	-/-
Regan, saline	33	-	-	-	-/-
Regent sicl, cl, sil	85	80	64	48	34/24
Rhame	60	57	46	35	24/17
Rhoades	30	28	22	17	12/8
Rhoades, saline	13	12	10	-	-/-
Ringling l, ch-l	35	33	26	20	14/10
Ringling chv-l	20	19	15	11	8/6
Roseglen	100	95	76	57	40/28
Ruso	40	38	30	23	16/11
Sakakawea	60	57	48	35	24/17
Saline alkali	20				
Saline alluvium	20				
Savage	90	85	68	51	36/25
Savage, saline	45	43	34	25	18/13
Schaller fsl, sl	40	38	30	23	16/11
Searing	65	63	50	38	26/18
Sen	80	76	61	46	32/22
Seroco lfs, ls	35	33	26	20	14/10
Sham l	45	43	34	26	-/-
Shambo	85	80	64	48	34/24
Sinai sicl	95	90	72	54	38/26
Sinnigam	30	28	22	17	12/8
Sinnigam, very stony	15	14	11	8	6/4
Southam	0-50	-	-	-	-/-
Square Butte	88	83	68	49	
Stady	60	57	46	35	24/17
Stirum sl, fsl	20	-	-	-	-/-
Stirum, ponded	10	-	-	-	-/-
Straw	95	90	72	54	38/26
Straw, channeled	20	20	-	-	-/-
Straw variant	70				
Sutley sil	60	57	46	35	24/17

Soil Series	Slope Group				
	A	B	C	D	E-F
Tally fsl, sl	65	63	50	38	26/18
Tansem	85	80	64	48	-/-
Telfer fsl, sl	50	48	38	29	20/14
Telfer, lfs, ls	40	38	30	23	16/11
Temvik	85	80	64	48	34/24
Tiffany sl, fsl, vfsl	30-75	-	-	-	-/-
Tiffany l, sil	30-85	-	-	-	-/-
Toby	55	43	42	32	
Tonka	40-85	-	-	-	-/-
Trembles fsl, sl	65	63	-	-	-/-
Tusler fsl, sl	45	43	36	30	24/20
Ustorthents	40	38	30	23	16/11
Vallers	40-70	-	-	-	-/-
Vallers, saline	35	-	-	-	-/-
Vallers, very stony	35	-	-	-	-/-
Vanda sicl	25	24	19	14	11/7
Vebar fsl, sl	60	57	46	35	24/17
Vebar l	70	67	54	41	28/20
Vebar, stony	33	31	25	19	13/9
Velva fsl, sl, vfsl	70	67	-	-	-/-
Velva l, cl	80	76	-	-	-/-
Velva, saline	35	-	-	-	-/-
Velva, channelled	20	20	-	-	-/-
Wabek l	35	33	26	20	14/10
Wabek, very stony	13	12	9	7	6/4
Wanagan	60	57	46	35	24/17
Watrous	65	63	50	38	26/18
Wayden sicl, cl	35	33	26	20	14/10
Wayden, very stony	15	14	11	9	6/4
Werner	45	43	34	26	18/12
Wet alluvial	40				
Williams	90	85	68	51	36/25
Williams, very stony	45	43	34	26	18/12
Williams, mine sink	20				
Wilton	95	90	72	54	-/-
Wolf Point sicl	85	80	-	-	-/-
Yawdim sicl, cl	35	33	26	20	14/10
Yegen l	85	80	64	48	34/24
Yetull fsl, sl	40	38	30	23	16/11
Zahill	50	48	38	29	20/14
Zahl	60	57	46	35	24/17
Zahill	50	48	38	29	20/14
Zahl	60	57	46	35	24/17

**Cropland Table 2.** Calculated average county cropland PI based on yield ratings for soil mapping units and acres of each soil mapping unit rated for cropland in the county (NRCS, Web Soil Survey, 2017).

<b>County</b>	<b>Calculated Average County Cropland PI (%)</b>
Southwest District <sup>1</sup>	62.5 (62.54)
Adams	64.4 (64.41)
Bowman	63.8 (63.79)
Stark	60.0 (59.98)
West Central District <sup>2</sup>	71.0 (71.04)
McLean	75.8 (75.79)
Mercer	73.0 (72.98)
Oliver	73.1 (73.07)

1. NDAS Southwest Agricultural Statistics District consisting of Adams, Billings, Bowman, Golden Valley, Hettinger, Slope and Stark counties
2. NDAS West Central Agricultural Statistics District consisting of Dunn, McKenzie, McLean, Mercer, and Oliver counties

**Hayland Table 1.** Soils key for pasture and hayland Forage Suitability Groups (FSG) in Major Land Resource Areas 53B and 54 in North Dakota (NRCS 2015).

This table lists the forage suitability groups for soil series commonly found in the NRCS soil survey information for coal mining counties in North Dakota. A soil series may be assigned to a different forage suitability group for some soil survey map units based on the slope range, landscape position or other characteristic. The pre-mine soil survey report should identify the forage suitability group interpretation for any soil map unit that would be more appropriately assigned to a group other than that listed in the table.

Soil Series	FSG	Soil Series	FSG	Soil Series	FSG
Absher	NS	Grassna	Lm	Reeder	DyLm
Amor	DyLm	Hamar *	W	Regan *	W
Arikara	NS	Hamerly *	Sb	Regent	CyS
Arnegard	Lm	Hanly	VDL	Rhame (Slope < 9%)	VDL
Arveson *	W	Harriet	NS	Rhoades	NS
Banks	Sa	Havre	Lm	Ringling	NS
Bearpaw	CyS	Havrelon	Lm	Roseglen	Lm
Beisigl	Sa	Heil	NS	Ruso	DyLm
Belfield	CyS	Janesburg	Cp	Sakakawea	LiUp
Benz	NS	Kniferiver	Lm	Savage	CyL
Bowbells	Lm	Korchea	Lm	Schaller (Slope < 6%)	VDL
Bowdle	DyLm	Kratka *	W	Searing	DyLm
Boxcut	Lm	Krem	Sa	Sen	DyLm
Boxwell	DyLm	Kremlin	Lm	Seroco	NS
Brandenburg	NS	Ladner	NS	Sham	CP
Breien	VDL	Lallie *	W	Shambo	Lm
Bryant	Lm	Lamoure *	W	Sinnigam	NS
Cabba	NS	Lawther	CyS	Southam	NS
Cabbart	NS	Lefor	DyLm	Square Butte	Lm
Chama	LiUp	Lehr	VDL	Stady	DyLm
Chanta	DyLm	Lihen	Sa	Straw	Lm
Cherry	LiUp	Linton	Lm	Tally	DyLm
Chinook	DyLm	Livona	Lm	Tansem	Lm
Cohagen	NS	Lohler	Ov	Telfer	Sa
Coleharbor	Lm	Ludden *	W	Temvik	Lm
Colvin *	W	Magnus	CyS	Tonka	W
Daglum	Cp	Makoti	Lm	Trembles	DyLm
Desart	VDL	Mandan	Lm	Tusler	Sa
Dilts	NS	Manning	VDL	Vallers *	W
Dimmick	NS	Marmarth	Lm	Vanda	NS
Divide	Sb	Marysland *	W	Vebar (Slope < 9%)	VDL
Dogtooth	NS	Max	Lm	Velva	Lm
Dooley	Lm	McKenzie *	W	Virgelle	VDL
Dragline *	W	Minnewaukan *	W	Wabek	NS
Ekalaka	Cp	Miranda	NS	Wanagan	DyLm
Falkirk	Lm	Moreau	CyS	Watrous (Slope < 6%)	DyLm
Farland	Lm	Morton	DyLm	Wayden	NS
Farnuf	Lm	Niobell	CyS	Werner	NS
Felor	Lm	Noonan	Cp	Williams	Lm
Flasher	NS	Nutley	CyS	Wilton	Lm
Flaxton	Lm	Oburn	NS	Wolf Point	CyS
Fleak	NS	Omio	Lm	Yawdim	NS
Glendive	DyLm	Parnell	NS	Zahill	LiUp
Golva	Lm	Parshall	Lm	Zahl	LiUp
Grail	CyS	Patent	LiUp	Zeeland	Ov
		Playmoor	Sal	Zeona	NS

\* For map units with "saline" or "very poorly drained" modifier use "Saline" or "Not Suited" group respectively



**Hayland Table 2.** Hayland yield estimates (t/ac) by Forage Suitability Groups in Major Land Resource Areas 53B and 54 (NRCS 2015).

The production estimates listed represent total annual above ground plant production on an air-dry-matter basis. Estimates of hay yields can be calculated from these numbers by multiplying them by a harvest efficiency. A 70 percent harvest efficiency is commonly used when converting to hay yields. (NRCS, Section II – FOTG, Forage Suitability Interpretations, 2015)

SUITABILITY GROUP	MLRA 53B		MLRA 54	
	High <sup>1</sup>	Median <sup>2</sup>	High <sup>1</sup>	Median <sup>2</sup>
Clayey Subsoil (CyS)	2.70	2.05	2.45	1.78
Claypan (Cp)	1.80	1.36	1.67	1.23
Droughty Loam (DyLm)	2.50	1.85	2.30	1.68
Limy Upland (LiUp)	2.48	1.83	2.30	1.65
Loam (Lm)	3.55	2.55	2.70	1.93
Overflow (Ov)	3.85	2.83	3.60	2.53
Saline (Sal)	2.08	1.58	1.70	1.29
Sand (Sa)	1.80	1.35	1.60	1.20
Steep Loam (SpLm)	2.50	1.85	2.36	1.72
Subirrigated (Sb)	4.15	2.98	3.70	2.60
Very Droughty Loam (VDL)	1.25	0.96	1.12	0.83
Very Shallow to Gravel (VSG)	1.25	0.96	1.12	0.83
Wet (W)	4.08	3.00	3.80	2.75
Not Suited (NS)	0.62	0.48	0.56	0.42

1. High management intensity level yield in tons/acre
2. Median management intensity level yield in tons/acre

The yield estimates provided in Hayland Table 2 were determined by calculating the average of the production estimates for all forage types listed in the NRCS Forage Suitability Interpretations. The high-level value is based only on the NRCS high management intensity estimates while the median-level value uses the production estimates for both the high and low management levels. The yield estimates provided for the median level of management in Hayland Table 2 were determined by using the median of the yield range estimates provided in the NRCS Forage Suitability Interpretations for the high and low management intensity. The yield estimate for an intermediate management level was developed to reflect what appears to best describe the management which is most commonly used on reclaimed pasture and hayland in North Dakota. The low management intensity level does not apply to reclaimed lands since they should not be overgrazed or improperly managed. Estimated values are included for those soil groups that are not suited for pasture or hayland. These values were derived using 50% of the yield for the least productive forage suitability groups which are the very droughty loam and very shallow to gravel suitability groups.

## II-D NATIVE GRASSLAND

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## **D. NATIVE GRASSLAND**

### **Definition**

Native grassland, as defined in NDAC 69-05.2-01-02, means land on which the natural potential plant cover is principally composed of native grasses, grass-like plants, forbs, and shrubs valuable for forage and is used for grazing, browsing, or occasional hay production. Land used for facilities to support ranching operations, which is adjacent to or an integral part of these operations is also included.

### **Requirements for Successful Revegetation**

According to NDAC 69-05.2-22-02(3) when the approved postmining land use is native grassland, the permittee shall select species of grasses, legumes, forbs, half-shrubs or shrubs seeded or planted and their pattern of distribution, to provide a diverse, effective, and permanent vegetative cover with seasonal variety, succession, and regenerative capabilities native to the area. Following establishment of vegetation, comparisons must be made between the reclaimed land and either a reference area or an approved standard. During the responsibility period, controlled grazing of the reclaimed native grasslands is highly encouraged. However, initial grazing plans must be approved by the PSC (NDAC 69-05.2-22-06).

Reference areas or approved standards must be used to verify that productivity, cover, diversity, seasonality and permanence of the reclaimed land equal or exceed that of similar agricultural lands in the surrounding area under equivalent management (practices which are similar but may have site specific requirements incorporated) (NDAC 69-05.2-22-01). For third-stage bond release, ground cover (limited to live perennial species not detrimental to the land use, and litter) must be equal to or greater than that of the reference area or approved standard with 90 percent statistical confidence [NDAC 69-05.2-22-07(3)(a)].

For fourth-stage bond release, productivity and ground cover must be equal to or greater than that of the reference area or approved standard. Demonstration of equivalence for both productivity and ground cover must be made with 90% statistical confidence for herbaceous vegetation in any two years after year six of the responsibility period [NDAC 69-05.2-22-07(4)(a) and (l)].

Additionally, diversity, seasonality, and permanence of reclaimed native grassland should be equivalent to that of the approved standard; however, these parameters do not require statistical comparisons.

### **Premining Assessment**

The following information is required as a part of the permit application package [NDAC 69-05.2-08]:

1. Delineate and identify on a map or aerial photograph of 1:4800 scale [NDAC 69-05.2-08-08(l)(a)]:

- a. All native grassland tracts within the proposed permit area;
  - b. All ecological sites; and,
  - c. Soil mapping units.
2. Tabulate total acreage of each ecological site for each surface owner within the proposed permit area [NDAC 69-05.2-08-08(1)(c)(1)].
  3. Compile a comprehensive list of all vascular plants [NDAC 69-05.2-08-08(1)(b)]. Special effort must be made to include information from all mapping units in the permit area. Recommended nomenclature found in Flora of the Great Plains (1986) or a newer similar source should be used. The species list must:
    - a. Include scientific names; and,
    - b. Identify any rare, endangered, poisonous, or noxious plants (if no such species are found, a statement to that effect should be made).
  4. Provide the following information for all ecological sites:
    - a. Annual production [NDAC 69-05.2-08-08(1)(c)(2)]; and,
    - b. Similarity index as a percent departure from the climax reference plant community using methodology described by NRCS in the National Range and Pasture Handbook (2003). [NDAC 69-05.2-08-08(1)(c)(3)]. The permit application must include the results of sampling that is done to determine similarity index, including the list of species composition. Double sampling (estimating and harvesting) techniques may be used as outlined in the National Range and Pasture Handbook and grazing adjustment factor(s), air dry percentages and growth curve information must be provided (NRCS CPA-33 Forage Production Clipping Worksheet).
  5. Provide a detailed narrative describing the nature and variability of the vegetation of all ecological sites [NDAC 69-05.2-08-08(1)(d)].
  6. For reference areas, which will be used to assess revegetation success, provide a brief description indicating which ecological sites will be represented, the proposed area where they will be located, and a narrative describing the general condition of the area. At the time equivalent management practices commence [NDAC 69-05.2-08-08(2)]:
    - a. Provide the number of reference areas and approximate size of each;
    - b. Delineate each reference area on a map of 1:4800 scale, or of sufficient scale to accurately show field location and boundaries; and,
    - c. Demonstrate that the proposed reference areas adequately characterize the ecological sites which they propose to represent by:
      - (1) Inventorying vegetation parameters on the reference area including:
        - A. Annual production;
        - B. Ground cover (basal or first-hit); and,
        - C. Similarity index as a percent departure from the climax reference plant community using methodology described by NRCS (2003).

The list of species composition by weight used to determine similarity index must be included.

- (2) Providing a comparison of reference area data [NDAC 69-05.2-08-08(2)(c)] with:
  - A. NRCS ecological site descriptions and estimated production values for the premine ecological sites represented;
  - B. Qualitative assessment of premine cover values;
  - C. Premine native grassland similarity index; and,
  - D. Conduct a field inspection with Commission personnel.

### **Postmining Assessment**

#### **Third-stage bond release**

The following information should be submitted for each reclaimed tract when making third-stage bond release requests:

1. An aerial photo of adequate scale which delineates the postmining native grassland tract(s) proposed for bond release [NDAC 69-05.2-12-12 (4)].
2. A narrative which includes the seed mix and seeding rate and describes methods used for seedbed preparation and seeding. Include information on all management practices prior to and following seeding (e.g. fertilization, weed control, burning) [NDAC 69-05.2-12-12 (10)].
3. A demonstration of adequate establishment of vegetation by quantitative measurement of cover [NDAC 69-05.2-12-12 (7)]. Cover data must include composition by species, litter and a measure of bare ground. Data submitted must include absolute cover values. Relative cover may also be submitted to aid in data interpretation. Data should be submitted in tabular form, and the table heading must include information on sampling method, location, sample size, and sampling date.
4. A map, which identifies the locations of sampling transects, or the sampling areas and number of randomly located sample units per area, whichever method is used.
5. All other information as required by NDAC 69-05.2-12-12.

#### **Revegetation Success standards for third-stage bond release**

The technical standard for evaluating ground cover is based on ARS research conducted by Hofmann et al. (1983) and Ries and Hofmann (1984) on reclaimed grasslands in North Dakota. According to Ries and Hofmann, erosion from reclaimed grasslands is similar to that of undisturbed native grassland when total cover is 73% or greater, based on basal hits measured with a point frame; or when total cover is 83% or greater, based on first-hits measured with a point frame. Therefore, for third-stage bond release, the reclaimed tract must have at least 73% total cover (live + litter), based on basal hits; or 83% total cover (live + litter), based on first-hits.

Live cover included in the standard must be perennial species not detrimental to the land use [NDAC 69-05.2-22-07(3)(a)].

Either standard must be achieved with 90% statistical confidence. In statistical calculations, a standard deviation of  $\pm 18$  for basal cover and a standard deviation of  $\pm 16$  for first-hit cover should be used for ARS data. These values are based on a sample size of 60 10-point frames (Hofmann, personal communications 1987). Calculations of standard deviation for the reclaimed tract must be based on the same methodology, i.e., use of one 10-point frame as the sample unit. A field inspection is required at this time.

#### **Fourth-stage bond release**

The following information should be submitted for each reclamation tract when making fourth-stage bond release requests:

1. An aerial photo of adequate scale, which delineates postmining native grassland tract(s) proposed for bond release. The aerial photo must depict ownership boundaries if separate landowners are involved, and for each landowner any site type units if a stratified sampling procedure was used. Provide in tabular form the acreages of site type units for each land-ownership within the reclaimed tract.
2. An aerial photo of adequate scale, which delineates the area soil-mapping units and ecological sites that were used to develop the standard.
3. An aerial photo of adequate scale, which delineates all corresponding reference areas and their soil-mapping units, which were used to develop the standard.
4. A narrative, which includes the soil replacement thicknesses, seed mix and seeding rate, and describes methods used for seedbed preparation and seeding. Include information on all management practices prior to and following seeding (e.g., fertilization, weed control, burning.)
5. Data and calculations which demonstrate that productivity and ground cover are equal to or greater than (with 90% statistical confidence) the approved standard in any two years after year six of the responsibility period. Production data must be provided by growth form (refer to Section III-D). Cover data must include composition by species, litter and a measure of bare ground. Data submitted must include absolute cover values. Relative cover may also be submitted to aid in data interpretation. All data should be submitted in tabular form, and the table heading must include information on sampling method, location, sample size, and sampling date.
6. A map, which identifies the locations of sampling transects, or the sampling areas and number of randomly located sample units per area, whichever method is used.
7. Information which is required to demonstrate that diversity, seasonality and permanence are equivalent to the approved standards. A complete list of all species present on each reclaimed tract during the years sampling was conducted to demonstrate revegetation success.
8. All other information as required by NDAC 69-05.2-12-12.

### **Revegetation Success Standards for fourth-stage bond release**

Vegetation data collected from reference areas may be used as the criteria for evaluating production and cover on reclaimed native grasslands. In this case, all areas in the premine tract must be represented by an appropriate reference area and direct comparisons made using weighted averages. However, since rangeland in North Dakota typically has a diverse landscape, which is dissected into several units or ecological sites (which often do not include large acreages), this type of assessment would require a large number of reference areas. Therefore, the following technical standards may be applied to reclaimed native grasslands, provided the dominant premining native grassland ecological sites are represented by reference areas to adjust data for climatic variation. In addition, technical standards have been developed for species diversity and seasonality. Although reference areas are not required for the diversity and seasonality standards, assessing diversity and seasonality based on production or cover data from the reference areas will be useful to justify any request for a variance from the technical standards.

A reference area is defined in NDAC 69-05.2-01-02 as a land unit maintained under appropriate management for the purpose of measuring vegetation ground cover, productivity and plant species diversity that are produced naturally (in the case of native grasslands). Reference areas must be representative of the geology, soil, slope and vegetation in the permit area. An ecological site, as defined by the NRCS is: “a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation” (NRCS National Range and Pasture Handbook – 2003). An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind or proportion of species or total production. Therefore, reference areas selected on the basis of ecological sites meet all the environmental criteria (i.e., geology, soil, slope and vegetation) that are required for proper selection of reference areas. In addition, ecological sites are also the required mapping units for premine native grassland assessments. Soils of the reference area must be mapped by a professional soil classifier to verify the soil mapping unit(s).

Selection of reference areas should be made by demonstrating that they adequately represent the premining areas, and are typical of the rangeland found in the area. Selection should be based on:

1. Proper representation of the premine area by ecological sites;
2. Proper representation of the premine area by soil series;
3. Similarity of the reference area's actual production to NRCS ecological site description production values (NRCS 2012) and those listed in Grassland Table 2
4. Similarity of the reference area's ecological condition/similarity index to that of the premine area; and,
5. Proximity to the permit area.

The ecological condition of reference areas should represent the current condition of lands in the surrounding area or be similar to that of the corresponding premine ecological site. It is recommended that management practices, which will maintain or improve the ecological condition of the reference area be used during the liability period. Management of the reference area should be equivalent in effect to that required for the approved postmining land use of the permit area, and reference areas and reclaimed areas must receive management that is equivalent in effect during the responsibility period as required by NDAC 69-05.2-22-07(1). Treatments such as grazing, haying, or burning must be based on site-specific requirements. Reference areas must be approved by the Commission prior to their establishment. The Reclamation Division should be consulted prior to using reference areas in reduced ecological condition for the purpose of final bond release. In some instances, it might be necessary to adjust the NRCS values listed in Native Grassland Table 2 to account for plant community changes that would result in an artificially low climatic adjustment factor. In other instances, it might be appropriate to use NRCS high or low productivity values rather than the representative value during years of excessive or an absence of moisture during the growing season.

Finally, reference area data and values from NRCS or ARS data (when required for a technical standard) for each ecological site are weighted by corresponding premine acreage to develop a standard for each parameter (production and ground cover) for comparison with the reclaimed native grassland. The reclaimed native grassland must be delineated by landowner and into site types if any recognizable differences in vegetation are noted. Vegetation parameters should be measured on all site types. Weighted average values should be calculated based on total acreage of each site type. Adequacy of sample numbers for measurements of total cover and total production should be estimated for each sampling unit (ecological sites for reference areas and site types for the reclaimed area).

## **PRODUCTION**

Productivity standards for reclaimed native grasslands can be derived utilizing NRCS ecological site production values in conjunction with reference area data to correct for climatic variation. Native Grassland Table 1 lists the soil series in Major Land Resource Areas 53B and 54 in North Dakota (NRCS-2015) and identifies the corresponding ecological site. Native Grassland Table 2 provides the mean grass and forb yield value of native grassland ecological sites in Major Land Resource Area (MLRA) 53B and 54. Ecological sites and associated mean grass and forb values will need to be established for permitted areas lying outside of Major Land Resource Areas 53B and 54.

A minimum of one reference area is required for each bond release tract to adjust the standard for climatic variation. It is recommended, however, that reference areas be established and maintained for all predominant premine ecological sites and that data from as many reference areas as possible be utilized to create an annual climatic adjustment factor. Using all reference areas will help capture the vegetative growth effects of seasonal precipitation variability and will improve representation of ecological condition of undisturbed lands in the area. For example, using only a loamy site to develop the correction factor may not be appropriate since warm season species are generally not well represented on the site and yet a variety of warm season species are generally seeded on reclaimed native grassland. The vegetative growth effects of a dry spring and wet summer would not be appropriately factored



into the climatic adjustment factor if only cool season species are being used to calculate the climatic adjustment factor.

To derive the productivity standard for a given reclaimed native grassland tract, a climatic correction factor is calculated by dividing the actual production of the reference area by the ecological site's expected grass and forb yields in Grassland Table 2. A mean climatic correction value is then calculated from the individual reference area values. Values from the predominant premine sites should be used to develop the climatic correction factor. The NRCS production values of the ecological sites present in the premine tract are then multiplied by the correction factor to obtain corrected production values. These values are weighted by the premine acreage of each ecological site. The summation of all these yields divided by the tract acreage is the target value.

### Example

Assume a 31-acre native grassland tract, in Major Land Resource Area 54 (Native Grassland Figure 2), which consisted of 5 acres Arnegard wet (Loamy Overflow) soil series/ecological site), 1 acre Belfield (Clayey), 2 acres Cabba (Shallow Loamy), 21 acres Amor (Loamy), and 2 acres Rhoades (Thin Claypan) soil series in its premine condition.

Step 1:

#### Calculate a climatic correction factor (CF).

In this example, a mining company has five native grassland reference area sites. The Loamy site produced 1850 lbs/ac, the Clayey 1675 lbs/ac, the Claypan 1225 lbs/ac, a Sandy site that produced 2050 lbs/ac and a Shallow Loamy site that produced 1200 lbs/ac. The native grassland climatic correction factor may be calculated as follows, or the dominant pre-mine sites of the tract may be used to calculate the climatic correction factor.

Divide the actual production measured on each reference area site by the NRCS production value estimate as listed in Native Grassland Table 2. Then calculate the mean value by dividing the sum of the values by the number of reference areas used. In this example,  $Loamy\ 1850/2330 + Clayey\ 1675/2060 + Claypan\ 1225/1460 + Sandy\ 2050/2320 + Shallow\ Loamy\ 1200/1350 = (0.79 + 0.81 + 0.84 + 0.88 + 0.89)/5 = 0.842$ . Therefore, the correction factor is 0.84 if all reference areas are given equal weight. The correction factor would be 0.79 if only the dominant premine site (loamy) was used.

Step 2:

In tabular form indicate acreages of ecological sites and soil series, which existed in the premine tract. List the appropriate production values for each ecological site from Native Grassland Table 2, and multiply these by the correction factor (CF) to obtain their adjusted production values:

Premine Information

<u>Ecological site/soil series</u>	<u>acres</u>	<b>NRCS Production (lb/ac)</b>	<b>CF</b>	<b>Production (lbs)</b>
Clayey/Belfield	1	2060	0.84	1730
Loamy/Amor	21	2330	0.84	41101
Loamy Overflow/Arnegard	5	3020	0.84	12684
Shallow Loamy/Cabba	2	1350	0.84	2268
Thin Claypan/Rhoades	2	780	0.84	1310
<b>TOTAL</b>	<b>31</b>			<b>59093</b>

Step 3:

Divide the weighted production by the total acreage to obtain the standard in lb/ac:

$$59093 \text{ lbs} / 31 \text{ ac} = 1906 \text{ lbs/ac}$$

It is acceptable to use individual reference area correction factors for premine sites represented by reference areas. In this example, site specific reference area data could be used for the loamy, clayey and shallow loamy sites, which would result in an adjusted standard of 1,829 lbs/ac.

Step 4:

The standard must be calculated for comparison with the actual yield from the reclaimed tract in each of the growing seasons that such comparisons are made for final bond release purposes.

**COVER**

A cover standard for a reclaimed native grassland tract can be derived by utilizing cover data from a representative reference area in conjunction with a fixed standard based on ARS (Hofmann et. al. 1983 and, Ries and Hofmann 1984). The ARS standard is based on the cover required to adequately protect grassland areas from erosion (i.e. 73% basal cover or 83% first-hit cover).

A minimum of one reference area is required for each bond release tract to ensure cover is similar to that occurring in natural vegetation of the area. Reference areas used must be representative of the premine soil(s), or the soil of the reclaimed tract. The soil of the reclaimed tract may be characterized by an evaluation of the premine soil survey data and the expected mixing that will occur, or by a field analysis of respread soils. This will eliminate the need for representing ecological sites which are extremely shallow or those with restrictive layers because soils of reclaimed areas tend to be more homogeneous. In most cases, the reference area may be limited to a sandy, loamy or clayey ecological site or, whichever is most representative of the reclaimed tract. If a loamy, sandy, or clayey ecological site was not present in the premine acreage, the cover value from the reference area most similar to the predominant range site

should be used. For example, if a premine sandy ecological site is predominant, the cover value of the sandy ecological site reference area should be weighted by the premine sandy ecological site acreage. This methodology assumes that the predominant premine ecological site will contribute most to the soil characteristics of the reclaimed tract. Cover for premine ecological sites not represented by the reference area will be represented by ARS data (i.e., total ground cover of 73% basal or 83% first-hit.) Cover values must be weighted by the representative premine ecological site acreage, or the soil of the reclaimed tract if that method is being used.

**Example using basal cover (10-point frame) measurement**

Assume a 31-acre reclaimed native grassland tract, which consisted of 5 acres loamy overflow, 1 acre clayey, 2 acres shallow loamy, 21 acres loamy and 2 acres thin claypan ecological sites. A reference area has been established on a loamy ecological site since this was the predominant premine site and the soils of the reclaimed native grassland would simulate this condition.

Step 1:

In tabular form list premine ecological sites and acreages:

<b>Ecological Site</b>	<b>Acres</b>	
loamy overflow	5	
clayey	1	(represented by reference area)
shallow loamy	2	
loamy	21	(represented by reference area)
thin claypan	<u>2</u>	
	31	

Step 2:

Measure cover values of the reference area and summarize (values which follow are assumed):

<u><b>Basal cover (%)</b></u>			
<u><b>Ecological area</b></u>	<u><b>Live</b></u>	<u><b>Litter</b></u>	<u><b>Bare</b></u>
Loamy	6	93	1
Clayey	7	93	0

Step 3:

Weighted cover values by premine range site acreages (total x acres), using reference area data and ARS standard value (73% in this example since basal points are used), and divide by the total acreage to derive a per acre cover value:

<u>Area</u>	<u>Cover</u>			<u>Acreage</u>	<u>Weighted Cover</u>
	<u>Live</u>	<u>Litter</u>	<u>Total</u>		
Loamy reference area	6%	93%	99%	21	2079
Clayey reference area	7%	93%	100%	1	100
Other ecological sites			73%	<u>9</u>	<u>657</u>
				31	2836

$$2836 / 31 = 91.5\% \text{ total basal cover (live + litter)}$$

Therefore, the approved standard in this example (using basal cover) is 91.5% total ground cover.

Step 4:

The mean total basal cover value from the reclaimed tract is compared to the standard in each of the growing seasons that such comparisons are made for final bond release purposes. All species used in determining ground cover revegetation success must be perennial species not detrimental to the land use [NDAC 69-05.2-22-07(3)(a)].

## **REQUIREMENTS FOR DIVERSITY AND SEASONALITY**

The presence of adequate plant species diversity in the reclaimed native grasslands is of much importance because it reflects environmental/community stability and ensures some degree of sustainability under the intended land use. Both cool and warm season grass species and forbs are important and needed in native grasslands. Therefore, reclaimed native grasslands must be established with both cool and warm season native grass species and other appropriate plant species in the approved seed mixtures. The diversity and seasonality standards that follow require that either production or cover data be used to show that the standards have been achieved. However, the same methodology must be used when measuring both diversity and seasonality in each of the years these measurements are taken on a given tract.

For final bond release, the permittee must demonstrate that at least five native grass species are present on the reclaimed tract using ground cover or production data (weight). The relative composition of all warm season grasses must be at least 15%. Four native grass species must each contribute at least 3% relative live basal cover or at least 5% relative composition by weight during the years sampling data is used for final bond release purposes. Of these four species, at least two must be warm season grasses and at least one must be a cool season grass. For each sampling year that is used to prove reclamation success, the permittee must also show that a fifth native grass species is present based on the sampling data and a species list must show that at least three native forbs species are present. Non-native species included in the approved seed mixture may be counted towards meeting these diversity and seasonality standards.

The following table provides an example of a prospective bond release tract that would be considered to have met the above mentioned standards for diversity and seasonality in a given year. Although the diversity and seasonality standards can be demonstrated using either live basal cover or plant weight data, this example shows that standards have been met using either method. There are 7 (based on cover) or 8 (based on weight) native grass species (5 required) in the tract. Of these, 4 are present in sufficient quantities (i.e., each of them exceeds 3% cover or 5% weight requirement) to be considered countable for meeting the 4 species standard. The tract contains 3 countable warm season grass species (2 required) and 1 cool season grass species as minimally required. The production sampling data shows that one native forb species was present (and a species list shows that two other native forbs species are present). The warm season grass species constitutes 52% of live basal cover, or 41% of vegetation by weight, when 15% is required to meet the seasonality standard. Thus all components of the diversity and seasonality standards for the tract are met.

Vegetation Composition Group/Species	Diversity / Seasonality Based on Cover				Diversity / Seasonality Based on Weight			
	% Cover Composition		Diversity (3% or greater count)	Seasonality (cool: warm)	% Weight Composition		Diversity (5% or greater count)	Seasonality (cool: warm)
	by species	by group			by species	by group		
<b>Native Cool Season Grasses</b>								
Western Wheatgrass	16		1		21		1	
Green Needlegrass	2		0		4		0	
Slender Wheatgrass	2		0		3		0	
<b>All cool season native grasses</b>		<b>20</b>	<b>1</b>	<b>20</b>		<b>28</b>	<b>1</b>	<b>28</b>
<b>Native Warm Season Grasses</b>								
Sideoats Grama	28		1		13		1	
Switchgrass	16		1		16		1	
Big Bluestem	7		1		10		1	
Blue Grama	1		0		1		0	
Little Bluestem	0		0		1		0	
<b>All warm season native grasses</b>		<b>52</b>	<b>3</b>	<b>52</b>		<b>41</b>	<b>3</b>	<b>41</b>
<b>Native shrubs/half-shrubs &amp; Forbs</b>	1	1	0	0	3	3	0	0
<b>Total number of native grass sps.</b>	<b>7</b>				<b>8</b>			
Number of native grass species exceeding 3% cover or 5% wt			<b>4</b>				<b>4</b>	

The Commission may suitably modify these diversity and seasonality standards based on a demonstration that:

1. Natural fluctuations in diversity or seasonality due to climate or other factors have occurred. The permittee must demonstrate that similar fluctuations have occurred on the reference area(s) used to establish the cover or production standards; or
2. Data collected during the responsibility period indicate a trend towards a diverse community. Based on the history of applied management and appropriate species composition data; the permittee must demonstrate that diversity counts on the reclaimed tract are approaching the standard.

The Commission may also suitably modify these diversity and seasonality standards in instances where the mining company is attempting to increase reclaimed grassland site type diversity through topographic variability within a tract. Modified diversity and seasonality standard must be specified in the approved permit and pre-determined based upon the detailed reclamation plan for the tract.

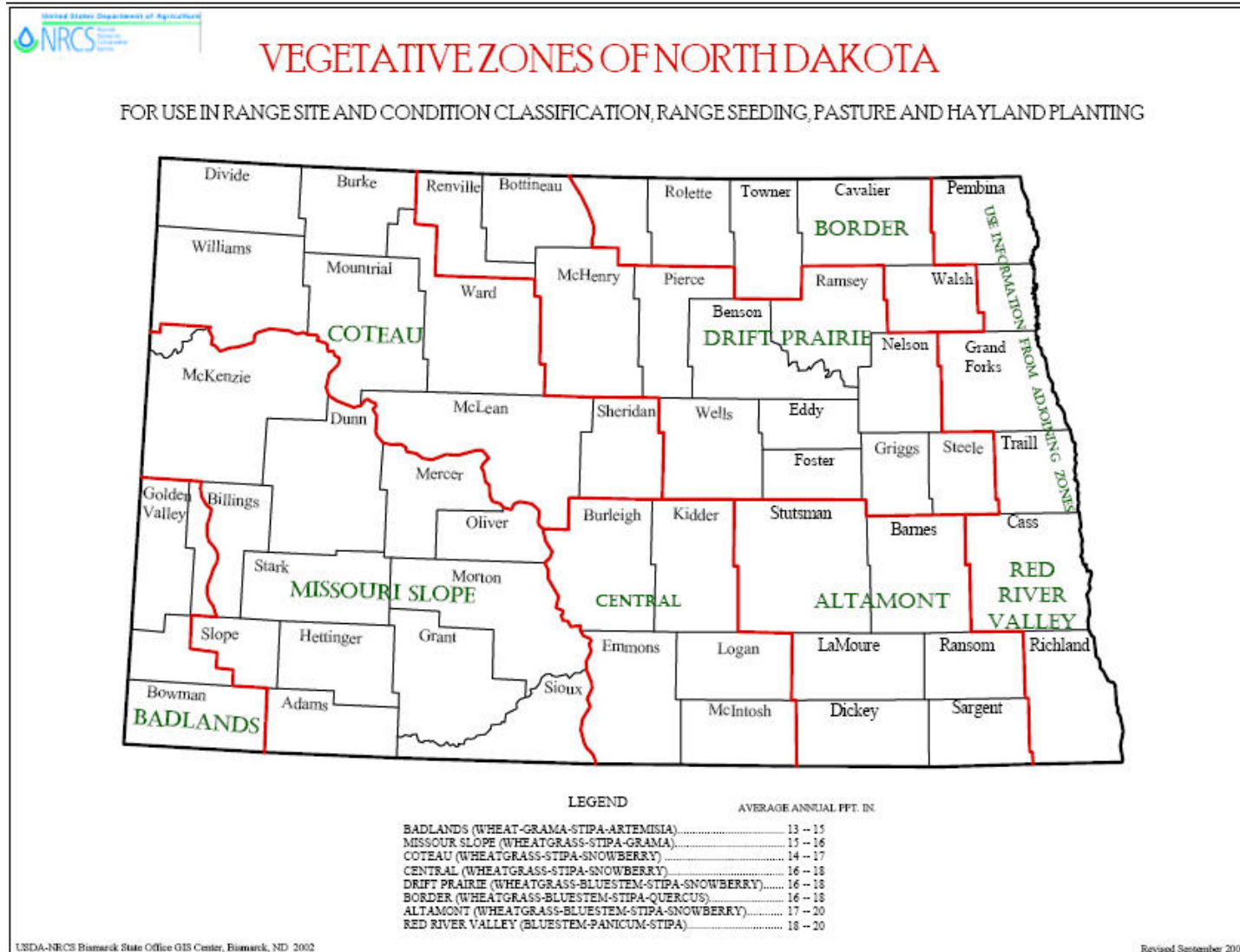
#### **PERMANENCE**

Ground cover, productivity, diversity and seasonality data will be used to assess the permanence of established vegetation.

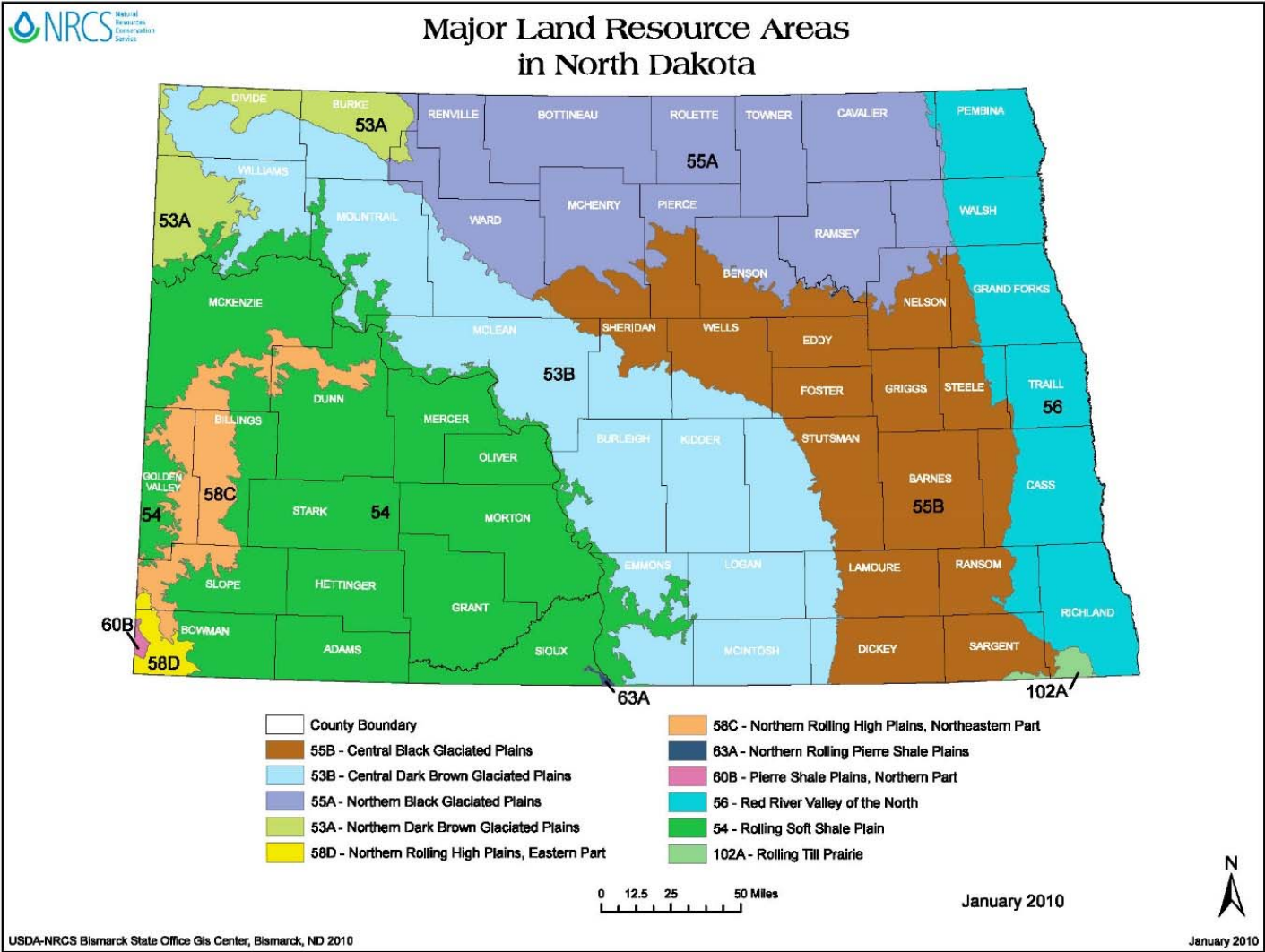
The revegetation responsibility period of ten years will provide sufficient time to prove vegetation establishment and regeneration; therefore, by meeting all other requirements for fourth-stage bond release, permanence will be deemed achieved.

# NATIVE GRASSLAND II-D-13

**Native Grassland Figure 1.** Vegetation zones of North Dakota, for use in range site and condition classification, and range seeding, and hayland plantings. (NRCS, 2009).



Native Grassland Figure 2. Major Land resource areas of North Dakota (NRCS 2010).





**Native Grassland Table 1: Soil Series Ecological Site**

**Soil Series Ecological Site (ES) for MLRA's 53B and 54**

Soil Series & Phase	MLRA	
	53B	54
Amor		Ly
Arikara		
Arnegard, saline		SL
Arnegard, wet	LyOv	LyOv
Arnegard, 0-3% slopes	Ly	Ly
Arnegard, 3-20% slopes	Ly	Ly
Arveson, poorly drained	WM	Sb
Arveson, very poorly drained	WL	Sb
Aquolls	WL	-
Aquolls, saline	-	-
Baahish	-	VS
Banks, commonly flooded	?	?
Banks, none rarely flooded	Sa	LyOv
syBearpaw	Cy	-
Beisigl	-	LSa
Belfield	Cy	Cy
Belfield, saline	-	SL
Bowbells, 0-3% slopes	LyOv	LyOv
Bowbells, 3-6% slopes	Ly	Ly
Bowdle	Ly	Ly
Brandenburg	-	VS
Breien, commonly flooded	-	Sy
Breien, rarely flooded	-	SyT
Brisbane	-	Ly
Bryant	Ly	-
Cabba	SwLy	SwLy
Chama	-	Tly
Cherry	-	TLy
Cohagen	SwSy	SwSy
Colvin, saline	WM	WM
Daglum Variant	Cp	Cp
Daglum, saline	-	SL
Desart	-	Sy
Dimmick	WL	WL
Divide	LSb	-
Divide, saline		
Dogtooth	-	TCp
Ekalaka	-	SyCp
Exline	TCp	-
Falkirk	Ly	Ly
Farland	-	Ly
Farnuf	Ly	Ly
Felor	-	Ly
Flasher	SwSy	SwSy
Flaxton, fsl, sl	Sy	Sy
Flaxton, lfs, ls	Sy	
Glendive, commonly flooded	-	?
Glendive, non-rarely flooded		SyT
Golva	-	Ly
Grail, saline		SL
Grail, 0-3% slopes	LyOv	Cy
Grail, 3-9% slopes	Cy	Cy
Grassna Variant		SL
Grassna, saline	?	SL
Grassna, 0-3% slopes	?	?
Grassna, 3-6% slopes	Ly	Ly
Hamerly	LSb	Sb

Soil Series & Phase	MLRA	
	53B	54
Hamerly, saline	SL	-?
Harriet	SL	SL
Harriet Variant	-	-
Havrelon Variant		Sb
Havrelon, commonly flooded		LyOv?
Havrelon, none-rarely flooded	LyOv	Ly
Havrelon, saline		
Heil	CD	CD
Hidatsa	-	Ly
Janesburg	-	Cp
Korchea, channeled	LyOv	LyOv?
Korchea, commonly flooded	-	?
Korchea, none-rarely flooded	-	LyT
Krem	Sa	Sa
Lakoa	-	? (TB)
Lallie	WM	WM
Lallie, saline	?	SL
LaPrairie, non-rarely flooded	LyT	-
Lawther	-	Cy
Lawther Variant		Cy
Lefor	-	Sy
Lehr	-	SwSy
Lemert	-	TCp
Lihen, fsl, sl	Sy	Sa
Lihen, lfs, ls	?	?
Linton	Ly	Ly
Livona, fsl, sl	Sy	Sy
livona, lfs, ls		
Lohler, commonly flooded	-	LyOv
Lohler, none-rarely flooded	(CyT)	LyT
Ludden	-	-
Ludden, saline		
Magnus, commonly flooded	?	?
Magnus, none-rarely flooded	Cy	LyT
Makoti	Ly/LyOv	Ly
Mandan	Ly	Ly/LyOv
Manning	Sy	Sy
Marysland, poorly drained	WM	-
Marysland, very poorly drained		-
Max	Ly	Ly
McKenzie	-	CD
Miranda	TCp	-
Moreau	-	Cy
Moreau Variant	-	SwCy
Moreau, saline	-	SL
Morton	Ly	Ly
Mott	-	SyT
Neché Variant	WL	-
Niobell	Cy	Cy
Noonan	Cp	Cp
Nutley	Cy	-
Omio	-	Ly
Parnell	WL	WL
Parnell, ponded		
Parshall	Sy	Sy
Parshall, saline	-	SL
Parshall, wet	-	-

Soil Series & Phase	MLRA		Soil Series & Phase	MLRA	
	53B	54		53B	54
Regan, saline	SL	SL	Velva, commonly flooded	?	LyOv
Regent	Cy	Cy	Velva, none-rarely flooded	Sy	Sy
Reeder	-	Ly	Velva, saline	SL	?
Regan, poorly drained	WM	WM	Wabek	VS	VS
Rhoades	TCp	TCp	Wanagan	-	Ly
Rhoades, saline	-	TCp	Watrous	-	Ly
Ringling	-	VS	Wayden	-	SwCy
Roseglen	LyOv	Ly	Werner	SwLy	SwLy
Ruso	Sy	Sy	Williams	Ly	Ly
Sakakawea	TLy	-	Wilton, 0-3% slopes	LyOv	LyOv
Savage	Cy	Cy	Wilton, 3-9% slopes	Ly	Ly
Savage, saline	-	SL	Yegen	-	Ly
Schaller	Sa	Sa	Zahill	TLy	-
Searing	-	Ly	Zahl	TLy	TLy
Sen	Ly	Ly			
Seroco	TSa	TSa			
Shambo	Ly	Ly			
Sinai	Cy	-			
Sinnigam	-	SwLy			
Southam	(NA)	-			
Stady	Ly	Ly			
Stirum	SL	SL			
Straw, channeled					
Straw, commonly flooded	LyOv	LyOv			
Straw, none-rarely flooded	Ly	LyT			
Sutley	TLy	TLy			
Tally	Sy	Sy			
Tansem	Ly	Ly			
Telfer, fsl, sl	Sy	Sy			
Telfer, lfs, ls	Sa	Sa			
Temvik	Ly	Ly			
Tiffany	WM	-			
Tonka	WM	WM			
Trembles Variant		Sy			
Trembles, commonly flooded	LyOv	LyOv			
Trembles, none-rarely flooded		SyT			
Vallers	WM	-			
Vallers, saline	SL	-			
Vebar	Sy	Sy			

- = Non-site or Soil not listed in MLRA

**Native Grassland Table 2.** Ecological site grass and forb yield values (lbs/ac) for native grassland in Major Land Resource Areas (MLRA) 53B and 54 in North Dakota (NRCS eFOTG 2015).

**Ecological Sites (ES)**

BF	Badlands Fan	LTe	Loamy Terrace	Sb	Subirrigated
Cy	Clayey	SL	Saline Lowland	TCp	Thin Claypan
Cp	Claypan	Sa	Sands	TLy	Thin Loamy
CD	Closed Depression	Sy	Sandy	TSa	Thin Sands
CS	Choppy Sands	SyCp	Sandy Claypan	VS	Very Shallow
LSa	Limy Sands	SyT	Sandy Terrace	WL	Wet Land
LSb	Limy Subirrigated	SwCy	Shallow Clayey	WM	Wet Meadow
LiR	Limy Residual	SwLy	Shallow Loamy		
LrM	Linear Meadow	SwG	Shallow to Gravel		

Ly	Loamy	SwM	Shallow Marsh		
LyOv	Loamy Overflow	SwSy	Shallow Sandy		

**Ecological Site Yield Data (lb/ac)**

ECOLOGICAL SITE	MLRA 53B		MLRA 54	
	HCPC/RPCP	Grass/Forb	HCPC/RPCP	Grass/Forb
Badlands Fan (BaF)	-	-	-	-
Clayey (Cy)	2300	2250	2100	2060
Claypan (Cp)	1700	1650	1500	1460
Closed Depression (CD)	3500	3060	2400	2100
Limy Sands (LSa)	-	-	1800	1730
Limy Subirrigated (LSb)	3600	3470	-	-
Limy Residual (LR)	-	-	2050	1990
Linear Meadow (LrM)	6000	4050	-	-
Loamy (Ly)	2400	2330	2400	2330
Loamy Overflow (LyOv)	3500	3180	3200	3020
Loamy Terrace (LTe)	-	-	2900	2510
Saline Lowland (SL)	3500	3410	2500	2420
Sands (Sa)	2500	2380	2500	2410
Sandy (Sy)	2500	2410	2400	2320
Sandy Claypan (SyCp)	2200	2130	2000	1930
Sandy Terrace (SyT)	-	-	3000	2730
Shallow Clayey (SwCy)	-	-	1200	1110
Shallow Loamy (SwLy)	2200	2120	1400	1350
Shallow Marsh (SwM)	6400	4800	-	-
Shallow Sandy (SwSy)	-	-	1400	1350
Shallow Gravel (SwG)	1600	1540	-	-
Subirrigated (Sb)	5000	4250	4000	3400
Thin Claypan (TCp)	1000	970	800	780
Thin Loamy (TLy)	1900	1830	1700	1640
Thin Sands (TSa)	1700	1640	1600	1540
Very Shallow (VS)	1200	1160	800	760
Wet Land (WL)	6000	4050	5900	3840
Wet Meadow (WM)	4500	3150	4500	3150

Badlands Fan (BaF) ecological site description is currently being developed at time of publication

The values listed for the Historic Climax Plant Community (HCPC), or Reference Plant Community Phase (RPCP), is the Representative Value (RV) listed for the ecological site which is the mean value between the low and high expected yields for the HCPC or RPCP. The value listed in the Grass/Forb column is the HCPC, or RPCP, RV value minus the trees, shrub and vine component, rounded to the nearest tenth. Ecological site descriptions that includes these values were obtained from Section II of the NRCS North Dakota electronic field office technical guide.

## II-E. TAME PASTURELAND

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## **E. TAME PASTURELAND**

### **Definition**

Tame pastureland, as defined in NDAC 69-05.2-01-02 means land used for the long-term production of predominantly adapted, domesticated species of forage plants to be grazed by livestock or occasionally cut and cured for livestock feed. Land used for facilities in support of pastureland that is adjacent to or an integral part of these operations is also included.

### **Requirements for successful revegetation**

When the approved postmining land use is tame pastureland, the permittee shall seed or plant species of grasses and legumes adapted to the local site conditions and capable of supporting grazing and occasional haying under proper management [NDAC 69-05.2-22-02(2)]. Any introduced species that are used must be compatible with plant and animal species of the region, must meet the requirements of applicable state seed or introduced species statutes, and must not be poisonous or noxious [NDAC 69-05.2-22-01].

The evaluation of revegetation success on tame pastureland includes measurements for productivity and ground cover. For third-stage bond release, vegetation establishment is determined on the basis of ground cover only. All species used in determining ground cover must be perennial species not detrimental to the approved postmining land use [NDAC 69-05.2-22-07(3)(a)]. For fourth-stage bond release, ground cover and productivity of the permit area must be equal to or greater than that of the approved standard, with 90% statistical confidence [NDAC 69-05.2-22-07(4)(b)].

### **Premining assessment**

The following information is required as a part of the permit application [NDAC 69-05.2-08]:

1. Delineate and identify on a map or aerial photograph of 1:4800 scale [NDAC 69-05.2-08-08(1)(a)(2)]:
  - a. All tame pastureland tracts within the proposed permit area; and,
  - b. Each soil-mapping unit in each tract of tame pastureland.
2. Tabulate total acreage of each soil mapping unit for each surface land owner within the proposed permit area [NDAC 69-05.2-08-08(1)(c)(1)].
3. Include all species which were found in tame pastureland tracts in the plant species list for the permit area. All noxious, poisonous, threatened, and rare species must be included; if none were found, a statement to that effect must be included [NDAC 69-05.2-08-08(1)(b)].
4. Provide an assessment of annual production, based on actual data or NRCS estimates.

5. Provide a narrative which describes the vegetation of each pastureland area, including dominant species and their relative proportions [NDAC 69-05.2-08-08(1)(d)].
6. If a control/reference area will be used to develop a revegetation success standard (see page II-E-4), provide a map showing the general location and soil-mapping units of the area. Also include a narrative which demonstrates that the area adequately represents the conditions in the permit area [NDAC 69-05.2-08-08(2)], and describes the method which will be used to establish the control area.

### **Postmining assessment**

#### **Third-Stage Bond Release**

The following information must be submitted for each reclaimed pastureland tract when making third-stage bond release requests:

1. An aerial photo of adequate scale, which delineates the reclaimed tame pastureland tract(s) proposed for bond release.
2. A narrative which includes the seed mix and seeding rate, describes the methods used for seedbed preparation and seeding, and all management practices used [NDAC 69-05.2-12-12(10)].
3. A demonstration of adequate establishment of vegetation [NDAC 69-05.2-22-07(3)(a)]. Cover data must include composition by species, litter and a measure of bare ground. Data submitted must include absolute cover values. Relative cover may also be submitted to aid in data interpretation. Data should be submitted in tabular form, and the table heading must include information on sampling method, location, sample size, and sampling date.
4. A map which identifies the approximate locations of sampling transects or the sampling areas and number of randomly located sample units per area, whichever method is used.
5. All other information as required by NDAC 69-05.2-12-12.

#### **Revegetation Success Standards for Third-stage Bond Release**

Each reclaimed tract must have at least 73% total cover (live + litter), based on basal hits, or 83% total cover (live + litter), based on first-hits, determined by the point frame method. All species used in determining ground cover must be perennial species not detrimental to the land use [NDAC 69-05.2-22-07(3)(a)]. The standard must be achieved with 90% statistical confidence. Methodology is described in Native Grassland, Section II-D. A field inspection will also be required to verify that ground cover is adequate to control erosion.

### **Fourth-Stage Bond Release**

The following should be submitted for each reclaimed pastureland tract when making fourth-stage bond release requests:

1. An aerial photo of adequate scale which delineates the reclaimed tame pastureland tract(s) proposed for bond release. The aerial photo must depict ownership boundaries if separate landowners are involved and within each ownership any site type units if a stratified sampling procedure was used. Provide in tabular form the acreages of site type units for each landowner within the reclaimed tract.
2. An aerial photo of adequate scale which delineates the area and soil-mapping units that were used to develop the standard.
3. An aerial photo of adequate scale which delineates any corresponding reference or control areas and their soil-mapping units, if used to develop the standard.
4. A narrative which includes the soil replacement thicknesses, seed mix and seeding rate and describes methods used for seedbed preparation and seeding. Include information on all management practices used (i.e., fertilization, weed control, burning, grazing, etc.) [NDAC 69-05.2-12-12(10)].
5. Data and calculations, which demonstrate that productivity and ground cover of each landowner's reclaimed tract are equal to or greater than (with 90% statistical confidence) the approved standard in any two years after year six of the responsibility period. Cover data must include composition by species, litter and a measure of bare ground. Data submitted must include absolute cover values. Relative cover may also be submitted to aid in data interpretation. All data should be submitted in tabular form, and the table heading must include information on sampling method, location, sample size, and sampling date.
6. A map, which identifies the approximate locations of sampling, transects or the sampling areas and number of randomly located sample units per area, whichever method is used.
7. All other information as required by NDAC 69-05.2-12-12.

### **Revegetation Success Standards For Fourth-Stage Bond Release**

#### **Production**

The NRCS has categorized soil series of each Major Land Resource Area (MLRA) in North Dakota into "Forage Suitability Groups" based on pasture and hayland species adaptability, yield, and management factors. For each group of soils considered suitable for pasture and hayland use, the NRCS has provided production estimates for low-level and high-level management [NRCS electronic Field Office Technical Guide, Section IIG, (NRCS 2003/2006)]. These information resources are used to develop productivity standards for reclaimed tame pastureland and hayland. Cover or production data may be used to establish relative species composition.

The unadjusted yield standard for reclaimed pasture and hayland is determined using the forage suitability group assigned to each dominant soil series named in the pre-mine soil survey map units (Pastureland Table 1) and the corresponding yield determined for each forage suitability group (Pastureland Table 2). The hayland table in the cropland section must be used if the reclaimed tame pastureland contains more than 25 percent alfalfa. The productivity estimates for a forage suitability group vary with the management intensity (High-level, Median-level) and Major Land Resource Area (MLRA, shown on Pastureland Figure 1). The median-level value would typically be used since it best represents the management most commonly used on reclaimed pasture and hayland. However, the high-level management value must be substituted if the mine operator fertilizes the reclaimed pastureland or hayland during the years affecting productivity demonstration. The management techniques must correspond to those described by the NRCS in the Forage Suitability Interpretations.

The yield value for each soil is weighted by the acreage that soil occupied in the tract prior to mining. The weighted values for all soils are summed and divided by the total acreage of the tract to obtain a weighted average yield per acre. This value is the unadjusted yield standard for the tract. A separate yield must be obtained, and a separate yield standard developed, for each landowner's property unless a regional standard or other methodology has been previously approved.

The unadjusted yield standard must be corrected for annual climatic variations by one of the following methods:

**Correction Method 1:**

Annual county yield data, reported by NDASS, can be used to calculate an annual climatic correction factor (CF). [If the hayland/tame pastureland vegetation on the reclaimed tract contains more than 25% alfalfa, the “alfalfa hay” yield reported by NDASS must be used. If the hayland/tame pastureland vegetation on the reclaimed tract contains less than 25% alfalfa, the “all other hay” yields reported by NDASS should be used.] The correction factor is derived by dividing the NDASS county yield for the current year ( $X_c$ ) by the long-term average yield for the county ( $X_{CLT}$ ). The county average yield ( $X_{CLT}$ ) is derived using a long-term average calculated from NDASS data. Calculation of the average should include data from the last fifteen years.

$$CF = \frac{X_c}{X_{CLT}} \quad (1)$$

This correction value is then multiplied by the unadjusted yield standard to derive the annual target value.

**Correction Method 2:**

This method involves the use of a control area which may be established using one of the following options:



1. An existing grass-legume tract that possesses similar species composition may be used. This control area must be established at least five-years prior to the first year that the reclaimed tract is assessed for bond release.
2. Land may be cultivated and seeded with the same species mixture that will be planted on the reclaimed area. This control area must be seeded at the same time as the reclaimed tract.

In either case, the proposed location of the control area must be identified in the permit application. The control area must be established in the same Major Land Resource Area and as close as possible to the permit area. The control area should contain some of the predominant premine soil series that occupied the reclaimed tract and should have similar slope and aspect. Prior to establishment, the permittee must provide the PSC with a description of the control area, including species composition and management history if option 1 is used. The PSC will review this information and inspect the control area prior to approval.

Management of the control area and the reclaimed tract may be site specific, but must be equal in effect during the years in which comparisons with the standard will be made.

A weighted average yield for the control area is obtained using the (Pastureland Table 1) yield estimates in the same manner as for the reclaimed pastureland tract. The control area is harvested each year that the reclaimed tract will be assessed for bond release. The actual yield of the control area is divided by the weighted average yield to derive the climatic correction factor for the current year. The unadjusted yield standard for the reclaimed tract is multiplied by the correction factor to obtain an adjusted yield standard. The actual yield from the reclaimed tract must equal or exceed the adjusted standard in any two years after year six of the responsibility period.

**Example**

The following is an example that uses the control area to calculate a climatic correction factor for a pastureland tract in MLRA 54:

Step 1:

Obtain yields for each premine soil series in the reclaimed tract and control area using Pastureland Tables 1, Soils Key, and 2, Yield Estimates. Weight each yield by the acreage the soil series occupies in the tract. Sum the weighted yields and divide by the total acreage to obtain an unadjusted yield standard for the reclaimed tract and a weighted average yield for the control area:

**Reclaimed tract:**

<u>Premine Soil</u>	<u>Suitability Group</u>	<u>Median yield (t/ac)<sup>1</sup></u>		<u>Premine acres</u>		<u>Weighted yield (t)</u>
Arnegard	Lm	1.62	X	3	=	4.86
Savage	CyS	1.31	X	4	=	5.24
Vebar-Cohagen	VDL/NS	0.83 & 0.42 <sup>2</sup>	X	2	=	1.33

Straw	Lm	1.62	X	$\frac{10}{19}$	=	$\frac{16.2}{27.63}$
TOTAL						

- <sup>1</sup> Median management level yield value (Pastureland Table 2)
- <sup>2</sup> Percentages of each soil series in the complex soil-mapping unit were not described in detailed soil survey; therefore, this example assumes 60% Vebar and 40% Cohagen

Unadjusted yield standard = 27.63 tons / 19 acres = 1.45 ton/ac or 1.5 ton/ac

**Control area:**

<u>Soil</u>	<u>Suitability Group</u>	<u>Median yield</u>		<u>Acres</u>	=	<u>Weighted yield</u>
Straw	Lm	1.62	X	5	=	8.10
Belfield	CyS	1.31	X	2	=	2.62
Flaxton	Lm	1.62	X	<u>2</u>	=	<u>3.24</u>
TOTAL				9		13.96

Weighted average yield = 13.96 tons / 9 ac = 1.55 ton/ac or 1.6 ton/ac\*

Step 2:

The actual yield of the control area for the current year (assumed to be 1.1 ton/ac) is divided by the weighted average yield of 1.6 ton/ac to obtain a climatic correction factor:

$$CF = 1.1 \text{ ton/ac} / 1.6 \text{ ton/ac} = 0.6875$$

Step 3:

Multiply the unadjusted yield standard of the reclaimed tract (1.5 ton/ac) by the correction factor to obtain a standard, which has been adjusted for climatic variation:

$$\text{Adjusted yield standard} = 1.5 \text{ ton/ac} \times 0.6875 = 1.03 \text{ ton/ac}^*$$

\*The same precision (i.e., decimal places) and units used in field measurements should be used for yields based on NRCS data.

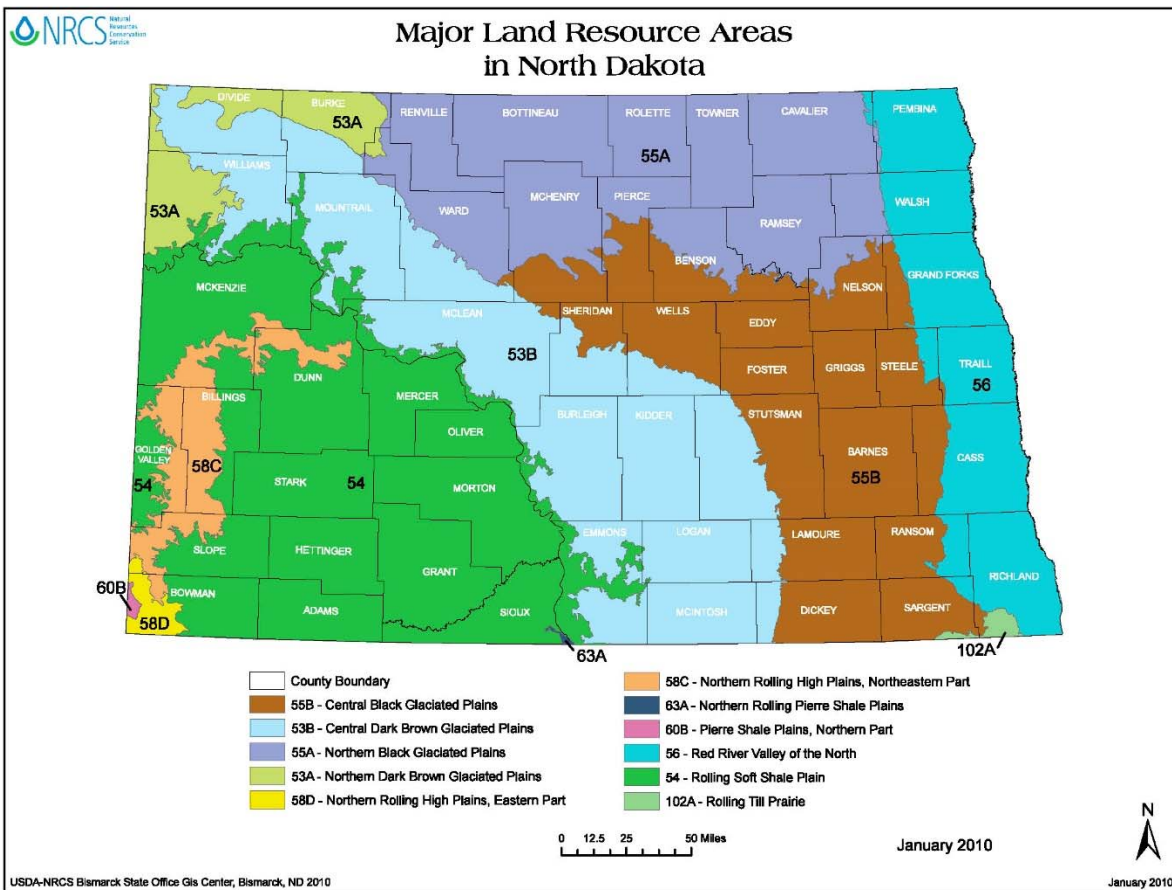
Step 4:

Compare the adjusted standard to the current year's actual yield from the reclaimed tract using appropriate statistical procedures (repeat steps 2 and 3 for each year of comparison). Further discussion on sampling and statistical procedures is given in Chapter III

**COVER**

The same standard used for third-stage bond release must be used to assess cover for fourth-stage bond release. In addition, the perennial species included in the approved tame pastureland seed mixture must be present and any non-seeded species must not be detrimental to the land use. This will be evaluated at the time of the final bond release based on the cover data and a field review of the reclaimed tract.

**Tame Pastureland Figure 1.** North Dakota Major Land Resource Areas (NRCS 2003).



**Pastureland Table 1.** Soils key for pasture and hayland Forage Suitability Groups (FSG) in Major Land Resource Areas 53B and 54 in North Dakota (NRCS 2015).

This table lists the forage suitability groups for soil series commonly found in the NRCS soil survey information for coal mining counties in North Dakota. A soil series may be assigned to a different forage suitability group for some soil survey map units based on the slope range, landscape position or other characteristic. The pre-mine soil survey report should identify the forage suitability group interpretation for any soil map unit component that would be more appropriately assigned to a group other than that listed in the table.

Soil Series	FSG	Soil Series	FSG	Soil Series	FSG
Absher	NS	Grassna	Lm	Reeder	DyLm
Amor	DyLm	Hamar *	W	Regan *	W
Arikara	NS	Hamerly *	Sb	Regent	CyS
Arnegard	Lm	Hanly	VDL	Rhame (Slope < 9%)	VDL
Arveson *	W	Harriet	NS	Rhoades	NS
Banks	Sa	Havre	Lm	Ringling	NS
Bearpaw	CyS	Havrelon	Lm	Roseglen	Lm
Beisigl	Sa	Heil	NS	Ruso	DyLm
Belfield	CyS	Janesburg	Cp	Sakakawea	LiUp
Benz	NS	Kniferiver	Lm	Savage	CyL
Bowbells	Lm	Korchea	Lm	Schaller (Slope < 6%)	VDL
Bowdle	DyLm	Kratka *	W	Searing	DyLm
Boxcut	Lm	Krem	Sa	Sen	DyLm
Boxwell	DyLm	Kremlin	Lm	Seroco	NS
Brandenburg	NS	Ladner	NS	Sham	CP
Breien	VDL	Lallie *	W	Shambo	Lm
Bryant	Lm	Lamoure *	W	Sinnigam	NS
Cabba	NS	Lawther	CyS	Southam	NS
Cabbart	NS	Lefor	DyLm	Square Butte	Lm
Chama	LiUp	Lehr	VDL	Stady	DyLm
Chanta	DyLm	Lihen	Sa	Straw	Lm
Cherry	LiUp	Linton	Lm	Tally	DyLm
Chinook	DyLm	Livona	Lm	Tansem	Lm
Cohagen	NS	Lohler	Ov	Telfer	Sa
Coleharbor	Lm	Ludden *	W	Temvik	Lm
Colvin *	W	Magnus	CyS	Tonka	W
Daglum	Cp	Makoti	Lm	Trembles	DyLm
Desart	VDL	Mandan	Lm	Tusler	Sa
Dilts	NS	Manning	VDL	Vallers *	W
Dimmick	NS	Marmarth	Lm	Vanda	NS
Divide	Sb	Marysland *	W	Vebar (Slope < 9%)	VDL
Dogtooth	NS	Max	Lm	Velva	Lm
Dooley	Lm	McKenzie *	W	Virgelle	VDL
Dragline *	W	Minnewaukan *	W	Wabek	NS
Ekalaka	Cp	Miranda	NS	Wanagan	DyLm
Falkirk	Lm	Moreau	CyS	Watrous (Slope < 6%)	DyLm
Farland	Lm	Morton	DyLm	Wayden	NS
Farnuf	Lm	Niobell	CyS	Werner	NS
Felor	Lm	Noonan	Cp	Williams	Lm
Flasher	NS	Nutley	CyS	Wilton	Lm
Flaxton	Lm	Oburn	NS	Wolf Point	CyS
Fleak	NS	Omio	Lm	Yawdim	NS
Glendive	DyLm	Parnell	NS	Zahill	LiUp
Golva	Lm	Parshall	Lm	Zahl	LiUp
Grail	CyS	Patent	LiUp	Zeeland	Ov
		Playmoor	Sal	Zeona	NS

\* For map units with “saline” or “very poorly drained” modifier use “Saline” or “Not Suited” group respectively

**Pastureland Table 2.** Yield Estimates (t/ac) for pastureland by Forage Suitability Group in Major Land Resource Areas 53B and 54 (NRCS 2015).

The production values listed represent total annual above ground plant production on an air-dry-matter basis. Estimates of hay yields can be calculated from these numbers by multiplying them by a harvesting efficiency. A 70 percent (0.70) harvesting efficiency is commonly used when converting to hay yields. (NRCS Section II-FOTG, Forage Suitability Groups, 2015)

SUITABILITY GROUP	MLRA 53B		MLRA 54	
	High <sup>1</sup>	Median <sup>2</sup>	High <sup>1</sup>	Median <sup>2</sup>
Clayey Subsoil (CyS)	2.28	1.65	1.86	1.31
Claypan (Cp)	1.63	1.18	1.45	1.05
Droughty Loam (DyLm)	2.21	1.59	1.72	1.24
Limy Upland (LiUp)	2.32	1.73	1.80	1.35
Loam (Lm)	2.80	2.00	2.24	1.62
Overflow (Ov)	3.17	2.40	2.95	2.16
Saline (Sal)	2.08	1.58	1.70	1.29
Sand (Sa)	1.93	1.44	1.57	1.20
Steep Loam (SpLm)	2.21	1.59	1.84	1.32
Subirrigated (Sb)	3.61	2.70	3.21	2.40
Very Droughty Loam (VDL)	1.25	0.96	1.12	0.83
Very Shallow to Gravel (VSG)	1.25	0.96	1.12	0.83
Wet (W)	4.08	3.00	3.80	2.81
Not Suited (NS)	0.62	0.48	0.56	0.42

1. High management intensity level yield in tons/acre
2. Median management intensity level yield in tons/acre

The yield estimates provided in Pastureland Table 2 were determined by calculating the average of the production estimates for only the grass species listed in the NRCS Forage Suitability Interpretations. The high-level value is based only on the NRCS high management intensity estimates while the median-level value uses the production estimates for both the high and low management levels. The yield estimates provided for the median level of management in Pastureland Table 2 were determined by using the median of the yield range estimates provided in the NRCS Forage Suitability Interpretations for the high and low management intensity. The yield estimate for an intermediate management level was developed to reflect what appears to best describe the management which is most commonly used on reclaimed pasture and hayland in North Dakota. The low management intensity level does not apply to reclaimed lands since they should not be overgrazed or improperly managed. Estimated values are included for those soil groups that are not suited for pasture or hayland. These values were derived using 50% of the yield for the least productive forage suitability groups which are the very droughty loam and very shallow to gravel suitability groups.

**II-F. WOODLAND**

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## F. WOODLAND

### Definition

NDAC 69-05.2-01-02 defines woodland as land where the primary premining natural vegetation is trees or shrubs. Trees, shrubs, half-shrubs, and woody vines constitute woody plants [NDAC 69-05.2-01-02]. Based on these definitions, only the immediate area where woody plants exist (whether pre- or postmine) will be considered as woodland. Adjacent areas where the primary vegetation is not woody plants must be evaluated based on the requirements of the appropriate land use.

### Requirements for Successful Revegetation

NDAC 69-05.2-22-02(4) requires that when the approved postmining land use is woodland, the permittee shall plant woody species adapted for local site conditions and climate, in combination with a cover of grains, grasses, legumes, or forbs to provide a diverse, effective, and permanent vegetative cover with the seasonal variety, succession, and regenerative capabilities native to the area. Commission approval of species composition, minimum stocking, spacing and planting arrangements of trees, shrubs, half-shrubs and ground cover will be based on local and regional recommendations following consultation with the State Game and Fish Department, State Forester and NRCS [NDAC 69-05.2-22-02(4)]. NDAC 69-05.2-22-07(4)(e) requires that success of revegetation on lands reclaimed to woodland be determined on the basis of tree and shrub numbers, vegetative ground cover, and an evaluation of species diversity, seasonal variety, and regenerative capacity of the vegetation on the permit area.

For third-stage bond release, the number of trees and shrubs must be equal to or greater than the approved standard. Understory growth must be controlled on young stands. Erosion must be adequately controlled by mulch or site characteristics [NDAC 69-05.2-22-07(3)(d)]. Planting understory herbaceous vegetation may inhibit growth of woody species; therefore, it may be deferred until it no longer interferes with the establishment of woody species. This is a normal conservation practice in North Dakota, as recommended by NRCS and the North and South Dakota Extension Services (Frank et. al. 1982, Helwig and Rader 1981, SCS 1984a, SCS 1984b, and Van Deusen 1979) and is not considered an augmented seeding.

For fourth-stage bond release, the permittee must demonstrate during the growing season of the last year of the responsibility period that:

1. The number of woody plants established on the permit area is equal to or greater than the stocking of live woody plants of the same life form of the approved standard with 90% statistical confidence [NDAC 69-05.2-22-07(4)(e)(1)].
2. The number of woody plants established is adequate to meet density standards, based on approved stocking rates, or on the density that existed prior to mining. Those which may be counted include trees, shrubs, half-shrubs, root crowns and root sprouts that:

- a. Are healthy;
  - b. Have been in place for at least two growing seasons; ~~and,~~
  - c. If any replanting of woody plants took place took place during the responsibility period, the total number planted during the last six years of that period must be less than twenty percent of the total number of woody plants required. Any replanting must be by means of transplants to allow for adequate accounting of plant stocking; and
  - d. Volunteer trees and shrubs of approved species will be considered at least two years of age and can be counted towards meeting success standards; however, volunteer trees must be at least thirty inches (76 centimeters) in height to be included in the count. Suckers on shrubby vegetation can be counted as volunteer plants when it is evident the shrub community is vigorous and expanding.
3. The ground cover is equal to or greater than 90% of the ground cover of the approved standard with 90% statistical confidence and is adequate to control erosion [NDAC 69-05.2-22-07(4)(e)(2)].
  4. Species diversity, seasonal variety, and regenerative capacity of the vegetation meet or exceed the calculated survival and reproduction rates for the species stocked [NDAC 69-05.2-22-07(4)(e)(3)].

### **Premining Assessment**

The following information is required as a part of the permit application package [NDAC 69-05.2-08]. Premining assessments are necessary when the woodland in question will be disturbed and woodland is the postmining land use:

1. Define areal extent by woodland type, i.e., deciduous trees, tall shrubs, and low shrubs:
  - a. Depict woodland types, i.e., trees, tall shrubs and low shrubs, on a map (scale 1:4800) with appropriate legend [NDAC 69-05.2-08-08(1)(a)(4)];
  - b. List the acreage of each woodland type for each surface owner [NDAC 69-05.2-08-08(1)(c)(1)]; and,
  - c. Provide a detailed description of the number and arrangement of trees and shrubs, probable age of trees, height of trees and characteristics of the understory vegetation [NDAC 69-05.2-08-08(1)(c)(4)]. The number of trees and shrubs may be estimated from density measurements.
2. Obtain cover data for herbaceous species associated with each woodland type using methods described in the methods sections of this document when necessary for the development of the standard. The permittee must generate a weighted average cover value, weighted by the acreage of each woodland type [NDAC 69-05.2-08-08(1)(c)(7)].
3. Prepare a comprehensive species list using scientific names for all vascular plant species, including noxious, poisonous, endangered and rare species [NDAC 69-05.2-08-08(1)(b)].



4. Provide a narrative describing the nature and variability of the vegetation in each woodland type based on a thorough reconnaissance and qualitative assessment [NDAC 69-05.2-08-08(l)(d)].

### **Postmining Assessment**

#### **Third-Stage Bond Release**

The following information should be submitted for each reclaimed tract when making third-stage bond release requests:

1. Provide an aerial photo or map of adequate scale which delineates the woodland areas in the proposed bond release tract(s).
2. Provide a description of the woody species stocked, the type of stocking used (e.g., bare root stock, containerized), and the stocking rate of each species. Include a narrative which indicates the herbaceous seed mix used and methods for seedbed preparation, seeding and seeding rate. Provide information on all management practices implemented on the area.
3. Provide all other information as required by NDAC 69-05.2-12-12.

#### **Revegetation Success Standards for Third-Stage Bond Release**

An on-site inspection by Commission personnel, the Reclamation Advisory Committee and the landowner will be conducted to determine that tree and shrub species are sufficient in number to provide a woodland that is healthy, based on the following characteristics:

- (1) All tree species stocked are capable of survival;
- (2) Shrubs are capable of regeneration;
- (3) Understory vegetation does not interfere with growth of woody species; and,
- (4) Erosion is adequately controlled.

#### **Fourth-Stage Bond Release**

The following information should be submitted for each reclaimed tract when making fourth-stage bond release requests:

1. A map of adequate scale which delineates the reclaimed woodland tract(s) proposed for bond release [NDAC 69-05.2-12-12(4)].
2. A description of the woody species stocked, the type of stocking used (e.g., bare root stock, containerized), stocking rate of each species and any management practices that occurred after the woody species were planted and herbaceous understory was seeded.
3. Data to demonstrate, using quantitative methods, that herbaceous ground cover is equal to or greater than 90% of the ground cover of the approved standard with 90% statistical confidence [NDAC 69-05.2-22-07(4)(e)(2)].

4. A calculation of the woody species density [NDAC 69-05.2-22-07(4)(e)(1)] based on:
  - a. The following major factors:
    - (1) Species and woodland types;
    - (2) Initial planting rate;
    - (3) Suckering ability of the species utilized; and,
    - (4) Estimated percent survival rates of species utilized; or,
  - a. Density estimates of each woodland type described in the premine assessment.
5. Data to demonstrate that species diversity, seasonal variety and regenerative capacity have been achieved based on species stocked and expected survival and reproduction rates [NDAC 69-05.2-22-07(4)(e)(3)].
6. Documentation that trees and shrubs have met the time in place requirement.
7. All other information as required by NDAC 69-06.2-12-12.

### **Revegetation Success Standards for Fourth-Stage Bond Release**

Revegetation success in reclaimed woodlands must be measured during the growing season of the last year of the responsibility period. The standard will be determined on the basis of whether the stocking rates were based on local and regional recommendations or on the premining vegetation data. The following standards have been developed.

#### **For plantings based on local and regional stocking recommendations:**

1. Meet the calculated woody species density [NDAC 69-05.2-22-07(4)(e)(1)], which has been pre-designated based on planting rates of woody species on the following regenerative capacities [NDAC 69-05.2-22-07(4)(e)(3)]:
  - a. At least 70% of the trees planted will remain at the time of final bond release;
  - b. Tall shrub and mixed tall and low shrub plantings will at least triple in number by suckering; and,
  - c. Low shrub plantings will at least quadruple in number by suckering.
2. Provide an assessment of diversity and seasonal variety [NDAC 69-05.2-22-07(4)(e)(3)] made on the basis of species stocked and expected survival rates:
  - a. Each species of tree, tall shrub and low shrub included in the initial planting should be present at the end of the responsibility period. At least 60% of the number of tree species planted should be present at 50% of the initial planting rate and at least 60% of the number of shrub species (tall and low) planted should each comprise at least 10% of the density standard; and
  - b. No trees and shrubs planted for less than two growing seasons shall be counted in determining stocking adequacy. However, tree and shrub stems occurring as a result of natural regeneration may be counted.
3. Provide verification that trees and shrubs have met the time in place requirement.

- a. Since natural woodlands in North Dakota are comprised of a dense stand of intermingled trees, tall shrubs, and low shrubs, locating the original planted species is not practicable, or necessary to ensure the success of the stand. Permanent quadrats may be established in each woodland community to document the time in place requirement. The total number of plants in year one must be provided. In year four or in the year that 60% of the liability period falls after, 80% of the total number planted must be present. This requirement will be deemed satisfied if the operator demonstrates that no replanting was done in the last six years of the responsibility period. This will verify that the success is based on the survival and reproduction of the majority of the trees and shrubs in the initial planting. Data from quadrats within a community may be averaged to obtain a value for the entire community; and,
  - b. Documentation must be provided which verifies that not more than 20% of the numbers present in year four have been replanted. The Federal Register, Volume 53, No. 173 page 34639 states that the rule [§816.116(b)(3)(ii)], in effect limits replanting to a maximum of 20% of the required stocking before restarting the liability period. Since the majority of the species planted are relatively short-lived species, and since the required stocking (standard) is based on reproduction rather than survival rates, the required stocking will not be present until near the end of the responsibility period. Therefore, the number of replantings allowed will be based on the number of plants present in year four. This interpretation is based on the U.S. Forest Service definition (USFS 1979), which defines stocking as the proportion of an area occupied by woody species, not as a planting density. A worksheet of each shrub and tree community must be provided, which lists annual replantings of each species. Receipts or appropriate records from nurseries or persons hired to do replantings must be retained for verification.
4. Since extensive herbaceous cover may be incompatible with maximum tree survival and growth, a light herbaceous cover is acceptable, provided total ground cover is adequate to protect the soil surface from erosion. Ground cover may be determined by sampling either total ground cover, a combination of herbaceous and woody vegetation, or herbaceous understory only. Total ground cover (i.e., live herbaceous, litter, and canopy from woody vegetation) must be at least 83%. If only herbaceous understory is measured, the live herbaceous cover and litter must constitute at least 66% total basal cover [90% of a 73% standard based on Ries and Hofmann (1985)] or 75% first-hit cover [90% of an 83% standard based on Ries and Hofmann (1984)]. The total ground cover, including the canopy cover of woody vegetation must provide adequate protection from erosion. The herbaceous cover must be comprised of desirable species not detrimental to the growth of woody vegetation.

**Example:**  
Trees:

<u>Tree</u>	<u>Initial Planting rate (trees/acre)</u>
green ash	820

burr oak	200
boxelder	280
cottonwood	500
aspen	<u>90</u>
	1890

The density standard for trees: 1890 trees (planted per acre) x 0.70 (30% expected mortality rate) equals 1323 trees per acre.

The reclaimed area should have, at a minimum, 60% of the species present (5 species x 60% = 3 species) at 50% of the initial planting rate. However, a total of 1323 trees per acre must also be present at final bond release (70% of the initial planting rate =  $0.70 \times 1890 = 1323$ ).

Tall Shrubs (and Mixed Tall and Low Shrub Plantings):

<u>Tall Shrub</u>	<u>Initial planting rate (stalks/acre)</u>
plum	266
chokecherry	420
buffalo berry	<u>124</u>
	810

The density standard for tall shrubs: 810 shrub stalks (planted per acre) x 3 (tripling rate assumption) equals 2430 shrub stalks.

The reclaimed area should have, at a minimum, 60% of the number of tall shrub species planted (3 species planted x 0.60 = 1.8 = 2 species) each contributing 10% of the tall shrub density standard ( $0.10 \times 2430$  shrubs = 243 shrub stalks/acre).

Low Shrubs

<u>Low shrub</u>	<u>Initial planting rate (stalks/acre)*</u>
western wild rose	900
snowberry	900
silverberry	<u>900</u>
	2700

\*A stalk is defined as the main trunk of a shrub which emanates from the ground and serves as the axis from which branches grow. It includes root crowns and root sprouts, that have been in place for at least 2 growing seasons, and are healthy. Of these, at least 80% must be in place for six years. (According to NDAC 69-05.2-22-07(4)(e)(1), this provision will be deemed satisfied if the operator demonstrates that no tree, shrub, or half-shrub replanting was done during the last six years of the liability period).

The density standard for low shrubs: 2700 shrub stalks (planted per acre) x 4 (quadrupling rate assumption) equals 10,800 shrub stalks per acre.

The reclaimed area should have, at a minimum, 60% of the number of low shrub species planted (3 species planted x 0.60 = 1.8 = 2 species) each contributing 10% of the low shrub density standard (0.10 x 10,800 shrub stalks = 1,080 shrub stalks/acre).

**For plantings based on premining assessments:**

1. Provide a comparison of woody species density of the reclaimed tract to that found in the premining assessment (with 90% statistical confidence) [NDAC 69-05.2-22-07 (4)(e)(1)].
2. Assess species diversity, regenerative capacity and seasonal variety by comparison with data from the premine area and by on-site inspection by Commission personnel and other interested parties [NDAC 69-05.2-12-12(11)].
3. Provide verification of the time in place requirement using methods described on page II-F-5, part 3.
4. Since extensive herbaceous ground cover may be incompatible with maximum tree survival and growth, a light herbaceous cover is acceptable, provided total ground cover is adequate to protect the soil surface from erosion. Herbaceous cover of the reclaimed woodland must be equal to or greater than 90% of the herbaceous cover that existed on the premine area for each woodland type, on a weighted basis, and adequate to control erosion. Herbaceous cover must be comprised of desirable species not detrimental to the growth of woody species.

In addition to either of the standards, the Commission will consider:

1. Modifying the target number of species and number of plants per species present at the end of the liability period if a natural disaster (e.g., disease epidemic, prolonged drought, etc.) affects the woody planting.
2. The use of an experimental planting over and above species planted to meet the standard. Extant "experimental" woody plants at the end of the liability period may be counted toward the target value of plants/species per acre.

**II-G. SHELTERBELT**

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## G. SHELTERBELTS

### Definition

A shelterbelt is defined as a strip or belt of trees or shrubs planted by man in or adjacent to a field or next to a farmstead, feedlot or road. Shelterbelt is synonymous with windbreak [NDAC 69-05.2-01-02]. Only the immediate area where trees and shrubs exist (whether pre- or postmine) will be considered a shelterbelt. Adjacent areas where the primary vegetation is not trees or shrubs must be evaluated based on the requirements of the appropriate land use. The standards in this section apply to shelterbelts that are specified in the reclamation plan as a postmining land use, or as otherwise required by the Commission as part of the approved permit.

### Requirements for Successful Revegetation

NDAC 69-05.2-22-02(5) requires that when the approved postmining land use is a shelterbelt, the permittee shall plant woody species adapted for local site conditions and climate. Understory vegetation must be controlled until it no longer interferes with the growth of woody species. The stocking of trees and shrubs must normally follow current standards and specifications developed by the NRCS for farmstead and field windbreaks in North Dakota. However, the Commission may allow stocking of trees and shrubs that follow specifications approved by the State Game and Fish Department or State Forest Service. Success of revegetation on lands reclaimed to shelterbelts will be determined on the basis of tree and shrub density and vigor, and erosion control [NDAC 69-05.2-22-07(4)(f)].

For third-stage bond release of shelterbelts, the number of trees and shrubs must be equal to or greater than the approved standard. Understory growth must be controlled on young stands. Erosion must be adequately controlled by mulch or site characteristics [NDAC 69-05.2-22-07(3)(d)]. Planting understory herbaceous vegetation may inhibit growth of woody species; therefore, it may be deferred until it no longer interferes with the establishment of woody species. This is a normal conservation practice in North Dakota, as recommended by NRCS and the North and South Dakota Extension Services (Frank et. al. 1982, Helwig and Rader 1981, SCS 1984a, SCS 1984b, Van Deusen 1979), and is not considered an augmented seeding.

For fourth-stage bond release of shelterbelts, the permittee must demonstrate revegetation success during the last year of the responsibility period that:

1. Trees, shrubs, half-shrubs, root crowns and root sprouts used in determining success of stocking must meet the following criteria [NDAC 69-05.2-22-07(4)(f)(1)]:
  - a. Are healthy;
  - b. Have been in place for at least two growing seasons; ~~and~~,
  - c. If any replanting of woody plants took place took place during the responsibility period, the total number planted during the last six years of that period must be less than twenty percent of the total number of woody plants required. Any

replanting must be by means of transplants to allow for adequate accounting of plant stocking; and

- d. Volunteer trees and shrubs of approved species will be considered at least two years of age and can be counted towards meeting success standards; however, volunteer trees must be at least thirty inches (76 centimeters) in height to be included in the count. Suckers on shrubby vegetation can be counted as volunteer plants when it is evident the shrub community is vigorous and expanding.
2. Density and vigor are equal to or greater than that of the approved standard [NDAC 69-05.2-22-07(4)(f)(2)].
3. Erosion is adequately controlled [NDAC 69-05.2-22-07(4)(f)(3)].

### **Premining Assessment**

The following information is required as a part of the permit application package [NDAC 69-05.2-08]:

1. Depict shelterbelts on a map of appropriate scale and legend [NDAC 69-05.2-08-08(1)(a)].
2. List the acreage of each shelterbelt for each surface owner [NDAC 69-05.2-08-08(1)(c)(1)].
3. Provide a description of the number and arrangement of trees and shrubs, length and number of rows, and associated plant species [NDAC 69-05.2-08-08(1)(c)(6)].
4. Prepare a comprehensive species list using scientific names for all vascular plant species, including noxious, poisonous, endangered and rare species [NDAC 69-05.2-08-08(1)(b)].

### **Postmining Assessment**

#### **Third-Stage Bond Release**

Third-stage bond release requests should include:

1. An aerial photo or map of adequate scale which delineates shelterbelt areas in the proposed bond release tract.
2. A narrative, which indicates the purpose, stocking rate and planting arrangements of trees and shrub species. Include information on all management practices prior to and following stocking.
3. Information, which confirms that each row of tree and shrub species has been adequately established.
4. All other information as required by NDAC 69-06.2-12-12.

#### **Revegetation Success Standards for Third-Stage Bond Release**



An on-site inspection by Commission personnel, the Reclamation Advisory Committee and the landowner will be conducted following a request for third-stage bond release. Trees and shrubs must be healthy. No gaps of two or more consecutive trees in any row may occur. Competitive vegetation must be controlled so that it is not interfering with tree or shrub growth. The site will be inspected to confirm that erosion control is adequate. In most cases the prevailing site characteristics (e.g., slope, soil type) of the site will prevent erosion; however, on erosive sites an evaluation of annual crop cover or mulch will be made.

#### **Fourth-Stage Bond Release**

Fourth-stage bond release requests should include the following:

1. A map of adequate scale which delineates the reclaimed shelterbelts in the proposed bond release tract(s) [NDAC 69-05.2-12-12(4)].
2. A description of the planting of tree and shrub species (e.g., bare root stock, containerized), planting rate of each species, and any management practices that occurred after initial planting.
3. The Windbreak Suitability group [NRCS 2007, Expected 20-Year Tree Heights and Windbreak Suitability Group Descriptions, Section II of North Dakota NRCS electronic Field Office Technical Guide (eFOTG), <http://efotg.nrcs.usda.gov/efotg>] that the reclaimed shelterbelt site most resembles.
4. Information on potential growth of each tree species planted including: expected height at 20 years [NRCS 2007, Expected 20-Year Tree Heights and Windbreak Suitability Group Descriptions, Section II of North Dakota NRCS electronic Field Office Technical Guide (eFOTG0, <http://efotg.nrcs.usda.gov/efotg>)] and life expectancy (Shelterbelt Table 1).
5. Verification of the time in place requirement.
6. All other information as required by NDAC 69-05.2-12-12.

#### **Revegetation Success Standards for Fourth-Stage Bond Release**

Revegetation success in reclaimed shelterbelts must be measured during the last year of the responsibility period. Selected characteristics of shelterbelts will be evaluated.

Success standards for shelterbelts are based on evaluation methods, developed by Frank, Gavit and Heintz (1982); Helwig, Baer and Dronen (1981); Van Deusen (1979); and SCS (1984a and 1984b).

Factors to be used in the evaluation are:

- (1) Shelterbelt effectiveness;
- (1) Vigor;
- (2) Competition of understory within rows;
- (3) Erosion control between rows;

- (4) Species diversity, seasonal variety and regenerative capacity; and,
- (5) Time in place requirement.

Criteria for evaluation of each factor are:

### **Shelterbelt effectiveness**

Shelterbelt effectiveness is correlated with the density of canopy cover provided by the shelterbelt. Density of the shelterbelt is evaluated as a percentage of the total area that should be occupied by the shelterbelt in relation to crown density and expected height from an observation point perpendicular to the face or tree rows of the shelterbelt. Tree spacing, number of rows and species planted are contributing factors.

**Standard:** A profile density of 40% for a single-row or 60% for a multirow shelterbelt must exist (Frank et al. 1982). Replacements must be made to eliminate gaps of two or more consecutive trees and/or shrubs in any row unless the gaps are not detrimental to windbreak function (SCS 1984a and 1984b).

### **Vigor**

Vigor will be assessed in spring or late summer when plants are actively growing. Healthy plants are characterized by an abundance of dark green foliage. Loss of vigor is characterized by wilted or dry foliage, yellowish or brown foliage, reduction in normal leaf size and reduction in crown density (less total foliage). In severe cases, portions of the crown may be broken or dead. The assessment of vigor is subjective and should be assigned by rows, not individual plants.

**Standard:** At least 75% of the trees and shrubs must be structurally sound, and have average or above average growth (Frank et al. 1982).

### **Competition**

Weed and grass control in shelterbelts is necessary to reduce competition for moisture. Control should be implemented until the understory vegetation no longer interferes with the growth of trees or until control is no longer physically possible. Weed control in the rows will be considered based on these requirements when evaluating ground cover at the time of bond release. A recommended weed control timetable for selected tree species developed by Helwig et al. (1981) is found in Shelterbelt Table 1.

### **Erosion control between tree and shrub rows**

Erosion control must be adequate. On sites subject to erosion, an evaluation of the permanent vegetation cover between tree and shrub rows will be made. Vegetation cover between tree and shrub rows should have been established according to NRCS recommendations (SCS 1984a and 1984b) and must be comprised of desirable species.

### Species diversity, seasonal variety and regenerative capacity

Species diversity, seasonal variety and regenerative capacity will be evaluated based on species stocked and planting arrangements. Local and regional recommendations will be considered (SCS 1984a and 1984b).

### Time in place requirement

The operator must provide documentation that at least 80% of the trees and shrubs have been in place for at least 60% of the liability period, or demonstrate that no replanting was done in the last six years of the liability period. A worksheet of each shelterbelt must be provided which lists annual replanting of each species. Documentation may be made by tagging or marking with paint, by photographic records, or by preservation of sales receipts from nurseries.

### Natural disaster modifications

The Commission will consider modifying the shelterbelt profile density standard if it is demonstrated that a natural disaster (e.g., disease epidemic, prolonged drought, etc.) has affected the planting. Any replanting due to a natural disaster will be considered a normal husbandry practice which will not restart the liability period.

**Shelterbelt Table 1.** Life Expectancy (Helvig et al. 1981) and recommended timetable for weed control (Frank et al. 1982) for trees planted in North Dakota shelterbelts.

Species	Approximate Life Expectancy (years)	Recommended Number of years of Weed Control
Boxelder	70	10
Caragana	55	5
Green Ash	60	10
Hackberry	60	10
Juniper	75	14
Oak	75	10
Pines	65	14
Poplars	30	5
Siberian elm	30	5
Spruces	55	14
Willows	30	5

## II-H. FISH AND WILDLIFE HABITAT

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## H. FISH AND WILDLIFE HABITAT

### Introduction and Definitions

Fish and wildlife habitat as defined in NDAC 69-05.2-01-02 means lands or waters used partially or wholly for the maintenance, production, protection, or management of fish or wildlife species. Fish and wildlife habitat often encompasses several "land uses" or vegetation types, as structural diversity and food source are of utmost importance for wildlife use. For this reason, this document segregates postmine fish and wildlife habitat standards into woodland, shelterbelt, grassland, wetland and annual grain crop vegetation types. This will enable appropriate postmine evaluations to be made of all areas included in fish and wildlife habitat. Vegetation types that occupy 5 percent or more of the total acreage of the fish and wildlife habitat must be evaluated (SCS 1982). However, if a fish and wildlife habitat area occupies less than 40 acres, this determination will be made on a site specific basis.

When an area is primarily used by wildlife prior to mining, the premine assessment must include a breakdown of vegetation types (i.e., woodland, shelterbelt, grassland, wetlands and annual grain crops), and descriptions as required by NDAC 69-05.2-08-08. Wetlands that occur in any land use must be assessed separately as described in this section. In all other cases, premine assessments must be categorized and analyzed as described for the appropriate primary land use.

**Woodland:** land where the primary vegetation is trees or shrubs, i.e., natural wooded areas.

**Shelterbelt:** a strip or belt of trees or shrubs planted by man in or adjacent to a field or next to a farmstead, feedlot or road. Shelterbelt is synonymous with windbreak.

**Grassland:** land where the primary vegetation is perennial grasses. This includes both areas of native species and those planted with introduced grass-legume mixtures.

**Wetland:** a natural depression area that is capable of holding shallow, temporary, intermittent, or permanent water. Wetlands, here defined, also refer to reclaimed basins intended to replace natural wetlands.

**Annual grain crops:** annual grains specifically planted to provide food and cover for wildlife use. Since annual grain crops planted for wildlife use either remain standing or are cut and stacked, performance standards based on agronomic yields are not appropriate.

NDAC 69-05.2-22-02(6) requires that where fish and wildlife habitat is included in the postmining land use, the permittee shall consult with appropriate state wildlife and land management agencies and select those plant species that will fulfill the needs of wildlife for food and cover. Plant groupings and water resources must be appropriately spaced and distributed. For areas reclaimed to fish and wildlife habitat land use, specific requirements and procedures for the assessment of each vegetation type follow.

## **WOODLAND AND SHELTERBELT**

The requirements and guidelines for meeting third-stage and fourth-stage bond releases and the success standards are synonymous with those described in the section entitled Woodlands and Shelterbelts of this document.

## **GRASSLAND**

### **Requirements for Successful Revegetation**

NDAC 69-05.2-22-07(3)(a) requires that for third-stage bond release, ground cover must be equal to or greater than that of the approved reference area or standard with 90% statistical confidence. All species used in determining ground cover must be perennial species not detrimental to the land use. For fourth-stage bond release, ground cover must be equal to or greater than the approved standard with 90% statistical confidence and adequate to control erosion. In addition, species diversity, seasonal variety and regenerative capacity must meet the approved standard. These requirements must be met the last year of the responsibility period [NDAC 69-05.2-22-07(4)(h) and (l)].

### **Postmining Assessment**

#### **Third-stage bond release**

The following should be submitted for each reclamation tract when making third-stage bond release requests:

1. An aerial photo of adequate scale which delineates the postmining grassland tract(s) proposed for bond release [NDAC 69-05.2-12-12 (4)].
2. A narrative which includes the seed mix and seeding rate and describes methods used for seedbed preparation and seeding. Include information on all management practices prior to, and following, seeding (e.g., fertilization, weed control, burning) [NDAC 69-05.2-12-12 (10)].
3. A demonstration of adequate establishment of vegetation by quantitative measurement of cover [NDAC 69-05.2-12-12 (7)]. Cover data must include composition by species, litter and a measure of bare ground. Data submitted must include absolute cover values. Relative cover may also be submitted to aid in data interpretation. Data should be submitted in tabular form, and the table heading must include information on sampling method, location, sample size, and sampling date.
4. A map, which identifies the approximate locations of sampling transects, or the sampling areas and number of randomly located sample units per area, whichever method is used.
5. All other information as required by NDAC 69-05.2-12-12.

### **Success standards for third-stage bond release**

Each reclaimed tract must have at least 73% total cover (live + litter), based on basal hits, or 83% total cover (live + litter), based on first-hits, determined by the point frame method. All species used in determining ground cover must be perennial species not detrimental to the land use [NDAC 69-05.2-22-07(3)(a)]. The standard must be achieved with 90% statistical confidence. Methodology is described in Native Grassland, Section II-D. A field inspection will also be required to verify that ground cover is adequate to control erosion.

### **Fourth-stage bond release**

The following should be submitted for each reclamation tract when making fourth-stage bond release requests:

1. An aerial photo of adequate scale which delineates postmining grassland tract(s) proposed for bond release. Provide in tabular form the acreage of each reclaimed tract.
2. A narrative, which includes the seed mix and seeding rate and describes methods used for seedbed preparation and seeding. Include information on all management practices prior to and following seeding (e.g., fertilization, weed control, burning).
3. Data and calculations, which demonstrate that ground cover is equal to or greater than the approved standard (with 90% statistical confidence) during the last year of the responsibility period [NDAC 69-05.2-22-07(4)(h)(1)]. Cover data must include composition by species, litter and a measure of bare ground. Data submitted must include absolute cover values. Relative cover may also be submitted to aid in data interpretation. Data should be submitted in tabular form, and the table heading must include information on sampling method, location, sample size, and sampling date.
4. A map which identifies the approximate locations of sampling transects, or the sampling areas and number of randomly located sample units per area, whichever method is used.
5. Information which is required to evaluate species diversity, seasonal variety and regenerative capacity.
6. All other information as required by NDAC 69-05.2-12-12.

### **Revegetation success standards for fourth-stage bond release**

#### **Cover**

1. To ensure adequate cover for erosion control, the same standard used for third-stage bond release must be used to assess cover for fourth-stage bond release.
2. To ensure wildlife cover, vegetation must be sufficient to provide protection to wildlife going into the winter months. (This will be field assessed at the time of final bond release).

### **Species diversity and seasonal variety**

The permittee must demonstrate that a majority of the species specified in the reclamation plan have become established in the tract and that the seeded species comprise at least 60% of the total composition during the years sampling is conducted for the purpose of final bond release. The presence of non-seeded species will be evaluated at the time of the final bond release inspection. Noxious weeds and other highly competitive species that are capable of out competing and displacing seeded species must not be present in quantities greater than that observed in the surrounding undisturbed lands.

The Commission may suitably modify these diversity and seasonality standards based on a demonstration that:

1. Natural fluctuations in diversity or seasonality due to climate or other factors have occurred.
2. Data collected during the responsibility period indicate a trend towards the desired plant community.

### **Regenerative capacity**

Regenerative capacity will be assessed by an evaluation of live surface cover and will be subjectively evaluated during the bond release field review. Sufficient live cover must be present to ensure regenerative capacity.



## WETLANDS

The following sections refer to the immediate wetland basin, and its characteristic vegetation, unless otherwise stated.

### Requirements for Successful Vegetation

For fish and wildlife habitat, where the vegetation type is wetland, vegetation zones and dominant species must be equal to those of the approved standard at the time of final bond release. In addition, wetland permanence and water quality must meet approved standards [NDAC 69-05.2-22-07(4)(g)].

### Wetland Classification

Depressional wetlands are classified according to the system of Stewart and Kantrud (1971). The use of prairie wetlands by waterfowl is strongly influenced by water characteristics, i.e., permanence, depth, and chemistry, and by land use. The complex interrelationships of these parameters are reflected in vegetation characteristics, including: life form, cover interspersion, species composition and species dominance. Vegetation zones in wetlands are distinguished by a unique community structure or life form, and a unique assemblage of plants. Since these characteristics are readily discernible in the field, they have been used as the principal criteria for classification. Stewart and Kantrud describe seven wetland classes. They are:

- |           |  |
|-----------|--|
| Class I   | ephemeral ponds; deepest part of the pond basin supports low-prairie vegetation;   |
| Class II  | temporary ponds; deepest part of the pond basin supports wet-meadow vegetation;  |
| Class III | seasonal ponds and lakes; deepest part of the pond basin supports shallow-marsh hydrophytes, often with peripheral wet-meadow and low-prairie zones;                                   |
| Class IV  | semi-permanent ponds and lakes; deepest part of the pond basin supports deep-marsh hydrophytes, often with peripheral shallow-marsh, wet-meadow and low-prairie zone;                  |
| Class V   | permanent ponds and lakes; permanent open-water zone of submergent hydrophytes, often with peripheral deep-marsh, shallow-marsh, wet-meadow and low-prairie zones;                     |
| Class VI  | alkali ponds and lakes; intermittent shallow saline water alternating with salt flats in the central zone, often with peripheral shallow-marsh, wet-meadow, and low-prairie zones; and |
| Class VII | fen (alkaline bog) ponds; central zone represented by fen vegetation, often with peripheral wet-meadow and low-prairie zones.  |

Non Depressional wetlands should be classified using NRCS Hydrogeomorphic Wetland Classification System (NRCS 2008) or other approved classification system.

For mining permit applications submitted prior to January 1, 1987, all premine Class III-VI wetlands had to be identified and replaced. Class I and II wetlands did not have to be identified nor were specific plans for replacement needed. Fen ponds (Class VII wetlands) are unlikely to occur in the mining regions of North Dakota; however, if fen ponds do occur, they must be treated on a site specific basis.

For mining permit applications submitted after January 1, 1990, the NRCS will be consulted during the wetland inventory and identification process. This is required to ensure compliance with the Wetland Conservation Provisions of the 1985 Food Security Act and the 1990 Food Agricultural, Conservation, and Trade Act. Consultation with the State Game and Fish Department and U.S. Fish and Wildlife Service is also recommended during the wetland inventory and identification process. Required notification must be given to the Army Corps of Engineers.

The success standards that follow apply to all Class III through VI wetlands. The total acreage of postmine wetlands, including Class I and II prior to final bond release, for the mine must equal the total premine acreage.

### **Premining Assessment**

1. Identify and show all Class I-VII wetlands on a map or aerial photograph (scale 1:4800) [NDAC 69-05.2-08-08(l)(a)(5)(b)].
2. For Class III-VII wetlands, tabulate total acreage of each wetland class for each surface owner within the proposed permit area [NDAC 69--05.2-08-08(l)(b)(1)].
3. For Class I and II wetlands provide the total acreage, list land use and extant vegetation. If these wetlands are tilled, indicate the crop normally grown.
4. Identify Class III wetlands, which are sampled. Wetlands sampled must be based on the number present, distribution and variability. Sample numbers, must be approved by the Commission.
5. For sampled Class III wetlands and all Class IV-VI wetlands, provide:
  - a. A description of vegetation zones or plant communities, identified by ecological dominant or co-dominant species, through the use of a line drawing of appropriate scale. Where premine wetlands, are disturbed by land use management, a discussion of the succession phase should be included.
  - b. A narrative describing the relationship among vegetation, soils and surface and groundwater hydrology in the wetlands as well as observed or historical anthropomorphic use.
  - c. A species list for each vegetation zone or plant community, which includes date(s) evaluated.
  - d. An assessment of surface water quality. Sampling Class IV-VII wetlands should be conducted two times per year, at high and low water, to reflect seasonal variation [NDAC 69-05.2-08-07(3)(b)]. Class III wetlands should be sampled once a year, in the early spring. A composite sample of three grabs should be

taken from Class III wetlands, whereas a minimum of three randomly located samples should be taken from Class IV-VI wetlands and reported as a mean and range. The number of years, that data is collected, must be approved by the Commission based on distribution and variability of wetlands. Results of this water quality analysis together with a discussion regarding the effects of water quality on extant vegetation should be provided. Water quality data must include:

- (1) Total dissolved solids;
  - (2) Specific conductance in mmhos/cm<sup>3</sup>;
  - (3) Major cations (calcium, magnesium, sodium and potassium);
  - (4) Major anions (bicarbonate, carbonate, sulfate and chloride);
  - (5) Total suspended solids;
  - (6) pH;
  - (7) Total iron; and
  - (8) Any additional parameters (e.g., selenium) as determined on a site specific basis.
6. Provide a narrative describing the nature and variability of the vegetation of each wetland class [NDAC 69-05.2-08-08(1)(d)].

### **Postmining Assessment**

#### **Third-Stage Bond Release**

The following information must be submitted for each reclaimed wetland when making third-stage bond release requests:

1. An aerial photograph (1:4800) which delineates reclaimed wetland basins and contiguous postmining land uses (if fish and wildlife habitat is the contiguous land use, vegetation types must be delineated).
2. A narrative which describes any plugging, seeding, respread of topsoil containing wetland species propagules, or other practices that were used to establish vegetation of the wetland basin [NDAC 69-05.2-12-12(7)(a)].
3. Evidence of vegetation zone development and adequate establishment of wetland vegetation [NDAC 69-05.2-12-12(7)(a)]. Include the following information:
  - a. A low altitude aerial photograph;
  - b. A detailed map to accompany the aerial photograph which delineates vegetation zone (if identifiable);
  - c. A descriptive narrative of each vegetation zone or plant community identified; and,
  - d. A species list for each vegetation zone or plant community identified.

4. A demonstration that erosion is being adequately controlled by the established vegetation in the contiguous vegetation types or land uses [NDAC 69-05.2-12-12(7)(b)]. Data required for the appropriate vegetation types within fish and wildlife habitat or land uses must be submitted.
5. All other information as required by NDAC 69-05.2-12-12.

### **Success Standards for Third-Stage Bond Release**

An on-site inspection by Commission personnel, the Wetlands Advisory Committee and landowner will be conducted following a request for third-stage bond release. [Personnel from the U.S. Fish and Wildlife Service, North Dakota Game and Fish Department, Natural Resource Conservation Service (NRCS) and ND Department of Environmental Quality, Water Quality Division will be invited to participate on the Wetlands Advisory Committee.] The wetland basin must exhibit the capacity to hold water. This can be shown by the establishment of wetland vegetation. Ground cover in the contiguous vegetation types or land uses must be adequate to control erosion to avoid sedimentation into the wetland basin. The extent of the contiguous area will be evaluated on a site specific basis to ensure that an adequate buffer zone is provided. Erosion control must be demonstrated as described for third-stage bond release requirements of the appropriate vegetation type(s), or appropriate land uses.

### **Fourth-Stage Bond Release**

The following information should be submitted for each reclaimed wetland when making fourth-stage bond release requests:

1. An aerial photograph of adequate scale which delineates reclaimed wetlands and adjacent land uses (or vegetation types within fish and wildlife habitat land use) proposed for bond release. In tabular form, include the acreage of the wetland(s).
1. A narrative which describes any plugging, seeding, or respread of topsoil containing wetland species propagules or other practices that were used to establish vegetation and any management employed thereafter [NDAC 69-05.2-12-12(8)(b)].
2. A brief description of the wetland design including the class (Stewart and Kantrud 1971, NRCS Hydrogeomorphic Classification or other appropriate classification) the wetland was designed to become.
3. A measure of the surface water quality (using methodology described for the premine assessment) for the last three years of the liability period, including:
  - a. Total dissolved solids;
  - b. Specific conductance in mmhos/cm<sup>3</sup>;
  - c. Major cations (calcium, magnesium, sodium and potassium);
  - d. Major anions (bicarbonate, carbonate, sulfate and chloride);
  - e. Total suspended solids;

- f. pH;
  - g. Total iron; and,
  - h. Any additional parameters (e.g., selenium) as determined on a site specific basis.
5. A postmining topography map which delineates the entire watershed of the wetland basin.
  6. Data on quality, quantity and dates of any water pumped into the wetland basin.
  7. Documentation that the vegetation of the reclaimed wetland exhibits vegetation characteristics of the wetland class it was designed to become. This information must be submitted annually to the Commission or at the time of bond release and include data collected during each of the last three years of the liability period. Each year's data must include:
    - a. A low altitude, preferably low oblique, aerial photograph;
    - b. A detailed map to accompany each aerial photograph which delineates identifiable vegetation zones;
    - c. A plant species list of each vegetative zone which ranks the occurrence of each species (i.e., very rare, occasional, abundant, very abundant, subdominant, dominant); and,
    - d. A descriptive narrative which characterizes each vegetation zone.
  8. All other information as required by NDAC 69-05.2-12-12.

### **Success Standards for Fourth-Stage Bond Release**

An on-site inspection by Commission personnel, the Wetlands Advisory Committee and landowner will be conducted following a request for final bond release. The wetland basin must exhibit the degree of permanence for the class for which it was designed (based on water supply from normal year precipitation as described by the ND Water Commission or based on basin configuration and the 50% annual water yield from the contributory watershed), to ensure the required acreage replacement. All, or nearly all, of the watershed must have final grade approval and additional water (e.g., water pumped in) must not be added to the wetland basin for the last five years of the liability period. A natural system must be present in order to evaluate the class size and ensure sufficient potential water supply.

A successfully revegetated wetland basin must exhibit vegetation zones dominated by native, perennial, emergent and submergent hydrophytes appropriate for the abiotic characteristics of the intended class. This will be determined by comparison with species lists for vegetation zones as listed by Stewart and Kantrud (1971), and with premine species lists. Species diversity, seasonal variety and regenerative capacity of species present on the reclaimed wetland must be similar to those in the zones listed by Stewart and Kantrud, or other suitable classification system. Small zones of vegetation from a more permanent wetland class (i.e., deep-marsh emergent and submergent hydrophytes) are acceptable in a portion of a Class III wetland basin. Ground cover in the contiguous area must meet the appropriate ground cover standards for erosion control to avoid sedimentation into the wetland basin. The extent of the

## FISH AND WILDLIFE HABITAT II-H-10

contiguous area will be provided on a site specific basis to ensure that an adequate buffer zone is evaluated. Water quality parameters will be evaluated based on recommendations from the Wetlands Advisory Committee.

## **ANNUAL GRAIN CROPS**

### **Postmining Assessment**

#### **Third-Stage Bond Release**

The following should be submitted for each reclaimed tract when making third-stage bond release requests:

1. An aerial photograph of adequate scale which delineates annual grain crops within the Fish and Wildlife Habitat.
2. A narrative which includes methods used for seedbed preparation, seeding and all management practices used prior to the bond release request [NDAC 69-05.2-12-12(10)].
3. A demonstration that the tract is capable of supporting crops and that standing crop, stubble or crop residues are adequate to control erosion [NDAC 69-05.2-22-07(3)(d)].
4. All other information as required by NDAC 69-05.2-12-12.

#### **Success Standards for Third-Stage Bond Release**

The vegetation will be considered suitable for the postmining land use upon demonstration that an adequate food source and adequate cover are present.

#### **Fourth-Stage Bond Release**

The following should be submitted for each reclaimed tract when making fourth-stage bond release requests:

1. An aerial photograph of adequate scale which delineates reclaimed annual grain crops within the fish and wildlife habitat proposed for bond release.
2. A narrative which includes a complete management history of the reclaimed annual grain crops. The narrative should include seed mix and rate, fertilizer program, conservation tillage practices, and any other management techniques used during the liability period [NDAC 69-05.2-12-12(10)].
3. Data showing the height of the standing grain crop or residual cover for the last year of the liability period.
4. Evidence that conservation tillage is practiced on the area and that erosion is adequately controlled to prevent the contribution of suspended solids to runoff.
5. All other information as required by NDAC 69-05.2-12-12.

**Success Standards for Fourth-Stage Bond Release**

Revegetation success of annual grain crops for fish and wildlife habitat must be evaluated during the last year of the responsibility period. The ground cover will be deemed successful upon demonstration that an adequate food source and adequate cover are present. Documentation must be provided to indicate that conservation tillage practices have been used and that suspended solids are not detrimental to stream flow.



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## I. OTHER LAND USES

### Introduction

Other land uses that may occur in the permit area are “recreation,” “residential”, developed water resources and “industrial and commercial.” There are no specific requirements for premining land use assessments for these uses under NDAC 69-05.2-08-08. Only a general description of the premine use is required under NDCC 38-14.1-14(2)(a).

For areas to be developed for recreation, residential, or industrial and commercial following mining, NDAC 69-05.2-22-07(4)(j) requires the vegetative ground cover on these areas not be less than that required to control erosion. This standard must be met at the time of fourth-stage (final) bond release. There is no specific third-stage bond release standard for these land uses under NDAC 69-05.2-07(3). However, vegetation must be established on the areas and documentation provided to show that the areas are not contributing suspended solids to streamflow or runoff outside the permit area as required by NDAC 69-05.2-12-12(7) for third-stage bond release. Therefore, the same standard will be applied for both third- and fourth-stage bond release on areas to be developed for recreation, residential, or industrial and commercial land uses. In addition, if areas developed for recreation use include woodland plantings and/or shelterbelts, the woody plants must meet all applicable fourth-stage bond release standards described under sections II-F and II-G of this document. There are no specific vegetation performance standards for developed water resources.

### Postmining Assessment

For each tract to be developed to recreation, residential, or industrial and commercial land use, the following information should be submitted when making third-stage or fourth-stage bond release requests:

1. An aerial photo of adequate scale, which delineates the tract(s) proposed for bond release [NDAC 69-05.2-12-12(4)].
2. A demonstration of adequate establishment of vegetation by quantitative measurement of cover [NDAC 69-06.2-12-12(7)]. Cover data must include composition by species, litter and a measure of bare ground. Data submitted must include absolute cover values. Relative cover may also be submitted to aid in data interpretation. Data should be submitted in tabular form, and the table heading must include information on sampling method, location, sample size, and sampling date.
3. A map, which identifies the approximate locations of sampling transects, or the sampling areas and number of randomly located sample units per area, whichever method is used.
4. If a recreation area includes woodland plantings, a demonstration, with supporting data, must be included showing that the applicable standards described under section II-F are met.
5. If a recreation area includes shelterbelts, a demonstration, with supporting data, must be included showing that the applicable standards described under section II-G are met.

6. All other information as required by NDAC 69-05.2-12-12.

### **Revegetation success standards for third stage and fourth stage bond release**

The technical standard for evaluating ground cover is based on ARS research conducted by Hofmann et al. (1983) and Ries and Hofmann (1984) on reclaimed grasslands in North Dakota. According to Ries and Hofmann, erosion from reclaimed grasslands is similar to that of undisturbed native grassland when total cover is 73% or greater, based on basal hits measured with a point frame; or when total cover is 83% or greater, based on first-hits measured with a point frame. Therefore, for third-stage bond release, the reclaimed tract must have at least 73% total cover (live + litter), based on basal hits; or 83% total cover (live + litter), based on first-hits. Live cover included in the standard must be perennial species not detrimental to the land use [NDAC 69-05.2-22-07(3)(a)].

Either standard must be achieved with 90% statistical confidence. In statistical calculations, a standard deviation of +18 for basal cover and a standard deviation of +16 for first-hit cover should be used for ARS data. These values are based on a sample size of 60 10-point frames (Hofmann, personal communications 1987). Calculations of standard deviation for the reclaimed tract must be based on the same methodology, i.e., use of one 10-point frame as the sample unit. A field inspection is required at this time.

For recreation areas that include woodland plantings and/or shelterbelts, the woody plants must meet all applicable standards described in Sections II-F and II-G for fourth-stage bond release.

### **Developed water resources revegetation success standards for fourth stage bond release**

The requirements listed in NDCC 38-14.1-17 (7) ( c) (2), NDCC 38-14.1-24 (7), NDAC 69-05.2-16-12 (1) and NDAC 69-05.2-16-19 must be addressed for developed water resources at the time of final bond release. Those portions of a developed water resource outside of the pool area of the developed water resource must be established with perennial vegetation and the site must be not be contributing suspended solids to streamflow or runoff outside the permit area as required by NDAC 69-05.2-12-12(7). The commitment for the future maintenance of a dugout type developed water resource that does not have an embankment, riser or other maintenance items is not required.

### III. PROCEDURES FOR SAMPLING, MEASUREMENT AND STATISTICAL ANALYSIS OF VEGETATION PARAMETERS

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## **A. INTRODUCTION**

Detailed information on various methods used in vegetation sampling and measurement is found in numerous agricultural and ecological publications. Some sources of information with direct relevance to vegetation assessment on premine and reclaimed lands include Cook and Bonham (1977), Bonham et al. (1980), Chambers and Brown (1983), Redente et al. (1983), and Van Dyne et al. (1984).

Before using a method for vegetation sampling or measurement of any vegetation parameter, it is recommended that the original source(s) of information be thoroughly reviewed, and checked for applicability. Moreover, it is recommended that mine operators confer with the PSC staff prior to implementation of the sampling plan designed for a reclaimed tract. This way, problems or questions can be addressed prior to bond release.

The following discussion summarizes recommended methodology for premine and postmine vegetation inventory and for evaluation of reclamation success.

## **B. USE OF SOIL MAPPING UNITS IN THE CALCULATION OF STANDARDS**

### **Soil Surveys**

The standard for a given tract of land must be derived using acreages of Soil mapping units from the professional soil classifier's soil survey for the permit area. Use of the County soil survey will not be allowed except in cases where the more detailed soil survey was not conducted.

### **Delineation of Bond Release Tracts**

One of two methods described below may be used to develop a specific standard for a given tract of land. Use of either method must be limited to a specific land use, and a separate standard must be developed for each landowner. Each land ownership must be sampled separately, unless otherwise approved by the Commission. Either method may be used; however, only one method may be used per designated area and must be specified in the permit.

1. The standard may be derived based on the acreage of all premine soil-mapping units that existed in a land use/landowner unit. The same standard must then be used for all bond release tracts that fall within the defined land use/landowner unit. For example, if an individual owns a quarter section that was all cropland, one cropland standard may be developed for use within this quarter section. This standard would be used for all individual bond release tracts for that quarter section. However, the various landforms (i.e., slope percentage, aspect, concave positions, convex positions, etc.) occurring in the larger unit used for developing the standard should also be adequately represented in each bond release tract. Otherwise, some individual bond release tracts may not meet the standard, while others exceed it.

Larger land use/landowner units for standards and bond release tracts are recommended since smaller units and/or tracts may result in biased estimates. Considering the mixing of the soils and the changes in topography that have occurred during reclamation, it is recommended that (to the extent possible) standards be developed from land use/landowner units of at least 40 acres in size, but not exceeding one section (640 acres).

2. The standard may be derived based on the acreage of premine soil-mapping units that existed in each specific bond release tract, i.e., whatever soil-mapping units occurred in a premine area will be used in the calculation of the standard for the same postmine area. Thus each bond release tract will have its own separate standard. If this method is employed, it must be used for all bond release tracts, regardless of premine soil-mapping units within a specific bond release tract. Therefore, this method should be used only if the postmining topography closely resembles the premine topography or if all bond release tracts are large and reflect the various landforms that occurred prior to mining.

In cases where the postmining land uses of nearby parcels within the same ownership have switched, the standard for each land use parcel will be derived based on the premine soil mapping units of the other. For example, the west half of Section 1 is owned by John Smith. In the premine condition, the NW quarter of Section 1 is cropland and the SW quarter is native grassland. Due to topographic changes resulting from the reclamation process, the SW quarter is reclaimed to cropland and the NW quarter to native grassland. Soil-mapping units from the premine cropland (NW quarter) must be used to derive the standard for the postmine cropland in the SW quarter, and soil-mapping units from the premine native grassland (SW quarter) must be used to derive the standard for the postmine native grassland in the NW quarter.

Regional standards that may be developed and applied to logical units must be approved by the PSC and the surface owners prior to use.

### **Soil Complexes**

In some cases, complex soil-mapping units are included rather than a consociation. Where this occurs, the description of the complete mapping unit found in the professional soil classifiers soil survey for the permit area should list percentages for each soil series. These percentages should then be used to develop the standards for the complex soil-mapping unit. If the soil classifier does not list percentages, the percentages specified in the county soil survey for that complex mapping unit should be used. If percentages are not listed in either soil survey, assume 60-40% distribution of soil series for each respective mapping unit. These percentages can then be applied to the acreage of the complex mapping unit to derive the standard.

## C. SAMPLING DESIGN

### Sampling Sites

For assessment of vegetation parameters on premining tracts and reference areas, the mapping units used for each land use category should be regarded as potential sampling sites. These include soil-mapping units for cropland and soil series for tame pastureland, and range/ecological sites (and, where necessary, soil series) for native grassland. For woodlands and fish and wildlife habitat, each vegetation type is a sampling site. For shelterbelts, each belt is a sampling site. All predominant mapping units must be sampled when quantitative assessment is required. Small sites need not be sampled if data from larger sites or published data can be used to represent them. It is recommended that GPS coordinates be obtained for each productivity sample location to ensure the mapping unit or revegetation initiation periods are properly represented.

Where a mapping unit occurs once in the permit area, only that location needs to be sampled. However, if the same mapping unit occurs more than once, a maximum of three such sites should be sampled, if necessary, to ensure that the data are representative of the mapping unit. An adequate number of samples must be taken from each mapping unit.

On reclaimed tracts, each landowner's property must be sampled separately. A stratified sampling procedure may be used where the tract is divided into site types based on recognizable differences in vegetation. When the permittee assigns site types within reclaimed tracts, it is recommended that the PSC review and approve the assignment of site types. If one site type crosses a land ownership boundary, data from the entire site type may be used in the calculation of both landowner standards. Data from other site types may be used to represent similar small or isolated sites which are not practical to sample. An adequate number of samples must be taken from each site type. If no recognizable differences occur in the vegetation, each landowner's reclaimed tract will constitute one sampling site from which an adequate number of samples must be taken.

Request for specific variances to the responsibility period must be made and approved in accordance with PSC Policy Memorandum No. 20 to Mine Operators prior to submitting final bond release applications. Data from areas for which a variance to the responsibility period has been approved must be included in the bond release application.

### Sample Size Adequacy

The number of samples or observations taken in a premining or reclaimed tract or reference area must be adequate to reflect the population mean for production and cover with 90% statistical confidence. The number of samples required within each sampling site will depend upon the variability of the vegetation being measured and should be determined using one of the procedures discussed below. In cases where the sample size derived from a given equation may appear to be unreasonably large due to non-parametric distributions, the PSC will evaluate such cases and establish a maximum sample size.



Determining an adequate sample size requires an iterative process where initial sampling is conducted to obtain estimates of the mean and variance of each site type or reference area. The required number of samples is then calculated from these estimates and the cycle is repeated. New observations are added to the original data set until an adequate number of observations are taken from the population. When hand sampling is used to measure productivity and cover, the initial number of samples which must be taken in each sampling site is as follows:

Five (5) 0.25 m<sup>2</sup> frames for total production on native grassland and tame pastureland;

Five (5) samples of appropriate size for production on cropland; and,

Fifteen (15) 10-point frames, for total cover. (NOTE: A minimum of one hundred (100) 10-point frames should be taken if cover data is to be used to demonstrate that diversity and seasonality success standards have been met.)

The mean and variance derived from the initial sampling must be used to calculate adequate sample size using one of the following procedures. The equation selected will depend on the type of data being analyzed. Cover data generally have a Poisson distribution (Hofmann and Ries 1990), while yield data usually show approximately a normal distribution (Greig-Smith 1983).

**Two-stage sampling technique**

**For use with production measurements:**

Stein's two-stage equation allows one to determine the necessary sample size to estimate a sample mean ( $\bar{x}$ ) by a confidence interval that falls within a given distance from the population mean ( $\mu$ ). Following the initial sampling, an estimate of the variance is obtained. This allows the calculation of the number of the samples necessary, using the following equation (Steel and Torrie 1980):

$$n = \frac{t^2 s^2}{d^2} \tag{1}$$

- Where:
- n = the minimum number of samples needed
  - t = t distribution value for a given level of confidence (90%, 1-tailed t distribution table)
  - s<sup>2</sup> = the variance estimate from preliminary vegetation sampling
  - d = the level of accuracy desired; 10% of sample mean, for the area being sampled, must be used

Following the determination of sample size based on preliminary sampling data, the additional number of samples required are taken and the calculation repeated. This equation is applicable when the population sampled has a normal distribution (Sowards 1982).

**For use with cover measurements:**

When the population sampled has a Poisson or binomial distribution (i.e. ground cover data), the following equation must be substituted (Hofmann and Ries 1990):

$$n = \frac{t^2 pq}{d^2} \tag{2}$$

Where: n = the minimum number of samples needed  
 t = t distribution value for a given level of confidence (90%, 1-tailed t distribution table)  
 p = cover percentage  
 q = 100 - p  
 d = absolute mean error = 10%

Following the determination of sample size based on preliminary sampling data, the additional numbers of samples required are taken and the calculation repeated.

**Standard error as a percentage of the mean**

Sample size (n) can be determined by setting the standard error of the mean equal to a predetermined percentage of the sample mean and solving for n, when examining a population with a normal distribution (Mueller-Dombois and Ellenberg 1974.) To derive a sample size comparable to that obtained with Equation 1, 6% of the sample mean must be used as the standard error. The calculations are as follows:

$$SEM = \frac{s}{\sqrt{n}} = 0.06 \bar{x} \tag{3}$$

or  $\sqrt{n} = \frac{s}{0.06 \bar{x}} \tag{4}$

or  $n = \frac{s^2}{(0.06 \bar{x})^2} \tag{5}$

Where: SEM = standard error of the mean  
 0.06  $\bar{x}$  = 6% of the sample mean  
 s = sample standard deviation  
 s<sup>2</sup> = sample variance

n = number of samples required

**Determination of Sampling Adequacy for Two Populations**

In situations where two different sites are to be compared, such as reference area versus a reclaimed area, sampling adequacy can be determined by the following procedure:

Step 1:

Obtain estimate of mean ( $\bar{x}$ ) and variance ( $s^2$ ) of production or cover from equal sample sizes (number of samples) from both the reference and reclaimed areas from a pre-sample or from past sampling experience.

Step 2:

Using the site with the largest variance and setting the value for d at 10% of the mean value for that site, compute the minimum sample size for the site as suggested by Chambers and Brown (1983) by doubling the minimum number of samples using Equation (1) as shown below in Equation (6) :

$$n = \frac{t^2 2s^2}{d^2} \tag{6}$$

For the initial estimate, t may also be set at 2.0. However, the t value should be based on n-1 degrees of freedom (df) and 0.1 probability and obtained from a one-tailed t value table.

Step 3:

Using the number of samples necessary as estimated using Equation (6), then:

- A. If the initial number of samples taken is less than the estimated number of samples from Equation (6), additional equal numbers of samples must be taken from both sites and Steps 1 through 3 repeated until the number of samples taken exceeds the number estimated by Equation (6); or,
- B. If the number of samples taken exceeds the estimated number of samples from Equation (6) then sample adequacy has been met and any additional statistical comparisons may be made as required.

**Sample size determination equations for stratified sampling**

Let there be h strata (groups within the populations) to be sampled and index the strata by h=1,2,3,...h. Further suppose that each stratum is of size  $N_h$  and that the total area to be sampled is  $N_1+N_2+\dots+N_h=N$ . Define the estimated stratum standard deviations to be given by  $s_h$  and let  $n_h$  be the number of sample values to be selected within the  $h^{th}$  stratum. Then the optimum allocation (i.e. proportional to stratum size as well as stratum standard deviation) is given by:

$$n_h = \frac{nW_h s_h}{\sum_{h=1}^h (W_h s_h)} \quad (7)$$

where:  $W_h=N_h/N$  and  $n$  is determined from the following:

$$n = \frac{Z_{1-\alpha/2}^2 \sum_{h=1}^h \left( \frac{W_h s_h^2}{d^2} \right)}{1 + Z_{1-\alpha/2}^2 \sum_{h=1}^h \left( \frac{W_h s_h^2}{d^2 N} \right)} \quad (8)$$

where:  $d$  is defined as 10% of the sample mean or  $0.10 \bar{x}$

$N$  is the total number of sampling units summed over all strata, and

$Z_{1-\alpha/2}$  is the standard normal deviate from Appendix Table A1, Cumulative Normal Distribution values (Gilbert, 1987). Some selected values from this table for commonly used values of  $\alpha$  are as follows:

$\alpha$	0.20	0.10	0.05	0.01
$Z_{1-\alpha/2}$	1.2816	1.6449	1.960	2.5758

For cover measurements using point frames,  $N$  is infinite and the denominator of Equation 8 reduces to 1.0.

The estimate of the mean from the stratified sample would be:

$$\bar{x}_{ST} = \sum_{h=1}^h \left( W_h \bar{x}_h \right),$$

and the variance of the mean would be:

$$s_{ST}^2 = \sum_{h=1}^h \frac{W_h^2 s_h^2}{n_h}.$$

Allocation proportional to stratum standard deviation can be obtained if  $W_h$  is replaced by 1.0 in Equations 7 and 8.

For additional information and examples, see Chapter 4 in Gilbert (1987).

## **D. METHODS FOR MEASURING**

Sampling procedures for demonstrating revegetation success need to reflect the variability in 1) soil redistribution thicknesses; 2) landscape forms; and, 3) reclamation age occurring in the reclaimed site(s) being sampled.

### **PRODUCTIVITY, COVER, AND DENSITY**

#### **Productivity**

As defined in NDAC 69-05.2-01-02, productivity means the vegetative yield produced by a unit area for a unit of time. Annual yield (bu/ac or lb/ac) is used to determine productivity of annual crops. For perennial crops (pasture, hay or native grass), the annual yield (lb/ac or t/ac) of the entire aboveground biomass is measured to determine productivity. Production of pasture, hay or native grass may be assessed by determining annual peak standing yield or by annual harvested yield. Methods used will vary based on land use and the respective requirements for premine and postmine assessments. Recommended procedures to measure productivity are outlined below.

#### **Annual Crops**

Annual crop yields may be obtained by harvesting the entire bond release field or by a statistically valid sampling procedure. In some instances, a crop-fallow management procedure may be used in the production of annual crops. If this is the case then productivity should be measured from both the after-fallow and after-cropping fields for the same year of data. A weighted average yield based on the acres of the two cropping management systems will need to be calculated which will be used as the reclaimed yield value to be compared with the adjusted standard yield for bond release. When harvesting or sampling annual crops, one of the following procedures must be used.

##### **1. Entire Field Harvest**

The entire field may be harvested using standard combining procedures. If the grain is taken to an elevator, the weight receipts and test weight and dockage grading records from the elevator must be retained. If the farmer is storing the grain rather than taking it to the elevator, the stored grain from the reclaimed tract must be accurately measured and samples taken to determine average test weight and dockage. If any other method will be used, the operator must document the method of yield determination, and the plan for yield measurements must be approved by the Reclamation Division, before proceeding with the harvest.

##### **2. Combine Sampling Procedure**

- A. The entire field may be divided into strips (sampling sites) allowing the harvest of strips through the entire field using standard combining methods. A strip may be defined as a single or several combine/swather widths from one end of the field to the

other end. All strips should be of equal size. The strips must be distributed throughout the field and the number of strips needed must be determined using a sample adequacy formula that reflects 90% statistical confidence. The yield for each strip must be obtained by harvesting, and weighing the crop harvested from that strip.

- B. Combines equipped with Global Positioning System (GPS) yield monitoring systems may be used to develop yield data for a field. The yield monitor must be calibrated before use and the calibration information included with the rest of the yield data in the bond release application for verification of accuracy of the unit. The data collected from the yield monitors may be used in one of two ways:
  - i. A single, entire field yield may be developed from the printout data, or
  - ii. A mean field yield and variance may be developed using the individual yields printed for the various parts of the field as recorded by the GPS yield monitor.

In addition, test weight, moisture content, and dockage of the crop must be determined and reported if either of these two combine sampling techniques are used. If the yield monitor calibration does not correct yield values for test weight and moisture content, these corrections must also be made when reporting yield data used to show reclamation success.

### **3. Hand Sampling Procedures**

Hand sampling annual grain crops will be allowed to prove reclamation success only when either the Cropland Reference Area Standard (Method 1) or a Control Area (when Correction Method A is used for the climatic correction for Method 2, the NRCS Cropland Technical Standard) is used to assess productivity and both the reference or control area and reclaimed tract are hand sampled in the same manner.

Hand sampling will not be allowed when Climatic Correction Method B (NDAS county average yield) is used to adjust the yield derived using the NRCS Cropland Technical Standard (Method 2). The adjusted yields derived using these correction methods are based primarily on yields from fields that are mechanically harvested. Grain yield measurements taken by hand sampling may result in significantly higher yields than when sample strips are harvested mechanically or when an entire plot is harvested (Bauer, 1992). Therefore, it is not appropriate to hand sample reclaimed tracts when the other climatic correction methods are used.

If hand sampling will be carried out on a reclaimed tract and reference or control area to assess productivity, seed rows must be harvested within sampling sites. The length of seed rows or area harvested will be dependent on the crop grown and approved sampling methodology. At each sampling location, drill overlap areas and field edges must be avoided. The number of samples needed for each sampling site must be determined using a sample adequacy formula that reflects 90% statistical confidence. If the entire reclaimed tract is considered one sampling site, the sampling locations must be randomly distributed throughout the tract. A mean yield in bu/ac must be calculated for each sampling site.

#### **4. Representative Strips**

Representative strips within a tract seeded to a pre-cropland mix may be broken and cropped to prove reclamation success on the larger tract while the rest of the vegetation of the tract remains in the pre-cropland mix which may be hayed or grazed. At least three representative strips of adequate size must be established. The "representative strips" for measuring productivity must reflect the variability in 1) soil redistribution thicknesses; 2) landscape forms; and, 3) reclamation age occurring in the larger reclaimed areas they represent. The representative strips must extend across the entire tract they represent and, to the extent possible considering factors 1-3 above, the strips should be equally spaced across the entire tract. The total acreage of the representative strips cropped each year that yield measurements are taken for final bond release must, at a minimum, equal ten percent of the entire reclaimed tract they represent. In addition, separate representative strips must be established for each landowner, unless the landowner agrees that other representative strips having the same characteristics are adequate to represent his or her reclaimed land. A map identifying proposed representative strips should be submitted to the Reclamation Division and approved prior to final selection. It is preferred that representative strips be entirely harvested to obtain a single yield value. However, if the representative strips are sub-sampled rather than completely harvested, then the number of sub-samples must meet sampling adequacy requirements.

#### **Perennial Crops**

Perennial crop yields (native grassland, hayland, and pastureland) may be obtained from a whole field harvest or portions of a field may be sampled to obtain an estimated yield. When harvesting perennial crops, one of the following procedures must be used.

##### **1. Harvesting the Whole Field**

Annual harvested yield may be obtained by haying the entire tract to obtain one yield value. After counting all bales within the tract, a random sample of bales (a minimum of 5 individual bales or at least one truckload of 6 or more bales) from each sampling site should be weighed to obtain an average bale weight. If the bales are green (wet), then a random sample should be used to obtain average moisture content and a wet-to-dry adjustment factor. No adjustment is needed for air-cured bales. Based on dry weights of counted bales, average production in lbs/acre or t/ac must be calculated for each sampling site.

##### **2. Harvesting a Portion of the Field**

To obtain annual harvested yield, the entire tract may be divided into sampling sites (e.g., strips); each site is separately hayed to obtain a bale count. If the sampling sites are very small, all harvested bales from each site must be weighed. Otherwise a random sample of bales for each site (a minimum of 5 bales or at least one truckload of at least 6 bales) must be used to obtain an average bale weight and moisture content, as described above.

Perennial grasses may also be hand harvested. Samples are clipped at ground level within a sampling quadrat. A single clipping per year of aboveground biomass may be made when dominant species are near peak production. Cages or enclosures may be required in instances where grazing is occurring to ensure total production is estimated. Air-dry percentages and growth curve tables cannot be used to demonstrate productivity revegetation success. The size and shape of the sampling quadrat used should be determined on the basis of the type of vegetation community to be clipped; however, consistent use of one size and shape is recommended. The number of samples for each sampling site must be derived using a sample adequacy formula. All samples must be clipped to estimate total production but double sampling techniques can be used for assessing seasonality, diversity, and species composition. Production must be separated by growth forms including: 1) annuals; 2) perennial cool season grasses and sedges; 3) perennial warm season grasses; 4) forbs; and, 5) shrubs and half-shrubs, and 6) noxious weeds. Native and non-native species should be separated is required to demonstrate revegetation success.

All clipped samples must be dried to a constant weight as soon as possible and weighed. Based on dry weights of the replicated samples, average production in lbs/ac must be calculated for each sampling site.

Ecological site similarity index for premine native grassland and native grassland reference areas must be calculated using procedures outlined by NRCS in form ND-CPA-20, Instructions for Determination of Similarity Index. This form is available in the GRASS-bundle from NRCS or online in Section IV of the North Dakota electronic Field Office Technical Guide (eFOTG), <http://efotg.nrcs.usda.gov/treemenuFS.aspx>. North Dakota ecological site descriptions are also available at this site in Section II of the North Dakota eFOTG). An NRCS forage production worksheet with cool and warm season forage growth curves and percent air-dry values for various growth stages is available as form ND-CPA-33 in Section IV of the North Dakota eFOTG but these values can only be used for pre-mining assessment purposes.

## **Cover**

### **1. Herbaceous Ground Cover**

Ground cover as defined in NDAC 69-05.2-01-02 "means the area of ground covered by vegetation and the litter that is produced naturally on site, expressed as a percentage of the total area of measurement." Ground cover can be determined by basal or first-hit measurements. The type of cover measurement, whether basal or first-hit, must be consistent in premine and postmine measurements. The measurement used must be specified and, thereafter, referred to as either basal or first-hit cover. Measurements for litter, rock, and bare soil must be included. Cover must be recorded by plant species. Measurement of cover near peak standing crop and prior to sampling for productivity is recommended.

Several methods are commonly accepted for quantitative analysis of vegetation cover on native grasslands; however, the point quadrat method is recommended because it is the most commonly used technique for Northern Great Plains vegetation (Van Dyne et al. 1984 b).



The single or multiple point quadrat method can be used to measure basal cover as well as canopy cover. Owensby (1973) provides a description of the single point or step-point quadrat. A multiple point quadrat generally possesses 10 points evenly spaced in a frame. Frames most frequently used are similar to the one described by Heady and Rader (1958). If first-hits are used, the height of the point frame must be tall enough to include all grass species, and the pins should be vertical.

It is recommended that basal ground cover be measured since basal estimates are less influenced by wind; height of vegetation; time of season; or, effects of wildlife or livestock. However, the point quadrat may be used with the following methods: 1) basal cover measurements, where each sharpened pin is lowered through the vegetation canopy to the ground surface, where it comes in contact with the basal portion of an individual plant, plant litter, rock or bare soil; or, 2) first-hit measurements, where each pin is lowered until it comes in contact with a portion of the live plant, bare ground, rock or litter.

It is recommended that frames be placed at random or stratified random locations and randomly oriented. Hofmann et al. (1978) found that quadrat orientation (in respect to seeded row direction) did not significantly affect vegetation analysis; however, complete randomization in final frame placement must exist. Therefore, to ensure complete randomization of frame placement, it is suggested that frame orientation is also random.

The number of samples required should be statistically established based on total cover, using the point frame as one sample.

Cover values can be calculated from field information. Cover for each species, total vegetation, litter, rock and bare ground can be calculated by dividing the summation of hits for a species or cover by the total number of pins. Relative vegetation values can be calculated by dividing the summation of hits of a species by the summation of hits of all species.

Average values of total cover, live cover by species, litter, and bare ground must be calculated for each sampling site. On reclaimed tracts, the total cover (live + litter) of sampling sites must be weighted by the respective acreage to obtain a weighted mean total cover for the tract.

## **2. Total Ground Cover in Woodland Areas**

Total ground cover for woodland areas includes live and litter components of herbaceous and woody vegetation. Total ground cover may be determined by sampling a combination of herbaceous and woody vegetation, or by sampling only the herbaceous understory. Total cover in woodlands may be measured using a Daubenmire frame (Daubenmire, R. 1959), or the line intercept method (Canfield, R.H. 1941 or Deibert, E.J. 1971.) The Daubenmire and line intercept methods may be used only where woody vegetation is present. If only herbaceous cover (live and litter) is sampled in woodlands, either the first hit or basal point quadrat method previously described may be used. It is recommended that the cover of herbaceous vegetation be determined using the first hit or basal point quadrat method when possible.

### **Diversity, Seasonality, and Composition**

Cover or production data may be used for assessing native grassland diversity, seasonality and composition. A minimum of one hundred (100) 10-point frames should be taken if cover data is to be used to demonstrate that diversity and seasonality success standards have been met.

Double sampling procedures may be used to aid in the evaluation of composition, diversity and seasonality. The technique of double sampling involves the collection of data indirectly by estimating, and directly by harvesting. Estimates of yields are corrected against harvested yields using regression analysis. Estimators must undergo extensive field training at the beginning of each field season. This involves clipping and weighing species, immediately after estimating species weights. Pechanec and Pickford (1937) outline procedures for training double sampling estimators, and procedures are outlined in Chapter 4 of the National Range and Pasture Handbook (NRCS 2003).

In sampling, weights of individual species or groups of species are ocular estimated prior to harvesting in all quadrats. Species are then clipped and weighed from randomly located quadrats. The number of quadrats clipped must meet sampling adequacy criteria required for the estimation of total production and must comprise at least 20% of the total number of quadrats. [Pechanec and Pickford (1937) recommend that 10-20% of all frames are weighed.] If a species occurs within an estimated quadrat, but is not included within a clipped quadrat, it should be clipped (within an estimated quadrat) so that its weight can be adjusted.

All estimated values must be adjusted by regression analysis. Clipped weights are considered the dependent variable (y) and estimated weights are considered the independent variables (x).

### **Density of Woody Vegetation**

Density of woody vegetation may be measured by direct counts of all woody species or by density quadrat sampling. Direct counts are recommended for shelterbelts; the density quadrat method is recommended for natural woodlands.

In the density quadrat method, randomly placed quadrats are used to obtain density counts. Quadrat shape and size should be proportional to the vegetation sampled. It is recommended that plots be permanently established within each reclaimed planting. A sampling quadrat of 10 x 10 m is sufficient for measuring trees. All trees and tree saplings which occur within the quadrat are counted and recorded by species. A sampling quadrat of 4 x 4 m is sufficient for measuring tall shrub density. A sampling quadrat of 2 x 2 m is sufficient for measuring low shrub density. All shrubs and saplings which occur within the quadrat are counted and recorded by species. Enough samples must be taken to reflect the population mean with 90% statistical confidence. The number of woody plants established must equal or exceed the approved standard with 90% statistical confidence.

## E. STATISTICAL ANALYSES

### I. Reclaimed sample mean values **equal to or greater** than the reference or adjusted standard.

For assessment of revegetation success for bond release, production and cover on a reclaimed tract must equal or exceed that of a reference area or adjusted technical standard. If the production or cover equals or exceeds those of the reference area or adjusted technical standard, no further statistical analyses are necessary. The reclaimed area will be considered to have met the requirements for final bond release.

### II. Reclaimed sample mean values **less than** the reference or adjusted standard values.

If the yield or cover on a reclaimed tract does not equal or exceed that of the reference area or adjusted technical standard, statistical tests may be used to determine whether the production or cover value from a reclaimed tract is statistically equivalent to that of the reference area or adjusted technical standard. If the appropriate statistical test demonstrates that, at the 90% confidence level, the production or cover value from a reclaimed tract is not significantly less than that of the reference area or adjusted standard, it will be assumed that the production or cover equals that of the reference area or adjusted standard for final bond release purposes.

Some of the notations used in this section are shown below.

<u>Symbol</u>	<u>Definition</u>
$\bar{x}$	Sample mean
$x_i$	Individual sample value
$n$	Number of individual sample values within a sample mean
$N$	Total number of sampling sites (ie acres) summed over all strata
$N_h$	Total number of sampling sites (ie acres) in the $h^{\text{th}}$ stratum
$W_h$	Proportion of population sampling sites in stratum $h$ , $W_h = N_h/N$
$\Sigma$	Summation
$s^2$	Sample variance
$s$	Sample standard deviation
$   $	Indicates that the absolute value (always positive) is used

**Note:** Subscript numbers are used to denote different sampling sites for means, variances, etc.;  $w$  as a subscript denotes the value is weighted

**Step 1: In order to conduct any statistical testing, the following values must first be calculated:**

### Sample Mean

$$\bar{x} = \frac{x_1 + x_2 + x_3 + \dots + x_n}{n} \quad \text{or} \quad \bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

*Example 1:* An area has 5 sample values of 12, 18, 29, 17, and 16 bu/ac. Thus  $n = 5$  and the mean value of this area would be:

$$\bar{x} = \frac{12 + 18 + 29 + 17 + 16}{5} = 18.4 \text{ bu/ac}$$

### Variance

$$s^2 = \frac{\left(x_1 - \bar{x}\right)^2 + \left(x_2 - \bar{x}\right)^2 + \left(x_3 - \bar{x}\right)^2 + \dots + \left(x_n - \bar{x}\right)^2}{n - 1}$$

or

$$s^2 = \frac{\sum_{i=1}^n \left(x_i - \bar{x}\right)^2}{n - 1}$$

Using the 5 values shown in Example 1 above of 12, 18, 29, 17, and 16 bu/ac, then the variance would be the following:

$$s^2 = \frac{(12 - 18.4)^2 + (18 - 18.4)^2 + (29 - 18.4)^2 + (17 - 18.4)^2 + (16 - 18.4)^2}{(5 - 1)} = 40.3$$

**Standard Deviation**

$$s = \sqrt{s^2} = \left( \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1} \right)^{1/2}$$

Using the variance calculated above for Example 1:

$$s = \sqrt{40.3} = 6.35$$

**Step 1A. If the tract is divided into a number of different sampling strata (for example by acres within the total area due to differences in vegetation, soils, soils depths, etc.), a weighted mean proportional by area can be calculated as follows using the example below:**

*Example 2:*

Sampling Area (strata)	Acres (N <sub>h</sub> )	Sample Values* (tons/acre)	Average Productivity (tons/acre)
1	8	0.6, 1.8	1.2
2	10	1.6, 2.2, 1.6	1.8
3	23	2.5, 3.2, 3.0	2.9
4	15	1.5, 1.9	1.7
5	12	1.9, 1.3	1.6
-	<b>Total acres=N=68</b>	<b>n=12</b>	-

\* **NOTE:** The number of sample values (n) per strata need not be equal.

**Weighted Mean**

$$\bar{x}_w = \frac{\bar{x}_1(W_1) + \bar{x}_2(W_2) + \bar{x}_3(W_3) + \dots + \bar{x}_h(W_h)}{N}$$

or

$$\bar{x}_w = \frac{\sum_{h=1}^h (\bar{x}_h W_h)}{N}$$

For the data shown above in Example 2, the weighted mean would be calculated as follows:

$$\bar{x}_w = \frac{(1.2 * 8) + (1.8 * 10) + (2.9 * 23) + (1.7 * 15) + (1.6 * 12)}{68} = 2.04 \text{ tons/acre}$$

### Weighted Variance

$$s_w^2 = \frac{\sum_{i=1}^n X_i^2 W_h - \frac{\left(\sum_{i=1}^n X_i W_h\right)^2}{n}}{n - 1}$$

For the data shown in Example 2, the weighted variance would be calculated as follows:

$$s_w^2 = \frac{\left[ \left(0.6^2 * \frac{8}{68}\right) + \left(1.8^2 * \frac{8}{68}\right) + \dots + \left(1.3^2 * \frac{12}{68}\right) \right] - \frac{\left[ \left(0.6 * \frac{8}{68}\right) + \left(1.8 * \frac{8}{68}\right) + \dots + \left(1.3 * \frac{12}{68}\right) \right]^2}{12}}{11}$$

$$= \frac{12.973 - \frac{29.976}{12}}{11} = \frac{10.475}{11} = 0.952$$

### Weighted Standard Deviation

For the data in Example 2, the weighted standard deviation would be calculated as follows:

$$s_w = \sqrt{s_w^2} = \sqrt{0.952} = 0.976$$

## Step 2: Determining the type of test to be used

### A. Using a t-Test for determining differences between mean values

A one-tailed t-test can be used to determine whether the mean production or cover value from a reclaimed tract is significantly less than that of a reference area or adjusted technical standard. A t value is calculated using the sample means and variances. The calculated t value is then compared to a tabular t value designated for the desired confidence level and degrees of freedom (df) (see t distribution table at end of this section). If the calculated t value exceeds the tabular t value, the mean from the reclaimed tract is considered significantly less than the mean of the reference area or technical standard.

**NOTE:** The type of t-test to be used depends on the availability of the information (such as weighted or unweighted means, standard deviations, and different sample sizes) for the areas that are to be compared. Adjusted technical standards or full field harvest techniques may also be used; however, no variance value or sample size will be available for these latter two cases. Following are examples of two t-tests that may be used based upon the amount of sample information available.

1. t-Tests for means (**NOTE:** if mean values are weighted, weighted variances and standard deviations should also be used)

**a. Reclaimed sample means versus adjusted field standards or full-field harvest values**

*Example 3:* Assume the following information

Reclaimed site production: Yield mean =  $\bar{x}_1 = 33.0$  bu/ac

Variance =  $s_1^2 = 1.10$

Standard deviation =  $s_1 = 1.05$

$n_1 = 15$

Adjusted yield standard (or full field harvest): Yield value =  $\bar{x}_2 = 33.2$  bu/ac

Calculate the  $t_{\text{calc}}$  value

$$t_{\text{calc}} = \frac{|\bar{x}_1 - \bar{x}_2|}{\left( \frac{s_1}{\sqrt{n_1}} \right)}$$

For Example 3,  $t_{\text{calc}}$  would be calculated as the following:

$$t_{\text{calc}} = \frac{|33 - 33.2|}{\frac{1.05}{\sqrt{15}}} = \frac{0.2}{0.27} = 0.74$$

*Find the tabular value for t at the desired confidence level and degrees of freedom and compare with the calculated t value.*

The tabular t value for a 90% confidence level and n-1 degrees of freedom (14 d.f.) from the table at the end of this section indicates the tabular t value would be 1.345.

For this example we would conclude that since  $t_{\text{calc}}$  is **less than** the tabular t value, the reclaimed yield is **not significantly different** than the adjusted yield standard (or full field harvest) and **would demonstrate revegetation success** for final bond release purposes.

- b. Where means and variances are known for both sites (sample sizes may be equal or unequal)

*Example 4:* Assume the following

Reclaimed site production: Yield mean =  $\bar{x}_1 = 28.5$  bu/ac  
 Variance =  $s_1^2 = 1.20$   
 $n_1 = 23$

Reference area production: Yield mean =  $\bar{x}_2 = 29.2$  bu/ac  
 Variance =  $s_2^2 = 0.80$   
 $n_2 = 25$

Calculate the  $t_{calc}$  value

$$t_{calc} = \frac{|\bar{x}_1 - \bar{x}_2|}{S_{pooled} \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where:

$$S_{pooled} = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

$$= \frac{|28.5 - 29.2|}{0.996 \sqrt{\left(\frac{1}{23} + \frac{1}{25}\right)}} = \frac{0.7}{0.288} = 2.43$$

$$\text{d.f.} = n_1 + n_2 - 2 \quad (\text{except where noted below})$$

*Find the tabular value for  $t$  at the desired confidence level and degrees of freedom and compare with the calculated  $t$  value.*

The tabular  $t$  value for a 90% confidence level and  $(n_1+n_2-2)$  degrees of freedom (46 d.f.) from the end of this section would be approximately 1.3. Thus for this example we would conclude



that since  $t_{\text{calc}}$  is greater than the tabular  $t$  value that the reclaimed yield **is not** equal to the adjusted yield standard (or full field harvest) and **would not qualify** for demonstrating vegetation success for final bond release purposes.

**NOTE:** The above calculation for degrees of freedom assumes that the variances calculated for the two means are statistically equal. If, however, the ratio of the variances is greater than 3, then it may be assumed that the variances **are not** equal and a correction in calculating the number of degrees of freedom must be used. The following formula (Satterthwaite Correction Factor) should be used to determine the degrees of freedom if the variances are considered unequal:

$$\text{d.f.} = \frac{\left( \frac{s_1^2}{n_1} + \frac{s_2^2}{n_2} \right)^2}{\left( \frac{\left( \frac{s_1^2}{n_1} \right)^2}{(n_1 - 1)} + \frac{\left( \frac{s_2^2}{n_2} \right)^2}{(n_2 - 1)} \right)}$$

For example, assume two samples have variances of 1.80 and 0.35 with sample sizes of 12 and 18, respectively. Assuming equal variances would result in 28 degrees of freedom. However, since the ratio of the variances is greater than 3, the corrected number of degrees of freedom that should be used is calculated as follows

$$\text{d.f.} = \frac{\left( \frac{1.8}{12} + \frac{0.35}{18} \right)^2}{\left[ \frac{\left( \frac{1.8}{12} \right)^2}{12 - 1} + \frac{\left( \frac{0.35}{18} \right)^2}{18 - 1} \right]} = \frac{0.0287}{0.00204 + 0.000022} = 13.9$$

= 14 degrees of freedom

**c. Using weighted mean values for both sites (equal or unequal sample sizes)**

*Example 5:* Assume the following values have been calculated from the weighted field values using the equations given earlier:

Reclaimed site production: Yield mean =  $\bar{x}_{w1} = 29.2$  bu/ac

Variance =  $s_{w1}^2 = 1.70$

$n_1 = 22$

Reference area production: Yield mean =  $\bar{x}_{w2} = 29.5$  bu/ac  
 Variance =  $s_{w2}^2 = 1.80$   
 $n_2 = 27$

Calculate the  $t_{calc}$  value:

$$t_{calc} = \frac{|\bar{x}_{w1} - \bar{x}_{w2}|}{S_{pooled} \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$\text{where: } S_{pooled} = \sqrt{\frac{(n_1 - 1)s_{w1}^2 + (n_2 - 1)s_{w2}^2}{n_1 + n_2 - 2}} = 1.325$$

$$= \frac{|29.2 - 29.5|}{1.325 \sqrt{\left(\frac{1}{22} + \frac{1}{27}\right)}} = \frac{0.3}{0.38} = 0.79$$

and d.f. =  $n_1 + n_2 - 2$  (except as noted above)

Find the tabular value for  $t$  at the desired confidence level and degrees of freedom and compare with the calculated  $t$  value.

The tabular  $t$  value for a 90% confidence level and  $(n_1+n_2)-2$  degrees of freedom (47 d.f.) from the end of this section would be approximately 1.3. Thus for this example we would conclude that since  $t_{calc}$  is **less than** the tabular  $t$  value that the reclaimed yield is equal to the adjusted yield standard (or full field harvest) and **would demonstrate** vegetation success for final bond release purposes.

### **B. Using one-tailed confidence limits or error estimates of a mean when an adjusted technical standard or full field harvest value is used**

The confidence limit approach compares the difference between the sampled mean estimate of cover or production of the reclaimed site and the adjusted standard or reference mean value to a calculated confidence interval. Since only the reclaimed site was sampled, one cannot

be entirely confident that the mean ( $\bar{x}$ ) of the sampled data set is the same as the reference ( $X_{\text{ref}}$ ) or adjusted standard ( $X_{\text{AD}}$ ) yield. Therefore, a range of values (confidence range) exists above and below the reclaimed mean value where one is uncertain (not confident) if the reference or adjusted standard yield lies within that range. The reference or adjusted standard yield cannot lie outside the end point of the confidence range in order to be considered equal to the reclaimed mean value. Thus, a confidence range can be used to indicate that the mean from the reclaimed sample is not significantly different than the reference or adjusted standard value.

The equation for confidence limit approach assumes that the difference in yield values must be smaller than the estimated confidence interval in order for the two means to be statistically equal. The confidence limit approach is calculated as follows:

$$\left| \bar{x} - (X_{\text{ref}} \text{ or } X_s) \right| \leq (t_{\alpha} s) / \sqrt{n}$$

where  $t_{\alpha}$  has  $n-1$  degrees of freedom.

*Example 6:* Assume the following information:

Reclaimed site production: Yield mean =  $\bar{x}_1 = 1900$  lbs/acre

Variance =  $s_1^2 = 155.2$

$n_1 = 21$

Reference site production or adjusted standard:

Yield =  $X_{\text{ref}} \text{ or } X_{\text{AD}} = 1950$  lbs/acre

*Calculate the interval estimate for the difference between the two means at a 90% confidence level:*

$$|1900 - 1950| \leq [(1.325)(12.46)] / \sqrt{21} = 50 \leq 3.60$$

Thus since the difference between the two yield values (50) is **greater than** the estimated confidence interval (3.60), we would conclude that the reclaimed production **is not equal** to the production of the reference site or adjusted standard and would not demonstrate revegetation success for final bond release.

## t-DISTRIBUTION VALUES FOR ONE-TAILED t-TESTS

<b>df</b>	<b>90% level</b>	<b>df</b>	<b>90% level</b>	<b>df</b>	<b>90% level</b>
1	3.078	13	1.350	25	1.316
2	1.886	14	1.345	26	1.315
3	1.638	15	1.341	27	1.314
4	1.533			28	1.313
5	1.476	16	1.337	29	1.311
		17	1.333	30	1.310
6	1.440	18	1.330		
7	1.415	19	1.328	40	1.303
8	1.397	20	1.325		
9	1.383			60	1.296
10	1.372	21	1.323		
		22	1.321	120	1.289
11	1.363	23	1.319		
12	1.356	24	1.318	$\infty$	1.282

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## **V. APPENDICES**

Appendix A – Initiation of the Revegetation Liability Period and Management During the Liability Period

Appendix B – Summary of Reclamation Laws and Rules 1969-1978

## APPENDIX A

### INITIATION OF THE REVEGETATION LIABILITY PERIOD AND MANAGEMENT DURING THE LIABILITY PERIOD

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### **Initiation of Liability Period**

On cropland and prime farmland, the liability period begins on the date of the seeding of a precropland seed mix, a temporary cover crop, or a harvestable crop. Establishment of a precropland mix rather than a crop at the beginning of the liability period is recommended for soil development and erosion control. However, in some cases immediate cropping of a reclaimed area may be desired.

The liability period begins following completion of the last augmented seeding, fertilization, irrigation, or other work on all non-cropland land uses. If a nurse or cover crop is seeded, the liability period is not initiated until that crop is replaced with a seed mix that has been approved for the postmine land use. If seeding is done in two phases (e.g., warm season grasses followed by cool season grasses), the responsibility period will not be initiated until the last seeding is completed. Forbs may be planted at any time during the revegetation responsibility period without restarting the liability period provided the established vegetation is preserved.

Shelterbelts and woodlands should be planted at the same time that the surrounding area is seeded, so that the liability period begins at the same time. This will ensure that the entire unit can be released at the same time. The liability period on wetlands begins following spread of soils in the wetland basin and seeding of contiguous areas.

### **Management During the Liability Period**

After initiation of the liability period, the use of augmentation practices that drastically affect revegetation will reinitiate the liability period. A differentiation must be made between augmentation practices and "normal conservation practices". Augmentation practices are those which exceed the commonly used management techniques on similar unmined lands in the surrounding area. In contrast, normal conservation practices are commonly used management techniques which provide sustained yields or vegetation cover.

Because the distinction between normal conservation practices and augmentation practices is not always clear, management practices must be reviewed on a site specific basis to determine whether they affect the liability period. The PSC should be consulted prior to implementing practices, which drastically affect established vegetation. Following is a discussion of those practices that are considered normal conservation practices which, when approved on a site specific basis, will not reinitiate the liability period. The discussion under "Augmentation Practices," includes those practices which will reinitiate the liability period.

#### **Normal Conservation Practices**

Normal conservation practices are defined as: those, which are used, as part of long-term management, or practices which if discontinued will not reduce the probability of permanent revegetation success. These are regarded as normal conservation practices since they are often routinely employed on unmined lands. This definition is consistent with 30 CFR 817.116(c)(4) which allows the regulatory authority to approve selective husbandry practices. NDCC 38-14.1-24(18) allows local conservation practices to be used in postmining management without

restarting the liability period. The Journal of the North Dakota Senate, March 6, 1981, discusses House Bill 1455 which provides further rationale for NDCC 38-14.1-24(18). The Journal stated that the term "normal conservation practices" is intended to mean those activities that include, but are not limited to: mowing; strip cropping; stubble mulching; shelterbelts; pest control; weed control; erosion control; interseeding; and, supplementary fertilization.

On all land uses, normal conservation practices include pest management (e.g., weeds, insects, etc.), which is usually routinely performed as required by infestations. Acceptable weed control techniques include: manual or mechanical removal; controlled burning; and, herbicide applications. Reseeding or interseeding of small areas, which may be necessitated by pest control, is considered a part of the management practice. Repair and subsequent management of minor erosion features is also regarded as a normal conservation practice because it is routinely done on agricultural lands in North Dakota. Repair may include backfilling and blading, and reseeded or interseeding small areas, along with curlexing, mulching, and other stabilization techniques.

Fertilization and irrigation are considered as normal management practices when they are part of long-term management plans for the reclaimed area (i.e., for cropland and hayland). Irrigation may be used during the first growing season to enhance establishment on any land use. However, irrigation and fertilizer application should not be continued during the liability period if they are not expected to be continued following bond release.

Normal conservation practices on cropland include the use of cover crops, strip-cropping, or minimum tillage. Plowing alfalfa or other hayland to reestablish the stand every 4 to 5 years also is an acceptable management practice.

Normal conservation practices on reclaimed native grassland and tame pastureland include burning, mowing, and grazing, as part of long-term management. Fertilizer or herbicide applications which are used to manipulate the cool season/warm season grass ratio are considered normal conservation practices since these are important management tools (Ries et al. 1987). Occasional haying, burning or light grazing of fish and wildlife habitat (grassland and wetland areas only) are frequently used in North Dakota (Fulton et al. 1986). Reinforcement interseeding to modify species composition or reestablish certain species (forbs), during stand establishment, is regarded as a normal conservation practice on native grasslands in the Northern Great Plains. Reinforcement interseedings do not reduce or enhance the probability of permanent vegetation success, and therefore, will not restart the liability period. A single reinforcement interseeding on an area may occur before the stand is considered established. A stand will be considered established when evaluated as a critical area planting as described in Ecological Science Practice 342, Herbaceous Vegetation Guide, (NRCS 2016), more specifically, the standard of 5 plants per square foot of bunch grasses and rhizomatous grasses must be achieved. Since reclamation of surface mined lands also requires a diverse and seasonal stand, a frequency measurement of the established plants must also be recorded. The frequency of species seeded must indicate that at least 50% of the seeded species are becoming established. The area must be evaluated as specified by the NRCS ND-CPA-9a, Grass Stand Evaluation Worksheet (June 2015). NRCS (2015) states that native warm-season species may require three growing seasons for establishment. Therefore, the evaluation should be conducted in year four

to allow time for all species seeded to become established. At this time, the mining company must provide data which indicates that the stand has not become established. If it is determined that the stand is not adequately established, a reinforcement interseeding will be allowed at the next favorable seeding time (spring of year five). Any interseeding other than forbs after year five will be considered a failed seeding and will restart the liability period.

Normal conservation practices, which are used to manage woodland or shelterbelt plantings include; weed control, supplemental watering, and delayed establishment of understory vegetation. These practices are commonly used to reduce competition and enhance woody plant establishment. Replacement of dead trees and shrubs and pruning and thinning also are considered normal conservation practices. According to NRCS Ecological Science Practice (612) Tree and Shrub Establishment (2011) "any tree or shrub that fails within the first 3 years should be replaced with a similar plant" however, as a minimum, replacements will be made to eliminate gaps of two or more consecutive trees and/or shrubs in a row and to maintain a stand of at least 85 percent." Because these practices are recommended by the NRCS and are commonly used for management of shelterbelts in North Dakota, they are considered as normal conservation practices. Also, voluntary plantings of trees and shrubs on agricultural land at the request of the landowner or to enhance fish and wildlife habitat are considered normal conservation practices.

### **Augmentation Practices**

Augmentation practices are those which exceed the management practices commonly used on similar unmined lands in the surrounding area. The use of an augmentation practice on reclaimed lands will reinitiate the liability period. Some examples include:

Fertilization or irrigation, if not used as specified in the management plan for that tract, on cropland, hayland, and pastureland.

Fertilization, when used in excessive amounts (based on soil tests and historic use), on cropland, hayland, and pastureland.

Fertilization or irrigation, when used to boost production on native grassland or on grasslands in fish and wildlife habitat.

Reseeding native grasslands, pasturelands, or grasslands in fish and wildlife habitat, to reintroduce the desired species.

Extensive replanting, plugging, or addition of soil containing propagules on wetlands.

Extensive replanting in woodland or shelterbelts.

Any significant surface modifications, which disturb the topsoil.

Any change in land use that requires a seed mix modification to support the intended land use.

APPENDIX B

SUMMARY OF NORTH DAKOTA  
RECLAMATION LAWS AND RULES

1969-1978

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## **INTRODUCTION**

Since some areas were mined under different sets of laws and rules, the release of areas from bond will have to be made on the basis of the requirements that existed when they were mined. North Dakota's reclamation law was enacted in 1969 and later revised in 1971, 1973, 1975, 1977 and 1979. In 1980, the Office of Surface Mining conditionally approved North Dakota's permanent regulatory program. Since then some additional changes in the law and rules have occurred, but the impact of such changes on requirements related to vegetation inventory or evaluation of revegetation success have been minimal. In view of these facts, it will be relevant to our present purpose to trace the development of revegetation requirements along with grading and soil requirements since the inception of the reclamation law in North Dakota.

### **1969 Law**

The operator was required to grade the land affected by surface mining to a rolling topography with slopes not to exceed 25% and traversable by farm machinery if the affected area was to be used as cropland or hayland. Peaks and ridges, were required to be struck off to a minimum width of 24 feet if the area was to be afforested, and to a minimum width of 35 feet if seeded to pasture. There were no requirements for soil removal or respreading. The operator was required to sow, set out or plant on the affected land seeds, plants, cuttings of trees, shrubs, grasses, or legumes as per the approved reclamation plan. Planting was not required on depressed haulage roads, final cuts and other areas subject to ponding of water. Reclamation had to be "acceptable" and would be deemed completed after the second seeding or planting.

### **1971 Law**

The operator was required to grade the land affected by surface mining to a rolling topography not to exceed 20% and traversable by farm machinery if the affected area was to be used as cropland or hayland. Peaks and ridges were required to be struck off to a minimum width of 35 feet if the area was to be afforested or seeded to pasture. There was no soil removal or respreading requirements. Revegetation requirements were similar to those of the 1969 law.

### **1973 Law and Rules**

The operator was required to return the land affected by surface mining to its approximate original contour or rolling topography or different topography required for an intended higher use. Final cuts and end walls were required to be backsloped to an angle not to exceed 35 degrees from the horizontal, unless water impoundments or other special topographic features were desired. Up to two feet of soil materials, were required to be removed and replaced on the regraded spoil. Seeding and planting requirements were similar to those of the 1969 law, but no exception was made for the final cuts and haulage roads within the mined area. The part of the law deeming reclamation as having been completed following second seeding or planting was repealed. Instead, reclamation was to be accomplished to the satisfaction of the Commission.

### **1975 Law and Rules**

The operator was required to return the land affected by surface mining to its approximate original contour unless required otherwise by the Commission. Final cuts and endwalls were required to be backsloped to an angle not to exceed 35 percent. Soil materials up to a maximum depth of 5 feet were required to be saved, segregated and respread on the regraded spoil. Characteristics of suitable plant growth materials were specified and topsoil had to be segregated from subsoil.

Seeding and planting requirements remained as they were in the 1969-1973 laws, but restoration of the level of inherent productivity equal to or greater than which existed prior to mining was mandated for the first time. No specific requirements were set for the procedures to be used in evaluating the revegetation success except that a request for bond reduction was required to be accompanied by appropriate soil tests, a complete history of initial and subsequent seeding and fertilization and supplemental irrigation or any other management practices employed. Reclamation was required to be conducted to the satisfaction of the Commission.

### **1977 Law and Rules**

The operator was required to backfill and regrade the mined areas to the gentlest topography consistent with the adjacent unmined landscape. All final cuts, highwalls, and endwalls were required to be backsloped to an angle not to exceed 35 percent from the horizontal, unless the operator wanted to implement alternative plans such as water impoundments or establish special topographic features. All soil materials within the permit area determined suitable for plant growth were required to be saved, segregated and respread in two lifts. Submission of maps delineating pre- and postmining land uses along with the major vegetation types and their distribution, was required under rules.

Requirements for seeding and planting were similar to the previous laws. However, pursuant to Commission rules which are intended to apply to all areas initially disturbed by mining after July 1, 1975, the operator was required to provide documentation that vegetation establishment and yield had achieved a level equal to or exceeding the premining level. On areas returned to permanent grass cover, the operator was required to submit pre- and postmining species composition, cover, density, and yield data. Bond release requests were required to be accompanied by a complete history of initial and subsequent seedings and fertilization, appropriate soil tests, supplemental irrigation or any other management practices employed. Reclamation was required to be conducted to the satisfaction of the Commission.

### **1978 Interim Rules**

When the federal interim regulations were developed following the enactment of SMCRA, the Commission also made changes in its rules in 1978 to comply with the federal requirements. According to these revised rules, the operator was required to develop "A premining and postmining vegetation inventory process . . . from established reference areas pursuant to methods approved by the Commission that [would] be used to determine the degree of success in the revegetated area. The purpose of this vegetation inventory [was] to develop a data base to compare postmining vegetation success". . . "For all new permits applied for after

October 1, 1978, reference areas [were to] be selected and premining inventory information, as specified and approved by the Commission [was to] be submitted with the permit application. Reference areas for all land affected after July 1, 1975, under [the then] existing permits and for all new permits issued prior to October 1, 1978 [were to] be selected in a timely manner and [were to] be specified and approved by the Commission".

Operators were required to "provide documentation that vegetative establishment and yield have achieved a level equal to or exceeding the premining level. The ground cover and productivity of living plants on all significant portions of the revegetated area [were] required to be shown to equal or exceed the ground cover and productivity of living plants of the approved reference area with a 90% statistical confidence for a minimum of two growing seasons". However, an exception was allowed for reaffected areas that were previously mined and, in some instances, reclaimed prior to the effective date of these interim rules. Ground cover for these areas was required to the extent that it "controlled erosion" and was not less than that existing before redisturbance. (However, if the reaffected areas were initially disturbed by mining activities after July 1, 1975, then the premine productivity level must be restored.) Also, the use of reference areas for evaluation of crop production was required.

The rules under the permanent regulatory program based on the new law that became effective July 1, 1979 are discussed in Section I of the guidelines.