PHASE III
REVEGETATION SUCCESS STANDARDS FOR RECREATION AND WILDLIFE HABITAT

Arkansas Department of Environmental Quality
Surface Mining and Reclamation Division
P. O. Box 8913
Little Rock, Arkansas 72219

Effective Date:

RECREATION AND WILDLIFE HABITAT

Appendices

I. Introduction

This policy describes the criteria and procedures for determining Phase III success standards for areas being restored to recreation and wildlife habitat.

Pursuant to the Arkansas Surface Coal Mining and Reclamation Code (ASCMRC)Section 816.116(b)(3), revegetation success on recreation and wildlife habitat must be determined on the basis of the following conditions:

- General revegetation requirements of the approved permit; and
- Ground cover; and
- Tree/shrub/ or half-shrub stocking and survival.

The permittee is responsible for measuring the vegetation and for submitting the data to the Director for analysis. Measurements of the vegetation must be made in accordance with the procedures outlined in this document.

II. General Revegetation Requirements

The general requirements for revegetation, as stated under ASCMRC Section 816.111, shall be considered satisfied upon the determination by the Director that:

A. The permittee has established on regraded areas and all other disturbed areas, except water areas, surface areas of roads and areas around buildings that are approved as part of the postmining land use, a vegetative cover that is in accordance with the reclamation plan in the approved permit and that is:

1. Diverse, effective, and permanent;
2. Comprised of species native to the area, or of introduced species which are allowable under ASCMRC Section 816.112, and necessary to achieve the postmining land use and approved by the regulatory authority;
3. At least equal in extent of cover to the natural vegetation of the area; and
4. Capable of stabilizing the soil surface from erosion.

B. The Director must also make the determination that the reestablished plant species are:

1. Compatible with the approved postmining land use;

2. Of the same seasonal characteristics of growth as the original vegetation;

3. Capable of self-regeneration and plant succession;

4. Compatible with the plant and animal species of the area; and

5. Allowed for planting under applicable State and Federal laws and regulations which control the growth of poisonous and noxious plants and introduced species.

III. Success Standards and Measurement Frequency

A. Ground Cover

1. The success standard for wildlife ground cover shall be considered acceptable if it has at least seventy percent (70%) density with ninety percent (90%) statistical confidence for the last year of the five (5) year responsibility period.

2. The aggregate of areas with less than seventy percent (70%) ground cover must not exceed five percent (5%) of the release area. These areas must not be larger than 1 acre and must be completely surrounded by desirable vegetation which has a ground cover of seventy percent (70%). Areas void of desirable vegetation may not be larger than 1/4 acre and must be surrounded by desirable vegetation which has a ground cover of seventy percent (70%).

3. No more than thirty-five percent (35%) of the stand can consist of approved species not listed in the permit.

4. There can be no more than forty percent (40%) deviation from the approved seeding mixture in the stand.

B. Tree and Shrub Stocking Rate

1. The stocking rate for trees, shrubs, or half-shrubs shall be determined on a specific permit basis with consultation and approval of the Arkansas Game and Fish Commission. The stocking of live woody plants shall be equal to or greater than ninety percent (90%) of the stocking of woody plants of the same life form approved in the permit. When this requirement is met and acceptable ground cover is achieved,

the five (5) year responsibility period shall begin.

A countable tree, shrub, or half-shrub shall:

a. have been in place at least two (2) growing seasons;

b. be alive and healthy; and

c. have at least one-third (1/3) of its length in live crown.

The permittee must provide documentation of this in the form of paid receipts, reclamation status reports, and/or normal correspondence. The inspection and enforcement section shall also verify plantings, by noting in reports, planting dates of specified areas.

2. Tree and shrub stocking rate shall be sampled once during the last year of the five-year responsibility period. The woody plants established on the revegetated site must be equal to or greater than ninety percent (90%) of the stocking rate approved in the permit with ninety percent (90%) statistical confidence. At the time of final bond release at least eighty percent (80%) of the trees and shrubs used to determine success shall have been in place for sixty percent (60%) of the applicable minimum period of responsibility.

IV. Sampling Procedures

A. Random Sampling

1. To assure that the samples truly represent the vegetative characteristics of the whole release or reference area, the permittee must use methods that will provide 1) a random selection of sampling sites, 2) a sampling technique unaffected by the sampler's preference, and 3) sufficient samples to represent the true mean of the vegetative characteristics.

2. Sampling points shall be randomly located by using a grid overlay on a map of the release or reference area and by choosing horizontal and vertical coordinates as described in Appendix A. Each sample point must fall within the release area boundaries and be within an area having the vegetative cover type being measured.**ADDITIONALLY, IF THE RELEASE AREA DOES NOT CONSIST OF A SINGLE UNIT, AT LEAST ONE SAMPLE POINT MUST BE MEASURED IN EACH NONCONTIGUOUS UNIT**.

3. The permittee shall notify the Director ten (10) days prior to conducting sampling or other harvesting operations to allow a representative from the state an opportunity to monitor the sampling procedures.

B. Sampling Techniques

1. Ground cover shall be measured as the area covered by the combined aerial parts of the plant species approved in the permit and the leaf litter that is produced naturally onsite, expressed as a percentage of the total area of measurement.

2. Trees and shrubs shall be measured as the number of countable approvable woody stems, expressed as stems per acre for the total area of measurement.

3. Because ground cover and tree/shrub density are measured differently, the techniques for sampling each must also be different. For ground cover, the permittee shall identify the species or type of cover using a line-point transect method. Trees and shrubs will be measured using randomly selected one-fiftieth (1/50) acre sampling circles.

4. Each transect or sampling circle must be entirely within a homogeneous area that accurately represents the vegetative cover type being measured. Samples must be taken in pure vegetation types and not in transition zones between adjacent types. Also, the sample sites must be located so they avoid the effects of neighboring vegetation types, roads, stream courses, ponds, etc.

a. Line-Point Transect (Ground Cover)

A line-point transect shall be a series of 100 points spaced 1 foot apart along a straight line. The permittee shall establish a transect at each of the randomly selected sampling points. The direction of the transect shall also be determined randomly. This can be done as easily as spinning a pencil on a clipboard or throwing it in the air and using the direction where it points.

The permittee shall classify the ground cover at each 1-foot interval along the entire length of the transect (starting at 1 foot from the random point). The area of measurement shall be a line projected downward and perpendicular to the ground at each 1-foot interval (100 in total).

At each point along the transect, ground cover shall be classified as acceptable or unacceptable as follows:

Acceptable	Unacceptable
Vegetation approved in permit	Vegetation not approved in permit
Acceptable-not approved in permit	Rock or bare ground
Dead vegetation or litter from acceptable species	

All data gathered from the line-point transects shall be recorded in the format shown in Appendix B, Part 2.

b. Sampling Circles (Trees/Shrubs)

A sampling circle shall be a round area one-fiftieth (1/50) of an acre in size (16.7 feet in radius). The permittee shall establish a sampling circle at each randomly selected sampling point such that the center of the sampling circle is the random point. Permittee may draw the circle by attaching a 16.7 foot string to a stake fixed at the random point and then sweeping the end of the string (tightly stretched) in a circle around the stake. The permittee shall count all living trees and shrubs within each of the sampling circles. In more mature tree/shrub areas, the stakes may need to be extended to elevate the string above the growth.

To count as a living tree or shrub, the tree or shrub must be alive and healthy; must have been in place for at least two (2) years; and must have at least one-third (1/3) of its length in live crown. At the time of liability release, 80 percent must have been in place for three (3) years.

All data gathered from the sampling circles shall be recorded in the format presented in Appendix C.

C. Sample Adequacy

The permittee shall collect samples using a two-staged sampling procedure. During the first stage, the permittee shall take an initial group of samples (minimum of ten). By using these initial samples and by applying the formula below, the permittee shall determine the actual number of samples needed:

$$N = \frac{(t^2)(s^2)}{(0.1x)^2}$$

N = minimum number of samples needed;

Where t^2 = squared t-value from the table in Appendix D (1.383 for n = 10);

S^2 = initial estimate of the variance of the release (or reference) area; and

(0.1O) = the level of accuracy (±10%) expressed as 10% of the mean.

(Example uses of the formula are presented in Appendices E and F) If the formula reveals that the required number of samples is equal to or less than ten, the initial sampling will satisfy the sampling requirements. If the number of samples needed is greater than ten, the permittee must take the balance of additional samples (Stage Two Sampling) as specified by the formula. This is repeated until sample adequacy is met.

V. Data Analysis

If the data shows that revegetation success has been met, the permittee shall submit the data to the Director for review in the format shown in Appendices B and C within thirty (30) days of collection.

When the data indicates that the average ground cover and/or tree and shrub average stocking density is insufficient, but close to the standards, the permittee may submit the data to the Director to determine if the vegetation is acceptable when statistically compared to the standards using a 90-percent statistical confidence interval. Appendices G and H explain how the statistical analysis will be performed.

VI. Maps

A. Whenever a new Phase III plan is submitted to the Director, it must be accompanied by maps showing the location of the area covered by the plan (i.e., the area proposed for release).

B. Whenever data from a previously approved plan is submitted to the Director, it must be accompanied by maps showing:

1. the location of each transect and sampling circle location,

2. the area covered by the plan, and

3. all permit boundaries.

VII. Mitigation Plan

Ground cover must be greater than or equal to 70% coverage and tree and shrub stocking must achieve the standards set in the permit the fifth year following completion of the initial seeding. If they do not achieve these standards, the permittee must submit a mitigation plan to the Director which includes the following:

1. a statement outlining the problem;

2. a discussion of what practices, beyond normal agronomic practices, the operator intends to use to enable the area to finally meet the release standards; and

3. a new Phase III liability release plan.

If renovation, soil substitution, or any other practice which constitutes augmentation is employed, the five-year responsibility period begins again.

APPENDIX A

Selection of Random Sampling Sites

The permittee shall use X and Y grid coordinates in establishing the location of sampling sites on the reclaimed area (and on the reference area, if a reference area standard is used).

A grid shall be placed or drawn on the map containing the areas to be sampled. The grid must be large enough so that all of the release or reference area is covered by the grid (see drawing in Figure 1). Also, the grid pattern shall be such that the axes are 200 feet apart or closer.

The X and Y axes shall be numbered in consecutive order beginning at the extreme lower left point of the grid (this point being 1).

The permittee shall generate random number pairs for each X and Y axis combination needed. For example, if five (5) sampling locations are to be established, the permittee must generate five (5) random number pairs.

The random numbers table shown in Table 1 may be used to choose the numbers needed. The table is used as follows:

Step 1) Choose an axis to work on (X or Y).

Step 2) Flip a coin twice to determine a column on which to start (refer to coin flip combinations at the head of each column).

Step 3) By beginning at the top of the column selected, begin reviewing the numbers until a number that falls within the range of those on the chosen grid axis is found. If the range of numbers on the axis is less than 10, then you will only review the last digit of the numbers in the column. If the range of numbers is more than 10 but less than 100, then the last two digits will be reviewed.

Step 4) Record the first number found.

Step 5) Beginning after the last number found, continue down the column until another number is located within the given range. Record this number and continue following the above procedure until the required amount of numbers is found and recorded. If you reach the bottom of the column before you locate enough numbers, proceed to one of the adjacent columns, starting again at the top. When all columns have been used, begin again with the first column used, except review only the first (instead of the

last) one or two digits of the numbers in the column.

Step 6) After enough numbers are generated for the first axis chosen, restart the process at Step 1 for the other axis.

After enough random number pairs have been generated for each axis, locate the sample points on the grid. If a point(s) falls outside the release or reference area, a new point(s) must be chosen as explained above.

APPENDIX A

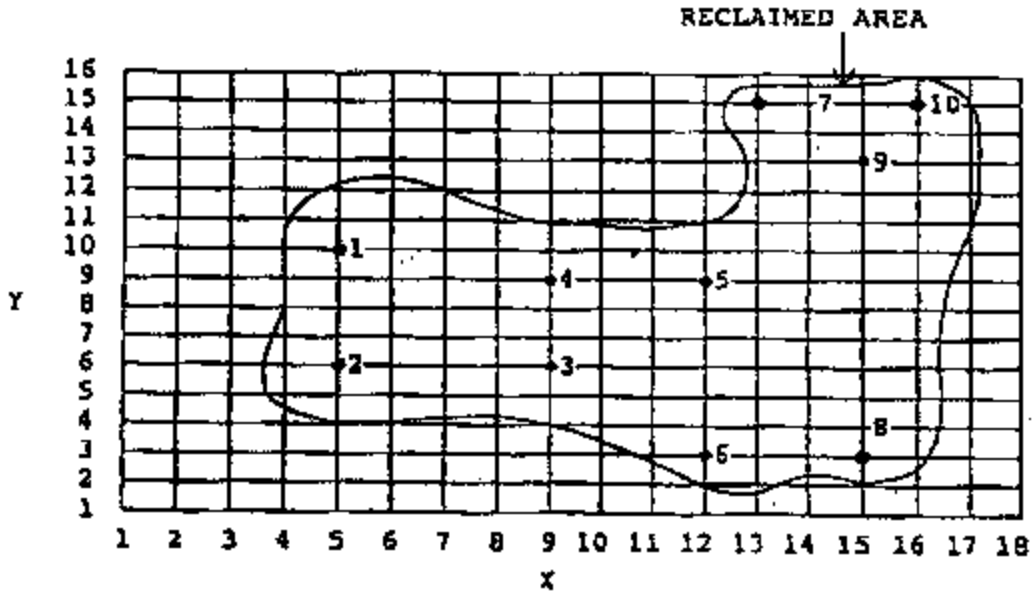
Table 1
A Set of Random Numbers

Heads/Heads Column 1	Tails/Ta ils Column 2	Heads/Tails Column 3	Tails/He ads Column 4
6327	0983	3798	4679
2167	6484	9467	9058
3939	0407	1804	8827
4672	3865	5689	9878
8071	5185	5514	5008
9509	0603	7461	8550
6615	2588	3558	3349
4833	2422	9790	1183
5594	1809	6931	6571
9441	1699	3947	7702
7922	9812	7229	5252
9419	6494	8179	8065
6178	3556	2466	2495
2647	3961	7546	4799
0474	1839	6926	6534
9814	1577	8293	0301
0104	4579	0627	8667
1608	9470	4131	5345
9722	1557	0471	5498
4189	3582	3675	9461
9855	8088	9006	6897
5791	8234	1472	3421
0872	3310	0510	9046
8953	9809	8037	8376
2895	4319	6544	8953
0609	5248	8734	2498
0795	2464	6170	1063
1572	7371	7936	2841
4307	0294	6060	5194
4857	0197	2401	7005
1632	7189	6463	9830
0745	8034	7882	7152
0736	5110	5165	6571
8168	7924	5876	1407
7468	5313	2736	9010
6044	5420	3077	9070
6716	0059	3001	8871
9342	0169	6880	7986
5809	6048	9051	1151
1532	9715	7081	0109
5506	5812	5917	4415
4045	1751	2817	9958
5966	9930	6437	7279
6062	3296	5093	2503
4097	8379	5670	0614
6793	3999	4645	5143
7960	4853	0583	1920
1321	4067	8503	1604

APPENDIX A
FIGURE 1

RANDOM PLOT LOCATIONS GRID OVERLAY

Random Plot	Random Numbers	
	X	Y
1	5	10
2	5	6
3	9	6
4	9	9
5	12	9
6	12	3
7	13	15
8	15	3
9	15	13
10	16	15



APPENDIX B, PART 1

Example of Format for Summarizing Line Point Transect Data

LINE POINT TRANSECT SUMMARY SHEET

Page ___ of ___

Company Name _____

Permit No. _____

Land Use _____

Acres in Release Area _____

No. of Transects Used (n) = _____

Date of Sampling _____

Transect No.(n)	Acceptable Points Found (Out of 100) (X)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18 (Extend as needed)	

n = _____ 'X = _____

Mean O = 'X/n = _____

APPENDIX B, PART 2

Example of Format for Recording Line Point Transect Information:

LINE POINT TRANSECT SHEET

Page _____ of _____
Company Name _____
Permit No. _____
Land Use _____
Date of Sampling _____
Line Point Transect # _____

Point #	Accept or Unaccept	Point #	Accept or Unaccept	Point #	Accept or Unaccept	Point #	Accept or Unaccept
1		26		51		76	
2		27		52		77	
3		28		53		78	
4		29		54		79	
5		30		55		80	
6		31		56		81	
7		32		57		82	
8		33		58		83	
9		34		59		84	
10		35		60		85	
11		36		61		86	
12		37		62		87	
13		38		63		88	
14		39		64		89	
15		40		65		90	
16		41		66		91	
17		42		67		92	
18		43		68		93	
19		44		69		94	
20		45		70		95	
21		46		71		96	
22		47		72		97	
23		48		73		98	
24		49		74		99	
25		50		75		100	

Species % Stand

$$\% \text{ Cover} = \frac{3 \text{ Accept}}{100} = \_\_\_\_\_$$

$$\% \text{ Accept/not approved} = \frac{3 \text{ ANA}}{100} = \_\_\_\_\_$$

APPENDIX C, PART 1

Example of format for summarizing sampling circles information.

SAMPLING CIRCLES SUMMARY SHEET Page _____ of _____

Company Name _____

Permit _____

Land Use _____

Date(s) of Sampling_____

Acres in Release Area_____

No. of Sampling Circles Used (n) _____

Area of Each Sampling Circle in Acres _____

Total No. of Countable Trees Tallied ('X) _____
(from Sampling Circles Data Sheet(s))

Total No. of Countable Trees 3 Years or Older ('3 Years)_____

% of Trees 3 Years or Older = ' 3 Years/'X = _____
(from Sampling Circles Data Sheet(s))

This figure must equal or exceed 80% to be successful for final bond release.

Total Number of Countable Trees Per Acre $\frac{('x)}{n} \times 50 =$ _____

Target Number of Trees Per Acre From Approved Phase III Release Plan = _____

APPENDIX C, PART 2

Example of format for recording sampling circles information.

SAMPLING CIRCLES DATA SHEET Page _____ of _____

Company Name _____

Permit _____

Land Use _____

Date of Sampling _____

Sampling Circle No. (n)	Countable Trees (X)	Number of Countable Trees 3 Years or Older (3 Years)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.(Extend as needed)		

n = 'x = '3 Years =

APPENDIX D

d.f.	t.100
1	3.078
2	1.886
3	1.638
4	1.533
5	1.476
6	1.440
7	1.415
8	1.397
9	1.383
10	1.372
11	1.363
12	1.356
13	1.350
14	1.345
15	1.341
16	1.337
17	1.333
18	1.330
19	1.328
20	1.325
21	1.323
22	1.321
23	1.319
24	1.318
25	1.316
26	1.315
27	1.314
28	1.313
29	1.311
inf.	1.282

Note: for the sample adequacy calculations and 1 tail productivity comparisons, use columnt.100.

From "Table of Percentage Points of the t.Distribution." Biometrika, Vol. 32 (1941), p.300. Reproduced by permission of the Biometrika Trustees.

APPENDIX E

Example Use of Sample Adequacy Formula for Ground Cover Measurements

In this example, the permittee has taken an initial group of samples from ten (10) randomly located line-point transects. The results of his sampling are as follows:

1) Calculating the variance:

Transect No. (n)	Acceptable Points (Out of 100) x	x^2
1	86	7,396
2	90	8,100
3	76	5,776
4	82	6,724
5	40	1,600
6	76	5,776
7	40	1,600
8	82	6,724
9	86	7,396
10	90	8,100
	$\sum x = 748$	$\sum x^2 = 59,192$

Now we need to calculate the variance, S^2:
Number of transects (n) = 10

$$S^2 = \frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}$$

or, put into words:

$$S^2 = \frac{\text{Sum of Squared Values Added} - \frac{\text{Square of Sum of All Values}}{\text{\# of Values}}}{\text{(Number of Values - 1)}}$$

From the data in the above example, we calculate:

$$S^2 = \frac{59,192 - \frac{(748)^2}{10}}{9} = \frac{59,192 - 55,950.4}{9} = \frac{3241.6}{9} = 360.18$$

APPENDIX E
Page 2

2) Determining sample adequacy:

From the t table, we find t for a sample size of 10.

n-1 = degrees of freedom.

10-1 = 9 degrees of freedom for our example.

From the t table, locate the t statistic for 9 degrees of freedom = 1.383

The sample adequacy formula is:

$$N = \frac{(t^2)(S^2)}{(0.1x)^2}$$

Where:

$$\text{Mean } O = \frac{'x}{n}$$

N = the number of samples which will need to be taken,

t^2 = t table value, squared,

S^2 = variance.

Plugging these values into the sample adequacy formula, we get:

$$N = \frac{(1.383^2)(360.18)}{(7.48)^2} = \frac{688.91}{55.95} = 12.31 \text{ or } 13$$

Since we already have taken 10 samples and the sample adequacy formula tells us we need only 13, we need to take an additional 3 transects (13 - 10 = 3).

Now, when those 3 additional transects have been taken, a new variance must be calculated and the sample adequacy formula recalculated. This is to ascertain that the 3 additional transects didn't somehow increase the variance and therefore, require still more transects. If this happens, the additional transects must be taken and the variance recalculated to determine sample adequacy.

The sample adequacy requirements must be fulfilled before a comparison to the standard can be made.

APPENDIX F

Example Use of Sample Adequacy Formula for Tree and Shrub Counts

In this example, the permittee has taken an initial group of ten (10) randomly located sampling circles. The results of this sampling are as follows:

Sampling Circle No. (n)	Countable Trees (X)	X^2
1	7	49
2	10	100
3	4	16
4	5	25
5	10	100
6	11	121
7	3	9
8	7	49
9	10	100
10	10	100
	$\Sigma X = 77$	$\Sigma (X^2) = 669$

Now we need to calculate the variance, S^2:

Number of sampling circles (n) = 10

$$S^2 = \frac{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}{n - 1}$$

or, put into words:

$$S^2 = \frac{\text{Sum of Squared Values Added} - \frac{\text{Square of Sum of All Values}}{\text{\# of Values}}}{\text{(Number of Values - 1)}}$$

From the data in the above example, we calculate:

$$S^2 = \frac{669 - \frac{(77)^2}{10}}{9} = \frac{669 - 592.9}{9} = \frac{76.1}{9} = 8.46$$

APPENDIX F
Page 2

2)Determining sample adequacy:

From the t table, we find t for a sample size of 10.

n-1 = degrees of freedom.

10-1 = 9 degrees of freedom for our example.

From the t table, locate the t statistic for 9 degrees of freedom = 1.383.

The sample adequacy formula is:

$$N = \frac{(t^2)(S^2)}{(0.1x)^2}$$

Where:

Mean O = $\frac{'x}{n}$

N = the number of samples which will need to be taken;

t^2 = t table value, squared; and

S^2 = variance.

Plugging these values into the sample adequacy formula, we get:

$$N = \frac{(1.383^2)(8.46)}{0.59} = 27.4 = 28 \text{ samples needed}$$

Since we already have taken 10 samples and the sample adequacy formula tells us we need a total of 28, the sample adequacy requirements have not been met.

Now, when the 18 additional samples have been taken, a new variance must be calculated and the sample adequacy formula recalculated. This is to ascertain that the additional samples didn't somehow increase the variance and therefore require still more samples. If this happens, the additional samples must be taken and the variance recalculated to determine sample adequacy.

In this example, it would have been wise to have taken an initial sample of 15 or 20. Whenever large variation is noted, initial sample size should be increased.

The sample adequacy requirements must be fulfilled before proceeding with comparison to the standard.

APPENDIX G

Statistical Analysis on Ground Cover Measurements

In performing statistical comparisons for ground cover, results of randomly assigned line-point transects will be compared to the success standard (i.e., seventy percent (70%) ground cover at a ninety percent (90%) confidence statistical interval), as illustrated in the following example:

Null hypothesis: Ground cover on release area $\geq$ 70% ground cover

Alternate hypothesis: Ground cover on release area < 70% ground cover

	Release Area Sample Results (X)	Ground Cover Standard
Assume that it took 10 samples to achieve sample adequacy	41% 72% 89% 42% 69% 80% 42% 57% 77% 89%	70%
	ΣX = 658%	

$$\text{Ground Cover Mean } (\bar{O}) = \frac{\Sigma X}{n} = \frac{658}{10} = 65.8$$

$$\text{Standard Deviation } (s) = \sqrt{\frac{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}{n-1}} = \sqrt{\frac{46574 - \frac{432{,}964}{10}}{9}} =$$

$$\sqrt{\frac{46574 - 43296.4}{9}} = \sqrt{\frac{3277.6}{9}} = \sqrt{364.178} = 19.08$$

Number of Samples (n) = 10

t table 0.10 a df (10-1) = 1.38

$$t \text{ calculated} = \frac{|\text{Ground Cover Mean of Release Area} - \text{Target Ground Cover}|}{s/\sqrt{n}}$$

$$\frac{|65.8-70|}{19.08/\sqrt{10}} = \frac{4.2}{6.03} = .695$$

Since .695 < 1.38, the null hypothesis is not rejected. It can then be determined that the ground cover on the release area is greater than or equal to the target ground cover.

APPENDIX H

Statistical Analysis on Tree and Shrub Stocking Measurements

This example assumes that 80% of the trees are more than three years old. If they are not, there is no reason to proceed with this analysis.

In performing statistical comparisons for tree and shrub stocking, results of randomly assigned sampling circles will be compared to the success standard (e.g., 225 trees or shrubs/acre at a ninety percent (90%) confidence statistical interval), as illustrated in the following example:

Null hypothesis: Stocking rate on release area $\geq$ 225 trees and shrubs.

Alternate hypothesis: Stocking rate on release area < 225 trees and shrubs.

	Release Area Sample Results (X)	Release Standard
Assume that it took 10 samples (n) to achieve sample adequacy	4	203 trees and shrubs (90% of 225) = 4.06 trees/plot (1/50 acre)
	4	
	4	
	4	
	6	
	4	
	4	
	4	
	4	
	4	
	$\Sigma X = 42$	

$$\text{Stocking Rate Mean } (\bar{O}) = \frac{\Sigma X}{n} = \frac{42}{10} = 4.2$$

$$\text{Standard Deviation } (s) = \sqrt{\frac{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}{n-1}} = \sqrt{\frac{180 - \frac{1764}{10}}{10-1}} =$$

$$\frac{\sqrt{3.6}}{\sqrt{9}} = \frac{\sqrt{.4}}{3} = .632$$

Number of Samples (n) = 10

t table 0.10 df (10-1) = 1.383

$$t \text{ calculated} = \frac{\text{Stocking Rate of Release Area - Target Stocking Rate}}{s/\sqrt{n}}$$

$$= \frac{4.2 - 4.06}{.632/\sqrt{10}} = \frac{.14}{.632/3.162} = \frac{.14}{.200} = .7$$

Since .700 < 1.383, the null hypothesis is not rejected. It can be determined that the stocking rate of the release area is greater than or equal to the release standard.

APPENDIX I

Examples of acceptable plant species for revegetation of nonagricultural land use areas:

Trees

Alder, European	Maple, Silver	Poplar, Yellow
Ailanthus	Maple, Sugar	Redcedar, Eastern
Ash	Oak, Bur	Sweetgum
Ash, Green	Oak, Chestnut	Sycamore, American
Ash, White	Oak, Red	Walnut, Black
Aspen, Hybrid	Oak, White	
Birch, Paper	Osage Orange	
Cherry, Black	Pine, Austrian	
Cottonwood	Pine, Shortleaf	
Hickory	Pine, White	
Locust, Black	Poplar, Hybrid	
Maple, Red	Poplar, Tulip	

Shrubs and Other Low-Growing Woody Species

Dewberry	Dogwood	Sumac	Blackberry
Greenbrier	Persimmon	Holly	Sourwood
Redbud	Honeysuckle	Autumn Olive	Bristly Locust

Grasses

Cool Season	Warm Season		
Ryegrass	Redtop	Deer Tongue	
Orchard Grass	Bluestem	Switch Grass	
Bromegrass	Bermuda Grass	Millet	
	Weeping Love Grass	Indian Grass	

Legumes	Forbes
Partridge Pea	Yarrow
Crown Vetch	Goldenrod
Lespedeza	Sunflowers
Bird's-Foot Trefoil	Plantains
Alfalfa	
Clovers	

* At any time during the planning, reclamation and sampling phases, the permittee may make a written request the Surface Mining and Reclamation Division accept plant species not listed here.

APPENDIX J

References

Bonham, Charles D., 1989. Measurements for Terrestial Vegetation. Wiley, New York, 338 pages.

Chambers, Jeanne C., and Ray W. Brown. 1983. Methods for Vegetation Sampling and Analysis on Revegetated Mined Lands. U. S. Forest Service, Intermountain Forest and Range Experiment Station, Odgen, Utah. General Technical Report INT-151.