Appendix 34.A

Final Surface Configuration Technical Report – Pinabete ~~Mine Plan~~ Permit Area

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APPENDIX 34.A

FINAL SURFACE CONFIGURATION TECHNICAL REPORT – PINABETE PERMIT AREA

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INTRODUCTION

This technical report provides supporting information and fluvial geomorphic design inputs used to create the geomorphic final surface configuration (FSC) for the Pinabete Permit area (permit area).

BACKFILLING AND GRADING DESCRIPTION

The draglines operating in the permit area will be used for overburden and interburden removal~~.~~. Dragline cut widths are generally 150 ~~'~~ to 160 ~~'~~ feet and lengths vary from ~~approximately 8,000' to 15,000'~~several hundred to 20,000 feet, depending on pit geometry and planned mining sequence. Multiple coal seams within each cut require that the draglines conduct multiple passes in order to uncover successively deeper seams as each exposed seam is removed. Generally, each dragline will operate on the highwall side of the pit to expose the upper seams and will uncover the lower seams from the spoil side. The

~~P~~proposed Pinabete mining operations and stripping layout are discussed in Section 20 (Mining Operations). Support Facilities, including overburden stockpiles, are discussed and presented in Section 22 (Support Facilities). ~~shown by the strip layout and sequence on Exhibit 20.1-1 "Pinabete Permit 25-Year Disturbance Schedule". Strips 14 to 49 are located in the northern portion of the permit area ("North Pit") and these are a continuation of the BNCC "Gilmore Pit" strips. Pinabete strips 1 to 29 are located in the southern portion of the permit area ("South Pit"). Following topsoil removal for proposed mining operations, the majority of the overburden is removed by a dragline stripping operation. This operation is assisted by a truck loader stripping operation which will primarily remove overburden in the box cuts as well as partings or interburden layers that exist between coal seams near the pit floor.~~

~~Development of the mine strips in the southern portion of the permit area required a step down box cut approach where the full pit depth to the lower most coal seam was reached over a series of four cuts starting at South Pit strip 1. The first box cut is developed by removing overburden 250' wide to the depth of the top mineable coal seam. The successive cuts to the lower coal seams were progressively narrower and required truck loader assist. Approximately 12.0 million bank cubic yards of overburden and interburden material removed by the truck loader fleet and placed as fill in the dragline spoils and ramps in the North Pit. An additional 6.7 million bank cubic yards was removed and placed ahead of the South Pit stripping operation in areas of low overburden cover labeled "Overburden Stockpile Area" on Exhibit 34.2-1. In the South Pit strip #24, the pit extends 1500' to the south which requires the step down box cut approach with 9.4 million bank cubic yards of truck loader assist over the first four cuts. This overburden and interburden material was placed in the South Pit access ramps, steepening the ramp grades.~~

Developing the final surface contours (FSC) requires that a balanced backfill surface be determined first. The initial step in this process was to model the associated dragline spoils that result from the coal removal sequence. Modeling of the mined-out cuts and illustrating the resulting dragline spoils was accomplished

using a combination of QUICKSURF™ software and dragline spoil modeling techniques that jointly operate in an AutoCAD environment.

Dragline spoil modeling is performed using routines that provide elevated contour drawings of the spoil peaks and valleys based on range diagram calculations inherent in the software programming. The spoil configuration consists of inputting AutoCAD drawn entities representing a 38° slope (measured from horizontal) that commences at the toe of the lowermost coal seam and includes a 30' wide bench approximately midway between the toe and spoil peak. Waste or unrecovered coal is assumed to remain in the pit and is accounted for by adding 8% of the total coal thickness to the pit floor surface prior to placement of the dragline spoils. The bank overburden material is also swelled 25% for spoil balance calculations. Final material cut/fill balance is achieved by incrementally raising or lowering the spoil peaks and valleys to match the modeled stripping volume. Any such adjustment is maintained within the operating parameters of the draglines.

Modeling to determine the dragline spoil surface also includes spoil displaced by coal haulage ramps that traverse the spoils. Spoil volumes for these entities are locally balanced to the cut volumes within corresponding cut(s) depending on the complexity of the mining and/or ramp configuration. Exhibit 34.2-1 shows the final post mining configuration at the end of the 25 year permit term.

After the dragline spoils are modeled, the next step in developing the ~~Final~~ final ~~Surface~~ surface ~~Configuration~~ configuration (FSC) is to bring the dragline spoils to a balanced state by cutting the spoil peaks and filling the valleys. This creates an adjusted surface to either begin manipulating for FSC or to commence placement of truck loader assist overburden stripping volume. The resulting balanced surface will, in many cases, contain low areas that do not properly drain as well as elevated areas possessing slopes that exceed the allowable maximums. These areas require further grading to develop an acceptable FSC where material balance is maintained throughout.

In addition to the iterative surface manipulations, drainages are also integrated into the FSC. Drainages were generally located where the final cut(s) and coal haulage access ramps create depressions in the spoil contours and can be incorporated into the graded spoils to allow proper drainage of the spoils. Spoil drainage gradient determination~~s~~ are either based on the gradients of the undisturbed portions of the associated drainage or maintained in a concave profile to insure hydraulic stability. The upper drainage gradients mimic the undisturbed gradient while the slope of the lower reaches is lessened to the extent possible. Generally, the overall gradient is kept as flat as practical to minimize the volume of material required to fill the final voids or ramps. Ramp areas and final pit voids are commonly graded with dozers using locally available fill. In some cases, material is dozed from the final highwalls to assist in regrading the final voids. When such areas require more fill than the dozers can practically push, additional material

is obtained from more distant spoil areas using the truck/loader operation. Additionally, any remaining box-cut spoil will be utilized in these areas to minimize the additional disturbance for backfill material. The resulting FSC is a materially-balanced surface with stable drainages and contours that approximate the pre-mining conditions. The FSC surface is considered balanced when the cut-fill volume variance is less than 5%. The cut-fill volumes calculated and shown by Exhibit 34.2-2 is 94.2 million cubic yards (Mcyds) (cut) and 91.2 Mcyds (fill) which is a variance of 3%.

GEOMORPHIC RECLAMATION APPROACH

Natural Regrade Software

The Carlson Natural Regrade™ software was utilized to develop the FSC reclamation surface. This is a computer model that applies fluvial geomorphic principles to develop a landscape design that generally mimics the natural landscape, as it would evolve over time under existing physical and climatic conditions. The software identifies the type of drainage network that would tend to form over a long period of time given the site's earth material, relief, and climate to achieve a stable landform. The product of the model represents the guide to design and build a suitable stable landform. The input variables are:

- Boundary Conditions
  - Disturbance limits
  - Drainage basins
  - Local stream base level for the main channel
  - Elevation at the head and mouth of the main drainage channel
- Watershed Characteristics
  - Reference Watershed
    - Length between channels, ridge to head length
    - Meander wavelength, A-channel length
  - Target drainage density
  - Stream Classification
    - Width to depth
    - Sinuosity
- Hydrologic/Hydraulic Parameters
  - Precipitation from the~~ the~~ 2-year, 1-hour (2yr-1hr) and 50~~-year,~~ yr-6~~-~~h~~ou~~r storm events to determine the bankfull and flood-prone flows
  - Runoff coefficient
  - Offsite drainage basins
  - Maximum discharge velocity

Boundary Conditions

Boundary conditions include identification of the overall regrade boundary, potential drainage basin, location of the channel elevations and the head and mouth of the channels. The grading limits were generally set by the mine plan disturbance schedule and stripping layout presented on Exhibit 20.1-1. The main drainage channels within the permit area are the Cottonwood and Pinabete Arroyos. These main channels are not disturbed or diverted by the Pinabete mining activities. Tributary channels to the Chaco, Cottonwood and Pinabete Arroyos which are affected by the Pinabete mine plan disturbance are identified with labels (Part 1 through Part ~~13D~~13c) along the grading limit boundary on Exhibit 34.1-1.

Watershed Characteristics

Watershed characteristics include drainage density, ridge to head of channel distance, stream width/depth ratio and channel sinuosity. The drainage basins and watershed analysis data from field investigations conducted in the Pinabete permit area have been used to develop the FSC reclamation surface.

Within Rosgen's channel classifications (Rosgen 1996), channels are classified based on slope and overall channel geometry. A-channels are those which have a slope greater than 4 percent, and tend to occur at the headwaters of a channel or near the ridge lines. In the Natural Regrade Global Settings, the input for Maximum distance from ridgeline to channel's head is 90 ft. and the 'A' channel reach value is 70 feet.

Drainage Density

Drainage density is a measure of channel spacing and is the ratio of the total length of channel to the drainage area. The drainage density of pre-mine drainage basins in the permit area varies from a low of 20 ft/acre to a high of 260 ft/acre depending on the amount of relief and presence of bedrock outcrops. The drainage density in the North portion of the permit area has significant relief, resulting in a higher drainage density than the South portion. The appropriate drainage density for a reclamation area should be a function of terrain aspect and slope as well as precipitation and soils. The overall reference drainage density of the permit area is between 25 and 80 ft/acre (the lower being on the South and the higher being on the North). Based on the extent and location of the Pinabete grading limits within the study area, a target

Drainage Density (Ft./Ac.)	Area (Ac.)	Drainage Density (Ft./Ac.)
Part 1	45.4	90
Part 2	143.6	44
Part 3	86.5	85
Part 4	98.1	89
Part 5	66.7	80
Part 5b	80.8	41
Part 6	74.7	78
Part 7	113.0	59
Part 8	232.6	50
Part 9	100.7	72
Part 10	685.2	74
Part 11	152.7	57
Part 12	553.8	57
Part 12A	35.9	90
Part 13A	546.1	58
Part 13C	52.5	78
Part 13D	146.1	71
Total	3,214.3	64

drainage density of 60 ft/acre (+/- 30%) was used for the FSC design.

Table 34.A-1 Final Surface Configuration Drainage Densities

Drainage Density (Ft./Ac.)	Area (Ac.)	Drainage Density (Ft./Ac.)
Part 1	45.4	90
Part 2	143.6	44
Part 3	86.5	85
Part 4	98.1	89
Part 5	66.7	80
Part 5b	80.8	41
Part 6	74.7	78
Part 7	113.0	59
Part 8	232.6	50
Part 9	100.7	72
Part 10	685.2	74
Part 11	152.7	57
Part 12	553.8	57
Part 12A	35.9	90
Part 13A	546.1	58
Part 13C	52.5	78
Part 13D	146.1	71
Total	3,214.3	64

Overall, the design drainage density result is 64 ft/acre.

Stream Classification

As previously stated, the Natural Regrade model utilizes principles described by Rosgen (Rosgen 1996). The Rosgen classification for a natural channel is based on slope, width to depth ratio, entrenchment ratio, sinuosity, and streambed particle size. The Rosgen classification scheme describes channels as A through G using multiple and single thread channels to differentiate between geological settings.

Channels A and A+ are narrower channels that exist in slopes greater than 4 percent. Multiple thread D and single-thread F and G are transitional formed channels that exist as the channel develops a more stable form and are generally associated with high erosion rates, sediment transport and deposition. B type channels have a relatively low sinuosity, with stepped transitions generally related to resistant rock strata generally occurring in narrow canyons with limited sinuosity. Types C and E differ through their width-to-depth ratio and sinuosity. An E channel generally has a lower width-to-depth ratio, is generally stable but is sensitive to disturbance of bank material and vegetation. A type C channel tends to migrate laterally through cutbank erosion and subsequent deposition.

Based on these classifications channel types A, C and E are generally utilized in developing stable reclamation designs. The model defaults create A and A+ channels at slopes greater than 4 percent and Bc for slopes less than 4 percent.

These channel characteristics were utilized for all tributaries within the Pinabete reclamation area:

- Width-to-depth
  - 10 – when the slope is greater than 4 percent
  - 12.5 – when the slope is less than 4 percent
- Sinuosity
  - 1.15 – when the slope is greater than 4 percent
  - 1.2 to 1.4 – when the slope is less than 4 percent

Hydrologic/Hydraulic Parameters

The Natural Regrade model estimates widths and depths for the channel based on precipitation during the ~~2-year, 1-hour~~ 2yr-1hr and the 50~~-year,~~yr-~~-~~6-h~~ou~~r storm events. Precipitation depths for these storm events are determined from the NOAA Atlas 14 based on the location and the elevation of the proposed reclamation site. The precipitation depths for the proposed reclamation area are 0.60 and 1.72 inches for the 2~~-year~~yr-1hr and 50~~-year~~ yr-6hr storms, respectively.

The Natural Regrade model defaults to using the 50~~-year,~~yr-~~-~~6-h~~ou~~r storm event and the Rational Method using a 0.89 runoff coefficient to estimate peak discharges for sizing the channels. ~~-~~Field investigation determined that a 0.75 runoff coefficient calculated channel widths and depths that were representative of the existing hydrologic conditions in the ~~Pinabete~~ permit area. However, the Natural Regrade default runoff coefficient (0.89) was used in the Pinabete FSC design to allow ~~a~~ some over-sizing for the drainage channels. ~~Th~~The Rational Method immediately concentrates the full runoff volume into the hydrology model~~ing~~ at the head of channel but not distributed along the length of the channel which also add a factor of safety ~~s some over-sizing for the~~ in the channel designs. Use of the 50~~-year,~~yr-~~-~~6-h~~ou~~r storm event in lieu of the 100~~-year~~yr-~~,~~6-h~~ou~~r storm in context of the Natural Regrade model is reasonable based on; 1) the 0.89 runoff coefficient which is conservative and adds a factor of safety in ~~over-sizing design~~ the channeldesigns, and 2) the effect of immediate concentration of runoff into the drainage by the Rational Method is also conservative. As a result, these factors effectively model the 100-y~~ea~~r~~,~~ ~~-~~6-h~~ou~~r storm in context of the Natural Regrade model.

The Natural Regrade model uses the permissible velocity method which uses a parameter called the maximum discharge velocity. A value of 4.5 feet per second was used for the Pinabete FSC. This value is the default value in the Natural Regrade model and represents the minimal channel erosion.

REFERENCES

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.