SECTION 37

POST-RECLAMATION VEGETATION

TABLE OF CONTENTS

SECTION 37

POST-RECLAMATION VEGETATION

LIST OF TABLES

SECTION 37

POST-RECLAMATION VEGETATION

LIST OF EXHIBITS

SECTION 37

POST-RECLAMATION VEGETATION

LIST OF APPENDICES

SECTION 37

POST-RECLAMATION VEGETATION

LIST OF REVISIONS DURING PERMIT TERM

REV. NUMBER	REVISION DESCRIPTION	DATE APPROVED

SECTION 37 POST-RECLAMATION VEGETATION

37.1 Post-Reclamation Vegetation Resources

BHP Navajo Coal Company (BNCC) has developed a comprehensive revegetation plan to be implemented on the Pinabete Mine Plan permit area (permit area). The revegetation plan will establish a diverse, stable, and self-sustaining vegetation community composed of native species capable of meeting the post-mining land use. The revegetation plan will satisfy the following criteria:

1) Adequate cover capable of stabilizing the soil surface from erosion,
2) Adequate forage to sustain the post-mining land uses (i.e., livestock grazing and wildlife habitat), and
3) Suitable species composition for enhancement of wildlife forage and cover.

BNCC will implement a geomorphic approach to reclamation, as discussed in Section 34 (Post-Reclamation Topography), by creating landforms that possess compatible topography and comparable erosional stability to the surrounding undisturbed landscape. However, circumstances may require the use of traditional reclamation strategies that include designing surface drainages and hill slopes that are dependent on riprap, gradient terraces, or other "hard engineering" approaches to stabilize drainages and control erosion as discussed in Section 38 (Post-Reclamation Surface Stabilization and Sediment Control). Geomorphic reclamation is accomplished by integrating variations in slopes and aspect in uplands, while conveying both run-on and run-off in appropriately designed channels that tie in, both upstream and downstream, with native channels. Geomorphic reclamation implementation, surface stabilization, and post-reclamation sediment control are discussed in more detail in Section 38 (Post-Reclamation Surface Stabilization and Sediment Control). The post-reclamation vegetation resource will be influenced by this topographic variability. With the application of a standard revegetation plan outlining the revegetation procedures and processes, BNCC anticipates that the revegetation communities may exhibit signs of succession during the life of the operation. Revegetation species may show preference for certain topographic conditions, such as nearly level slopes, north or south aspects, or location within the landscape such as in low-lying areas. This will ultimately help to meet the revegetation goals by creating a diverse, stable, and self-sustaining vegetation community.

The following revegetation plan describes the procedures and methods BNCC will implement to revegetate disturbed areas of the permit area. These disturbed areas include but are not limited to; mining pits, transportation facilities, coal stockpiles and preparation facilities, utilities, and other support facilities.

37.2 Revegetation Plan

Revegetation is initiated on areas that have been graded and topdressed (or graded if suitable overburden exists) during the first normal period for planting following the completion of grading and topdressing activities. Revegetation activities, e.g. seeding, mulching, and irrigation applications, may begin as early as

January and will be completed by the end of October. Seeding and mulching applications may begin in January and will be completed by mid June. BNCC may conduct late or dormant season seeding application, outside of the normal seeding window, if favorable conditions exist. Irrigation applications will be initiated as soon as a practicable after the area has been mulched and will be completed by the end of October unless unusually warm weather necessitates additional irrigation. BNCC will not conduct topdressing or revegetation activities in areas of active coal spoil fires. If a coal spoil fire ignites beneath a previously revegetated area, it will be monitored until it extinguishes itself. The area will then be assessed and, if necessary, revegetated.

Revegetation activities will be conducted on logical operational areas, or blocks. Revegetation blocks will be sized for safe and efficient equipment operation and to minimize redisturbance of previous reclamation blocks (areas which have been regraded, topdressed, and seeded). Occasionally, topdressing activities may begin within a revegetation block and not be completed before the end of the normal seeding period. These blocks may be revegetated using late or dormant seeding applications or will be seeded in the next available normal seeding period. Revegetation blocks within the permit area are shown on Exhibit 37.1-1. Within the first permit term, BNCC will be initiating mining; therefore there will be minimal, if any, areas available for revegetation. Areas revegetated between January 1 and December 31 will be shown on maps and submitted to the Office of Surface Mining Reclamation and Enforcement (OSM) in the annual report submitted on or before August 31. BNCC will update the permit exhibit (Exhibit 37.1-1) at permit renewal to reflect the revegetation blocks to date at the time of renewal.

37.2.1 Revegetation Seeding and Planting

37.2.1.1 Seedbed Preparation

An essential component of a successful revegetation program is a properly prepared seedbed. BNCC will either replace topdressing material, discussed in Section 36 (Post-Reclamation Soil), or prepare the existing surface material to create an effective seedbed. Topdressing material that has been redistributed on regraded areas will be mechanically prepared to achieve the following benefits:

- Reduce soil compaction caused by heavy equipment used in regrading and redistribution of topdressing
- Provide a transition at the interface between spoil material and the topdressing to enhance root penetration
- Promote water infiltration
- Help control wind and water erosion
- Provide a firm and smooth surface for proper seed placement
- Improve seed to soil contact for early seed development

During reclamation, certain areas can become heavily compacted as a result of repeated traffic by heavy equipment (e.g. roads). These heavily compacted areas are either ripped with a dozer, blade, or farm tractors using ripping implements adequate to alleviate severity of compaction.

The severity of compaction, depth of topdressing, and texture of topdressing determine the type and number of seedbed operations utilized. For example, a 36-inch chisel may be required to break through deep, heavily compacted, and heavy-textured topdressing. It has been BNCC's experience that this generally leaves deep furrows and large clods. Thus, the topdressing surface, or seedbed, would require a second disking utilizing a smaller disk and/or roller harrow to smooth and firm the seedbed surface. Rough seedbed surfaces are less effective for seeding because seeders are designed to place different seeds at their optimum seeding depth in smooth, firm seedbeds.

37.2.1.2 Seed Mixture

BNCC has conducted numerous revegetation research studies at Navajo Mine, directly adjacent to the permit area, and at San Juan Mine, approximately 19 miles north of the permit area. The focus of these research studies included identifying optimal plant species and seeding application rates for revegetation in the arid Southwest. The permit area seed mixtures were developed utilizing the research and experience gained from revegetation programs at Navajo Mine and San Juan Coal Company's San Juan Mine. BNCC will continue to evaluate the seed mixes to ensure the established revegetation communities meet reclamation goals.

BNCC has developed seed mixes that utilize 21 different native plant species; 10 grasses, 4 forbs, and 7 shrub species (Table 37.2-1). The selected seed mix species are all native to the San Juan Basin (Table 37.2-1). This accounts for their ability to survive soil and climatic conditions associated with the permit area. The herbaceous species provide nutrition to livestock during the growing season, and the palatable shrubs, such as fourwing saltbush (*Atriplex canescens*), shadscale (*Atriplex confertifolia*), and winterfat (*Krascheninnikovia lanata*), provide nutrition throughout the year. Three native shrub species with minimal palatability, green Mormon tea (*Ephedra viridis*), greasewood (*Sarcobatus vermiculatus*), and rabbitbrush (*Chrysothamnus viscidiflorus*), are included in the seed mix to provide cover for small mammals and passerine birds.

The seed mix species are combined in various rates and species to form three specialized seed mixes, which include: 1) cool season mix (Table 37.2-2), 2) warm season mix (Table 37.2-3), and 3) high shrub mix (Table 37.2-4). Seed mix selection for a specific revegetation block is based on factors including soil temperature, planting season, and topography. Soil depth and texture may influence seed mix selection or specific seed rates. Revegetating with specialized seed mixtures will increase species diversity over the entire mine and reduce competition among species within a given seed mix. Each seed mixture is designed

to emphasize the establishment of assorted native species based on natural differences in germination requirements.

The three seed mixes have a maximum of 14 different species per mix. Applying three specialized seed mixtures will reduce the amount of competition between species within a given seed mixture, but will increase the total number of different species being seeded over the permit area.

If the standard species are unavailable for seeding due to seed availability or cost, additional species have been identified as suitable substitutes. These substitute species in Table 37.2-1 may replace any of the standard species as needed. Additionally, the quantities of pure live seed (PLS) used per acre and corresponding numbers of seeds per square foot may be adjusted subject to seed availability. To ensure the best germination results, BNCC will utilize quality seed from reputable dealers using standards outlined under the Federal Seed Act.

The geomorphic approach to reclamation will assist BNCC in creating diverse revegetation communities. A geomorphically stable landscape increases the variations in aspects and slope classes. Some plant species may express themselves differently on the various aspects due to available soil moisture and sun exposure. The undulating topography will create the opportunity for variable topdressing depths. Studies have shown that variable topdressing depths enhance the final revegetation communities' species diversity and life form composition (Bowen et.al. 2005 and Buchanan et.al. 2005).

Research on other species that are adapted to environmental conditions associated with the permit area and are compatible with the post-mining land use (PMLU) will continue on the permit area. Should other native or introduced species indicate suitability for revegetation and compatibility with PMLU, they will be added to the revegetation species list (Table 37.2-1) with the approval of OSM.

37.2.1.2.1 Cool Season Seed Mixture

This mixture has 14 species; 8 grasses, 3 forbs, and 3 shrub species (Table 37.2-2). Most species in this mixture are characterized as "cool" season species and have the best germination results in cooler temperatures. This seed mixture will mainly be applied in early spring or late fall when daytime soil temperatures are less than 60°F.

37.2.1.2.2 Warm Season Seed Mixture

This mixture has 13 species; 5 grasses, 4 forbs, and 4 shrub species (Table 37.2-3). Most species in this mixture are characterized as "warm" season species and have best germination results in warmer temperatures. This mixture will mainly be applied in late spring through early fall when daytime soil temperatures are greater than 60°F.

37.2.1.2.3 High Shrub Seed Mixture

This mixture has a total of 14 species; 5 grasses, 2 forbs, and 7 shrub species (Table 37.2-4). The species seeding ratios are designed to enhance wildlife cover by establishing "shrub corridors" or "pockets". This seed mixture will be applied to revegetation blocks throughout the revegetation period. BNCC will apply this seed mixture to areas with a desirable topography, such as low-lying areas or small basins where water may accumulate.

37.2.1.3 Planting and Seeding Methods

Seeding is accomplished by either broadcast or drill seeding. These seeding methods are designed to place each species at their optimum planting depths. With consideration to safety of operators and equipment, all seeding will be done on the contour whenever possible.

Seeded species are separated into three groups to improve distribution and ensure that each species is planted at its optimal depth. The three groups are:

- Broadcast seed group: These are small seeds that germinate best on the surface or less than 0.25 inches deep
- Fluffy seed group: These are seeds with hairy or bristly appendages on the seed coat. This group of seed is contained in a separate seed box on the seed drill. This seed is drilled to a targeted depth of 0.25 to 0.50 inches
- Large smooth group: These are large seeds that are less likely to bind or clog within the seed drill. These seeds are also contained within their own seed box on the seed drill. This seed is drilled to a targeted depth of 0.5 to 1.0 inches

Hand seeding will occasionally be used on areas where slopes are considered too steep for the safe operation of equipment or for small area applications, such as around rock habitat structures or localized spot-seeding areas.

37.2.1.4 Special Seedings and Plantings

BNCC may undertake special native species seeding and planting projects on a limited basis, at BNCC's discretion, as opportunities present themselves. The purpose of special projects would be to create habitat niches or augment the standard seeding practices. Examples of these projects include, but are not limited to, establishing native species that may not be included in the standard seed mixes (i.e., riparian species within drainages) or site-specific planting of live native species stock (i.e., bare-root or containerized native plants). Planting live stock is cost prohibitive over large areas and thus may only be utilized in small selected areas. Special seedings and plantings may be conducted anytime between November and the end of February.

The location and species used in the special seeding and planting projects will be submitted to OSM in the annual report on or before August 31.

37.2.2 Revegetation Mulching Techniques

Native grass mulch will be applied after seeding, primarily to control wind and water erosion while the plants germinate. Other advantages of mulch are:

1) Slows evaporation at the soil surface,
2) Promotes water infiltration,
3) Conserves soil moisture,
4) Lowers surface temperature, and
5) Provides an organic base (carbon) for reestablishing a beneficial microbial population, and therefore promoting nutrient cycling.

The mulch is applied to the seeded area at a rate of about 2.0 to 2.5 tons per acre. Once applied, the mulch is mechanically crimped into the soil, on the contour when practical.

37.2.3 Revegetation Irrigation

Research and experience at BNCC demonstrate that irrigation is needed to promote germination and produce self-sustaining stands of vegetation in a reasonable period of time. BNCC has conducted numerous research studies and trial programs to answer many questions about how irrigation application rates, scheduling, and application systems aid the establishment of the revegetation communities. BNCC will utilize this experience to develop and implement an irrigation program for the permit area.

Research on methods for reducing water use has been, and will continue to be, an important aspect of BNCC's revegetation programs. Water is a vital resource in the region and finding methods to reduce water consumption, without adversely affecting the quality of revegetation communities, is one of the main goals of the Pinabete permit revegetation plan.

The irrigation system for the permit area consists of a solid-set system, which uses various sizes of aluminum pipe to cover the revegetation block. This system allows for optimum timing and scheduling and has led to more efficient water use without adverse effects on seed germination and vegetation establishment.

The irrigation program for the permit area is generally conducted for two growing season periods, depending upon natural precipitation. Irrigation will be applied to the revegetation blocks from March to mid-October. BNCC may extend the irrigation past October if unusual warm weather late in the growing

season warrants additional irrigation. Small areas of reseeding, interseeding, or first-time seeding may not be irrigated based on their size and proximity to irrigation equipment (e.g., delivery lines and pumps).

The irrigation schedule for the first growing season is divided into a germination cycle and support cycle (Table 37.2-5). The goal of the germination cycle is to achieve field capacity, or the limit of water the soil can hold without discharging, to overcome seed inhibition and initiate germination. The germination cycle begins as soon as practicable after mulch application and irrigation system setup. Irrigation is applied for 5 hours at 55 psi (within the lateral pipes), which is equivalent to 0.10 acre-feet (ac-ft) or a 1.15-inch application. This 5-hour application rate is repeated every fourth day for 13 days, supplying a total germination application of 4.6 inches. Sprinkler head pressure is monitored using a pressure gauge with a Pitot tube attachment. This gradual application allows water to penetrate deep into the soil profile and slowly reach its field capacity.

The support cycle is initiated immediately following the 13-day germination cycle. The support cycle requires irrigation for 2.5 hours at 55 psi, which is equivalent to 0.05 ac-ft or a 0.57-inch application. This 2.5-hour application is repeated every 11 to 13 days, depending on soil moisture and other environmental conditions. The support cycle typically continues through mid-October. Soil moisture is retained longer during the cooler weather in September and October, resulting in a reduced frequency of application. The occurrence of natural precipitation will decrease irrigation application accordingly.

Irrigation is discontinued by the third week in October when hard freezing typically occurs. The irrigation pipe system is drained to avoid water freezing damage and left in place on the revegetated areas over the winter.

Revegetation blocks may receive light irrigation during the second growing season (Table 37.2-5). The goal of the second-year irrigation is to promote root development. The second-year irrigation is generally a one-time application scheduled in April or May. Irrigation is applied for 5 hours at 55 psi, which is equivalent to a 1.15-inch application. During drought periods, additional irrigation may be applied in June or July depending on environmental conditions such as temperature and total precipitation. During years of unusually high winter and/or spring precipitation, the need for second-year irrigation is reduced or may be unnecessary. Revegetation blocks are not planned for irrigation during the third growing season.

37.2.4 Pest and Disease Control

Pest and disease control plans are not anticipated for the permit area. If such plans become necessary, BNCC will notify OSM prior to their implementation.

37.2.5 Noxious and Invasive Weed Control

Native plant communities in New Mexico experience challenges from the presence of noxious and invasive weeds. These plant species specialize in colonizing disturbed areas and quickly out-compete native species. Competition from noxious and invasive weeds is a problem to the native plant communities throughout the area surrounding the permit area. Noxious and invasive weeds, such as halogeton (*Halogeton glomeratus*) and saltcedar (*Tamarix spp.*), were documented within the permit area during the baseline vegetation community surveys (Appendix 15.A).

BNCC is committed to prevent the introduction and spread of noxious and invasive weeds. The introduction of noxious weeds is reduced by using revegetation seeds from reputable vendors which are not contaminated with weed seed. BNCC also utilizes native grass mulch from credible producers to minimize introduction of noxious and invasive weeds into revegetated areas. Seed vendors and mulch producers may be inspected by BNCC to audit their quality control procedures and ensure their products are free of noxious and invasive weeds.

Noxious and invasive weeds are generally classified as Class A, Class B, or Class C weed species. Classification is based on likelihood of occurrence within the region and recommended level of management. The classes are:

1) Class A- Potential Invaders: These are noxious weeds as yet not found in the region, but the potential for invasion is imminent. Emphasis will be placed on prevention, education, awareness, identification, and monitoring
2) Class B- New Invaders: New noxious weeds known to have invaded isolated locales within the region. Emphasis is placed on immediate control and prevention of seed spread. Eradication, education, awareness, identification, control, and monitoring will be priorities
3) Class C- Established Noxious Weeds: These are weeds that are widespread and well established within the region and rank high on the economic impact criteria, but control effort is costly and generally ineffective. Management is limited to awareness. Emphasis is placed on management, education, awareness, identification and monitoring

The Bureau of Indian Affairs (BIA) and the Navajo Nation are currently working to develop regional weed control plans. Until these plans are finalized, BNCC will implement its own weed control management plan for the permit area (Appendix 37.A). Once the BIA and Navajo Nation's plans become finalized, BNCC will review and revise, if needed, the permit area weed control plan to ensure compliance with the agencies' regional weed management plans.

All revegetation areas are monitored informally and formally on a regular basis. If noxious and invasive weeds are encountered during monitoring, proper action will be taken as outlined in the Pinabete Permit Noxious Weed Management Plan (Appendix 37.A).

Noxious and invasive weeds are a regional problem. Absent a complete eradication from the region, it is likely these species will occur within the reclamation area of the permit area. BNCC has no control of the noxious and invasive weed seed sources outside of its lease area. These outside seed sources will continue to contribute to the noxious and invasive weeds present within the permit area. Therefore, it is likely the reclamation areas will have a similar distribution of noxious and invasive species as the off-lease areas.

37.2.6 Revegetation Grazing and Other Husbandry Practices

BNCC is not proposing any grazing or other husbandry practices at this time. This section will be revised prior to BNCC implementing any grazing and husbandry practices on the permit area.

37.3 Revegetation Success Determination

The primary goal of revegetation success is to ensure that reclaimed areas are capable of supporting the post-mining land use, which is designated as livestock grazing and wildlife habitat. To meet this goal, BNCC conducts both interim and bond release revegetation community studies. Interim revegetation success studies are conducted, as needed, during the responsibility period to identify trends in the revegetation communities. These interim studies will aid BNCC in making management decisions and evaluating the progress of the community. Bond release studies are conducted to evaluate whether the revegetated community has developed into a diverse, stable, and self-sustaining vegetation community. These studies may be conducted six years after any augmented seeding, fertilizing, irrigation, or other similar activity, excluding approved grazing or husbandry practices. The revegetation community must meet the revegetation success criteria in any two of the final four years of the responsibility period. The revegetation success criteria for the permit area are presented in Table 37.3-1 and discussed further in Section 37.3.3. All revegetation sampling, interim, and bond release studies will be conducted between June and October. This period was selected to provide for a sampling period that would provide the highest expression of revegetation species. Results of revegetation success studies, if conducted, will be reported to OSM in the following year's annual report.

37.3.1 Reference Area

To demonstrate revegetation success, BNCC will compare the post-mining, or revegetation, communities to reference areas that are managed similarly to the revegetation communities.

BNCC will use the OSM approved Area 4 North reference areas from the Navajo Mine permit (BNCC 2009). Reference areas are not disturbed by mining activities; are of sufficient contiguous size to

adequately determine vegetation success parameters; are similar in plant composition to baseline vegetation communities; and are able to be managed similar to the revegetation communities. The reference areas are presented on Exhibit 37.1-1.

The reference areas are posted to identify the area as a reference area and fenced to control livestock grazing. These areas are managed similar to the reclamation areas (areas that have been regraded, topdressed, and seeded) to which it will be compared. Both areas, reference and reclamation, will experience the same management practices within a given year. At this time, grazing is not proposed for the reclamation areas on the permit area. If in the future, grazing is proposed, grazing plans for both the reference area and reclamation areas will be submitted to OSM for approval prior to grazing. Reference areas will be grazed with similar intensity, livestock, and duration as the reclamation areas. If the reference area needs additional rest before grazing, it will receive deferred grazing as approved in the grazing plan submitted to OSM.

In the event that future mining-related activity impacts the reference areas, BNCC will identify potential replacement reference areas, in consultation with OSM, either within or outside of the permit or lease area. If necessary, BNCC will commence discussions with appropriate grazing and customary use area permittee(s) and agencies about obtaining right of entry to those sites. BNCC will obtain OSM's approval prior to final selection and use of any replacement reference areas.

37.3.2 Methods to Determine Revegetation Success

Due to the proximity to BNCC's Navajo Mine (OSM Permit No. NM-003F) and the similarity in management and revegetation practices, BNCC will implement similar measures and methods to determine revegetation success for the permit area. The methods to determine revegetation success for the permit area have two basic premises:

1) Implementation of a set of standards that will establish the basis for comparisons of the performance of reclaimed lands to a reference area for two out of the last four years of the bond (responsibility) period, starting after year six of the responsibility period, and
2) Establishment of a set of standards that will ensure that the reclamation areas are capable of supporting the post-mining land uses of livestock grazing and wildlife habitat.

Depending on location and site conditions, reclamation areas may not be sampled at the earliest opportunity. Reclamation areas eligible for bond release sampling may be combined into a single sampling unit. The justification for combining reclamation areas may include, but is not limited to:

- Adequate sampling area
- Seed-mix used
- Proximity to one another

- Availability of water in a proposed release area
- Logical grazing blocks
- Similar appearance

The revegetation success criteria will include annual success criteria for total vegetation cover and production and technical standards for shrub density and species diversity. For final bond release, a reclaimed area (sampling unit) will meet each of the revegetation success criteria in any two of the final four years of the responsibility period. The revegetation success criteria are presented in Table 37.3-1 and discussed in Section 37.3.3.

Before conducting any bond release sampling, the areas proposed for sampling will be discussed with OSM. The same sampling procedures will be used on the reference and reclamation areas. Sample locations in each area will be selected using randomly generated grid coordinates overlain on a map, computer-generated stratified random point locations, or some other appropriate randomization method. Sampling will be conducted according to the procedures and criteria discussed in the following sections.

37.3.2.1 Sample Adequacy

A minimum of 20 samples will be collected within the reclamation and reference areas. Sampling will continue in both areas until sample adequacy is achieved or a maximum of 40 samples are collected, whichever comes first. Sample adequacy will be calculated using the following formula (Cochran 1977):

$$n_{\min} = \frac{(ts)^2}{(d\bar{x})^2}$$

Where:
- $n_{\min}$ = Number of samples (minimum sample size)
- t = varies with sample size and confidence interval (1.685 for 90% confidence interval and 40 observations)
- s = Sample standard deviation
- d = Precision level for desired percentage of the sample mean (expressed as a decimal) (0.10 for 90% confidence interval)
- $\overline{x}$ = Sample mean

37.3.2.2 Total Vegetation Cover

Total vegetation cover will be collected along a 50-meter point-intercept transect. Starting at the beginning of the transect, a reading will be taken perpendicular to the ground at every 0.5 meter along the transect. This will result in 100 readings per transect. A reading, or hit, is defined as the first interception of bare ground, litter, rock (gravel or stone), or basal or canopy vegetation. If vegetation is encountered, the species will be recorded. Each 50-meter transect will be considered to be one sample unit. Cover data will be reported as a percentage of either absolute or relative cover.

37.3.2.3 Total Production

The current year's growth of herbaceous and shrub species will be clipped from a 1-square meter (m^2) (10 centimeter x 10 meter) plot located along the point-intercept transect. The plot will be located between the 5-meter mark and the 15-meter mark of each transect and will be positioned so the long edge of the plot runs parallel to and contiguous with the transect. The plot will also be located on the opposite side of foot traffic to minimize impact to the vegetation. The clipped material will be bagged by life form (i.e., annual grass, perennial grass, annual forb, perennial forb, shrub) with the exception of the dominant species (described below), which will be bagged separately by species.

Based on the 1985 baseline cover data the dominant species for each reference area range site follow:

- Alkali Wash: *Sporobolus airoides*, *Pleuraphis jamesii*, *Atriplex corrugata*, and *Atriplex obovata*.
- Arroyo Shrub: *Achnatherum hymenoides*, *Ericameria nauseosus ssp. nauseousus*, and *Sarcobatus vermiculatus*.
- Alsan: (combination of Calcareous Sands, Sands and Saline Sands) *Achnatherum hymenoides*, *Sporobolus airoides*, and *Pleuraphis jamesii*.

The dominant species in the reclaimed areas will be the three perennial species with the highest percent covers as identified from previous sampling of the reclaimed areas. Before sampling for final bond release, OSM approval of the dominant species for the reclaimed areas will be sought.

All herbaceous biomass will be air dried for a minimum of 10 days and weighed to the nearest 0.1 gram to produce an air-dried weight. Shrub production will be clipped, dried, weighed, or a verified model that estimates shrub production based on measurable characteristics of the shrubs will be developed. Biomass from broom snakeweed (*Gutierrezia sarothrae*) and saltcedar (*Tamarix spp.*) will not be included in the determination of revegetation success. Production data will be reported as pounds of biomass per acre.

37.3.2.4 Shrub Density

Shrub density will be measured in a 100-m^2 (2 meter x 50 meter) belt transect located parallel to and contiguous with the vegetation cover transect (i.e., 1 meter wide along each side of the 50-m transect). Shrub density will be reported as the number of shrubs per acre.

37.3.2.5 Species Diversity

BNCC will calculate species diversity for both herbaceous and shrub species. Grass and forb diversity will be calculated from the point-intercept transect cover data. In periods of drought (i.e., years when cumulative total precipitation for January through April is less than or equal to 0.85 inches), forb species

diversity will be calculated using occurrences, or observations, within the shrub density belt transect. In all years, shrub species diversity will be calculated from the shrub density belt transect.

BNCC has adopted a technical standard for species diversity. Revegetation diversity will be successful if the following take place:

1) At least one perennial grass species has a relative perennial herbaceous cover value equal to or greater than 5%, and a second perennial grass species will have a relative perennial herbaceous cover value equal to or greater than 3%. No one species shall account for more than 85% relative herbaceous cover.
2) Perennial forbs on the reclamation area are greater than or equal to 0.5% relative perennial herbaceous cover. This forb standard will be adjusted in drought years. In years when cumulative total precipitation for January through April is less than or equal to 0.85 inch, the forb component will be successful if at least one perennial forb is observed within at least one of the 100-m^2 shrub density belt transects.
3) In addition to the dominate shrub species there will be a minimum of 20 shrubs per acre of additional combined species.

37.3.3 Revegetation Success Comparisons

The reclaimed areas vegetation parameters will be compared to an arithmetic mean of the reference area vegetation communities. Revegetation will be considered successful when the total vegetation cover, total vegetative production, and shrub density are not less than 90% of the revegetation success criteria (Table 37.3-1).

Revegetation success data will be first evaluated to determine if they are normally distributed. If the data do not approximate the normal distribution, OSM will be consulted to identify appropriate statistical techniques to be used, such as the sign test or Mann-Whitney test (Snedecor and Cochran 1989), to evaluate the data and determine revegetation success. When the vegetation cover and production data approximate a normal distribution; a one-sided, two sample t-test (alpha = 0.1) will be used to determine if the cover and production on the reclamation areas are greater than or equal to 90% of the cover and production of the reference area. The two sample t-test will use the following null and alternative hypotheses:

$$H_O: \mu_{reclaimed} \geq 0.90\ \mu_{reference}$$

$$H_A: \mu_{reclaimed} < 0.90\ \mu_{reference}$$

When shrub density approximates a normal distribution, a one-sided, one sample t-test (alpha = 0.1) will be used. If the data do not approximate a normal distribution, OSM will be consulted to identify appropriate statistical techniques to be used to evaluate the data and determine revegetation success. Shrub density will

be considered successful if the number of shrubs is greater than or equal to 190 shrubs per acre on 80% of the area and greater than or equal to 500 shrubs per acre on 20% of the area in shrub islands and corridors.

37.4 Prime Farmlands Restoration Plan

This section is not applicable to the permit area. There are no areas identified as prime farmlands within the permit area. The negative results of the prime farmland investigation are presented in Section 14 (Soil).

Personnel

Persons or organizations responsible for data collection, analysis, and preparation of this permit application package section:

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Vivie Melendez
BHP Navajo Coal Company

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Table 37.2-1 Standard and Substitute Revegetation Seed Mix Species for the Pinabete Permit Area

Common name	Scientific name	Drought tolerance‡	Salinity tolerance‡	pH			Palatability	Season	Growth habit	Life form	Seeds per pound
				Acidic	Neutral	Basic					
Grasses											
Indian ricegrass	*Achnatherum hymenoides*	3	2	0	3	1	3	C	Bunch	P	141,000
Blue grama	*Bouteloua gracilis*	3	2	0	3	1	3	W	Sod	P	825,000
Bottlebrush squirreltail	*Elymus elymoides*	3	3	1	3	2	2	C	Bunch	P	192,000
Thickspike wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	3	1	0	3	1	2	C	Sod	P	154,000
Needle and thread	*Hesperostipa comata ssp. comata*	3	1	0	3	2	2	C	Bunch	P	115,000
Prairie Junegrass	*Koeleria macrantha*	3	NA	0	3	1	NA	C	Bunch	P	2,315,400
Galleta	*Pleuraphis jamesii*	2	2	0	3	2	2	W	Sod	P	159,000
Alkali sacaton	*Sporobolus airoides*	1	3	0	2	3	1	W	Bunch	P	1,758,000
Sand dropseed	*Sporobolus cryptandrus*	2	2	1	3	1	2	W	Bunch	P	5,298,000
Giant dropseed	*Sporobolus giganteus*	2	NA	1	3	0	NA	W	Bunch	P	1,723,000
Forbs											
White sagebrush	*Artemisia ludoviciana*	2	0	0	3	1	1	-	-	P	4,500,000
Evening primrose	*Oenothera pallida*	3	NA	0	3	1	NA	-	-	P	512,000
Palmer penstemon	*Penstemon palmeri*	3	NA	0	3	1	NA	-	-	P	610,000
Gooseberry-leaf globemallow	*Sphaeralcea grossulariifolia*	3	NA	0	3	1	NA	-	-	P	500,000
Shrubs											
Fourwing saltbush	*Atriplex canescens*	3	3	0	2	3	3	-	-	P	52,000
Shadscale	*Atriplex confertifolia*	3	3	0	1	3	0	-	-	P	64,900
Mat saltbush	*Atriplex corrugata*	3	NA	0	0	1	3	-	-	P	60,000
Winterfat	*Krascheninnikovia lanata*	3	3	0	3	2	3	-	-	P	56,700
Douglas rabbitbrush	*Chrysothamnus viscidiflorus*	3	3	1	3	2	1	-	-	P	782,000
Green Mormon tea	*Ephedra viridis*	3	2	0	3	2	2	-	-	P	25,000
Black greasewood	*Sarcobatus vermiculatus*	3	NA	0	2	3	NA	-	-	P	245,000
Substitute Species											
Purple threeawn	*Aristida purpurea*	3	1	0	3	1	2	W	Bunch	P	250,000
Smallflower globemallow	*Sphaeralcea parvifolia*	3	NA	0	3	1	NA	-	-	P	500,000
Scarlett globemallow	*Sphaeralcea coccinea*	3	NA	0	3	2	NA	-	-	P	500,000
Western blueflax	*Linum lewisii*	3	NA	1	3	1	NA	-	-	P	293,000
Mound saltbush	*Atriplex obovata*	3	3	0	1	3	2	-	-	P	207,600
Rubber rabbitbrush	*Ericameria nauseosus ssp. nauseosus*	3	3	1	3	2	1	-	-	P	400,000

0 = poor, 1 = moderate, 2 = good, 3 = high
NA – Information not available
Season: C = cool, W = warm
Life Form: P = perennial

‡ Office of Surface Mining Reclamation and Enforcement. 1988. Plant Materials Handbook.

Table 37.2-2 Cool Season Reclamation Seed Mix for the Pinabete Permit Area

Common name	Scientific name	Seeding method[1]/ Seed group[2]	Avg. # of seeds/lb	Seeding rate (avg PLS[3] lb/ac)	PLS/sq ft
Grasses					
Thickspike wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	D/LS	154,000	0.75	2.65
Blue grama	*Bouteloua gracilis*	D/F	825,000	0.15	2.84
Galleta	*Pleuraphis jamesii*	D/LS	159,000	0.15	1.62
Prairie Junegrass	*Koeleria macrantha*	B/B	2,315,400	0.05	2.66
Indian ricegrass	*Achnatherum hymenoides*	D/LS	141,000	1.50	4.86
Bottlebrush squirreltail	*Elymus elymoides*	D/LS	192,000	0.50	2.20
Alkali sacaton	*Sporobolus airoides*	B/B	1,758,000	0.04	1.61
Needle and thread	*Hesperostipa comata ssp. comata*	D/F	115,000	0.20	0.53
Forbs					
Evening primrose	*Oenothera pallida*	D/LS	512,000	0.30	3.53
Palmer penstemon	*Penstemon palmeri*	B/B/	210,000	0.40	1.93
Gooseberry-leaf globemallow	*Sphaeralcea grossulariifolia*	D/F	500,000	0.30	3.44
Shrubs					
Fourwing saltbush	*Atriplex canescens*	D/LS	52,000	1.20	1.43
Shadscale	*Atriplex confertifolia*	D/LS	64,900	1.00	1.49
Winterfat	*Krascheninnikovia lanata*	B/B	56,700	1.30	1.69
			Total	7.84	32.48

[1] Seeding method: B = broadcast, D = drilled

[2] Seed group: Seeds are separated into groups; B = broadcast seed, F = fluffy seed, LS = large smooth seed

[3] PLS = pure live seed

Table 37.2-3 Warm Season Reclamation Seed Mix for the Pinabete Permit Area

Common name	Scientific name	Seeding method[1]/ Seed group[2]	Avg. # of seeds/lb	Seeding rate (avg PLS[3] lb/ac)	PLS/sq ft
Grasses					
Blue grama	*Bouteloua gracilis*	D/F	825,000	0.30	5.68
Galleta	*Pleuraphis jamesii*	D/LS	159,000	0.30	3.24
Alkali sacaton	*Sporobolus airoides*	B/B	1,758,000	0.04	1.61
Sand dropseed	*Sporobolus cryptandrus*	B/B	5,298,000	0.05	6.08
Giant dropseed	*Sporobolus giganteus*	B/B	1,723,000	0.10	3.96
Forbs					
White sagebrush	*Artemisia ludoviciana*	B/B	4,500,000	0.05	5.17
Evening primrose	*Oenothera pallida*	D/LS	512,000	0.45	5.29
Palmer penstemon	*Penstemon palmeri*	B/B/	210,000	0.40	1.93
Gooseberry-leaf globemallow	*Sphaeralcea grossulariifolia*	D/F	500,000	0.30	3.44
Shrubs					
Fourwing saltbush	*Atriplex canescens*	D/LS	52,000	0.75	0.90
Winterfat	*Krascheninnikovia lanata*	B/B	56,700	1.50	1.95
Douglas rabbitbrush	*Chrysothamnus viscidiflorus*	D/F	782,000	0.30	5.39
Black greasewood	*Sarcobatus vermiculatus*	D/LS	245,000	0.40	1.93
			Total	4.94	46.57

[1] Seeding method: B = broadcast, D = drilled

[2] Seed group: Seeds are separated into groups; B = broadcast seed, F = fluffy seed, LS = large smooth seed

[3] PLS = pure live seed

Table 37.2-4 High Shrub Reclamation Seed Mix for the Pinabete Permit Area

Common name	Scientific name	Seeding method[1]/ Seed group[2]	Avg. # of seeds/lb	Seeding rate (avg PLS[3] lb/ac)	PLS/sq ft
Grasses					
Thickspike wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	D/LS	154,000	0.20	0.71
Blue grama	*Bouteloua gracilis*	D/F	825,000	0.08	1.52
Galleta	*Pleuraphis jamesii*	D/LS	159,000	0.15	1.62
Bottlebrush squirreltail	*Elymus elymoides*	D/LS	192,000	0.20	0.88
Alkali sacaton	*Sporobolus airoides*	B/B	1,758,000	0.02	0.81
Forbs					
Evening primrose	*Oenothera pallida*	D/LS	512,000	0.25	2.94
Gooseberry-leaf globemallow	*Sphaeralcea grossulariifolia*	D/F	500,000	0.20	2.30
Shrubs					
Fourwing saltbush	*Atriplex canescens*	D/LS	52,000	1.00	1.19
Shadscale	*Atriplex confertifolia*	D/LS	64,900	1.50	2.23
Mat saltbush	*Atriplex corrugata*	D/LS	60,000	0.75	1.03
Winterfat	*Krascheninnikovia lanata*	B/B	56,700	1.70	2.21
Douglas rabbitbrush	*Chrysothamnus viscidiflorus*	D/F	782,000	0.30	5.39
Green Mormon tea	*Ephedra viridis*	D/LS	25,000	0.10	0.04
Black greasewood	*Sarcobatus vermiculatus*	D/LS	245,000	0.50	2.41
			Total	6.95	25.28

[1] Seeding method: B = broadcast, D = drilled

[2] Seed group: Seeds are separated into groups; B = broadcast seed, F = fluffy seed, LS = large smooth seed

[3] PLS = pure live seed

Table 37.2-5 First- and Second-Year Irrigation Schedule for the Pinabete Permit Area

Irrigation event	Duration between applications (days)	Time of application (hours)	Pressure (PSI)	Inches of irrigation
First growing season				
Germination cycle				
1st application	4	5	55	1.15
2nd application	4	5	55	1.15
3rd application	4	5	55	1.15
4th application	4	5	55	1.15
Support cycle[1]				
Application	11 to 13	2.5	55	0.57
Second growing season [2]				
1st application	4	5	55	1.15
2nd application	4	5	55	1.15

[1] Support cycle irrigation continues, as required, throughout the first year of seeding.

[2] Second year irrigation is generally a one-time application in April or May; however, additional applications may be applied in June or July, as conditions require.

Table 37.3-1 Pinabete Permit Area Revegetation Success Criteria

Vegetation sampling parameter	Revegetation areas standard
Total vegetation cover[1]	Annual mean
Total vegetative production[1]	Annual mean
Shrub density	190 or 500 shrubs per acre[2]
Species diversity	Two perennial grasses species[3]
	Perennial forbs ≥ 0.5% relative perennial herbaceous cover[4]
	Two shrub species[5]

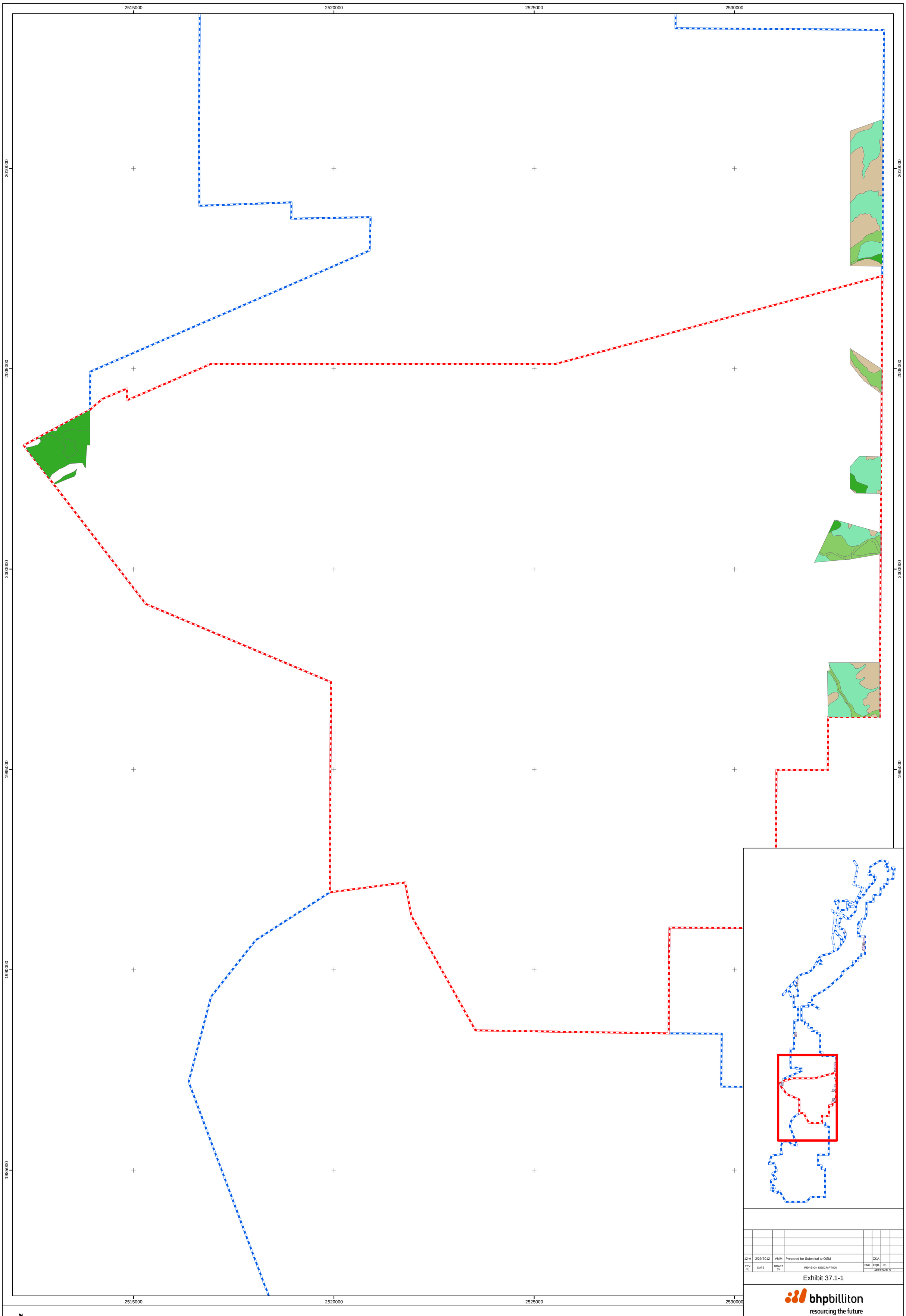
[1] Total vegetation cover (i.e., percent cover of live plants plus litter) and total vegetation production (i.e., annual and perennial vegetation production) will reflect only current year's growth

[2] Shrub density is considered successful if the number of shrubs is equal to or greater than 190 shrubs per acre on 80% of the area and greater than or equal to 500 shrubs per acre on 20% of the area in shrub islands and corridors.

[3] At least one perennial grass with a relative perennial herbaceous cover of greater than or equal to 5%, and a second perennial grass species with a relative perennial herbaceous cover value greater than or equal to 3%. No one species shall account for more than 85% relative herbaceous cover.

[4] In drought years, years when the cumulative precipitation between January and April is less than or equal to 0.85 in, the forb parameter is successful if at least one perennial forb is observed within at least one of the 100-m^2 shrub density belt transects.

[5] In addition to the dominant shrub species there will be a minimum of 20 shrubs per acre of additional combined species.



Coordinate System: NAD 1983 StatePlane New Mexico West
Projection: Transverse Mercator
Datum: North American 1983
Units: Foot US

N

0 500 1,000 2,000 3,000 Feet

1:12,000

Legend

Reference Areas Vegetation Communities
- Alkali Wash (Al/Wa)
- Arroyo Shrubs (Ar/Sh)
- Badlands (Bd)
- Sands (Sa)

- SMCRA Permit Boundary
- BNCC Lease and ROWs

REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	EQD.	PE.	APPROVALS
12-A	2/29/2012	VMM	Prepared for Submittal to OSM		CKA		

Exhibit 37.1-1

bhpbilliton
resourcing the future

BHP NAVAJO COAL COMPANY
Pinabete Permit
Revegetation and
Reference Ares

PREPARED BY: VMM	DRAWN BY: VMM	PAPER SIZE: ARCH D
APPROVED BY: CKA	DATE: 2/13/12	

Appendix 37.A

Pinabete Permit

Noxious Weed Management Plan

PINABETE PERMIT

NOXIOUS WEED MANAGEMENT PLAN

1.0 INTRODUCTION

Invasive weeds pose a serious threat to many native plants in New Mexico. They specialize in colonizing highly disturbed ground. They are able to establish quickly and grow faster on disturbed areas than other plants.

As a surface coal mining operation, BHP Navajo Coal Company (BNCC) has numerous acres of disturbed land. Land disturbances associated with mining can provide a habitat conducive to invasion and spread of noxious weeds. A weed management plan is needed to assist with BNCC's revegetation plan to establish diverse, stable, and self-sustaining vegetation that will satisfy the following criteria:

1) Adequate cover capable of stabilizing the soil surface from erosion,
2) Adequate forage to sustain the post-mining land uses (i.e., livestock grazing and wildlife habitat), and
3) Suitable species composition for enhancement of wildlife forage and cover.

The Navajo Nation is in the process of developing a Noxious Weed Management Plan. BNCC may integrate the Navajo Nation's Noxious Weed Management Plan into the Pinabete Permit application package when the Navajo Nation's plan is completed and accepted.

2.0 INVENTORY OF NOXIOUS WEED SPECIES

The areas of concern for noxious weeds on the Pinabete Permit area (permit area) are on the disturbed and revegetated plots and along constructed waterways or impoundments. BNCC will monitor revegetation plots undergoing irrigation for noxious weeds, however, we will not address the noxious weeds unless the weeds consistently persist after irrigation has ceased. These irrigated plots commonly have a high initial density of noxious weeds (which are in the form of annuals). However, the amount is often reduced when the area is no longer irrigated.

There are five weed species that are known to be present in the permit area (Table 1). Three of the weeds listed are considered noxious weeds.

Table 1. Weed Species Found in the Pinabete Permit Area.

Scientific name	Common name	New Mexico class	Comments
Halogeton glomeratus	Halogeton	B	Noxious
Salsola tragus	Prickly Russian thistle	Not designated	Not noxious
Tamarix spp.	Saltcedar	C	Noxious
Kochia scoparia	Kochia	Not designated	Not noxious
Bromus tectorum	Cheatgrass	C	Noxious

3.0 OBJECTIVES

One of the reclamation objectives stated in the permit is to "Establish on all affected areas a diverse, effective, and self-sustaining vegetation cover of the same seasonal variety as the native vegetation" (Section 30 Post-Reclamation Land Use). In addition, BNCC's Health, Safety, Environmental, and Community (HSEC) policy strives for long-lasting benefits to the local environment from mining operations. Noxious weeds must be addressed to adhere to this internal policy.

The objectives of BNCC's weed management plan are prevention, early detection, and control of noxious weeds to assist in achieving successful reclamation.

3.1 Prevention

The best weed management action is to prevent noxious weeds from becoming established in the first place. Preventing weeds from invading a site is the most effective and least costly method for control.

Reclamation activities provide a venue for the introduction of noxious weeds. The introduction of noxious weeds can be reduced by purchasing seeds and mulch from reputable dealers. Routine inspections of seeds and mulch, and familiarization with the dealers that provide them will be conducted to ensure no new weed seeds or vegetative parts enter the site through a contaminated seed source in seed mix and mulch.

Areas will be seeded using native species or carefully chosen, non-invasive introduced species as soon as possible after mining has ceased. Quickly establishing a good stand of desirable vegetation will minimize the opportunity for noxious weed establishment.

3.2 Detection

Detection of new infestations on the mine site is crucial for controlling noxious weeds. The BNCC environmental department will remain up-to-date on the noxious weeds present on the mine site and those that have the potential to invade from surrounding areas. BNCC environmental specialists will perform periodic inspections of the reclamation areas to detect and identify isolated infestations of noxious weeds. Detecting the isolated infestations of noxious weeds is a high priority to minimize their potential spread and colonization of reclamation areas.

3.3 Control

Control of noxious weeds on the permit area primarily consists of informally monitoring the disturbed and reclaimed areas, via regulatory inspections, irrigation pipeline checks, and general field inspections by BNCC environmental specialists. Infestations of noxious weeds will be addressed according to suitable control measures for each individual species.

3.3.1 Halogeton

Halogeton is an annual forb introduced from Russia. It is toxic to grazing animals, especially sheep. It is adapted to alkaline soils and semiarid environments. Halogeton is not extremely competitive with other plants, because it does not grow a large root system early in the growing season. When an infestation occurs, it makes the area less favorable for revegetation with other species. The abundance of halogeton is dependent upon year-to-year precipitation. Halogeton produces both brown and black seeds. The brown seeds are controlled by long photoperiods, have no dormancy, and are viable for one year. The black seeds are produced during short photoperiods, have dormancy, and can survive buried up to 10 years.

A concern for halogeton on the permit area could be on older reclaimed plots where irrigation has ceased and halogeton continues to persist. The control plan for halogeton is to mechanically or chemically treat an infested area. Infestations will be determined by cover, which will be calculated by randomly placing ten 50-meter point intercept transects (if size allows) in areas where halogeton is present. If the average cover of halogeton in the reclaimed area is greater than the average halogeton cover across the BNCC reference areas in the same year, the area will be deemed infested. These areas will be treated either mechanically (e.g. by hand pulling or hoeing) or chemically as appropriate.

3.3.2 Saltcedar

Saltcedar was introduced from Europe and Asia. It is commonly found where water is present such as irrigation canals, springs, seeps, lakes, playas, arroyos, and dirt stock tanks. Saltcedar's root system is dominated by a root crown that extends about 12 to 18 inches below the soil surface. Saltcedar species are considered to be a "facultative phreatophye" which means they can develop an extensive taproot to accesses water sources deep below the surface. Saltcedar has a high evapotranspiration rate which can dry out springs, drain pools, and even dry up perennial streams (Johnson 1986).

Saltcedar is established along existing water sources within the permit area. Methods that target and destroy the root crown are the only techniques that truly provide plant control. In areas reclaimed by BNCC, if saltcedar becomes well established, appropriate mechanical and/or chemical treatments may be applied to kill at least 90% of the existing saltcedar plants.

3.3.3 Cheatgrass

Cheatgrass, also known as downy brome, is a winter annual grass introduced from Europe and Asia. It is widely distributed throughout most of the United States, Canada, and northern Mexico. Cheatgrass infestations can be found in both native areas and areas disturbed by cultivation and abandonment, excessive livestock grazing, and repeated fires. Plants geminate in late fall or early spring. This early spring growth habitat helps cheatgrass out compete native plants for water and nutrients.

Cheatgrass infestations are wide spread and well established throughout New Mexico. BNCC will manage cheatgrass infestations within the permit area by purchasing native seeds and mulch from reputable dealers and establishing diverse, self-sustaining vegetation communities.

4.0 REFERENCES

Johnson, S. 1986. Alien plants drain western waters. The Nature Conservancy News, Oct-Nov 1986.

New Mexico State University (NMSU). 2009. Saltcedar Information. NMSU Dept. of Range and Animal Sciences, Las Cruces, New Mexico. http://age-web.nmsu.edu/saltcedar/ (Verified 13 February 2012).