SECTION 34

POST-RECLAMATION TOPOGRAPHY

TABLE OF CONTENTS

SECTION	SECTION TITLE	PAGE NUMBER
34	POST-RECLAMATION TOPOGRAPHY	1
34.1	Post-Reclamation Final Surface Configuration	1
34.2	Final Surface Configuration or Approximate Original Contour	2
34.2.1	Area 1	3
34.2.2	Area 2	4
34.2.3	Area 3	5
34.3	Backfilling and Grading Schedule	5
34.3.1	Post-Reclamation Slope Stability	7
34.4	Subsidence Plan	7

SECTION 34

POST-RECLAMATION TOPOGRAPHY

LIST OF TABLES

TABLE NUMBER	TABLE TITLE
34-1	Regrade Volume by Area
34-2	Drainage Control Structures
34-3	Slope Distribution by Area for Pre and Post-mining Topography (not in text)

SECTION 34

POST-RECLAMATION TOPOGRAPHY

LIST OF FIGURES

FIGURE NUMBER	FIGURE TITLE
34-1	Conceptual Design of North Block C Bluff
34-2	Reclamation Volume Available for Fill and Volume Regraded by Fiscal Year
34-3	Reclamation Schedule by Year and Pit (not in text)

SECTION 34

POST-RECLAMATION TOPOGRAPHY

LIST OF EXHIBITS

EXHIBIT NUMBER	EXHIBIT TITLE
34-1	Area 1 North Final Surface Configuration
34-2	Area 1 South Final Surface Configuration
34-3	Area 2 Final Surface Configuration
34-4	Area 2 Final Surface Configuration
34-5	Area 2 Permit Area Block C Premine Bluff
34-6	Area 3 Final Surface Configuration
34-7	FY 2011 Regrade, Mitigation and Topsoil Map
34-8	FY 2011 Revegation Map
34-9	Area 4 North Final Surface Configuration- not in Text
34-10	Area 3 Life of Mine Plan for Contemporaneous Reclamation (not in text)
34-11	Lowe Corner 3 East Drop Structure Design Plan Profile Section(not in text)

SECTION 34

POST-RECLAMATION TOPOGRAPHY

LIST OF APPENDICES

APPENDIX NUMBER	APPENDIX TITLE
34.A	Lowe Corner 3 East and North Drop Structures

SECTION 34

POST-RECLAMATION TOPOGRAPHY

LIST OF REVISIONS DURING PERMIT TERM

REV. NUMBER	REVISION DESCRIPTION	DATE APPROVED

34 POST-RECLAMATION TOPOGRAPHY

34.1 Post-Reclamation Final Surface Configuration

As described in Section 20 – Mining Operations overburden and parting material is removed by a dragline and cast into the adjacent mined out cut. Such placement creates spoil ridges (rows) or peaks which need to be backfilled and/or graded. Backfilling and grading will be done in logical blocks that follow the stripping sequence allowing large areas to be regraded at one time. This will provide a more consistent topography between regraded areas and will improve irrigation coverage by providing large, continuous areas rather than small irregular blocks. In most cases, these logical blocks become available every 1-3 years in each mining area, which will result in a substantial distance between the previous regraded area and the active pit just prior to the block becoming available. The areas around and in active ramps will be regraded to provide a road suitable for mining activities that include coal haulage. Pre-stripping ahead of the active mining strip allows for the material removed to be used in backfilling and grading. These materials are used to backfill finished pits, active mining ramps, and regrade areas requiring additional fill. Final pits will remain open until all mining activities are complete, at which time they will be backfilled. The backfilling and grading operations of each logical block are divided into primary and secondary operations.

Primary regrading utilizes track dozers to level off the spoil ridges. Primary regrading will be accomplished as necessary to accommodate the FSC and the reclamation schedule in Table 34-1. Some pits and ramps may not have sufficient backfill material readily available for bulldozers to adequately regrade the area. In these instances, supplemental equipment may be used to facilitate primary regrading activities. This equipment includes, but is not limited to, scrapers, draglines, and end-dump trucks working with a large front-end loader.

Several areas at Navajo Mine may require delays in reclamation in order to facilitate reaching the desired postmining topography. Changes or fluctuations in the dragline stripping sequence may cause variations in spoil placement resulting in localized peaks or valleys that may require regrading equipment and cause primary regrading delays.

Secondary regrading may, if needed, follow primary grading for additional smoothing of the land surface to accommodate topdressing replacement. At this time, any special water control or wildlife habitat features will be constructed.

During the process of secondary grading, small depressions may be established on an opportunistic basis. These features will enhance post-mining topographic diversity and act as seasonal surface water collection

sites. Small depressions will serve as wildlife enhancement features and micro-topographic niches for establishment of mesic and/or hydric plant species. Although these depressions will not have specific design criteria, they will be small enough that they will occur within the limits of the approved FSC. These small depressions will also meet the following specific criteria:

- Each depression or combination of directly adjacent depressions will be less than one acre foot total capacity
- No depression will be deeper than 10 feet
- All small depressions will be incised (below ground level)
- The maximum inslope for the small depression will be 6:1 and
- At bond release, small depression areas will be subject to vegetation sampling similar to any area within the bond release parcel

Highwalls and ramps will be backfilled and graded as shown on the FSC maps (Exhibit 34-1, Exhibit 34-2, Exhibit 34-3, Exhibit 34-4, Exhibit 34-5, and Exhibit 34-6). Interior slopes will be graded to less than or equal to 6.5 horizontal to 1 vertical (6.5h: 1v) overall. All outslopes of the affected areas will be graded to less than or equal to 4h: 1v overall. The overall slope will be measured from the crest to the toe of the slope. On long slopes a portion of the slope between the crest and toe could be steeper to facilitate the construction of terraces. The analysis indicates that the weighted average soil loss from a post-mining watershed exceeds the per-mining condition then terraces are constructed on long steep slopes to shorten the slope lengths and thereby minimize the erosion off the slope. Drainage details are available in Section 41 – Probable Hydrologic Consequences and in the Reclamation Surface Stabilization Handbook (NTEC formerly known as BHP- Navajo Mine, 1992), which was approved by the Office of Surface Mining Reclamation and Enforcement (OSMRE) in 1992. In locations where ash disposal has occurred, disposed ash volumes will be taken into consideration when developing the FSC.

Regraded lands are blended into the surrounding topography to establish drainage patterns, and the postmining land use of range livestock grazing will be unimpaired following topdressing distribution and revegetation.

34.2 Final Surface Configuration or Approximate Original Contour

Through the mining process, the original or pre-mine surface configuration and surface contour are altered. Reclamation plans are based on grading the mined areas to meet specific criteria outlined in this section. In order to ensure that these criteria will be met and the material balance maintained, designs of a new topographical surface are created based on current mine plans and features for a given operating area. This

replacement surface is defined as the Final Surface Configuration (FSC) or Approximate Original Contour (AOC); both terms can be used interchangeably within this permit. Reclamation plans are based specifically around meeting the drainage requirements of this FSC (or AOC) surface. Because this FSC (or AOC) surface is created from a modeled post mine surface, the actual contour configuration of the reclaimed topography may deviate from the design FSC (or AOC). The locations, configurations, and timing of mining plans and features may vary slightly from plans (e.g. ramp centerline locations, dragline plug locations, and so forth). However, these deviations will not be significant. The actual reclaimed surface will closely approximate the approved FSC (or AOC) and this surface will ensure current FSC (or AOC) drainage designs are maintained, still meet the requirements this section, and ensure a material balance.

The Final Surface Configuration (FSC) is achieved at Navajo Mine by:

1. Achieving mass balance while maximizing contemporaneous regrade acreage between ramps without requiring disturbance of revegetated pre-law lands,
2. Achieving positive drainage, except for the small depressions mentioned above, from all areas including pits and ramps,
3. Developing an adequate drainage density, and
4. Allowing development of stable drainage channels.

34.2.1 Area 1

The Area 1 North final surface configuration is shown in Exhibit 34-1. The northwestern portion of the exhibit is characterized by a hill that primarily slopes to the southeast. The area to the southeast is featured by a hilly terrain that contains a drainage. This drainage is called the Bitsui Wash that leaves the permit site to the north. The area from the Bitsui Wash to the southwestern corner of the exhibit is generally sloped to the northeast. The Dodge Diversion, originating near N 2,070,000 and a smaller drainage are located in this area. These two drainages facilitate the entire Area 1 North up to the Bitsui Wash. Cross sections for Area 1 North are shown in Exhibit 13-2. These cross sections illustrate that the post-mining surface generally resembles the pre-mining topography.

Near Doby Ramp 7 is hill (Power Pole Hill) that contains slopes on the south side that exceed 6.5h: 1v. This hill is pre-law but a narrow strip of Permanent Program land that traverses the toe was added to capture the public access across the mine. During reclamation of this road, slopes in excess of 6.5h: 1v were constructed in order to tie-in with the steep Pre-law slope. The area of Power Pole Hill containing the slopes is roughly 1 acre in size, is stable with respect to erosion and has established perennial vegetation

The Area 1 South final surface configuration is shown in Exhibit 34-2. The topography is described to be a moderately sloped terrain. The area between N 2,070,000 and N 2,065,000 divides and generally slopes to the east and west. The western slope will start dipping to the north near the lease line and tie in with the Area 1 North. The eastern half will drain off lease before connecting with a drainage to the south. This drainage is called the Chinde Diversion that will trend westerly near N 2,055,000. The area south of N 2,065,000 will generally be sloped to the southwest corner of the exhibit or the Big Fill area. This terrain will be moderately flat and trend across the Bighan and Doby Ramps down to the Chinde Diversion. The Area 1 South slope histogram shown in Figure 13-1 illustrates the post-mining slope distribution to generally be the same as the pre-mining distribution.

34.2.2 Area 2

The Area 2 final surface configuration is shown in Exhibit 34-3 and Exhibit 34-4. Exhibit 12-6A displays the Chinde Diversion, discussed in Area 1, and another drainage trending from the Figure 13-1 southeast to the northwest exiting at the Big Fill area. The drainage will run parallel but not directly on top of the final pit of North Barber. This channel will be routed through the final pits of Hosteen and Yazzie to merge with the Chinde Diversion. To the west of the drainage, the topography transitions into a hilly terrain sloping to the northwest. In Exhibit 12-6, the rolling terrain extends to the southwest where the topography flattens into moderate hills. This flat terrain contains drainages that trend from the southeast to northwest. Figure 13-2, Area 2 Slope Histogram shows the post-mining slope distribution to generally be the same as the pre-mining distribution.

In order to reestablish topographic diversity, bluff features will be constructed in the Block C area. These features will be established to recreate bluffs removed during the mining process. The location of premine bluffs are shown in Exhibit 34-6. Prior to disturbance, approximately 2,580 linear feet of native bluffs existed in the proposed disturbance area with slopes ranging from 25% to 60%. Prior to mining, the native topography in the Block C area included bluff-like features in the form of rock outcroppings, steeply sloped badlands with exposed rock strata and caprock, and scoria capped knobs. The constructed bluff features will consist of in situ overburden including fractured siltstones, mudstones, sandstones, and shales. In constructing the bluff features, the existing highwall will be backfilled to a minimum of 3 feet above the exposed rider coal seam leaving no more than 20 feet of exposed rock face. The bluff features will be constructed as shown in the conceptual drawing (see Figure 34-1). The area of constructed bluff features will be approximately 500 linear feet in length with no more than 20 vertical feet of exposed bluff. The constructed bluff features are intended to promote post-mine topographic diversity in the Block C area and may be considered a wildlife enhancement feature. In addition, the bluff features will result in an increase

in sinuosity of the reconstructed drainage in the reclaimed area. The native area drains to the north away from the constructed bluff features and no major spalling or slope instability should occur; however, similar to natural bluffs the face of the bluff is expected to physically weather over time, which will result in the creation of a rubble zone at the base of the feature. Based on the availability of suitable competent rock, rubble zones may also be constructed with boulders at the base of the bluff features to further enhance the utility of the features for wildlife and mimic natural bluffs in the area.

34.2.3 Area 3

The Area 3 final surface configuration will generally be a flat terrain with moderate hills between drainages. The northern section will typically be flat with drainages directed to the west. These northern drainages will reconnect with the western half of the Lowe Arroyo. To the east, the final Lowe and north Dixon Pits will be regraded to become a drainage channel aligned to the south, west and north, back to Lowe Arroyo. The drainages in south Dixon will tie in with the Cottonwood Arroyo. The Area 3 final surface configuration is shown in Exhibit 34-6.

Figure 13-3, Area 3 Slope Histogram generally shows the lower slope range (0-2.9 percent) to decrease and increase in the middle slope range (3-5.9% to 12-14.9%). The rolling topography created by the drainage system over a primarily flat pre-mine area will decrease the lower slope range and increase the middle slope range distribution.

34.3 Backfilling and Grading Schedule

SMCRA regulation state backfilling and grading activities "shall occur as contemporaneously as practicable with mining operations" (30 CFR 816.100). NTEC will use the following guidelines to define practicable backfilling and grading:

- Sufficient equipment capacity and manning levels to sustain constant progress backfilling available areas simultaneous with mining operations
- Holding equipment and manning levels at a steady rate (not hiring or laying off extra people to meet demands caused by short term fluctuations in available regrade volumes).
- Allowing spoil material that is reserved to fill final pits and ramps to remain ungraded in place until the final pits or ramps are available to fill (not double handing material to develop out-of-pit spoil dumps)

NTEC provides information for short term and long term backfilling and grading. Both of these sources combined constitute the backfilling and grading plan.

Short term information is provided in Exhibit 34-7 and Exhibit 34-8. Exhibit 34-7 shows detailed regrading, mitigation and topsoil areas by year for three years. Exhibit 34-8 shows detailed revegetation and irrigation areas by year for three years. NTEC will submit these exhibits on an annual basis in conjunction with the submittal of the annual report by August 31st each year for OSM's review and approval

Long term backfill and grading information is provided in Table 34-1 and Figure 34-2. Table 34-1 shows the approximate volume of material placed in final regrade of Area 2 and Area 3 by fiscal year until all pits in those areas are completely regraded. Disturbed acres in this table are based on Exhibits 2-1 and 2-2, Permit Term Disturbance Schedule. Figure 34-2 shows a summary schedule for the final regrading of Area 2 and Area 3. The bars represent the cumulative fill volume available for final regrade i.e. final pits, ramps or fill areas. The lines represent the planned volume to be placed in final regrade in that fiscal year. Figure 34-1 and Table 34-1 do not provide information on the number of acres completed as "final regrade", regrade acres are provided in Exhibits 34-7 and Exhibit 34-8. The volumes presented in Table 34-1 and Figure 34-2 are general estimates based on the current mine plan and may be altered due to unforeseen significant changes

There are several factors in determining the appropriate timing for contemporaneous reclamation to be completed. Five examples of these factors are explained below.

1. Pit Backfill A buffer of approximately 4500 feet from the centerline of the final pit is required to leave enough cut material to backfill the final pit to FSC elevation. In order to successfully time the backfilling of pits, some spoil material must remain in place until their final resting place becomes available for regrading to the final surface configuration (FSC). This material is required for backfilling the ramps and pits, and will not be moved until the designated location for that material is available to be filled.
2. Drainage Construction. The re-establishment of postmining drainages requires that some acres not be regraded during active mining, but regraded after the area is inactive. This allows ramps and pits to be backfilled to proper elevations to establish drainage either through the old pits and ramps or through other mined-out areas as dictated by the FSC.
3. Maximization of Coal Recovery. In some areas, the land must not be regraded until a later date in order to facilitate future coal recovery in adjacent areas.

In FY 2011, the first 'jog' in Dixon Pit and the dragline stripped pit in Hosteen/Yazzie become available for backfilling. In FY 2014, the final Lowe Pit and the second 'jog' in Dixon Pit become available for

backfill. In FY 2019, the final Dixon Pit becomes available. In 2020, the final Hosteen/Yazzie Pit becomes available for backfill.

According to the Long-Term Regrade Plan, Barber Pit backfilling will be completed in FY 2015. Lowe Pit backfilling will be completed in 2019. Final backfilling for both Area 2 and Area 3 will be completed in FY 2021. Figure 34-2 shows the estimated annual material movement in Area 2 and Area 3.

34.3.1 Post-Reclamation Slope Stability

In certain cases reclaimed areas may require designed drainage control structures in order to stabilize reclaimed lands and minimize erosion. Drainage structures for surface water control and surface stabilization on reclaimed lands, will be designed and constructed following the guidelines outlined in the Reclamation Surface Stabilization Design Handbook (NTEC formerly known as BHP Minerals – Navajo Mine 1992). As-Built designs for control structures on permanent program lands, are provided in Appendix 34.A and listed in Table 34-2.

In addition to using drainage control structures, where appropriate and feasible, cattle may also be utilized to stabilize reclaimed land and minimize erosion. Cattle grazing will be used to impact reclaimed land to reduce erosion by incorporating mulch and seed into the soil, and increase water infiltration by creating increased surface roughness with cattle hoof action.

34.4 Subsidence Plan

No underground mining is anticipated within the proposed Permit Area, and therefore, there is no subsidence monitoring. No known active or abandoned underground workings exist within 500 feet of the Permit Area.

Table 34-1 Regrade Volume by Area

Volume Moved (Bank Cyds)	Location		
Year	Area 2	Area 3	Area 4
2010	6,113,331	4,602,065	
2011	5,583,134	4,826,890	
2012	4,249,955	5,770,431	
2013	4,942,521	5,463,651	
2014	5,452,429	4,064,407	
2015	6,063,844	4,378,689	248,000
2016	3,759,176	6,781,872	1,140,000
2017	2,500,000	8,308,488	2,330,000
2018	2,500,000	7,354,127	3,320,000
2019	2,500,000	10,775,504	
2020	5,500,964	4,599,732	2,660,000
2021	2,192,310	5,052,194	5,930,000
2022			4,571,000

Estimated volume (cubic yard) of spoil material moved each fiscal year for cut and/or fill requirements to meet Final Surface Configuration (FSC)

Table 34-2 Drainage Control Structures

Structure Name	Location	Structure Type	Comments
Lowe Corner 3 Drop Structures	NE Lowe	Highwall Drop Structure	Gabion mats and grouted rip-rap
West Lowe Drainage Control Structures	West Lowe	Ephemeral Channel	Gabion and rip-rap

Table 34-3 Slope Distribution by Area for Pre- and Post-mining Topography

Percent

	Area 1			Area 2			Area 3			Area 4 North		
	AOC	PRE	**Variance**	AOC	PRE	**Variance**	AOC	PRE	**Variance**	FSC	PRE	**Variance**
0-2.9%	47.2%	62.0%	**-14.8%**	28.8%	34.9%	**-6.1%**	50.1%	57.4%	**-7.3%**	23.8%	49.3%	**-25.6%**
3-5.9%	25.9%	23.4%	**2.6%**	31.4%	27.6%	**3.8%**	25.6%	18.7%	**6.9%**	12.1%	11.5%	**0.6%**
6-8.9%	12.7%	7.9%	**4.7%**	18.9%	14.3%	**4.6%**	11.7%	9.0%	**2.7%**	15.0%	9.3%	**5.7%**
9-11.9%	6.4%	3.3%	**3.1%**	10.0%	8.4%	**1.6%**	6.2%	4.8%	**1.4%**	27.7%	5.3%	**22.4%**
12-14.9%	3.7%	1.6%	**2.1%**	5.5%	5.1%	**0.4%**	3.1%	2.8%	**0.3%**	9.6%	3.5%	**6.1%**
15-19.9%	2.5%	1.1%	**1.5%**	3.5%	4.3%	**-0.8%**	2.1%	2.8%	**-0.7%**	5.3%	5.0%	**0.3%**
> 20.0%	1.6%	0.7%	**0.8%**	1.9%	5.5%	**-3.5%**	1.2%	4.6%	**-3.4%**	6.5%	16.0%	**-9.5%**
Total	100%	100%		100%	100%		100%	100%		100%	100%	

Acres

	Area 1			Area 2			Area 3			Area 4 North		
	AOC	PRE	**Variance**	AOC	PRE	**Variance**	AOC	PRE	**Variance**	FSC	PRE	**Variance**
0-2.9%	1,035	1,360	**(325)**	1,690	2,047	**(356.9)**	2,060	2,359	**(298.9)**	167	347	**(180.1)**
3-5.9%	568	512	**56**	1,846	1,622	**223.7**	1,052	768	**283.6**	85	81	**4.5**
6-8.9%	278	174	**104**	1,110	838	**271.6**	481	369	**111.8**	105	65	**39.9**
9-11.9%	140	72	**68**	587	493	**93.9**	255	196	**59.3**	195	37	**157.8**
12-14.9%	81	35	**46**	321	297	**23.2**	129	115	**14.3**	68	25	**43.1**
15-19.9%	56	23	**33**	204	251	**(47.6)**	85	116	**(30.7)**	37	36	**1.9**
> 20.0%	34	16	**19**	113	321	**(208.4)**	50	189	**(139.3)**	46	113	**(67.1)**
Total	2,193	2,193		5,870	5,870		4,113	4,113		704	704	

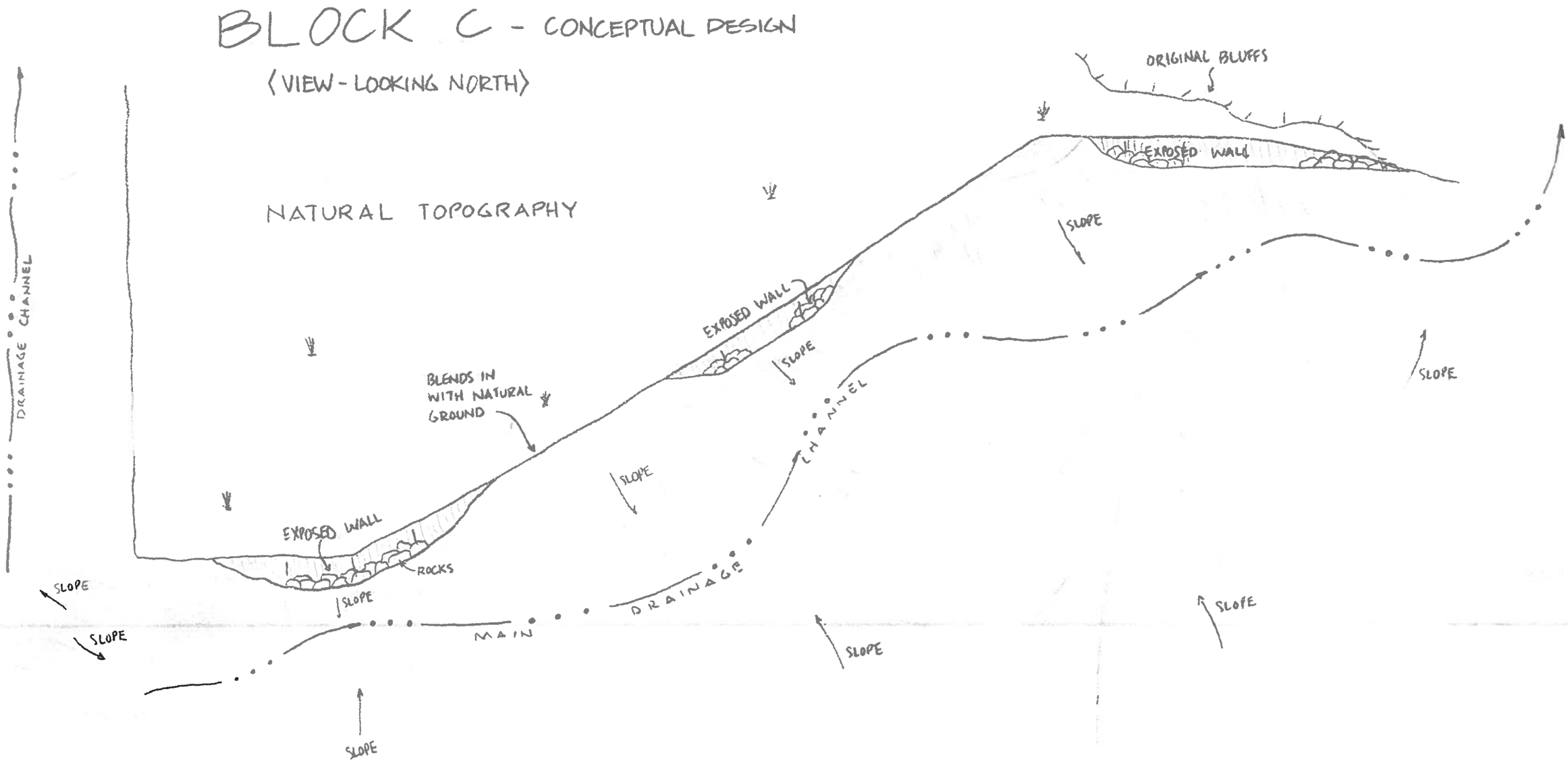

BLOCK C - CONCEPTUAL DESIGN
(VIEW - LOOKING NORTH)
NATURAL TOPOGRAPHY
ORIGINAL BLUFFS
EXPOSED WALL
EXPOSED WALL
EXPOSED WALL
BLENDS IN WITH NATURAL GROUND
ROCKS
SLOPE
SLOPE
SLOPE
SLOPE
SLOPE
SLOPE
SLOPE
SLOPE
SLOPE
DRAINAGE CHANNEL
MAIN DRAINAGE CHANNEL

Figure 34-1

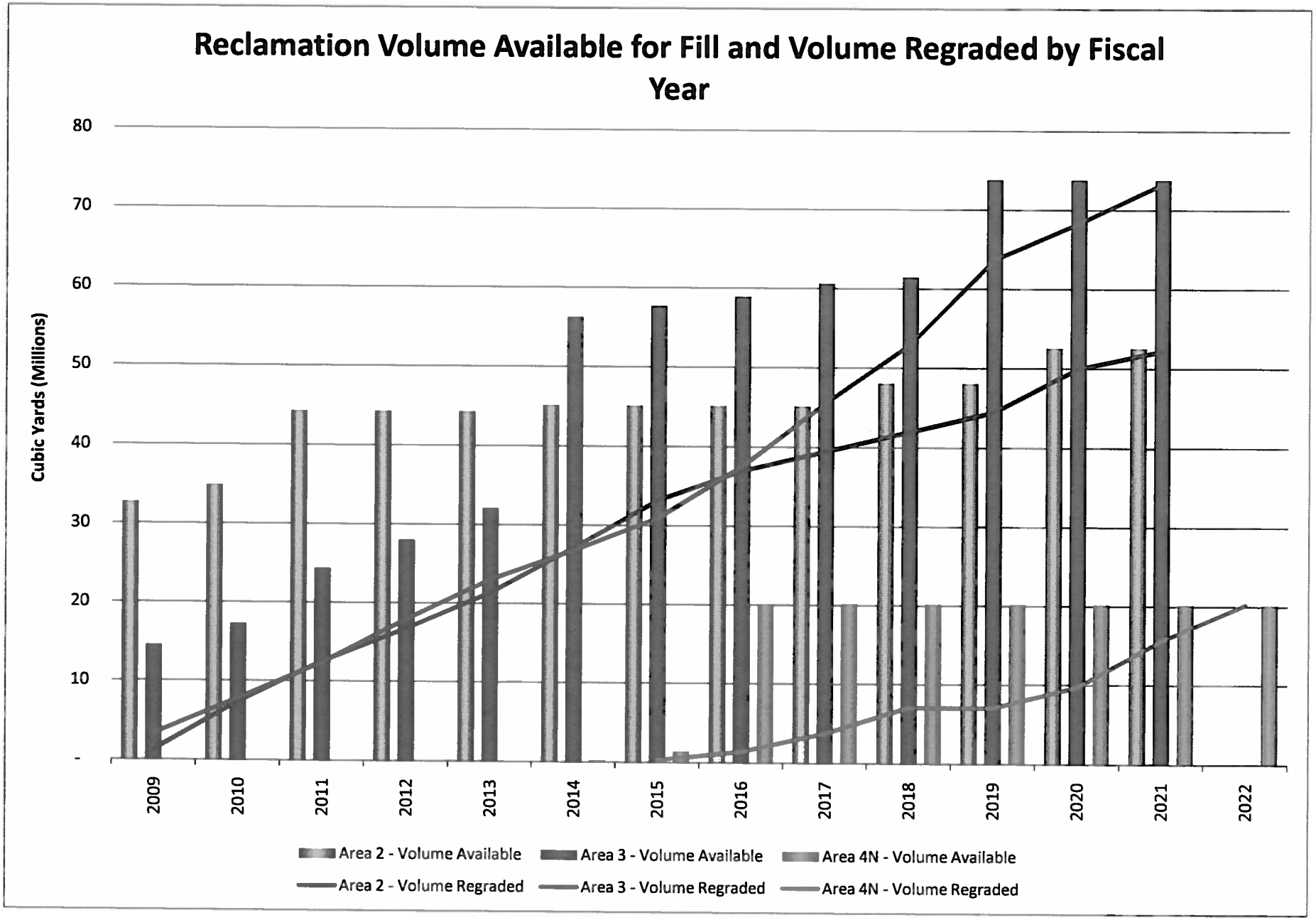

Reclamation Volume Available for Fill and Volume Regraded by Fiscal Year
Cubic Yards (Millions)
80
70
60
50
40
30
20
10
-
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Area 2 - Volume Available
Area 3 - Volume Available
Area 4N - Volume Available
Area 2 - Volume Regraded
Area 3 - Volume Regraded
Area 4N - Volume Regraded

Figure 34-2

Figure 12.2-2

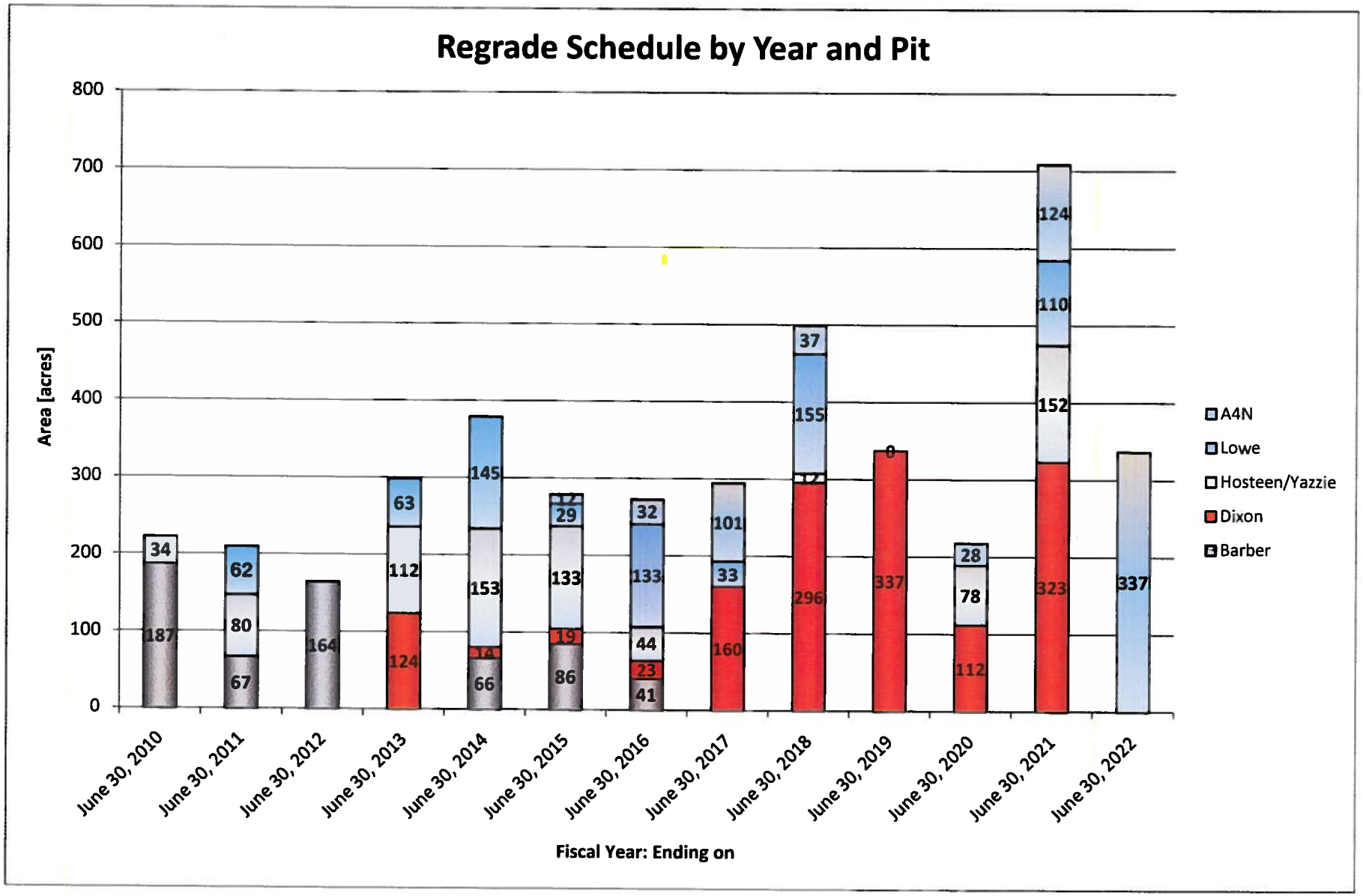

Regrade Schedule by Year and Pit
Area [acres]
800
700
600
500
400
300
200
100
0
June 30, 2010
June 30, 2011
June 30, 2012
June 30, 2013
June 30, 2014
June 30, 2015
June 30, 2016
June 30, 2017
June 30, 2018
June 30, 2019
June 30, 2020
June 30, 2021
June 30, 2022
Fiscal Year: Ending on
A4N
Lowe
Hosteen/Yazzie
Dixon
Barber
34
187
62
80
67
164
63
112
124
145
153
14
66
12
29
133
19
86
32
133
44
23
41
101
33
160
37
155
12
296
0
337
28
78
112
124
110
152
323
337

Figure 12.2-3

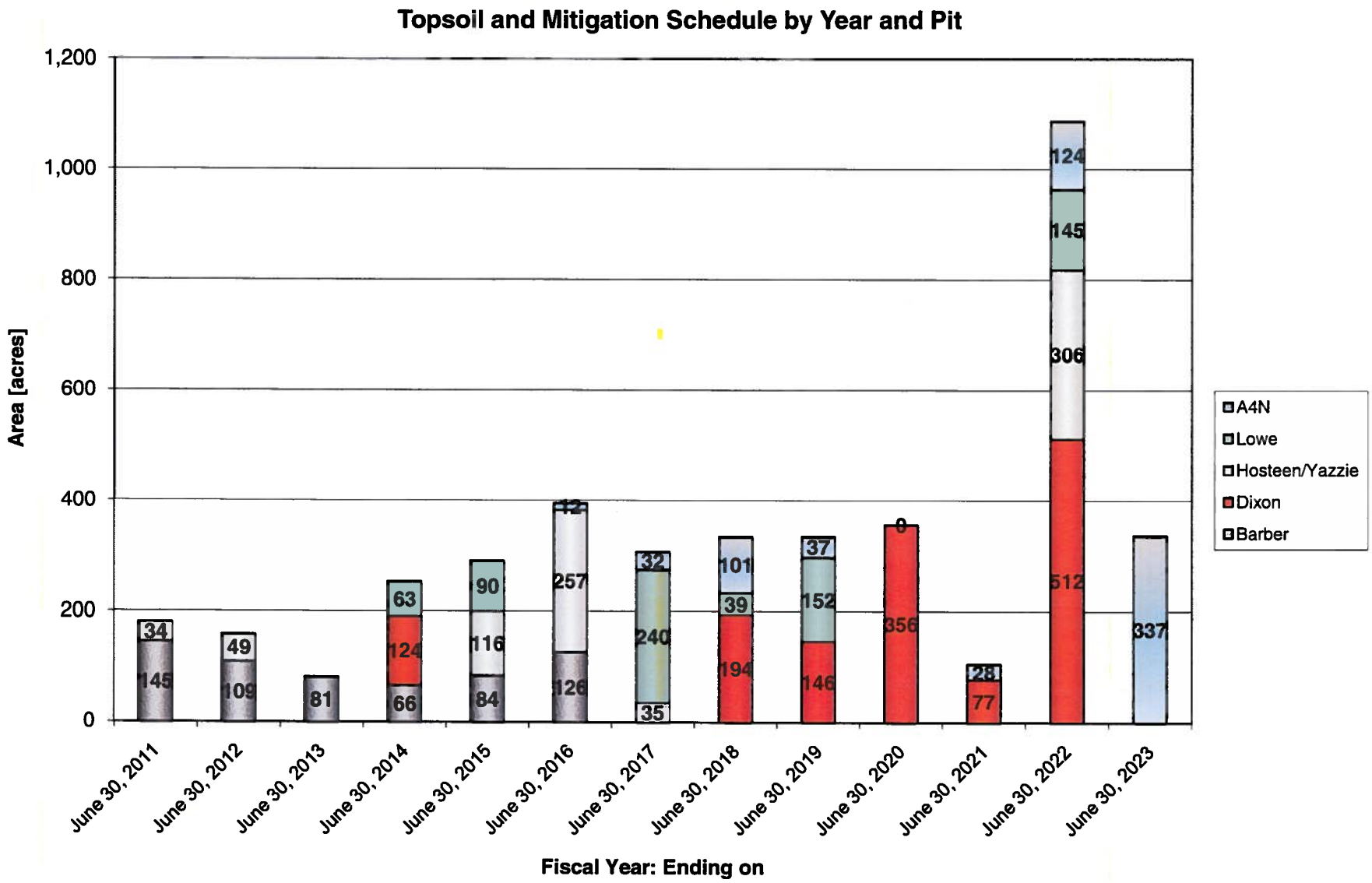
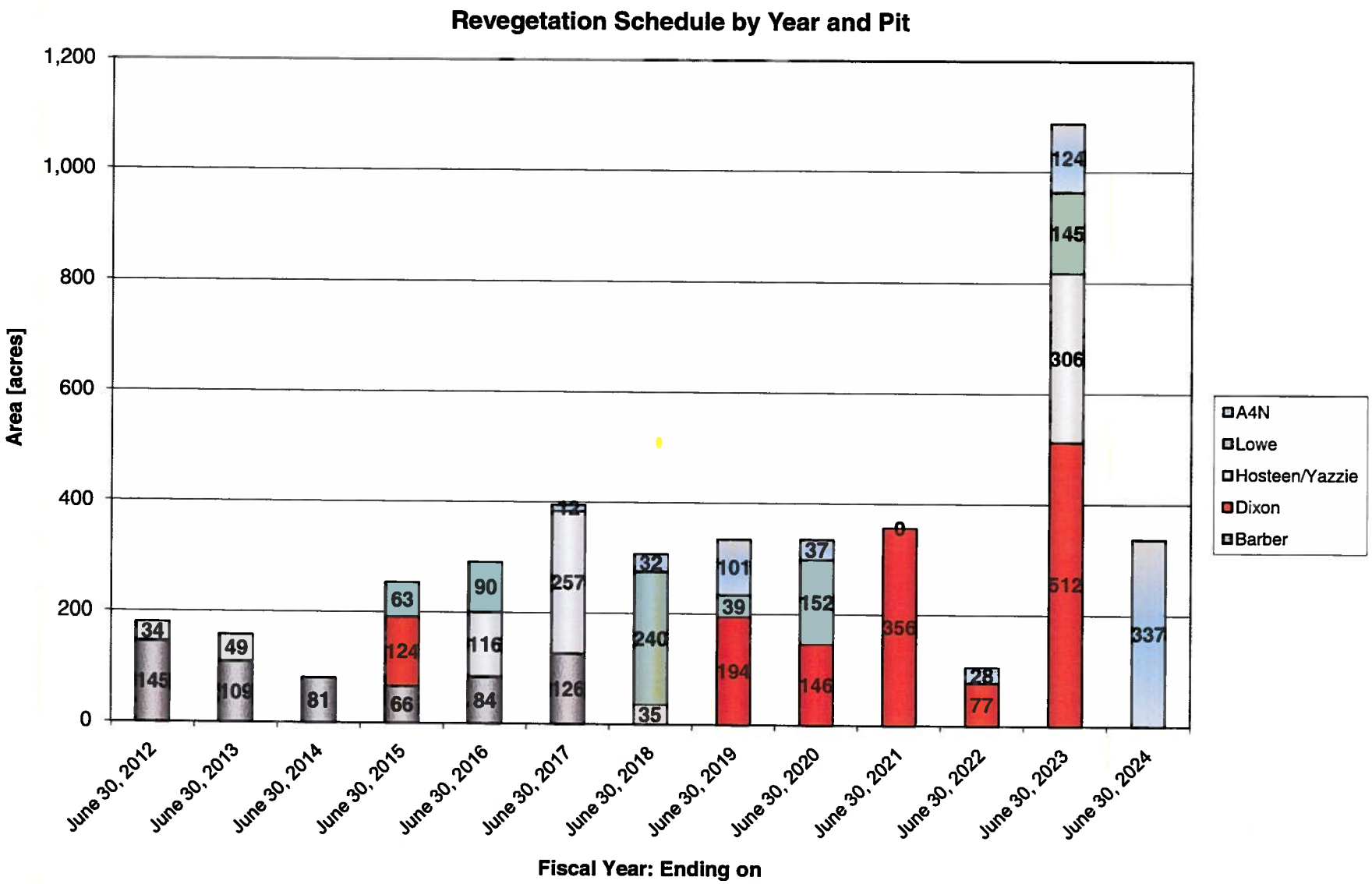

Topsoil and Mitigation Schedule by Year and Pit
Area [acres]
1,200
1,000
800
600
400
200
0
34
145
49
109
81
63
124
66
90
116
84
12
257
126
32
240
35
101
39
194
37
152
146
0
356
28
77
124
145
306
512
337
June 30, 2011
June 30, 2012
June 30, 2013
June 30, 2014
June 30, 2015
June 30, 2016
June 30, 2017
June 30, 2018
June 30, 2019
June 30, 2020
June 30, 2021
June 30, 2022
June 30, 2023
Fiscal Year: Ending on
A4N
Lowe
Hosteen/Yazzie
Dixon
Barber

Figure 12.2-4


Revegetation Schedule by Year and Pit
Area [acres]
1,200
1,000
800
600
400
200
0
June 30, 2012
June 30, 2013
June 30, 2014
June 30, 2015
June 30, 2016
June 30, 2017
June 30, 2018
June 30, 2019
June 30, 2020
June 30, 2021
June 30, 2022
June 30, 2023
June 30, 2024
Fiscal Year: Ending on
34
145
49
109
81
63
124
66
90
116
84
12
257
126
32
240
35
101
39
194
37
152
146
0
356
28
77
124
145
306
512
337
A4N
Lowe
Hosteen/Yazzie
Dixon
Barber

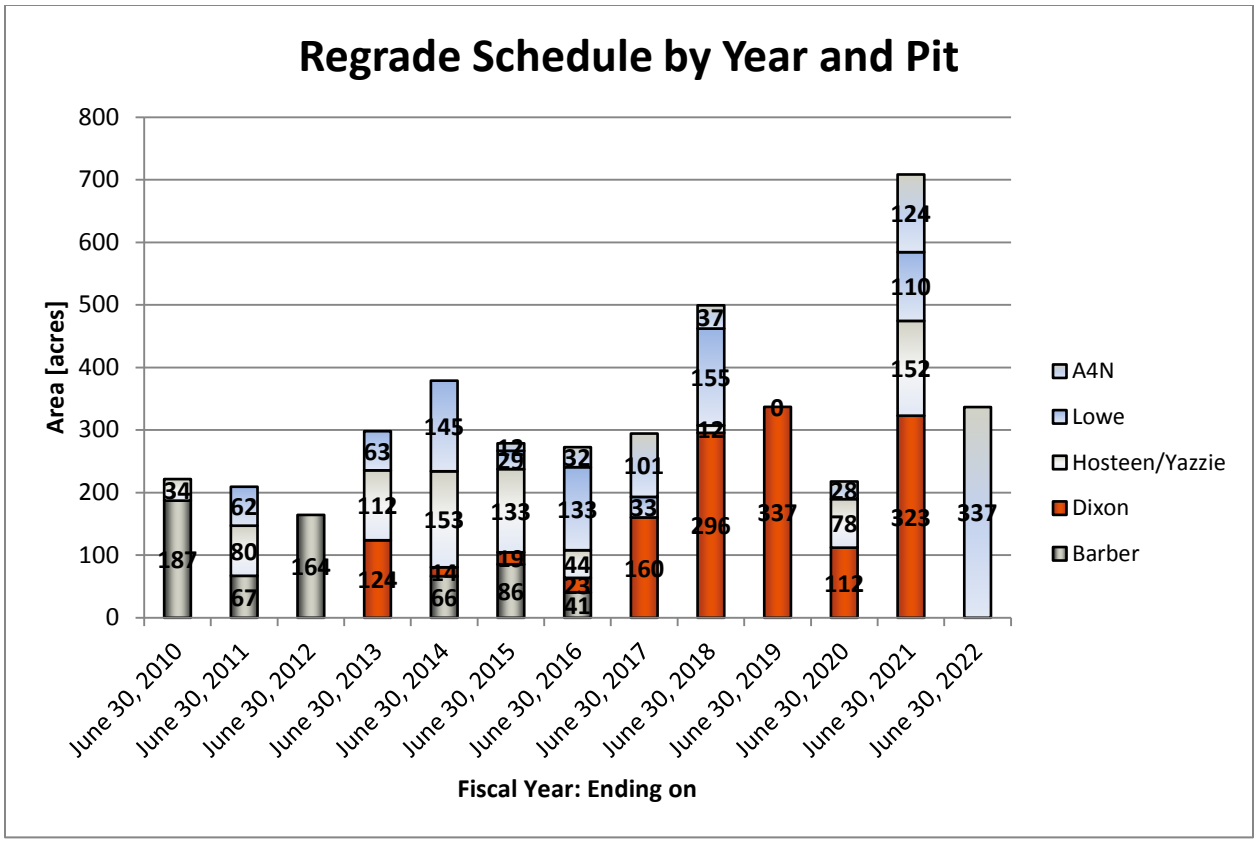
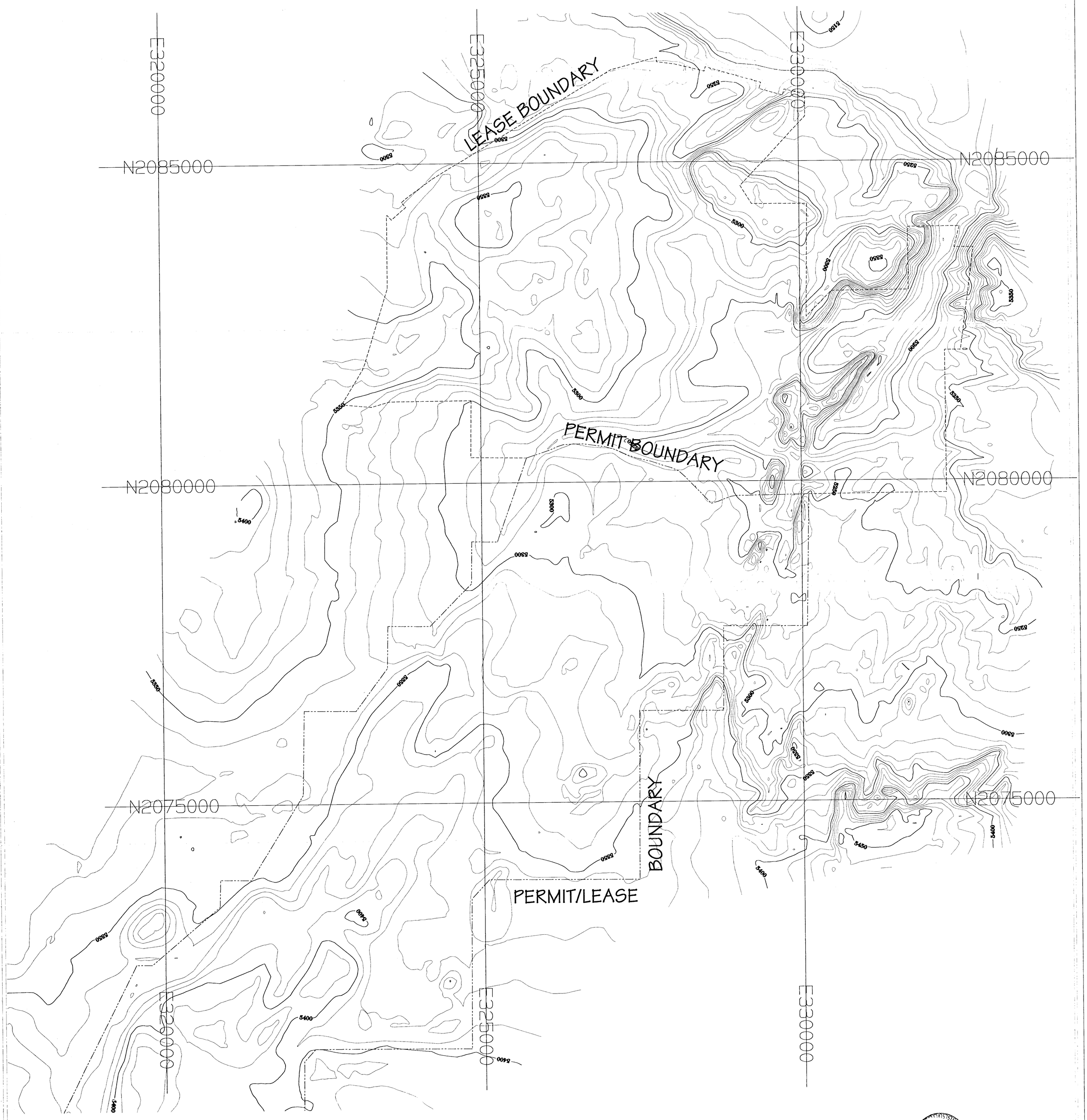

Regrade Schedule by Year and Pit
Area [acres]
800
700
600
500
400
300
200
100
0
June 30, 2010
June 30, 2011
June 30, 2012
June 30, 2013
June 30, 2014
June 30, 2015
June 30, 2016
June 30, 2017
June 30, 2018
June 30, 2019
June 30, 2020
June 30, 2021
June 30, 2022
Fiscal Year: Ending on
A4N
Lowe
Hosteen/Yazzie
Dixon
Barber

Figure 34-3



LEGEND

— — — ·	LEASE BOUNDARY
— — — —	PERMIT BOUNDARY
x5338.5	SPOT ELEVATION
5900	INDEX CONTOUR
	INTERMEDIATE CONTOUR
218 5422.45	HORIZ. & VERT. CONTROL
L-30	LEASE CORNER

GRAPHIC SCALE 1"=500'

0 500 1000 1500

REV. NO.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
A	8/01/98	KBB	SUBMITTED TO OSM FOR APPROVAL	KBB	MC	LR		

APPROVALS

EXHIBIT 34-1

NAVAJO COAL COMPANY

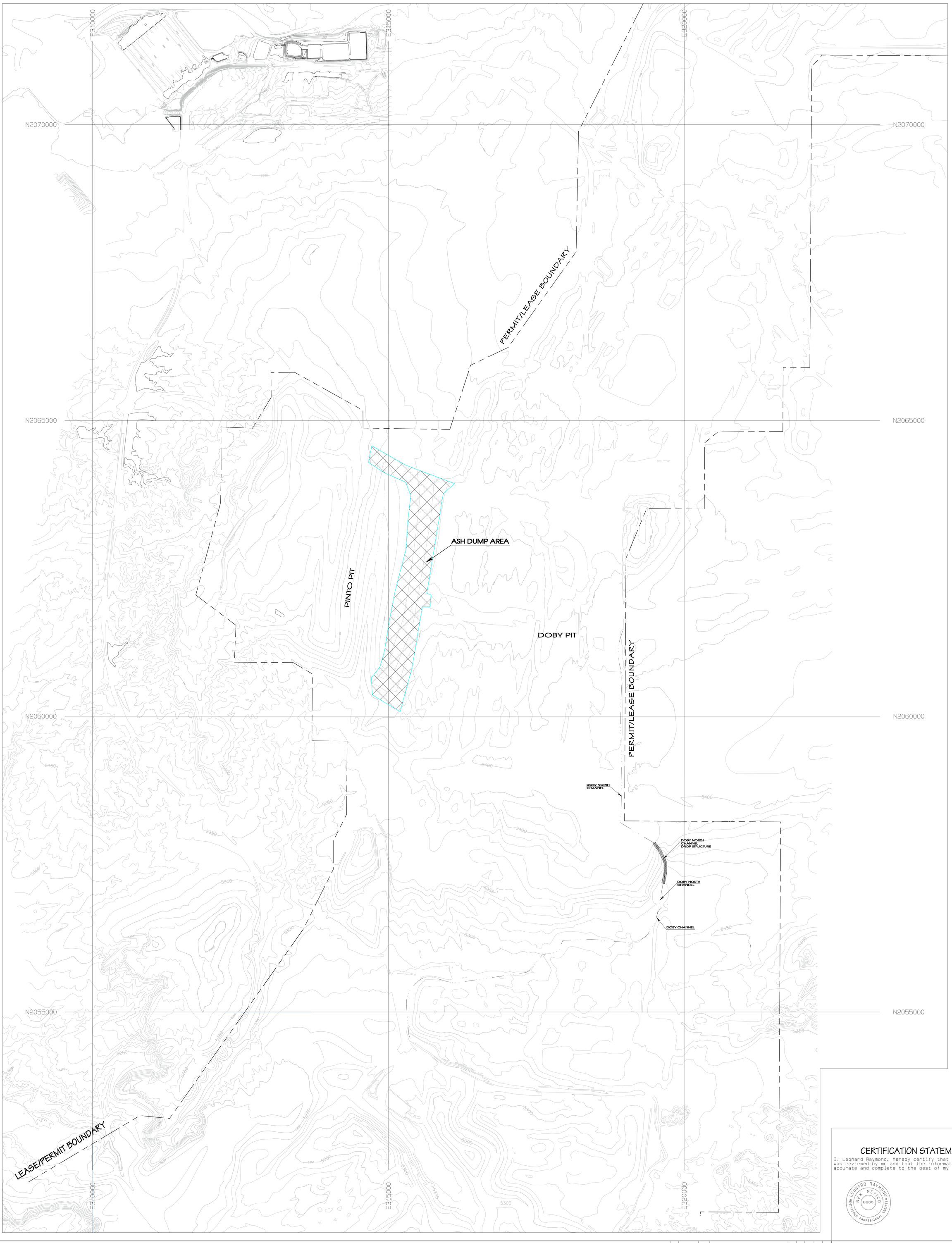
NAVAJO MINE

P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

AREA 1 North

Final Surface Configuration

PREPARED BY KBB	DRAWN BY KBB	SCALE AS NOTED
APPROVED BY LR	DATE 8/01/98	REF DWG
DWG LOC		



CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

LEGEND

— — —	LEASE BOUNDARY
— — —	PERMIT BOUNDARY
×5338.5	SPOT ELEVATION
5300	INDEX CONTOUR
	INTERMEDIATE CONTOUR
218 5422.45	HORIZ. & VERT. CONTROL
L-30	LEASE CORNER

GRAPHIC SCALE 1"=500'

500 0 500 1000 1500

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
D	1-10-07	PJF	Revised FSC at Pinto, removed Drop Structure and submitted to OSM for Review.	LR	KJ	LR		
C	9-26-06	PJF	Revised FSC at Pinto, change Ash Dump Bndy, added North Doby Channel and Drop Structures, submitted to OSM for Review.	LR	KJ	LR		
B	10-21-99	PJF	ADDED FUTURE ASH DISPOSAL AREA BOUNDARY AND SUBMITTED TO OSM FOR APPROVAL	CN	MC	LR		
A	8/01/98	KBB	SUBMITTED TO OSM FOR APPROVAL	KBB	MC	LR		

APPROVALS

EXHIBIT 34-2

NAVAJO COAL COMPANY

NAVAJO MINE

SAFETY PAYS

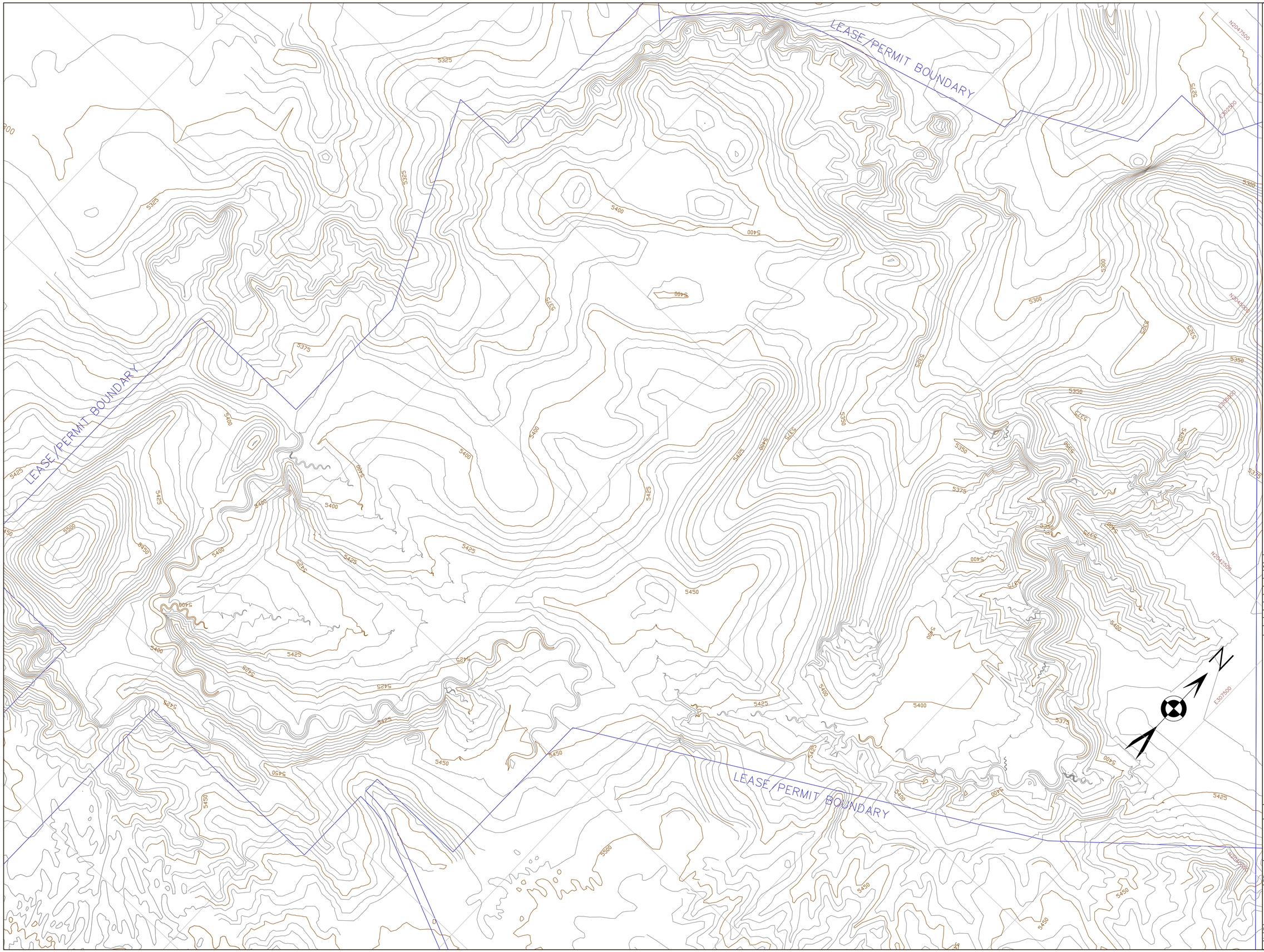
P.O. BOX 1717 FRUITLAND, NEW MEXICO 87416

AREA I South

Final Surface Configuration

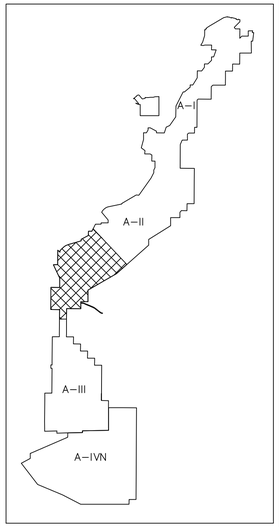
PREPARED BY KBB	DRAWN BY KBB	SCALE AS NOTED
APPROVED BY LR	DATE 8/01/98	

G:\Departments\Gs\OSM_SUBM\PER_PROG\CH_12_PAP EXHIBITS\12-05A_A1-AOC\2006 Data\Area-1AOC_F
Tue Feb 13 08:13:09 2007



LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- x 5338.5 — SPOT ELEVATION
- 5300 — INDEX CONTOUR
- INTERMEDIATE CONTOUR
- 218 / 5422.45 — L-30 — LEASE CORNER
- LEASE/PERMIT BOUNDARY
- COAL STOCKPILE



REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	C.G.	P.E.	P.S.	DATE
H	9-17-12	CJB	A2 FSC REVISION OF LANDFORMS. SUBMITTED TO OSM FOR REVIEW AND APPROVAL.					
11-A	FEB-2011	PJF	AREA II NORTH REVISION RESUBMITTAL TO OSM FOR REVIEW AND APPROVAL. FUTURE ASH DISPOSAL AREA REMOVED.	KA	SO	LR		
G	6-08-05	PJF	A2 FSC Revision and submitted to OSM for Review.	LR	MC	LR		
F	10-13-04	PJF	A2 FSC Revision and submitted to OSM for Review.	LR	MC	LR		
E	8-29-03	PJF	AOC Revision, and submitted to OSM for Review.	LR	MC	LR		
D	3-31-03	PJF	AOC Revision, and submitted to OSM for Review.	CJB	MC	LR		
C	10/21/99	PJF	Added Future Ash Disposal Area Boundary and Submitted to OSM for Approval	CN	MC	LR		
B	05/19/99	PJF	REVISE SUBJECT AREA AND SUBMITTED TO OSM FOR REVIEW AND APPROVAL.	BH	MC	LR		SRP
A	07/23/98	FTJ	SUBMITTED TO OSM FOR APPROVAL	FTJ				

APPROVALS

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND — NEW MEXICO — 6600 — REGISTERED PROFESSIONAL ENGINEER

Exhibit 34-3

bhpbilliton

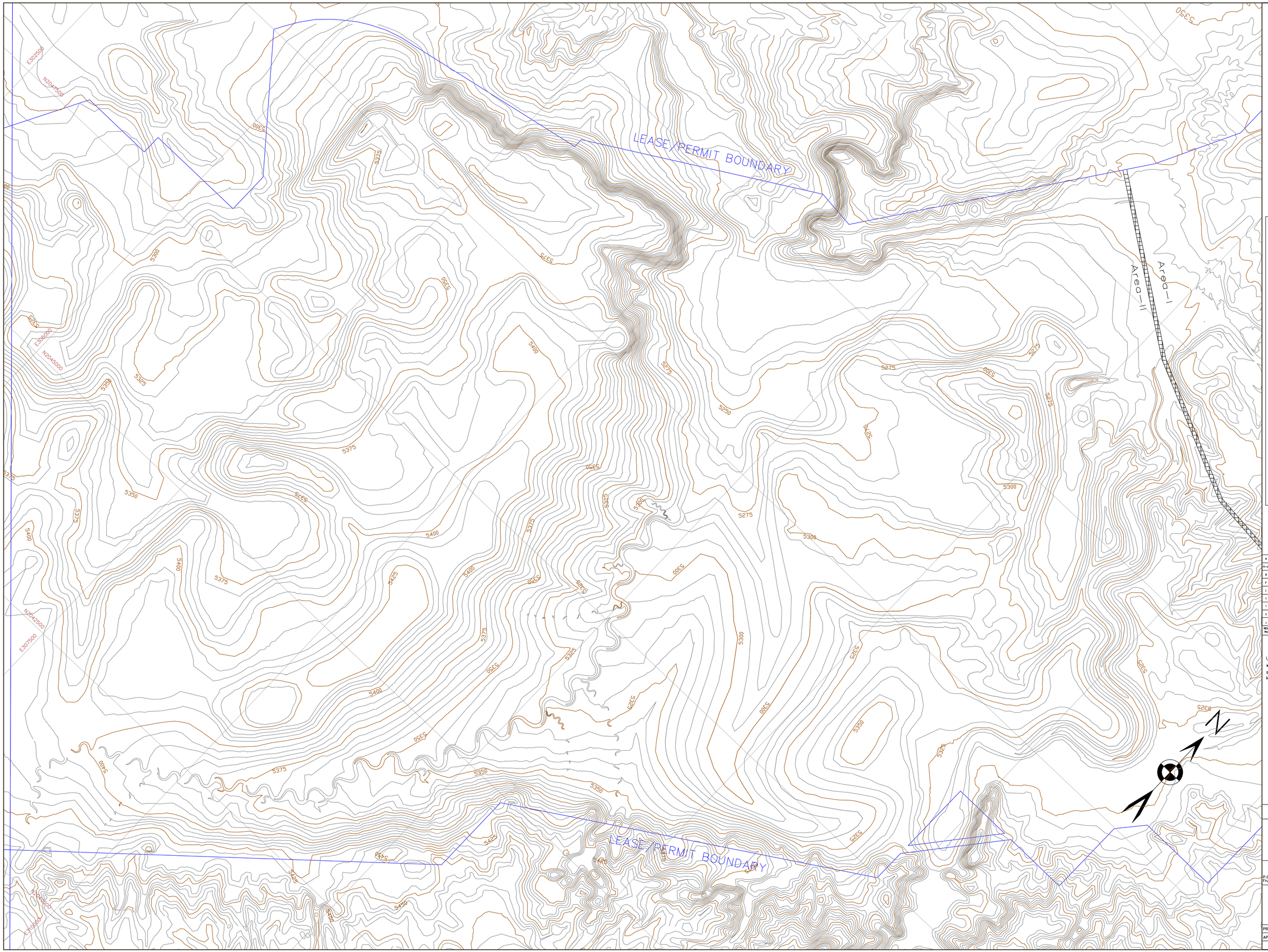
BHP Navajo Coal Company

P.O. Box 1717
Fruitland,New Mexico,87416

Phone: 505-598-4200
Fax: 505-568-3361

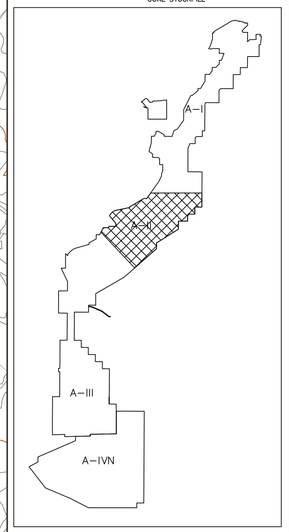
AREA II
FINAL SURFACE CONFIGURATION

PREPARED BY CJB	DRAWN BY CJB	SCALE 1"= 500'
APPROVED BY LR	DATE 09.17.2012	REF DWG EXH. 12-6B



LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- x 5338.5 — SPOT ELEVATION
- 5300 — INDEX CONTOUR
- INTERMEDIATE CONTOUR
- 218 / 5422.45 — LEASE CORNER
- L-30
- LEASE/PERMIT BOUNDARY
- COAL STOCKPILE



REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
				APPROVALS				
H	9-17-12	CJB	A2 FSC REVISION OF LANDFORMS. SUBMITTED TO OSM FOR REVIEW AND APPROVAL.					
11-A	FEB-2011	PJF	AREA 4 NORTH REVISION RESUBMITTAL TO OSM FOR REVIEW AND APPROVAL. FUTURE ASH DISPOSAL AREA REMOVED.	KA	SO	LR		
G	6-08-05	PJF	A2 FSC Revision and submitted to OSM for Review.	LR	MC	LR		
F	10-13-04	PJF	A2 FSC Revision and submitted to OSM for Review.	LR	MC	LR		
E	8-29-03	PJF	ADC Revision, and submitted to OSM for Review.	LR	MC	LR		
D	3-31-03	PJF	ADC Revision, and submitted to OSM for Review.	DJR	MC	LR		
C	10/21/99	PJF	Added Future Ash Disposal Area Boundary and Submitted to OSM for Approval	CN	MC	LR		
B	05/19/99	PJF	ADDED BLOCK-C ADC AND SUBMITTED TO OSM FOR REVIEW AND APPROVAL.	BH	MC	LR		SRF
A	07/23/98	FTJ	SUBMITTED TO OSM FOR APPROVAL	FTJ				

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

Exhibit 34-4

bhpbilliton

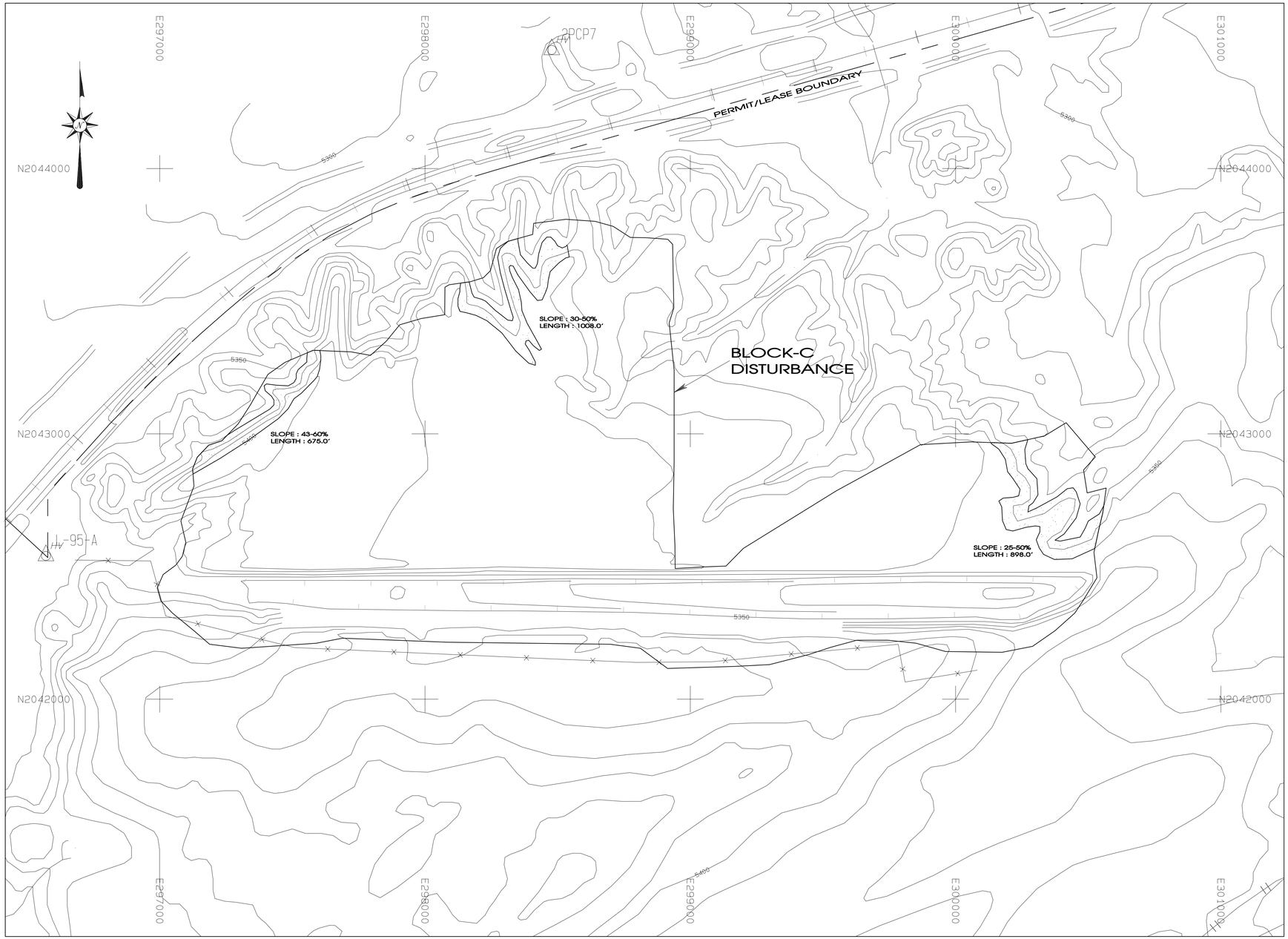
BHP Navajo Coal Company

P.O. Box 1717
Fruitland,New Mexico,87416

Phone: 505-598-4200
Fax: 505-568-3361

AREA II
FINAL SURFACE CONFIGURATION

PREPARED BY CJB	DRAWN BY CJB	SCALE 1"= 500'
APPROVED BY LR	DATE 09.17.2012	REF DWG EXH. 12-6B



LEGEND

PREMINE BLUFF

REV. No.	Date Submitted	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.Q.		DATE APP'D
A	9-29-00	PJF	RECLAMATION PLAN REVISION.	LR	MC		

APPROVALS

EXHIBIT 34-5

BHP NAVAJO COAL COMPANY

NAVAJO MINE — SAFETY PAYS

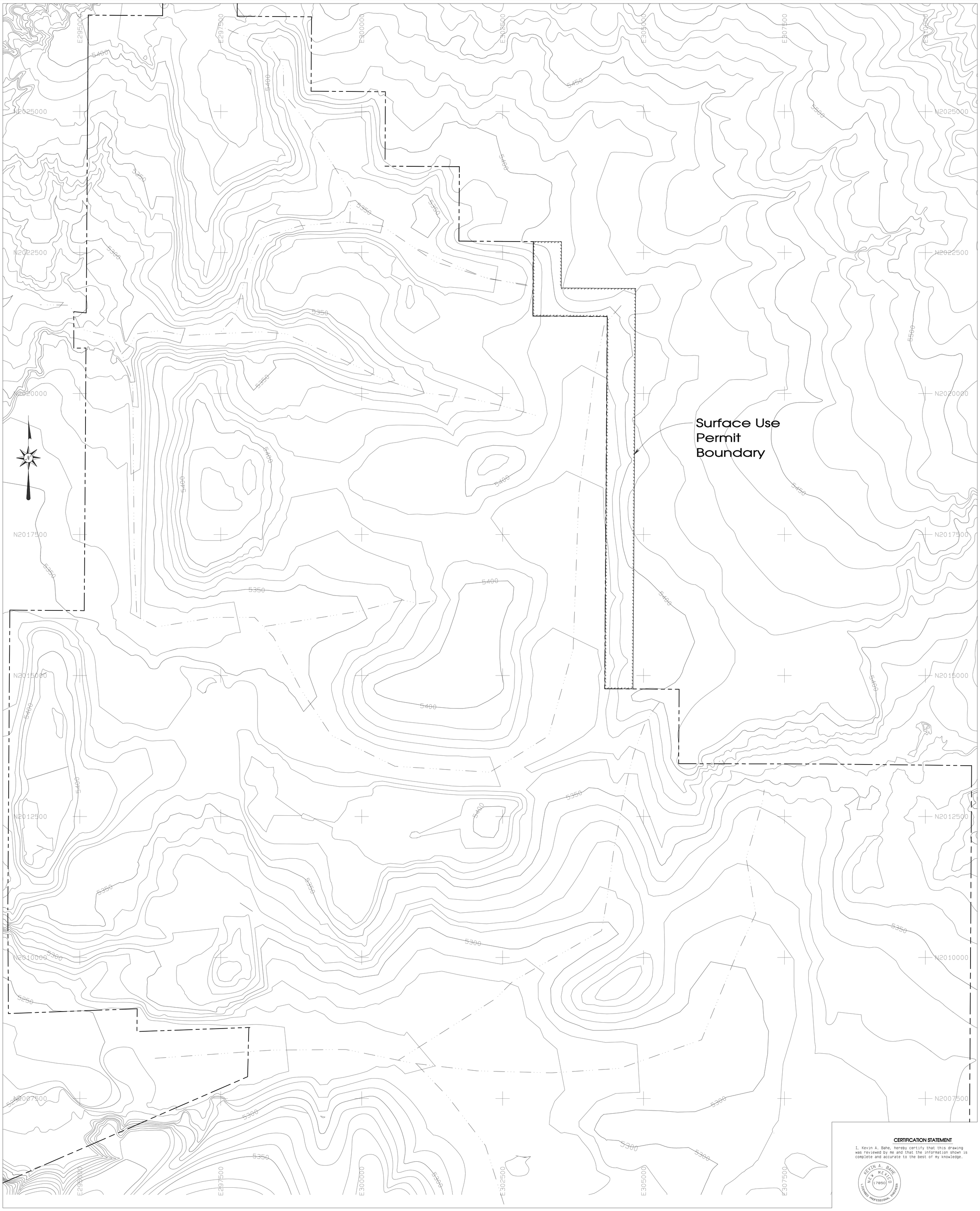
P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

,AREA 2 PERMIT AREA
BLOCK_C
PRE MINE BLUFFS

PREPARED BY LR	DRAWN BY PJF	SCALE 1" = 200'
APPROVED BY	DATE SEPT.29, 2000	

PATH: G:\Departments\Gs\OSM_SUBM\PER_PROG\CH_12_PAP EXHIBITS\12-4

Path: G:\Departments\Gs\OSM_SUBM\PER_PROG\CH_12_PAP EXHIBITS\12-42\EXH 12-42.pro
PJFoster \Plot Time: Thu Oct 27 14:31:57 2005



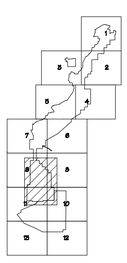
CERTIFICATION STATEMENT

I, Kevin A. Bahe, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

KEVIN A. BAHE
NEW MEXICO
17850
LICENSED PROFESSIONAL ENGINEER

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- INTERMEDIATE CONTOUR
- LEASE/PERMIT BOUNDARY
- DISTURBANCE LIMIT



G:\Gs\OSM_SUBM\PER_PROG\CH_12_PAP EXHIBITS\12-07_AIII_A4N-AOC\2009 Data\R3-EXH 12-7_A3_FSC.pro
\Plot time: Wed Jul 15 11:03:27 2009

Original Certified signed exhibits are maintained at the Mine Site and OSM

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.
09-B	7-12-09	PJF	ADDED IBR EASTSIDE OF LOWE PIT AND SUBMITTED TO OSM FOR REVIEW.	Shawn Smith	YB	KAB
09-A	6-22-09	PJF	REVISED TO REFLECT FSC REVISIONS AND SUBMITTED TO OSM FOR APPROVAL.	KJ	YB	KAB
D	10-17-06	PJF	REVISED TO REFLECT FSC REVISIONS AND SUBMITTED TO OSM FOR APPROVAL.	LR	KJ	LR
C	3-17-03	PJF	AOC REVISION, SUBMITTED TO OSM FOR REVIEW AND APPROVAL.	LR	MC	LR
B	8-16-01	PJF	CHANGE SCALE FROM 1"=2000' TO 1"=500' IN THE TITLE BLOCK AREA AND RESUBMITTED TO OSM FOR REVIEW AND APPROVAL	LR	MC	LR
A	5-10-01	PJF	SUBMITTED TO OSM FOR REVIEW AND APPROVAL	LR	MC	LR

APPROVALS

EXHIBIT 34-6

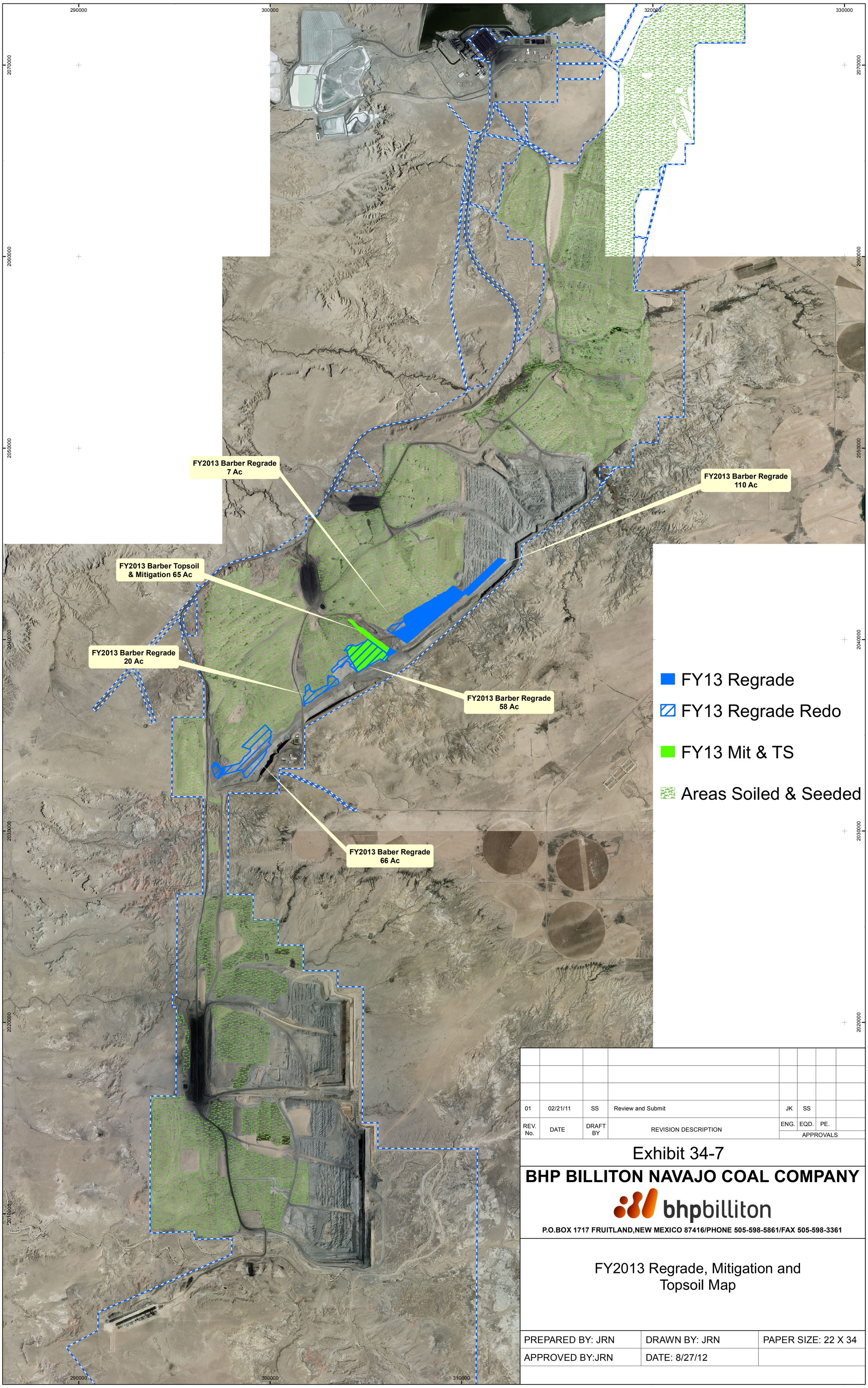
BHP NAVAJO COAL COMPANY

NAVAJO MINE — SAFETY · PEACE · PAYS

P.O. BOX 1717 FRUITLAND, NEW MEXICO 87416

AREA 3
FINAL SURFACE CONFIGURATION

PREPARED BY PJF	DRAWN BY PJF	SCALE 1"= 500'
APPROVED BY LR	DATE 4-29-2001	



REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	EQD.	PE.
01	02/21/11	SS	Review and Submit	JK	SS	

APPROVALS

Exhibit 34-7

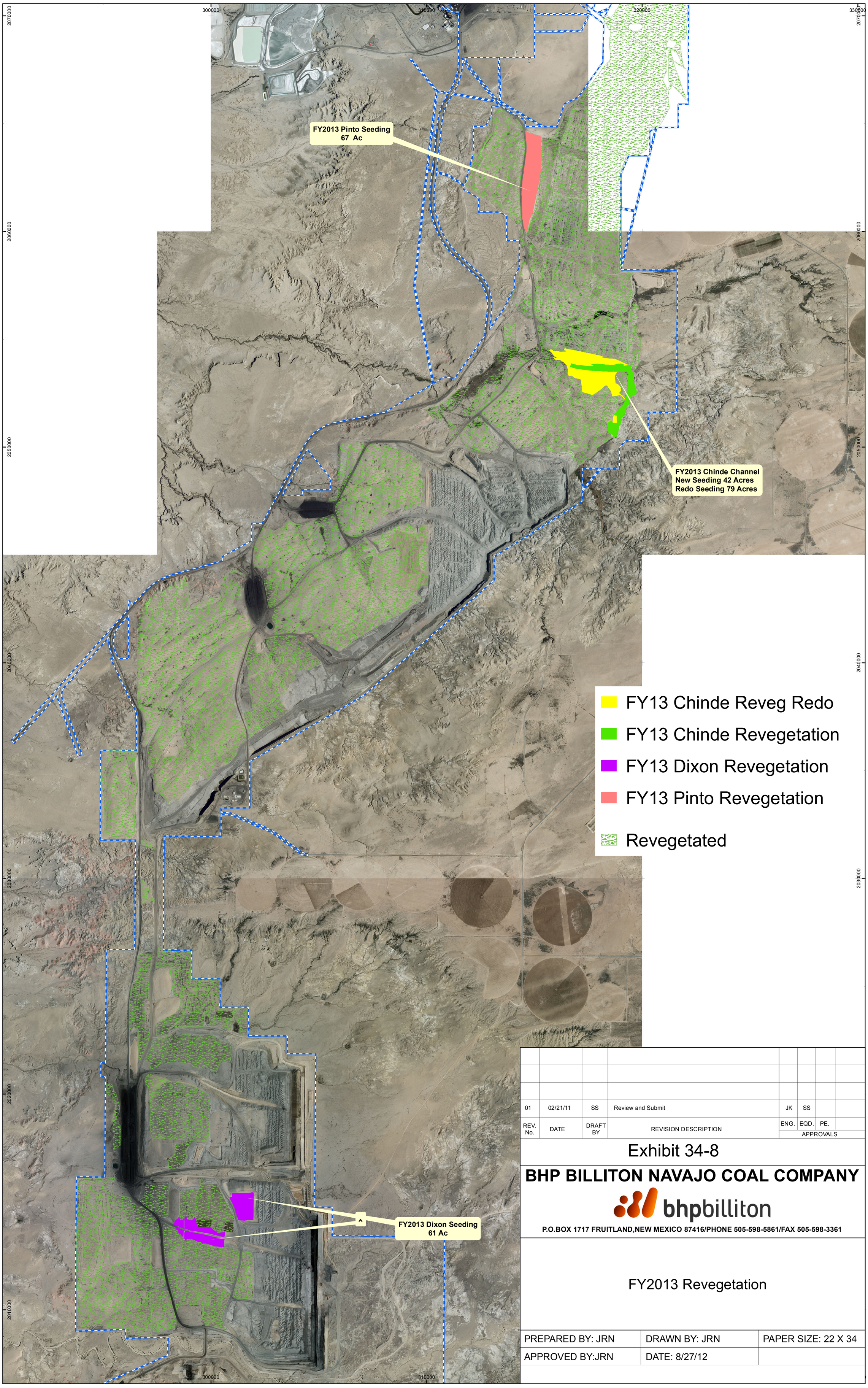
BHP BILLITON NAVAJO COAL COMPANY

bhpbilliton

P.O.BOX 1717 FRUITLAND,NEW MEXICO 87416/PHONE 505-598-5861/FAX 505-598-3361

FY2013 Regrade, Mitigation and Topsoil Map

PREPARED BY: JRN	DRAWN BY: JRN	PAPER SIZE: 22 X 34
APPROVED BY:JRN	DATE: 8/27/12	



REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	EQD.	PE.	
01	02/21/11	SS	Review and Submit	JK	SS		
				APPROVALS			

Exhibit 34-8

BHP BILLITON NAVAJO COAL COMPANY

bhpbilliton

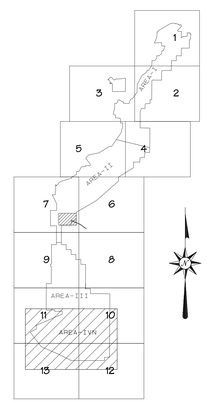
P.O.BOX 1717 FRUITLAND,NEW MEXICO 87416/PHONE 505-598-5861/FAX 505-598-3361

FY2013 Revegetation

PREPARED BY: JRN	DRAWN BY: JRN	PAPER SIZE: 22 X 34
APPROVED BY:JRN	DATE: 8/27/12	

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5299 INTERMEDIATE CONTOUR
- 218 5422.45
- L-30 LEASE CORNER
- LEASE/PERMIT BOUNDARY
- DISTURBANCE LIMIT



CERTIFICATION STATEMENT

I, Ron C. Van Valkenburg, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG — NEW MEXICO — 9263 — LICENSED PROFESSIONAL ENGINEER

REV No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENGR	EG	PE	PLS
				APPROVALS			
21-A	FEB-2011	PJF	AREA 4 NORTH REVISION RESUBMITTAL TO OSM FOR REVIEW AND APPROVAL	RCV	SD	RCV	
A	11-15-04	PJF	SUBMITTED TO OSM FOR APPROVAL	LR	MC	LR	

EXHIBIT 34-9

bhpbilliton

BHP Navajo Coal Company

P.O. Box 1717
Fruitland, New Mexico, 87416

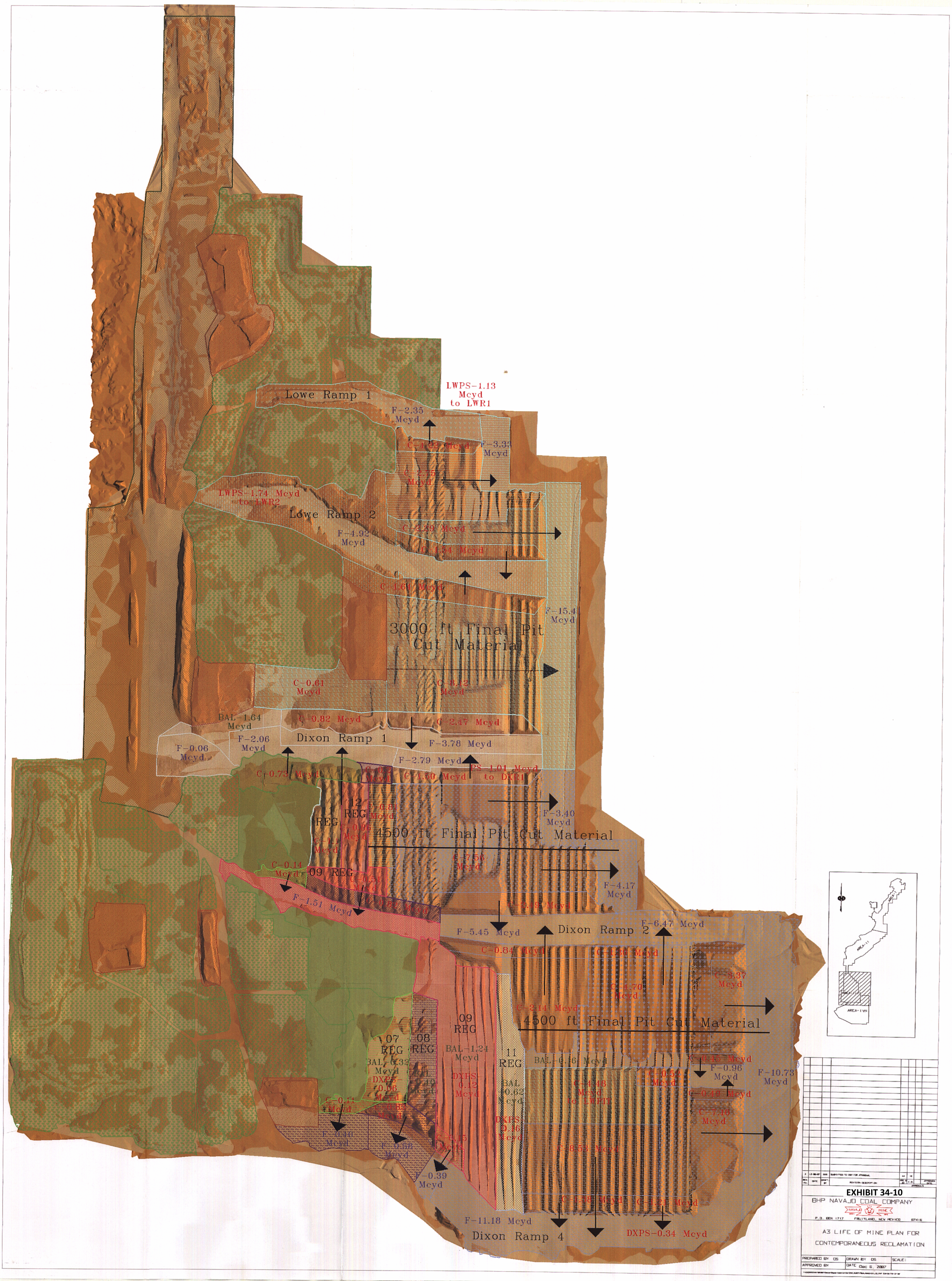
Phone: 505-598-4200
Fax: 505-568-3361

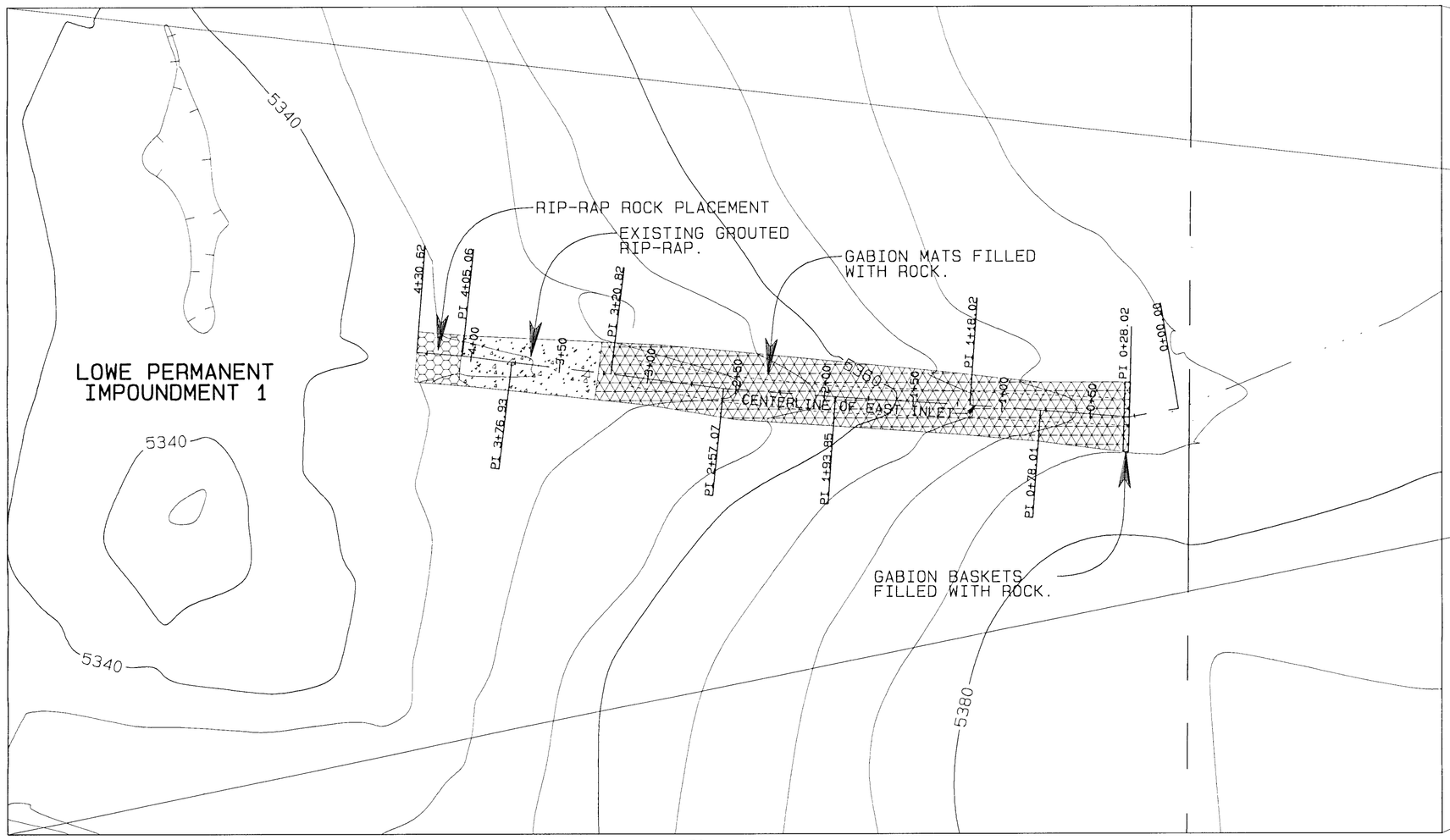
AREA-4N FINAL SURFACE CONFIGURATION

PREPARED BY PJF	DRAWN BY PJFOSTER	SCALE 1"= 500'
APPROVED BY LR	DATE 11-18-04	

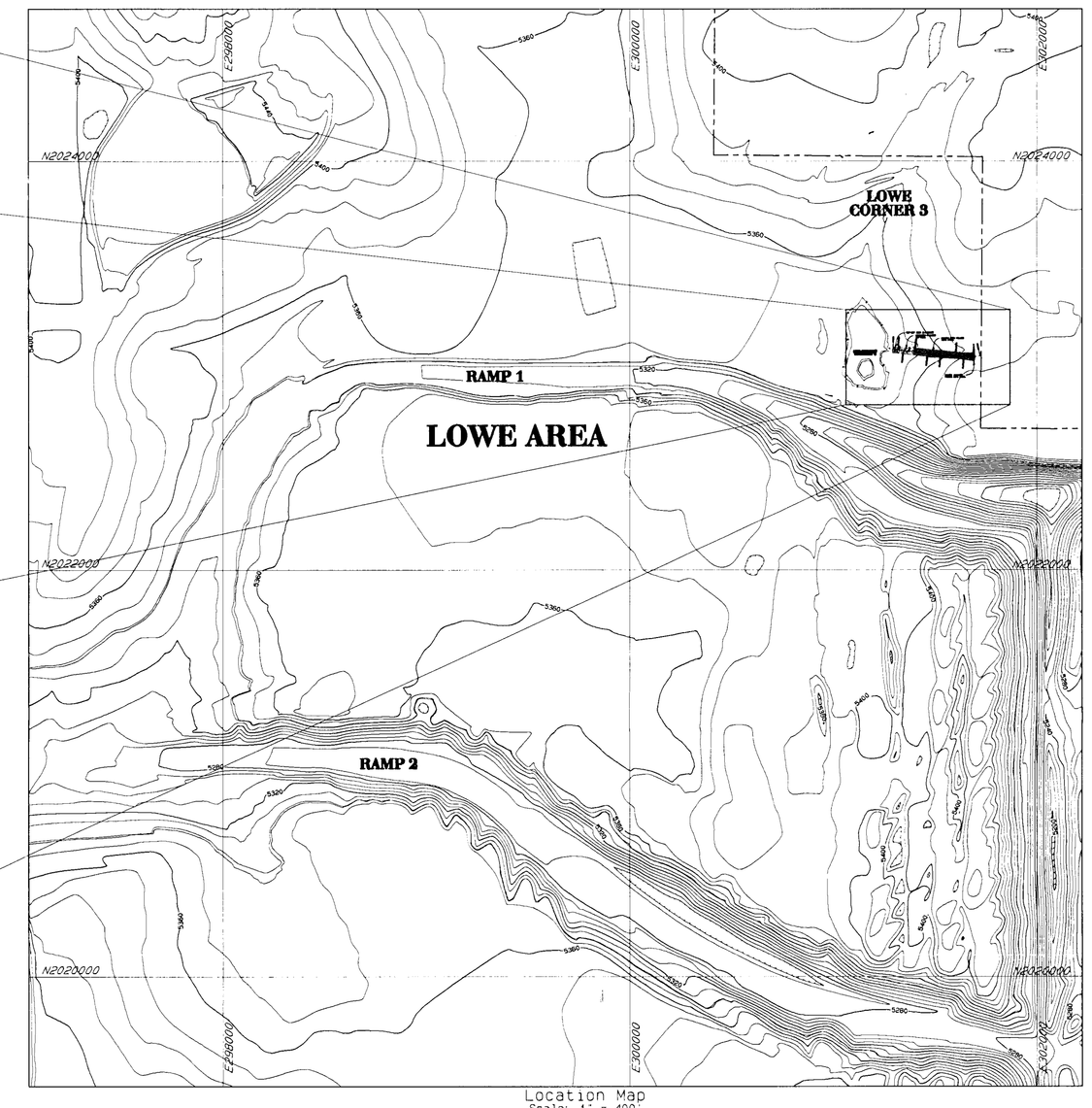
G:\Gis\Permit F\Ch 12\Exhibit 12-007_A3 AOC\OSM Subm-Feb-2011\EXH 12-7A_A4N_FSC.prs

Project Desc.: NEW AREA-III AOC/REVISED BY KGUNESC Path: G:\Gis\Permit F\Ch 12\Exhibit 12-007_A3 AOC\OSM Subm-Feb-2011\EXH 12-7A_A4N_FSC.prs
PJFoster \Plot time: Fri Feb 04 10:06:49 2011


Lowe Ramp 1
LWPS-1.13 Mcyd to LWR1
F-2.35 Mcyd
C-1.22 Mcyd
F-3.33 Mcyd
C-2.75 Mcyd
LWPS-1.74 Mcyd to LWR2
Lowe Ramp 2
F-4.92 Mcyd
C-2.29 Mcyd
C-1.34 Mcyd
C-1.64 Mcyd
F-15.4 Mcyd
3000 ft Final Pit Cut Material
C-0.61 Mcyd
C-8.12 Mcyd
BAL-1.64 Mcyd
C-0.82 Mcyd
C-2.47 Mcyd
F-2.06 Mcyd
Dixon Ramp 1
F-0.06 Mcyd
F-3.78 Mcyd
F-2.79 Mcyd
C-0.73 Mcyd
C-1.50 Mcyd
PS-1.01 Mcyd to DXR1
12 REG
11 REG
C-0.81 Mcyd
F-3.40 Mcyd
4500 ft Final Pit Cut Material
C-7.56 Mcyd
C-0.14 Mcyd
09 REG
F-4.17 Mcyd
F-1.51 Mcyd
C-2.19 Mcyd
F-5.45 Mcyd
Dixon Ramp 2
F-6.47 Mcyd
C-0.84 Mcyd
C-1.30 Mcyd
C-3.37 Mcyd
C-4.70 Mcyd
C-2.14 Mcyd
4500 ft Final Pit Cut Material
09 REG
07 REG
08 REG
BAL-1.24 Mcyd
11 REG
BAL-0.16 Mcyd
C-0.45 Mcyd
F-0.96 Mcyd
F-10.73 Mcyd
C-0.54 Mcyd
C-0.49 Mcyd
C-7.10 Mcyd
C-0.11 Mcyd
F-0.40 Mcyd
F-0.58 Mcyd
F-0.39 Mcyd
C-8.53 Mcyd
C-1.38 Mcyd
C-1.21 Mcyd
F-11.18 Mcyd
Dixon Ramp 4
DXPS-0.34 Mcyd
AREA-II
AREA-I VN
EXHIBIT 34-10
BHP NAVAJO COAL COMPANY
NAVAJO MINE
P.O. BOX 1717 FRUITLAND, NEW MEXICO 87416
A3 LIFE OF MINE PLAN FOR
CONTEMPORANEOUS RECLAMATION
PREPARED BY DS
DRAWN BY DS
SCALE:
APPROVED BY
DATE Dec 6, 2007



Plan
Scale: 1" = 50'



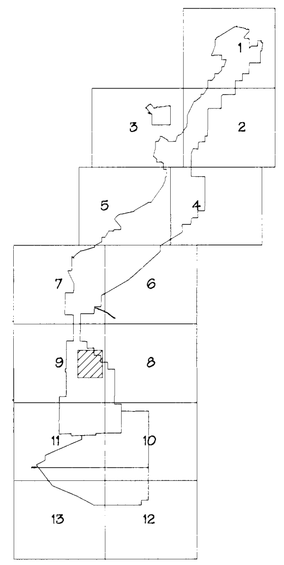
Location Map
Scale: 1" = 400'

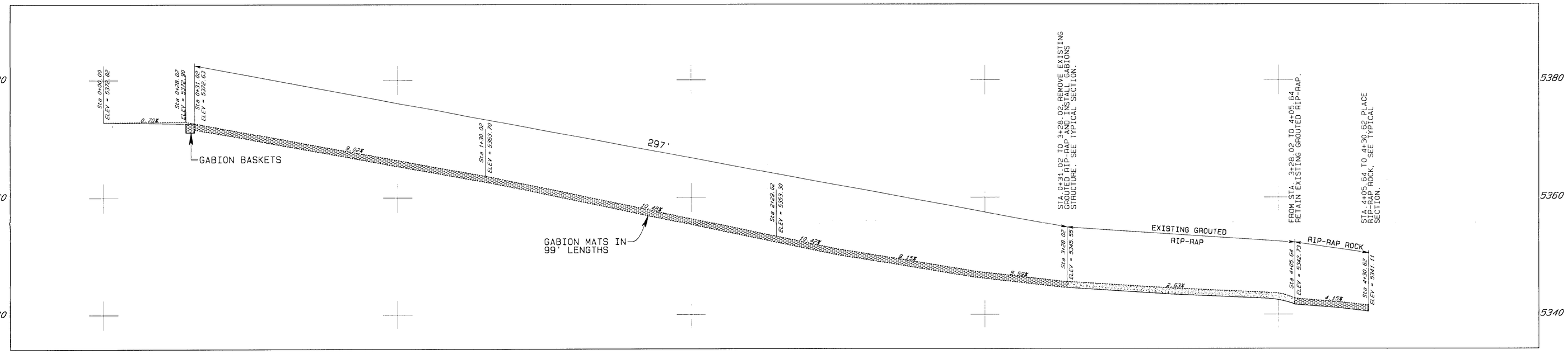
LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- POWERLINE
- x5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- LEASE BOUNDARY

NOTES

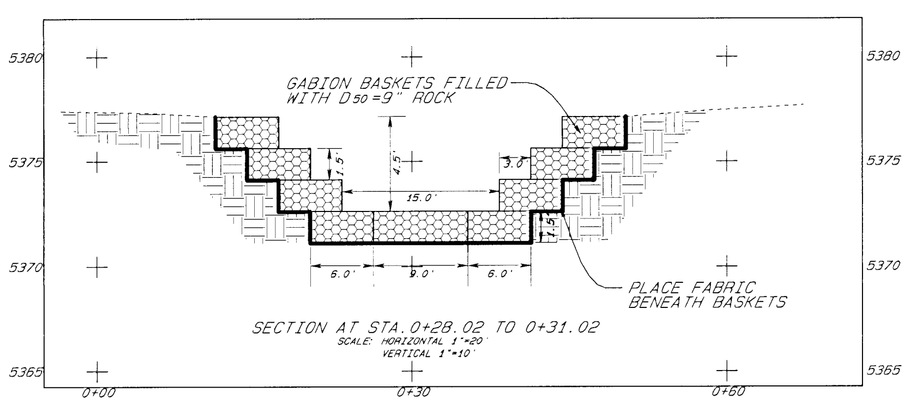
1. For design information refer to Appendix 12-F in the approved PAP.
2. Install Gabions per manufacture's procedures and recommendations.



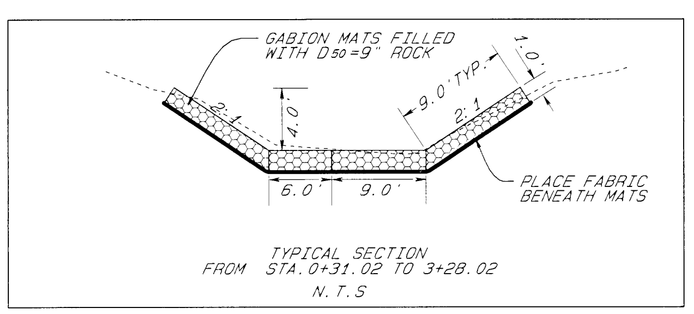


Centerline Profile
Horizontal: 1" = 20'
Vertical: 1" = 10'

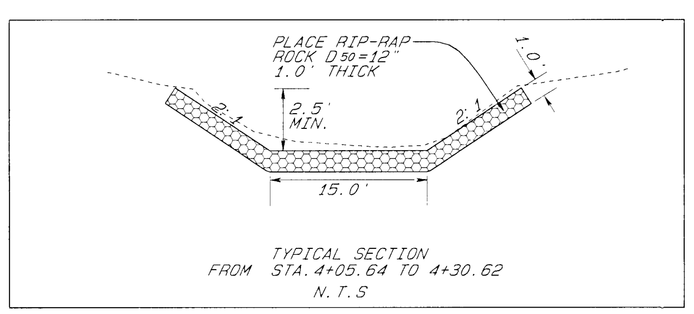
SCALE AS NOTED



SECTION AT STA. 0+28.02 TO 0+31.02
SCALE: HORIZONTAL 1"=20'
VERTICAL 1"=10'



TYPICAL SECTION
FROM STA. 0+31.02 TO 3+28.02
N.T.S



TYPICAL SECTION
FROM STA. 4+05.64 TO 4+30.62
N.T.S

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing has been reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 8800 REGISTERED PROFESSIONAL ENGINEER

12-18-03

DEC 2003 APPROVED

REV NO.	REV BY	DATE	DESCRIPTION
1			SUBMITTED TO OSM FOR APPROVAL
2			
4			
5			

PROJECT MANAGER: DH
ENGR. of RECORD: LH
REG. NO. 8800
SRVYR. of RECORD:
REG. NO.

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

ACCOUNT:
DATE: December 17, 2003
DESIGNED BY: HAZZIE
DRAWN BY: LH
CHECKED BY:
APPROVED BY: LH

PLAN, PROFILE AND SECTION

EXHIBIT 34-11
LOWE CORNER 3
EAST DROP STRUCTURE DESIGN

DRAWING

SHEET 1 OF 1

Appendix 34.A

Lowe Corner 3 East and North Drop Structures

Appendix 34.A

Lowe Corner 3 East and North Drop Structures

Due to reformatting of the Navajo Mine PAP, the following references in this appendix have been changed, deleted or renumbered:

NM-0003F Paper Reference	NM-0003F Electronic Permit
Appendix 11X	Appendix 41.L
Appendix 12F	Appendix 34.A
Exhibit 12-33	Exhibit 34-11
Exhibit 12-47	Exhibit 12-47 as built folder

Lowe Corner 3 East and North Drop Structure

The D50 riprap size required for the east drop structure is approximately 2.5 feet; the availability of this size material is very limited in the local area. Gabion mats will be utilized in lieu of a normal riprap lining. Computer software developed by Maccaferri Incorporated was used to design the gabions. The design flows were taken from Appendix 11-X "Lowe Arroyo Post-mining Hydrology & Sedimentology"; 25 year-6 hour storm event for stability design and 100 year-6 hour event storm for capacity design. The printouts for the design are attached. The plan, typical section, and profile are shown on Exhibit 12-33.

The north drop structure also requires large size riprap. The riprap placed in this structure was grouted with concrete to produce a more rigid structure that would withstand the high flow velocity. This structure will remain as is and monitored for stability in the future.

MACRA1 2002

Program released to: Leonard Raymond
Company: BHP Navajo Coal Company
Tel: 505-590-3268
EMail: leonard.r.raymond@bhpbilliton.com

Title: Lowe Reclamation
Description: Drop structure east of Lowe Premanent Imp.
25 yr-6 hr Storm

Folder: Lowe Corner 3 east DS 25yr6hr
Date: 12/16/03

Notice
Maccaferri is not responsible for the drawings and the calculations trasmitted, since they should be intended as general design outlines and advice,aiming only to the best use of the products.

Run n.1

Gradient [%]	0.50	Froude number	0.59
Discharge [ft3/s]	334.00	Cross section [ft2]	64.99
Water level [ft]	3.07	Wetted perimeter [ft]	28.75
Average velocity [ft/s]	5.14	Hydraulic radius [ft]	2.26

Stretch	Length [ft]	V [ft/s]	K	Vadm [ft/s]	Vb [ft/s]	Material	Veg	tau max [lb/ft2]	tau adm [lb/ft2]	GeoFil
3.0	10.06	3.42	1.00							
3.1	10.06			5.00	0.90	GabionMats 12"	N	0.73	8.95	Y
4.0	15.00	5.84	1.00							
4.1	15.00			5.00	0.90	GabionMats 12"	N	0.98	10.45	Y
5.0	10.06	3.42	1.00							
5.1	10.06			5.00	0.90	GabionMats 12"	N	0.73	8.95	Y

Run n.2

Gradient [%]	5.60	Froude number	1.77
Discharge [ft3/s]	334.00	Cross section [ft2]	28.68
Water level [ft]	1.58	Wetted perimeter [ft]	22.07
Average velocity [ft/s]	11.64	Hydraulic radius [ft]	1.30

Stretch	Length [ft]	V [ft/s]	K	Vadm [ft/s]	Vb [ft/s]	Material	Veg	tau max [lb/ft2]	tau adm [lb/ft2]	GeoFil
3.0	10.06	7.34	1.00							
3.1	10.06			5.00	3.01	GabionMats 12"	N	4.22	8.95	Y
4.0	15.00	12.55	1.00							
4.1	15.00			5.00	3.01	GabionMats 12"	N	5.63	10.45	Y
5.0	10.06	7.34	1.00							
5.1	10.06			5.00	3.01	GabionMats 12"	N	4.22	8.95	Y

Run n.3

Gradient [%]	10.50	Froude number	2.35
Discharge [ft3/s]	334.00	Cross section [ft2]	23.33
Water level [ft]	1.32	Wetted perimeter [ft]	20.91
Average velocity [ft/s]	14.32	Hydraulic radius [ft]	1.12

Stretch	Length [ft]	V [ft/s]	K	Vadm [ft/s]	Vb [ft/s]	Material	Veg	tau max [lb/ft2]	tau adm [lb/ft2]	GeoFil
3.0	10.06	8.93	1.00							
3.1	10.06			5.00	4.13	GabionMats 12"	N	6.63	8.95	Y
4.0	15.00	15.27	1.00							
4.1	15.00			5.00	4.13	GabionMats 12"	N	8.84	10.45	Y
5.0	10.06	8.93	1.00							
5.1	10.06			5.00	4.13	GabionMats 12"	N	6.63	8.95	Y

Materials used Description	Roughness	Allow. shear stress [lb/ft2]	Veg	Rock d50 [inch]	Thickness [ft]	Rockfill unit weight [lb/ft3]	Time [h]	C Shields
GabionMats 12"	0.0380	10.45	N	8.85	0.98	165.51		0.14

Where,

V= Maximum flow velocity
K= Correction factor for curvature
Vadm= Maximum allowable interface velocity beween the gabion structure and soil (erosive velocity of the soil)
Vb= Calculated interface velocity
Veg= Is vegetation established through the gabions (Y=yes or N=no)
tau max= Calculated maximum shear stress
tau adm= Maximum allowable shear stress
GeoFil= Is filter fabric used beneath the gabion (Y=yes or N=no)
C= Shields Coefficient

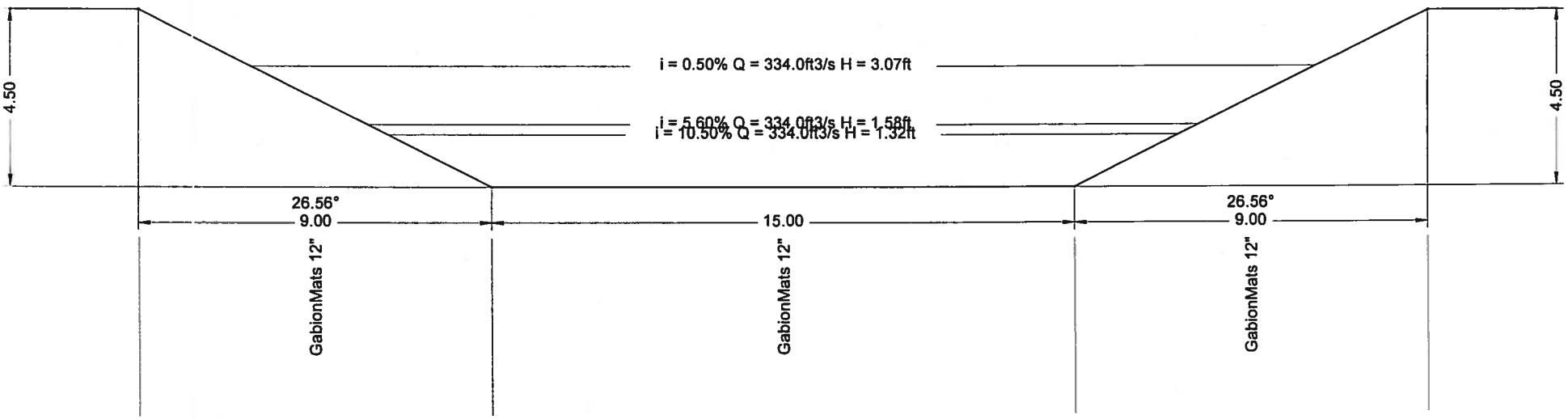
Macra1 2002

Maccaferri River Analysis
Bank Protections

Title: Lowe Reclamation
Description: Drop structure east of Lowe Premanent Imp.
25 yr-6 hr Storm

Folder: Lowe Corner 3 east DS 25yr6hr
Date: 12/16/2003

Program released to:Leonard Raymond
BHP Navajo Coal Company
505-590-3268
leonard.r.raymond@bhpbilliton.com



MACRA1 2002

Program released to: Leonard Raymond
Company: BHP Navajo Coal Company
Tel: 505-590-3268
EMail: leonard.r.raymond@bhpbilliton.com

Title: Lowe Reclamation
Description: Drop structure east of Lowe Premanent Imp.
100 yr-6 hr Storm

Folder: Lowe Corner 3 east DS 100yr6hr
Date: 12/16/03

Notice
Maccaferri is not responsible for the drawings and the calculations trasmitted, since they should be intended as general design outlines and advice,aiming only to the best use of the products.

Run n.1

Gradient [%]	0.50	Froude number	0.60
Discharge [ft3/s]	482.00	Cross section [ft2]	83.98
Water level [ft]	3.74	Wetted perimeter [ft]	31.71
Average velocity [ft/s]	5.74	Hydraulic radius [ft]	2.65

Stretch	Length [ft]	V [ft/s]	K	Vadm [ft/s]	Vb [ft/s]	Material	Veg	tau max [lb/ft2]	tau adm [lb/ft2]	GeoFil
3.0	10.06	3.89	1.00							
3.1	10.06			5.00	0.90	GabionMats 12"	N	0.89	8.94514	Y
4.0	15.00	6.66	1.00							
4.1	15.00			5.00	0.90	GabionMats 12"	N	1.19	10.445	Y
5.0	10.06	3.89	1.00							
5.1	10.06			5.00	0.90	GabionMats 12"	N	0.89	8.94514	Y

Run n.2

Gradient [%]	5.60	Froude number	1.83
Discharge [ft3/s]	482.00	Cross section [ft2]	36.62
Water level [ft]	1.94	Wetted perimeter [ft]	23.67
Average velocity [ft/s]	13.16	Hydraulic radius [ft]	1.55

Stretch	Length [ft]	V [ft/s]	K	Vadm [ft/s]	Vb [ft/s]	Material	Veg	tau max [lb/ft2]	tau adm [lb/ft2]	GeoFil
3.0	10.06	8.42	1.00							
3.1	10.06			5.00	3.01	GabionMats 12"	N	5.19	8.94514	Y
4.0	15.00	14.39	1.00							
4.1	15.00			5.00	3.01	GabionMats 12"	N	6.91	10.445	Y
5.0	10.06	8.42	1.00							
5.1	10.06			5.00	3.01	GabionMats 12"	N	5.19	8.94514	Y

Run n.3

Gradient [%]	10.50	Froude number	2.43
Discharge [ft3/s]	482.00	Cross section [ft2]	29.70
Water level [ft]	1.63	Wetted perimeter [ft]	22.28
Average velocity [ft/s]	16.23	Hydraulic radius [ft]	1.33

Stretch	Length [ft]	V [ft/s]	K	Vadm [ft/s]	Vb [ft/s]	Material	Veg	tau max [lb/ft2]	tau adm [lb/ft2]	GeoFil
3.0	10.06	10.25	1.00							
3.1	10.06			5.00	4.13	GabionMats 12"	N	8.16	8.94514	Y
4.0	15.00	17.53	1.00							
4.1	15.00			5.00	4.13	GabionMats 12"	N	10.87	10.445	Y
5.0	10.06	10.25	1.00							
5.1	10.06			5.00	4.13	GabionMats 12"	N	8.16	8.94514	Y

Materials used Description	Roughness	Allow. shear stress [lb/ft2]	Veg	Rock d50 [inch]	Thickness [ft]	Rockfill unit weight [lb/ft3]	Time [h]	C Shields
GabionMats 12"	0.0380	10.45	N	8.85	0.98	165.51		0.14

Where,

V= Maximum flow velocity
K= Correction factor for curvature
Vadm= Maximum allowable interface velocity beween the gabion structure and soil (erosive velocity of the soil)
Vb= Calculated interface velocity
Veg= Is vegetation established through the gabions (Y=yes or N=no)
tau max= Calculated maximum shear stress
tau adm= Maximum allowable shear stress
GeoFil= Is filter fabric used beneath the gabion (Y=yes or N=no)
C= Shields Coefficient

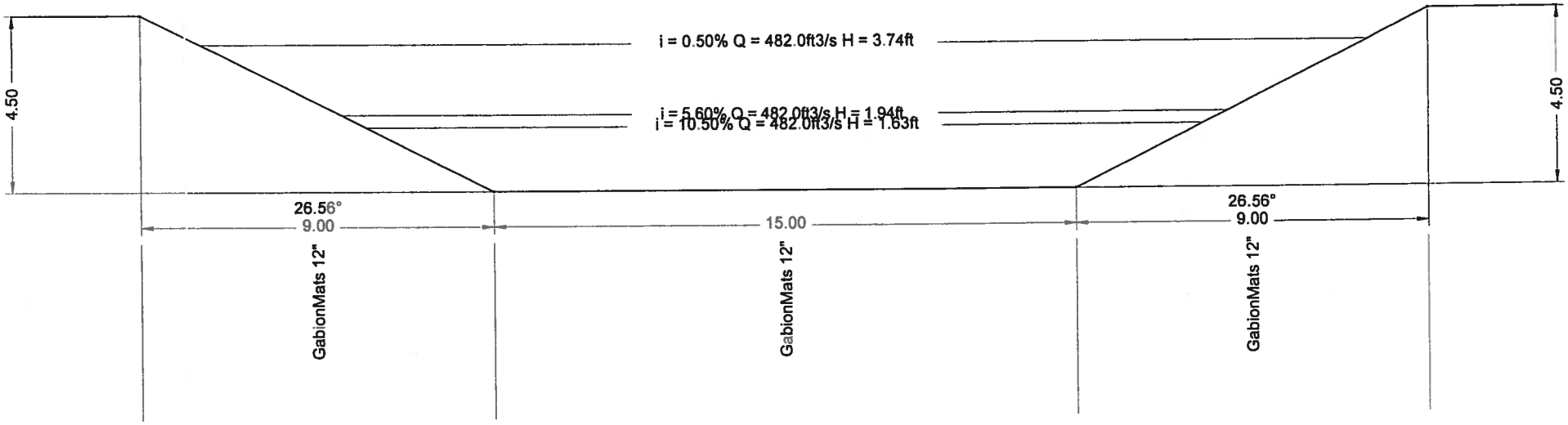
Macra1 2002

Maccaferri River Analysis
Bank Protections

Title: Lowe Reclamation
Description: Drop structure east of Lowe Premanent Imp.
100 yr-6 hr Storm

Folder: Lowe Corner 3 east DS 100yr6hr
Date: 12/16/2003

Program released to:Leonard Raymond
BHP Navajo Coal Company
505-590-3268
leonard.r.raymond@bhpbilliton.com



Lowe Corner 3 North Downdrain Sta 0+26 to 3+85, Stability Design, 25yr-6hr Storm Event (As-built)

Material: Grouted Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
12.00	3.0:1	3.0:1	12.1	0.0250	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	146.00 cfs	
Depth:	0.70 ft	1.70 ft
Top Width:	16.20 ft	22.20 ft
Velocity:	14.77 fps	
X-Section Area:	9.88 sq ft	
Hydraulic Radius:	0.601	
Froude Number:	3.33	

Lowe Corner 3 North Downdrain Sta 0+26 to 3+85, Capacity Design, 100yr-6hr Storm Event (As-built)

Material: Grouted Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
12.00	3.0:1	3.0:1	2.3	0.0250	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	212.10 cfs	
Depth:	1.38 ft	2.38 ft
Top Width:	20.28 ft	26.28 ft
Velocity:	9.52 fps	
X-Section Area:	22.27 sq ft	
Hydraulic Radius:	1.074	
Froude Number:	1.60	

Lowe Corner 3 North Downdrain Sta 3+85 to 5+16, Stability Design, 25yr-6hr Storm Event (Asbuilt)

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
10.00	5.0:1	5.0:1	2.4	1.00		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	146.00 cfs	
Depth:	0.97 ft	1.97 ft
Top Width:	19.72 ft	29.72 ft
Velocity*:		
X-Section Area:	14.44 sq ft	
Hydraulic Radius:	0.725	
Froude Number*:		
Manning's n*:		
Dmin:	4.00 in	
D50:	12.00 in	
Dmax:	15.00 in	

Velocity and Manning's n calculations may not apply for this method.

Lowe Corner 3 North Downdrain Sta 3+85 to 5+16, Capacity Design, 100yr-6hr Storm Event (Asbuilt)

Material: Ripap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	3.0:1	3.0:1	2.4	0.0400	1.00			10.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	212.10 cfs	
Depth:	1.91 ft	2.91 ft
Top Width:	21.44 ft	27.44 ft
Velocity:	7.08 fps	
X-Section Area:	29.96 sq ft	
Hydraulic Radius:	1.359	
Froude Number:	1.06	

West Lowe Drainage Control Structure

West Lowe Drainage Control Structures

The West Lowe drainage control structures were constructed in 1990. These structures consist of a Gabion drop structure, a rip-rapped channel and rip-rapped check dams. Refer to Exhibit 12-47 for as-built plan, profile and section details.

With a watershed of 49 Acres, this channel is an Ephemeral drainage channel and the minimum design storm frequency is 10 year-6 hour (Table A, Reclamation Surface Stabilization handbook). Computer software developed by Maccaferri Incorporated was used to check the typical configuration and safety factor of the as-built gabion structure. Refer to Appendix 12-F for the Sedcad and Maccaferri results.

Existing West Lowe Gabion Structure, location NW of Lowe Coal Stockpile.

Inflow information upstream of West Lowe Gabion Structure.

RYazzie

BHP Billiton
Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: 505 598 2007

General Information

Storm Information:

Storm Type:	Type II 70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	West Lowe Gabion

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	45.100	45.100	23.34	1.37

Structure Detail:

Structure #1 (Null)

West Lowe Gabion

Subwatershed Hydrology Detail:

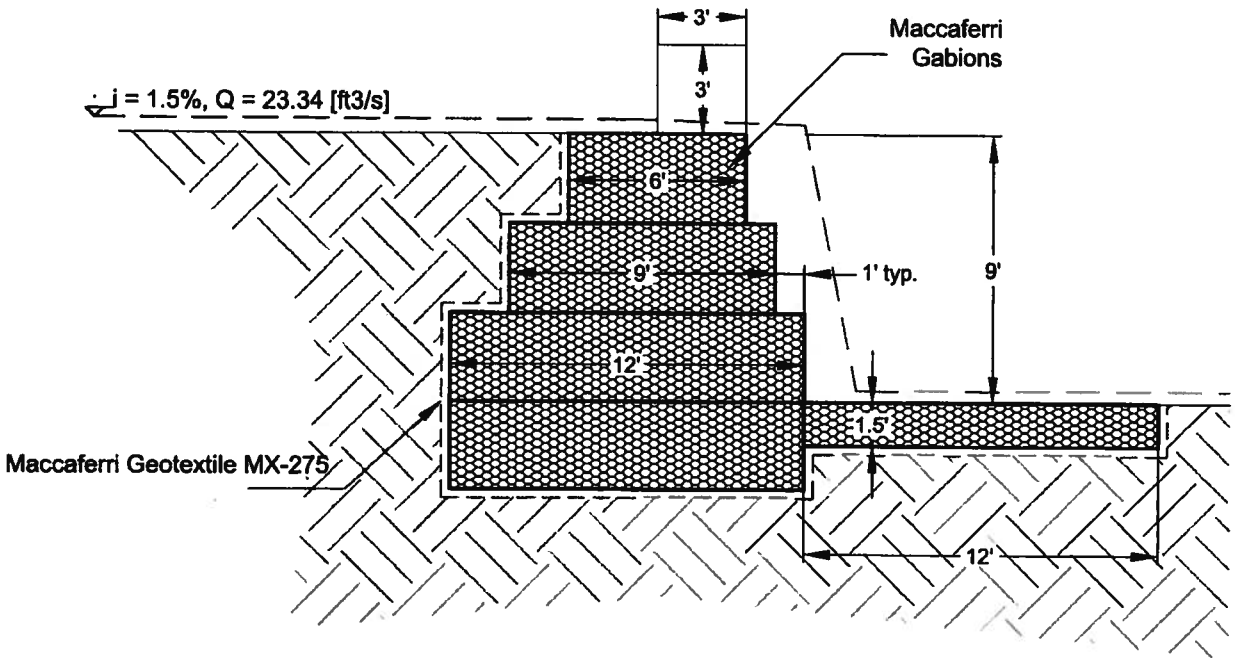
Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	45.100	0.207	0.000	0.000	86.000	M	23.34	1.37
	S	**45.100**						**23.34**	**1.37**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.69	5.70	212.00	1.630	0.036
		8. Large gullies, diversions, and low flowing streams	2.14	58.00	2,711.08	4.380	0.171
#1	**1**	**Time of Concentration:**					**0.207**

SECTION VIEW

NOTES:
1. Gabion Mesh to ASTM A975.
2. Gabion Fill to ASTM D6711:
   - 2.1. Rock Size 4" to 8", D50 = 6"
   - 2.1. Rock Unit Weight 157 pcf min.
   - 2.2. Voids 30% max.
3. Maccaferri is not responsible for the Bearing Capacity of the Soil.



1 **9' TYPICAL CROSS SECTION**

Maccaferri Gabion Weir

Maccaferri Inc. assumes no responsibility for the drawings and calculations it provides, as they must be intended as a general indication to suggest the proper use of its products.

Rev:	Issue / Revision:	Drawn:	App:	Date:

MACCAFERRI

Maccaferri, Inc.
10303 Governor Lane Blvd.
Williamsport, MD 21795-3116 USA
Ph. (301) 223-6910 Fax (301) 223-6134

Designed: EG	Date: 02/28/08	Project Title: BHP NAVAJO	Title: Typical Cross Section Maccaferri Gabion Weir
Drawn: EG	Date: 02/28/08	Client: Contractor Limited	Scale: NTS / Project No: —
Checked: LV	Date: 02/28/08	NOT FOR CONSTRUCTION	Rev: 0 / Units: Feet / Drawing No: 1 / 1

Macraz

Program released to:
Company:
Title: BHP Navajo
Description:

Folder:
Date: 2/29/2008

Tel:
EMail:

Notice
Maccaferri is not responsible for the drawings and the calculations trasmitted, since they should be intended as general design outlines and advice,aiming only to the best use of the products.

Run n.1

Design discharge	Q [ft3/s]	23.34
River bed gradient	i [%]	1.50
Roughness coefficient	n	0.033
Soil Granulometry in the pool	dt [inch]	10.00
Channel Width	L3 [ft]	12.00
Bank top elevation	fp [ft]	15.00
Slope of left bank	Pl [deg]	33.00
Slope of right bank	Pr [deg]	23.00

Soil unit weight	[lb/ft3]	113.97
Soil friction angle	[deg]	32.50
Soil type		Fine Sand
Gabion porosity	n	0.30
Soil-weir friction angle	[deg]	10.00
Soil-foundation friction coefficient	f	0.70
Underpressure influence	Sot (%)	50.00
Bligh coefficient	Cb	4.00

Weir Data - Weir with Vertical Drop

Crest elevation	fg [ft]	9.00
Crest width	Lg [ft]	12.00
Slope of crest wings	Pg [deg]	33.00
Total weir height	H [ft]	12.00

Summary of Hydraulic Results

Water elevation on crest	zg [ft]	9.48
Water elevation downstream	z3 [ft]	0.53
Backwater elevation	z0 [ft]	9.71
Scour depth downstream	fb [ft]	-4.65
Scour location	X [ft]	3.02
Water elevation under nappe flow	zv [ft]	-3.13
Water elevation at the nappe toe	z1 [ft]	-4.54

Summary of Static Results

Normal force on foundation	N [klb]	16771.63
Shear force on foundation	T [klb]	6391.22
Restoring moment	Ms [klb*ft]	139769.91
Overturning moment	Mo [klb*ft]	50103.12
FS against sliding	**FSsl**	1.84
FS against overtuning	**FSov**	2.79
FS against seepage	**FSseep**	1.06
Normal stress on downstream edge	Sigma1 [klb/ft2]	2081.32
Normal stress on upstream edge	Sigma2 [klb/ft2]	154.90

Static Results Details

Active thrust coefficient	Ka	0.30
Active thrust of upstream backfill soil	Pam [klb]	1489.00
Horizontal component	Pamh [klb]	1466.40
Lever arm of horizontal component	bPamh [ft]	4.00
Moment of horizontal component	MPamh [klb*ft]	5865.61
Vertical component	Pamv [klb]	258.43
Lever arm of vertical component	bPamv [ft]	15.00
Moment of vertical component	MPamv [klb*ft]	3876.49
downstream soil active thrust	Pav [klb]	93.06
Upstream hydrostatic pressure	Pwm [klb]	5018.39
Lever arm of upstream hydrostatic pressure	bPwm [ft]	4.21
Moment of upstream hydrostatic pressure	MPwm [klb*ft]	21130.80
Downstream hydrostatic pressure	Pwv [klb]	0.52

Lever arm of downstream hydrostatic pressure	bPwv [ft]	-0.04
Moment of downstream hydrostatic pressure	MPwv [klb*ft]	-0.02
Lever arm of Weir unit weight	bP [ft]	5.92
Moment of Weir unit weight	MP [klb*ft]	89795.04
Soil unit weight	Pt [klb]	3707.82
Lever arm of Soil unit weight	bPt [ft]	11.50
Moment of Soil unit weight	MPt [klb*ft]	42639.97
Water unit weight	Pw [klb]	448.72
Lever arm of Water unit weight	bPw [ft]	7.50
Moment of Water unit weight	MPw [klb*ft]	3365.37
Uplift pressure	Vw [klb]	2805.73
Lever arm of Uplift pressure	bVw [ft]	8.24
Moment of Uplift pressure	MVw [klb*ft]	23106.70

West Lowe existing Rip-rapped Structure

Location NW of Lowe Coal Stockpile and downstream of existing Gabion Structure.

RYazzie

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	

#1
Channel

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	49.000	49.000	24.95	1.49

Structure Detail:

Structure #1 (Riprap Channel)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
13.00	2.0:1	2.0:1	9.8	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Depth:	0.20 ft	1.20 ft
Top Width:	13.79 ft	17.79 ft
Velocity*:		
X-Section Area:	2.63 sq ft	
Hydraulic Radius:	0.189	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	49.000	0.217	0.000	0.000	86.000	M	24.95	1.49
	S	**49.000**						**24.95**	**1.49**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.69	5.70	212.00	1.630	0.036
		8. Large gullies, diversions, and low flowing streams	2.41	73.55	3,047.00	4.660	0.181
#1	**1**	**Time of Concentration:**					**0.217**

Lowe Reclamation
Lowe Boxcut Channel

Lowe Boxcut Channel Southwest of Explosive yard. Design is for a 10yr-6hr storm event.

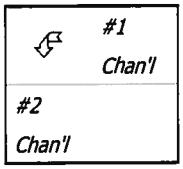
Shawn Smith

Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#2	0.000	0.000	
Channel	#2	==>	End	0.000	0.000	Riprap Section



Structure Detail:

Structure #1 (Erodible Channel)

Trapezoidal Erodible Channel Inputs:

Material: Shales and hardpans

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
9.00	5.0:1	4.0:1	5.0	0.0250				6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	16.89 cfs	
Depth:	0.30 ft	
Top Width:	11.69 ft	
Velocity:	5.47 fps	
X-Section Area:	3.09 sq ft	
Hydraulic Radius:	0.263 ft	
Froude Number:	1.87	

Copyright 1998 - 2007 Pamela L Schwab

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.000 inches

Structure Detail:

Structure #2 (Riprap Channel)

Riprap Section

Trapezoidal Riprap Channel Inputs:

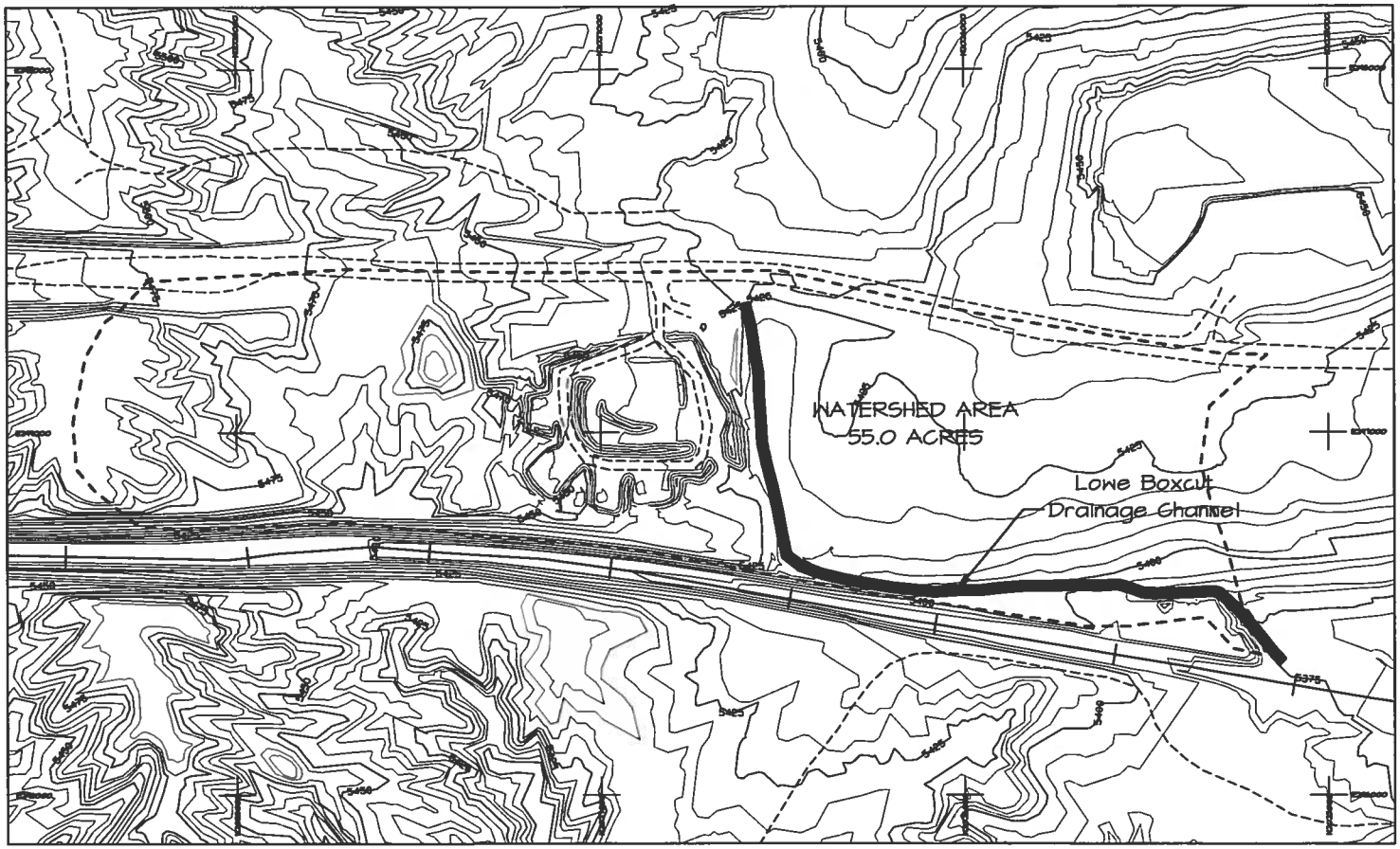
Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	3.0:1	7.0:1	9.5			

Riprap Channel Results:

PADER Method - Steep Slope Design

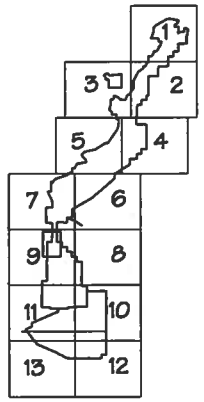
	w/o Freeboard	w/ Freeboard
Design Discharge:	44.79 cfs	
Depth:	0.84 ft	
Top Width:	12.37 ft	
Velocity:	6.53 fps	
X-Section Area:	6.85 sq ft	
Hydraulic Radius:	0.547 ft	
Froude Number:	1.55	
Manning's n:	0.0470	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	



PLAN 1"=500'

GEND

- PAVED ROAD
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- RAILROAD
- TREES
- POWERLINE
- x5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- WATERSHED



CERTIFICATION STATEMENT

I, Ron C. VAN VALKENBURG, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

Ron C. VAN VALKENBURG
NEW MEXICO
9263
LICENSED PROFESSIONAL ENGINEER

REV. NO.	DATE	REVISED BY	REVISION DESCRIPTION	DRN.	C.S.	P.E.	P.S.	PROJ. ENG.
A	1-15-09	RY	SUBMITTEDTO OSM FOR APPROVAL	SS	SS	FG	RCV	BH

NAVAJO COAL COMPANY

NAVAJO MINE

P.O. BOX 133 FRUITLAND, NEW MEXICO 87416

LOWE RECLAMATION
LOWE BOXCUT CHANNEL
LOCATION AND WATERSHED AREAS

PREPARED BY RY	DRAWN BY RY	SCALE 1"=500'
APPROVED BY RCV	DATE JAN. 15, 2009	

DWG LOC C:\Keys\Terrasoft\Lowe\Lowe_boxcut_drain_pitch.pro