Stratigraphic Sequence in Drilling Data Fence Lake Area

Gretchen H. Roybal and Frank W. Campbell

Open File 145
New Mexico Bureau of Mines and Mineral Resources

TABLE OF CONTENTS

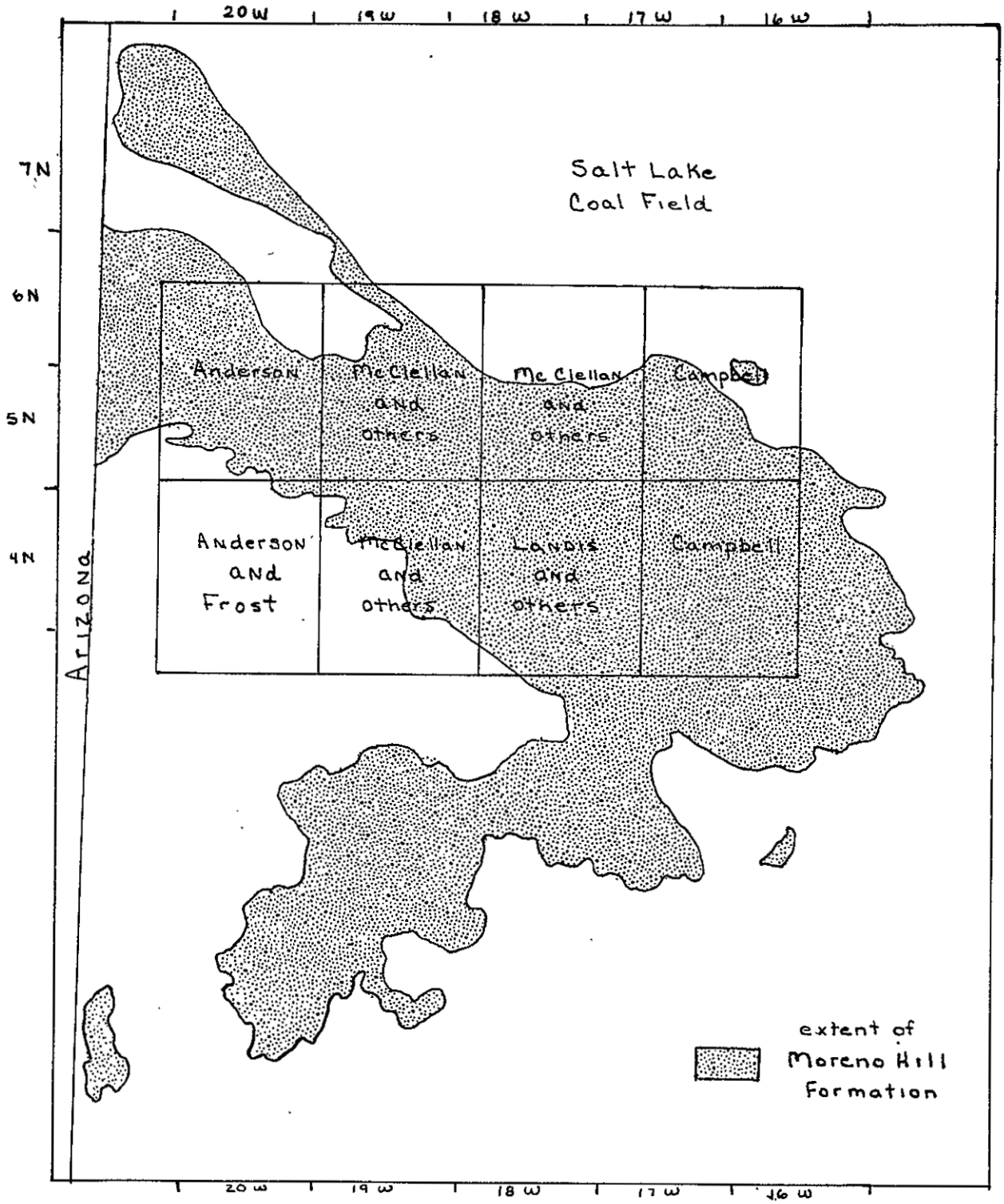
INTRODUCTION

The area of study in the Salt Lake coal field covers portions of Townships 3, 4, 5, 6, 7 North and Ranges 15, 16, 17, 18, 19 West. Cretaceous rocks overlie an area of approximately 1000 sq miles and are exposed over 800 square miles, with coal bearing strata present over an area of approximately 400 sq miles. Figure 1 shows the general location of the Salt Lake coal field and its geology. Work by McClellan et al (1981) have placed the coal-bearing Cretaceous rocks in the Moreno Hill Formation. The oldest unit in the area is the Triassic Chinle Formation, while the youngest is a basalt flow dated at 1.3+/-.23 my (Laughlin). Figure 2 is a generalized composite geologic column for the Salt Lake coal field, based on both outcrop and subsurface data.

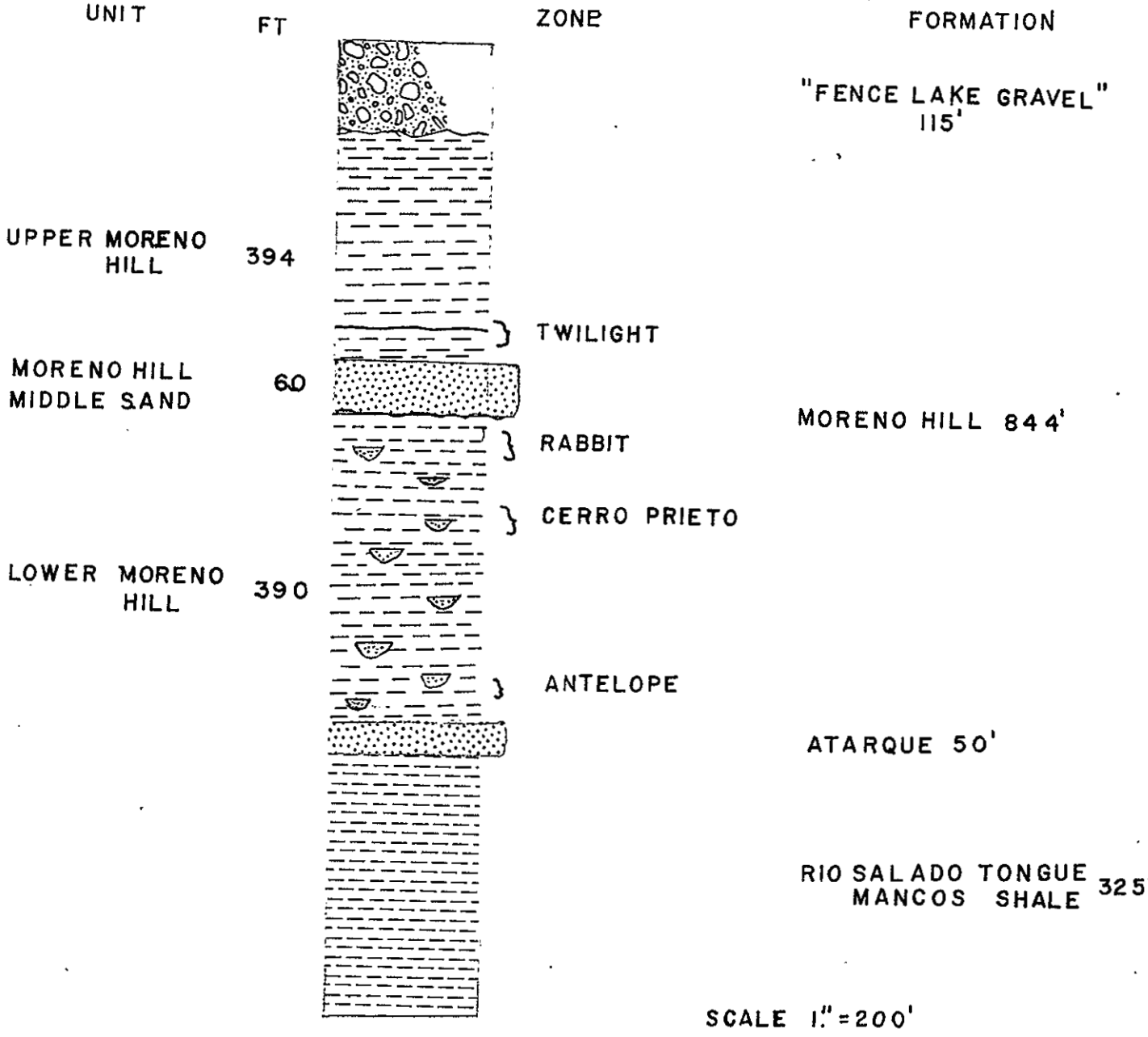
The surface of the central portion of this field, an area comprising eight quadrangles(see fig. 1), has been mapped jointly by the U.S.G.S. Coal Resources branch and the New Mexico Bureau of Mines and Mineral Resources. In addition to this surface data, geophysical logs from 62 drill holes were obtained. Thirty-three of these logs were from holes drilled by the New Mexico Bur. Mines, the remaining 29 logs have been obtained from private companies. Drill hole summary sheets for these holes are given in Appendix I. The purpose of this report is to evaluate these logs to determine the regional structure, coal resources, and trend of the coals of the Salt Lake coal field.

The majority of the holes drilled by the U.S.G.S. and the NMBM&MR (25) were drilled on two quadrangles, Cerro Prieto and The

TABLE AND FIGURES



Authorship Map of Fence Lake 1:50000
Geologic Map



GENERALIZED GEOLOGIC COLUMN OF SALT LAKE COAL FIELD
EMPHASIZING COAL ZONES

FIG. 2

Dyke. The remaining eight holes were drilled on three quadrangles, Rincon Hondo, Fence Lake and Fence Lake S.W. All holes were logged geophysically, for both coal and stratigraphy. The logs run were natural gamma, density, resistivity, resistance, caliper, SP, and neutron. Cuttings for all holes drilled by the NMBM&MR were collected at five-foot intervals. The coals were picked on the basis of low density (less than 1.8 g/cc), low gamma, high resistivity, and high neutron.

Drilling penetrated both Tertiary and Cretaceous strata. The units penetrated are: Fence Lake Gravel (Tertiary); Moreno Hill Formation; Atarque Formation; and Rio Salado Tongue of the Mancos Shale. These units have characteristic log signatures and are readily recognized in subsurface.

The youngest unit penetrated, other than Quaternary alluvium is the Fence Lake Gravel (Tflg). This unit consists of large basaltic boulders (up to 2 ft in diameter), and smaller clasts of rhyolite, chert, petrified wood, and Cretaceous sandstone fragments, in a calcareous sandstone matrix. None of these constituents of the Fence Lake Gravels are high in potassium, uranium, or thorium, therefore have a relatively low natural gamma reading (60 api). The density log shows large extremes (1.2-2.8g/cc) for two reasons, the variation in the densities of the different components, and the porous nature of the sandy matrix. The compactness of the basalt and the rather unconsolidated nature of the matrix results in large fluctuations of the caliper log, which to a degree are reflected in the bulk

density log. The resistance is high, as would be expected from a calcareous conglomerate. The Fence Lake Gravels are best shown in drill holes 519-21-1 and 517-31-1. These two holes penetrated 92 ft and 46 ft of Fence Lake Gravels, respectively. These are the only holes that penetrated the Fence Lake Gravels in which water was present to the surface thus making the electrical logs valid within the interval in question. Five other holes (418-11-1, 519-19-1, 518-31-1, 518-29-1, 518-33-1) penetrated the Fence Lake Gravels, however, no water was present for logging, so the electrical logs were not run. The thickest section of Fence Lake Gravel penetrated was 92 ft in hole 519-21-1, while the thinnest section was 25 ft in hole 518-31-1. No trend in grain size or readily subdividable units were observed from the logs.

The Fence Lake Gravel overlies the Cretaceous Moreno Hill Formation. This unit is a series of fluvial channels, crevasse splays, and floodplain deposits. The Moreno Hill Formation can be divided into three units, based on both outcrop and subsurface data. The upper unit consists of mudstones and claystones, with a few channel sands. The middle unit is a sandstone sequence, consisting of coarse-grained sand, with no matrix. The lower Moreno Hill Formation is dominated by fluvial channels, with crevasse splays, dark-gray mudstones/claystones, and coals. The lower sands have a silt and clay matrix, with a grain size less than that of the middle sand. Each of these units will be dealt with separately.

The upper Moreno Hill (Kumh) contains very few channel sandstones, and is dominated by mudstones and claystones, with some carbonaceous shales and a few thin coals. Holes 517-31-1, 518-28-1, 518-31-1, 518-29-1, 518-33-1 penetrate the upper Moreno Hill Formation. Of the drill data listed in appendix I the thickest section of upper Moreno Hill is found in 416-27-1, 250 ft, and the thinnest section is in 518-33-1, 30 ft. The Upper Moreno Hill Formation exhibits several characteristic log signatures. The resistivity is generally very low, 6-20 ohm/m, indicating a dominance of fine-grained materials (shales, mudstones, and claystones). The gamma for the shale sequence is approximately 100 api. The density log reading, 2.3 g/cc should be higher than that found in the lower unit due to the lack of organic material. Due to the effects of hole diameter on the density log the density reading is not as accurate as the gamma log, which is not as sensitive to the hole diameter.

The middle sandstone of the Moreno Hill Formation (Kmmh) is penetrated in several different holes. The middle sand is present in all of the cross sections. The holes shown in cross section that penetrated this sand are 517-31-1, 518-31-1, 518-29-1, 518-33-1. A contour based on the top of the Moreno Hill Middle sand uses both subsurface and outcrop data. In outcrop this sandstone is approximately 60 ft thick, contains no silt or clay matrix, with a grain-supported fabric. The sand grains are dominantly coarse grained quartz with up to 15% feldspar clasts. This unit is trough and planar cross-bedded. The thickest section

of middle sandstone is in 519-30-1 , 60 ft, and the thinnest is in 416-3-1, 13 ft, (see in appendix I).

The geophysical log signatures of the Moreno Hill middle sand unit are distinctive and readily identifiable. The resistivity pattern for the middle sand is pronounced, ranging from 530 to 250 ohm/m, being higher than other sandstone units in either the Upper or lower Moreno Hill. The density log averages 2.1 g/cc, which is indicative of a clean sand having a porosity of approximately 20%. Gamma logs show low values in the 60 api range due to a lack of potassium bearing minerals, specifically clays in the matrix. There is no general fining upward of the entire unit, as would be expected from a single channel deposit. The upper and lower contacts show sharp changes, which are reflected in both the resistivity and gamma readings. The overall resistivity pattern is blocky, with small units showing a fining upward of individual channels. Although individual Channels cannot be traced from hole to hole, the sequence can be traced indicating a sheet-like structure. There are no systematic changes in the gamma value within the middle sand sequence. This unit is probably a braided stream deposit. This sheet-like geometry of the middle sand is not of uniform thickness throughout the study area. The western portion of the study area is where this sandstone sequence is thinnest, being approximatey 25 ft thick, to the east this unit reaches a thickness of 60 ft.

The contour map of the Moreno Hill middle sand (see appendix II) is based on the upper contact elevation of the formation from

subsurface and outcrop data. These points show a general dip to the southeast. The higher elevations are to the north and the northwest with the lowest elevations to the southeast. There is an area of constant elevation between 517-31-1 and 418-11-1 which continues to the east/southeast with a small flexure present in the southeastern portion of the study area. In this region there is a sudden increase in elevation occurring to the northwest of hole 416-7-2 from an elevation of 6800 to 7050 ft. The trend of the middle sand agrees with the southeastly dip of the outcrops seen in this area.

The lower Moreno Hill (Klmh) sequence is characterized by fluvial sandstones with siltstones, mudstones, claystones, and coals. The holes that penetrate this sequence and are shown in cross section are; 518-29-1a, 518-29-1, 518-33-1, 517-34-1, 516-31-1, 518-11-1, 517-7-1, 518-3-1, 517-1-2, 518-28-1, 518-17-1, 518-1-1, 517-9-1, 517-26-1, 517-24-1, 517-25-1, 416-7-1, 416-22-1, 417-3-1, 417-14-1, 417-23-1. The lower Moreno Hill is thickest in 517-7-1 (390 ft) and thinnest in 518-6-1 (17 ft). In cross-section B-B', 490 ft of lower Moreno Hill sediments are indicated in the area between the holes 516-31-1 and 416-7-2. This unit thins to the west, while generally thickening to the east. The sands present in the lower Moreno Hill sequence have a clay and silt matrix, that can amount to as much as 15%, with the grains being matrix supported. These sands have a sharp basal contact as indicated by a sudden increase in the resistivity log in passing into the sand body. The decreasing resistivity from

the base up, is indicative of a channel sandstone. The gamma indicates a greater silt content at the top of the channel with 60 api at the base, increasing to 80 api gamma reading at the top, as would be expected in a channel deposit. Individual channels are not traceable from hole to hole, but are present in nearly all holes that penetrate the lower Moreno Hill formation, indicating a discontinuous lateral distribution. This type of sandstone body geometry is suggestive of a meandering stream deposit. Crevasse splays are also recognizable in this sequence. The resistivity patterns have sharp contacts at both the upper and lower contacts, indicating an abrupt change in grain size. A typical resistivity in a crevasse splay is an abrupt change from a reading of 23 ohms/m for the overlying or underlying shales to 135 ohms/m in the splay deposit. The gamma readings for crevasse splays are higher overall (80 api) than that for the channel deposits, due to the increased clay content. Density log values for the shales are only slightly higher than that found in the upper Moreno Hill shales . The density reading is dependent on the diameter of the hole, which is washed out at this point in the reference log (517-13-1), making density an unreliable factor without a porosity log. The gamma logs show a slightly higher value, 120 api, than the upper Moreno Hill shales, due to the lower Moreno Hill mudstones having a greater organic fraction in them, which tend to concentrate uranium and thorium. The resistivity is generally less than 9 ohm/m for these shales. There are no limestone or dolomite deposits in this sequence, indicating an absence of lake deposits. Carbonaceous shales are recognizable, having densities in the

range of 2.0 g/cc, a higher gamma count than that found in coals, due to increased clay content and a lower resistivity than that found in coal. The shales probably represent floodplain deposits with swamps represented by those intervals with carbonaceous shales.

The majority of the coal seams in the Salt Lake coal field are present in four zones one in the upper Moreno Hill and three in the lower Moreno Hill sequence. On some of the logs the presence of tonsteins or, kaolinitic partings, are readily identifiable, the 9 ft coal present in 416-31-1 being the best example, shows two kaolinitic partings. In the core taken from this hole, the upper parting is .25 inch thick, while the lower parting is .5 inch thick. These partings show a slightly higher density, 1.45 to 1.5 g/cc than the coal, 1.35 g/cc. This density is not what is expected from kaolinite (2.6 g/cc), however since the log was run at a scale of 1.0 inch/10 feet and data from the probe is taken at .1 foot increments, such thin partings would not show their full deflection. The gamma reading is higher for the tonsteins, 55 to 80 api, compared to the surrounding coal which has a very low gamma of 30 to 40 api. Such partings are useful in correlating coals from one hole to the next.

The Atarque (Ka) is the first marine unit penetrated in the area. This formation is a marine beach deposit. The holes shown in cross section that penetrate the Atarque are: 516-31-1, 517-13-1, 517-34-1, 517-9-1, 517-4-1, 517-5-1, 617-33-1, 517-7-1, 518-11-1, 518-3-1, 518-1-1, 417-3-1. The thickest section of Atarque is in 517-27-3 (53 ft) and the thinnest Atarque is 20 ft in 516-31-1 (data from appendix I). The Atarque is a beach sand

characterized by a sharp upper contact and a gradational lower contact. This sand has a high resistivity reading, averaging 350 to 345 ohms/m in the upper part and 118 to 23 ohms/m in the lower section. This variation in resistivity indicates a coarsening upward of the grain size. The gamma readings are low, 40 api to 60 api, for the Atarque Formation and indicate a clean sand. The lower portion of the Atarque Formation has a higher silt and clay content, recognized by an increased gamma reading, 80 api. The density log is fairly uniform, averaging 2.1 g/cc matrix density, which is expected from a clean quartz sand.

The data for the Atarque contour map (appendix III) is based on the upper contact elevation of the Atarque sandstone from well logs and surface exposure. The contours show a rise in elevation from the Santa Rita Mesa to the northeast. The western most points (520-13-1, 520-3-1) show an increase in elevation to the northwest. There is a syncline or low in the Santa Rita - Rincon Hondo area. This is an area of extensive faulting, (cross-section E-E') The elevation of the Atarque flattens in the area of 517-5-1, 517-4-1, and 517-9-1 with a rise in elevation trending to the west.

The Rio Salado Tongue of the Mancos (Kmrs) Shale was penetrated in holes; 518-11-1, 517-7-1, 517-5-1, 617-33-1, 518-7-1, 517-9-1, 517-4-1, 517-1-2. The Rio Salado is a thick sequence, predominantly marine shales with thin beds of limestone and glauconite. The shales have a consistent geophysical log signature throughout the Rio Salado. This sequence varies in thickness from 130 ft to 240 ft. The shales have a lower

resistivity averaging 14 ohms/m, and a higher gamma of 100 api, than the overlying Atarque Sandstone. Density of the shales averages 2.5 g/cc matrix density, indicative of high clay (illite or kaolinite) content. The limestone beds of the Rio Salado are approximately 1 ft thick. These thin beds stand out on the geophysical logs because of their low gamma, 60 api. The resistivity readings appear low for limestones, 40 to 28 ohms/m due to the thinness of the beds. Limestone density is slightly higher than the surrounding shales, 2.55 g/cc. Three glauconite beds were noted in the Rio Salado ranging from 0.5 to 1 ft thick. The glauconite is indicative of a marine environment with slow sedimentation taking place and reducing conditions. These beds have high gamma readings of 200 api and low resistivity averaging 15 ohms/m, and a density of 2.1 to 2.2 g/cc.

STRUCTURE OF THE SALT LAKE COAL FIELD

CROSS SECTIONS

Five cross sections were constructed for the Salt Lake coal field, to give an idea of regional structure. These cross sections are concentrated in the eastern and central portion of the field where most of the subsurface data is located. The locations of A-A' through E-E' are shown in Figure 1. A description of each cross section follows.

Section A-A'

This cross section is approximately along dip, along a northeast to southwest trend. There are three major faults in this cross section. A fault with a 275 ft displacement is seen between

518-31-1 and 518-29-1 with the southwest side faulted up. The middle sand of the Moreno Hill is thinner to the southwest. A 50 ft displacement occurs between 518-29-1A and 518-28-1 with the southwest side up with respect to the northeast side of the fault. Here the middle sand of the Moreno Hill is thinner to the northeast. A change in dip angle occurs from the southwest to the northeast. Between 518-1-1 and 517-7-1 is a 150 ft displacement. The southwest side is down with respect to the northeast side of the fault. The dip is to the southwest at this point in the cross section. There is a change in dip from the southwest to the northeast from 517-5-1 to 617-33-1. Apparent dips on this cross section vary from 1 to 6 degrees with general dip of 2 degrees to the southwest.

Section B-B'

This cross section is essentially along the strike of the area with a northwest southeast trend. There are 2 major faults in this area, one between 517-4-1 and 517-9-1 with 265 ft of displacement. The northwest side of this fault is down with respect to the southeast side. The dip changes from 6 degrees to half a degree from the northwest side to southeast side of this fault. A 210 ft displacement is seen between 517-9-1 and 517-26-1 with the northwest side downfaulted with respect to the southeast side. The dip changes from essentially zero to 3 degrees from northwest side of the fault to the southeast side.

The B-B' cross section shows the true southeast dip of the units, evident in the surface exposures changing from lower Moreno

Hill in the northwest to upper Moreno Hill in the southeast. The upper Moreno Hill is evident in the southeast end of the section and in the northwest end. The Atarque is seen in the northwest end of the cross section in the subsurface but not in the southeast section. The middle part of the cross section is dominated by the lower Moreno Hill and coals are present in this area. The Cerro Prieto and Rabbit zones are present in the middle part of B-B'. The Twilight coal zone is in the subsurface at the southeast end of the cross section. The maximum thickness of the lower Moreno is 490 ft. The middle Moreno is only evident in a small knoll and is 50 ft thick. The Atarque is maximum of 40 ft at 517-4-1.

Section C-C'

This section is along an East-West line. There are three faults in this cross section, one between 518-31-1 and 518-29-1 which also evident in A-A'. There is a 235 ft displacement at this fault with the west side up relative to the east side . A change of dip from half a degree to 3 degree dip to the west occurs here. There is a second fault between 518-29-1A and 518-33-1 with a displacement of 80 ft with the east side downfaulted. The apparent dip changes from 3 degrees from the west to half a degree to the east in the area of this fault. A small fault in the vicinity of 517-34-1 shows a displacement of 60 ft with the west side having been faulted downward. The dip changes again between 518-33-1 and 517-31-1 from a half degree to the east to essentially zero. There is a small anticlinal flexure

between 517-34-1 and the eastern end of the cross section C-C' with the a dip change to the east. The evidence for the dip change is from outcrop data of the middle Moreno Hill and general outcrop dip of 3 degree dip to the southeast is applied.

To the east Fence Lake Gravel caps most areas in the C-C' cross section. The upper Moreno Hill is prevalent in the subsurface of this cross section. Most of the surface outcrops of upper Moreno Hill are located in the west half of the C-C' cross section. Maximum thickness is 330 ft of upper Moreno at the east end of C-C'. The middle sand of the Moreno Hill is also thickest in the east, 60 ft, thinning to the west to 20 ft. The middle Moreno Hill and lower Moreno Hill are in the subsurface except west of 517-31-1. The Atarque is seen in the subsurface data in the eastern half of the cross section and varies in thickness from 30 to 50 ft.

Cross Section D-D'

This cross section is on a north-south line in the eastern part of the field. There is one fault along this line between 517-1-2 and 517-13-1 with a 250 ft displacement. The north side of the fault has moved down with respect to the south side of the fault. An apparent 2 degree dip to the south extends from this area to 417-14-1 where the apparent dip changes to 1 degree to the south. Near 417-14-1, further to the south, the dip changes to a 1 degree apparent dip to the north.

The lower Moreno Hill and many of the coals in this unit are shown in D-D'. The maximum thickness of the lower Moreno Hill is

the surface and the knoll at the east end of the section is middle sand and varies in thickness from 25 to 50 ft. Most of the subsurface data in the western half of E-E' indicates the presence of Rio Salado.

COAL GEOLOGY

Work by Campbell (1981) has shown that the coals in the eastern portion of the Salt Lake coal field are Bituminous B and C in rank. Extending this data to the western portion of the field, the minimum thickness for minable coals is 1.2 ft. Using this value and the method for calculating coal resources as outlined in U.S.G.S. Bull 1450-B, and based on the data from this study, the coal resources for the Salt Lake Coal Field amount to 347 million tons. Table 1 breaks these resources into depth categories (Table 2a) and measured, indicated, and ownership tonnages for township and ranges involved in the study area.

Most of the resources for the Salt Lake field are in the eastern portion, on The Dyke and Cerro Prieto quadrangles, where the average seam thickness is 3.1 ft, and an average depth of 116 ft. The coals in the western portion of the field are thinner 2.1 ft and generally much deeper, averaging 179 ft. The apparent overburden is much greater in the western portion, the main reason for this is that drilling in the western portion of the field was almost entirely located on the mesa top (Santa Rita mesa, Rincon Hondo). These holes therefore go through the Fence Lake gravel and portions of the upper Moreno Hill and Moreno Hill Middle sand. The coals penetrated by these holes are in the upper Moreno Hill, and are generally thin. Access to outcrops of the coal bearing

370 ft in this cross section. Three coal zones are present, the Rabbit, Cerro Prieto, and Antelope. The middle sand and upper Moreno Hill are present only in the higher topographic regions of the middle part of this cross section. The Atarque and Rio Salado are seen in the subsurface of the drill holes in the northern portion of the cross section. The Atarque is at the bottom of the holes in the southern part of D-D'.

Cross Section E-E'

There are four faults in E-E' which is located in the northeastern part of the area. The fault between 518-11-1 and 518-1-1 has a displacement of 270 ft. The west side of the fault is uplifted with respect to the east side of the fault. The dip varies from 2 degrees east on the west side of the fault to 6 degrees east on the east side of the fault. A fault between 518-1-1 and 517-7-1 shows a displacement of 160 ft with east side of the fault down. The apparent dip also changes from the west side to the east side of the fault, from a 6 degree dip to the east to a 3 degree dip to the west. A third fault is between 517-5-1 and 517-4-1 showing a 110 ft displacement with the west side faulted up relative to the east side. Another fault between 517-4-1 and 517-9-1 shows a displacement of 360 ft. The dip levels out to the east of this log (517-9-1) to almost zero dip.

The entire surface of cross section E-E' is lower Moreno Hill except for near 517-9-1 and the knoll at the east end of section. The maximum thickness of lower Moreno Hill is 380 ft. The Atarque is seen throughout the subsurface data. At 517-9-1 Atarque is at

TABLE 1

a) DEMONSTRATED COAL RESOURCES FOR SALT LAKE COAL FIELD

	0-150	150-250	>250
T. 7 N. R. 20 W.	9.05	0.00	0.00
T. 6 N. R. 17 W.	5.43	0.00	0.00
T. 6 N. R. 16 W.	20.77	.84	0.00
T. 5 N. R. 19 W.	9.19	0.00	0.00
T. 5 N. R. 18 W.	8.77	8.88	4.68
T. 5 N. R. 17 W.	46.81	14.99	20.98
T. 5 N. R. 16 W.	10.90	13.37	3.37
T. 4 N. R. 18 W.	3.06	0.00	6.71
T. 4 N. R. 17 W.	66.53	14.92	0.00
T. 4 N. R. 16 W.	39.11	7.82	2.76
T. 3 N. R. 17 W.	3.86	0.00	0.00
T. 3 N. R. 16 W.	3.60	0.00	0.00
TOTAL	227.08	60.82	38.50

TABLE 1

b) DEMONSTRATED COAL RESOURCES FOR SALT LAKE COAL FIELD

	Measured	Indicated	Federal	State	Private
T. 7 N. R. 20 W.	1.13	7.92	0.00	0.00	9.05
T. 6 N. R. 17 W.	0.00	5.43	3.76	1.67	0.00
T. 6 N. R. 16 W.	2.33	19.28	21.61	0.00	0.00
T. 5 N. R. 19 W.	.86	8.33	0.00	0.00	9.19
T. 5 N. R. 18 W.	3.76	18.57	9.09	0.00	13.24
T. 5 N. R. 17 W.	19.50	63.29	50.64	8.76	2.81
T. 5 N. R. 16 W.	6.74	20.89	27.72	.67	0.00
T. 4 N. R. 18 W.	1.09	8.69	19.56	0.00	0.00
T. 4 N. R. 17 W.	17.04	64.41	77.01	9.86	3.69
T. 4 N. R. 16 W.	8.32	42.68	27.51	19.59	3.03
T. 3 N. R. 17 W.	0.00	3.86	3.39	.48	0.00
T. 3 N. R. 16 W.	2.04	1.56	3.60	0.00	0.00
TOTAL	62.81	264.91	234.11	41.03	41.01

lower Moreno Hill sequence is difficult, due to the lack of roads and rough terrain.

Four coal zones (Antelope, Cerro Prieto, Rabbit, Twilight) are identifiable from outcrop and geophysical log data. The lowest zone termed here the Antelope zone is located within 50 ft above the top of the Atarque Formation. Holes 517-34-1, 417-14-1, 517-1-fe, 517-3-fe penetrate this zone. The only analyses are from 517-34-1, which show a high ash content, however, these analyses were done on cuttings. The seams in this zone are thin averaging 2.1 +/- .6 ft and consist at most of two seams, with their average total thickness being 2.7 +/- 1.7 ft. The average overburden for this zone is 178 +/- 77 ft. The resources for this zone, for the measured and indicated categories is 26.09 million tons.

Approximately 150 ft above the Antelope zone is a second coal zone, the Cerro Prieto zone. This zone increases in thickness from the western (30') to the eastern portion (70') of the field and is exposed in outcrop mostly in the eastern portion of the Salt Lake field. Four seams comprise the Cerro Prieto zone, ranging in thickness from 2-10 ft. Generally there is one major seam that varies from 6-10 ft and is readily recognizable, by having two thin kaolinitic partings. These coals and their partings are best exposed in sec. 9 T. 4 N. R. 17 W and sec. 23 T. 4 N. R. 17 W. Appendix V-a,b is an isopach map of the total coal thickness of the Cerro Prieto zone. This map shows the thickest coal to have a northwest-southeast trend. Good control is present to the northeast, however there are no control points southwest of

the 10 ft contour interval. Field reconnaissance to the west and southwest indicate more lower Moreno Hill sediments, in this area, which suggests further drilling. The average overburden thickness is 145 +/- 85 ft, with the average total coal thickness being 6.2 +/- 3.3 ft, and the average individual seam thickness being 4.2 +/- 2.5 ft. The known combined coal resources for both the measured and indicated categories are 155.19 million tons.

The next highest coal zone is the Rabbit zone, located approximately 290 ft above the top of the Atarque, 90 ft above the Cerro Prieto zone and approximately 60 ft below the base of the Moreno Hill middle sand. The thickness of this zone varies from west to east, as does the Cerro Prieto, being 30 ft thick in the west and 70' thick in the east. The Rabbit zone has four seams, with the second from the bottom being the thickest. In the thickest coal is a single kaolinitic parting, which distinguishes this zone from the lower Cerro Prieto zone. Appendix V-c is an isopach map of total coal thickness in the Rabbit zone, and appendix V-d is an overburden isopach map. The trend of greatest coal thickness is northeast-southwest. This would indicate that the paleoshoreline is to the northwest, when these coals were deposited. The average total seam thickness in the Rabbit zone is 5.1 +/-3.3 ft, while the average seam thickness is 2.7 +/- 1.1 ft. The overburden for this zone averages 105 +/- 71 ft. The known combined resources for the Rabbit zone in the measured and indicated categories is approximately 129.77 million tons of coal.

The highest coal zone is the Twilight zone, which is found approximately 50 ft above the Moreno Hill middle sand, placing

this coal in the Upper Moreno Hill formation. This zone consists of 1-3 seams, which never become thicker than 3.0 ft, the average thickness of the seams being 1.9 ft. The average overburden for this zone is 157 +/- 93 ft, while the average total coal thickness is 3.3 +/- 2.0 ft. The total known resource for the Twilight zone, for both the measured and indicated categories is 48 million tons of coal.

Ten samples, both from cuttings and core were taken from both the Cerro Prieto and Rabbit zone. These samples were analyzed for proximate, ultimate and Btu values. Table 2 shows the results of these analyses for each of the coal zones on an as received basis. The Rabbit zone appears to be a better grade coal than the Cerro Prieto zone. Use of the student-t test shows that most of the values for these two zones are significantly different with the sulfur content showing the greatest difference. The total sulfur for the Rabbit zone is significantly higher (1.1%) than that in the Cerro Prieto zone (0.8%). Only the ash, nitrogen and as received Btu values appear to be from the same population. Moisture was not included in this evaluation of the two coal zones since the moisture was as received moisture, and does not indicate the true moisture content of the coals. The Antelope zone appears to be closest to the Cerro Prieto zone in quality, however there are only two samples from this zone (see appendix IV). No analyses are available for coals from the Twilight zone.

Table 3 compares the Salt Lake coals to the nearby Gallup and Datil Mountains coal fields, as well as the coals from the Fruitland and Crevasse Canyon formations. Coal in the Datil

TABLE 2

ANALYSES OF COALS FROM COAL BEARING HORIZONS IN SALT LAKE FIELD

(as received basis)

	Antelope	Cerro Prieto	Rabbit
No. of Analyses	2	5	5
Volatile Matter	32.11	33.4+/-3.1	36.9+/-1.5
Fixed Carbon	35.59	38.3+/-6.8	43.8+/-2.6
Moisture	1.85	8.0+/-3.0	2.3+/-0.3
Ash	30.45	20.4+/-9.9	17.1+/-3.9
Carbon	50.16	55.1+/-8.5	60.9+/-3.2
Hydrogen	4.04	4.3+/-0.4	4.6+/-0.2
Nitrogen	.96	1.1+/-0.2	1.2+/-0.1
Sulfur	.65	0.8+/-0.1	1.1+/-0.1
Oxygen	11.90	10.3+/-1.2	12.9+/-0.6
Btu	8696	9709+/-1441	10622+/-562
MM£Btu	13190	12528+/-440	13085+/-168

TABLE 3

COMPARISON OF SALT LAKE COALS TO OTHER NEW MEXICO COALS

(as received basis)

	SALT LAKE		DATIL		FRUITLAND		CREVASSE CANYON		GALLUP	
No. of samples	14		24		47		156		129	
	AVG	S.D.	AVG	S.D.	AVG	S.D.	AVG	S.D.	AVG	S.D.
Moisture	4.9	3.1	5.5	2.8	9.7	1.7	10.9	1.1	11.8	1.2
V.M.	35.1	3.4	36.4	3.0	30.7	2.5	38.9	.7	39.0	1.6
F.C.	40.7	6.7	42.2	2.8	36.1	3.1	43.9	1.3	40.9	6.7
ASH	21.8	11.0	15.9	6.5	24.7	5.2	9.8	2.0	8.8	3.6
C	55.8	7.7	62.2	4.6	48.1	8.1	59.7	2.3	62.4	5.4
H	4.4	.4	4.8	0.4	4.9	.5	5.3	.3	5.8	.6
N	1.1	.2	1.0	0.1	.9	.2	1.1	.1	1.1	.1
O	11.7	1.5	10.0	0.9	22.8	2.4	20.1	2.1	20.9	3.5
S	.8	.3	.8	0.6	.8	.2	.7	.1	.6	.1
BTU	9660	1516	11113	829	9714	820	10939	241	11114	533
MMFBTU	12455	778	13464	688	13260	750	12248	122	12304	186

Mountains field is of slightly better quality than that found in the Salt Lake field. Specifically the ash is lower while the Btu and carbon values are higher than that present in the Salt Lake field. Only the Rabbit zone approaches the quality found in the Datil Mountains field. The Gallup/Zuni coal field is north of the Salt Lake coal field. The Btu, total carbon, sulfur and ash in the Gallup/Zuni field indicate a better quality of coal than that found in the Salt Lake coal field. Comparison of the Salt Lake coals to coals from the Crevasse Canyon and Fruitland formations shows that the Salt Lake coals have a greater similarity to the Fruitland coals.

Moisture in coal is usually reported on an as received basis, rather than capacity moisture. The as received analyses are not as accurate as the capacity moisture in indicating moisture content of coals, since the effects of sampling and time elapse from sampling to analysis are unknown. Therefore comparison of these various coals on a dry basis reduces (Table 4a)the uncertainty of the effects of moisture content. The Salt Lake coals compare favorably to those present in the Datil Mountains field and the Fruitland Formation coals. The only significant difference being in the oxygen content, which appears higher in the Datil Mountains and Fruitland coals. Coals from the Crevasse Canyon Formation and the Gallup field appear to be of better quality, and have a significantly lower ash content.

Proximate and ultimate analyses are best compared when both the effects of moisture and ash have been removed. Table 4b

compares the Salt Lake coals to the other coals on a dry ash free basis. There is again close similarity between the Salt Lake coals and those present in the Datil Mountains field and the Fruitland formation. Many of the differences with the Crevasse Canyon coals are eliminated, with only hydrogen and oxygen having significant differences. Gallup field coals have a slightly greater difference, in that the volatile matter content is also significantly higher than that present in the Salt Lake coals.

CONCLUSIONS

The Moreno Hill Formation in the Salt Lake Coal Field shows a gentle dip (approximately 5 degrees) to the southeast. The lower Moreno Hill and middle sand of the Moreno Hill are thinning to the west in subsurface and outcrop data. The upper Moreno Hill is thinning to the west, also due to the regional dip and upper erosional contact with the Fence Lake Gravels. The major area of faulting Santa Rita Mesa area. The faulting has little influence in the eastern part of the field where the coals of the lower Moreno Hill have the greatest stripping potential.

The coal zones of the Moreno Hill in the Salt Lake Field are of high volatile C Bituminous rank. These coals are low in sulfur, but have a high ash content (21%). In comparison the Salt Lake coals are close in chemical composition to the coals of the Datil Mountains and Fruitland Formation.

The Salt Lake coal field contains an estimated 327 million tons of coal. This resource is split into four coal zones, found in the Moreno Hill formation. These zones are, from bottom to top; Antelope, Cerro Prieto, Rabbit and Twilight. The Antelope and Twilight zones have small resources (26 and 48 million tons respectively), and poor stripping ratios, with the Antelope zone averaging 66:1 and the Twilight zone averaging 48:1. The Cerro Prieto and Rabbit zones are the most likely candidates for mining. The Cerro Prieto zone has a demonstrated resource of 155 million tons with a stripping ratio average of 23:1. The Rabbit zone has a demonstrated resource of 130 million tons with an average stripping ration of 21:1. Both the Rabbit and Cerro Prieto zones show northeast to southwest trends in subsurface and field reconnaissance. To the west and southwest of the Cerro Prieto quadrangle lower Moreno Hill outcrops are present. Further drilling both to the south and southwest of the Cerro Prieto quadrangle and to the northeast of The Dyke quadrangle would better delineate these two zones.

REFERENCES

Allen, D.R., 1975, Identification of sediments - their depositional environment and degree of compaction - from well logs: in; Chilingarian, G.V., and Wolf, K.H., ed, Compaction of Coarse Grained Sediments, p. 349-402.

A.S.T.M., 1977, CLASSIFICATION OF COAL AND COKE: D388-77

Century Geophysical Corporation, 1979, Mineral Logging Manual, Technical Report 153.

Dane, C.H., Bachman, G.O., 1965, Geologic map of New Mexico: U.S. Geol. Survey, 2 sheets.

Marr, R.J., 1956, Geology of Lynch Ranches Catron and Valencia Counties, New Mexico: Master's Thesis, University of Texas, 113 p.

McClellan, M., Hashkie, L., Johnson, L., 1981, Nomenclature of the Upper Cretaceous Stratigraphy of the Salt Lake Coal Field, in press.

Seimers, C.T., 1977, Core and Wire-line Log Analysis of a Coal-Bearing Sequence: Lower Part of the Upper Cretaceous Menefee Formation (Mesaverde Group), Northwestern New Mexico; Proceedings of the Second Symposium on the Geology of Rocky Mountain Coal, Hodgson, H.E., p. 165-180.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal and resource classification system of the U.S. Bureau of Mines and U. S. Geological Survey: U.S. Geol. Survey, Bull. 1450-B, 7p.

DRILL HOLE SUMMARY SHEETS

Well Name: 416-3-1 — Township 4 N. Range 16 W. Sec. 3

Company: N.M.B.M.M.R. — Footage: 1650 ft(502m) E. of W. Line

Quadrangle: Cerro Prieto — 2400 ft(731m) N. of S. Line

County: Cibola — Field: Salt Lake

Total Depth: 258 ft(78m) — Elevation: 6980 ft(2127m)

Mineral Ownership:P — Surface Ownership:P

Formation	Depth	Thickness	Elevation
Upper Moreno Hill	000	245 ft(74m)	6980 ft(2127m)
Moreno Hill Middle Sand	245 ft(74m)	13 ft(3m)	6735 ft(2052m)
Lower Moreno Hill			

Coal

Thickness	Depth	Elevation	Zone
1.2 ft(.4m)	45 ft(13m)	6935 ft(2113m)	Twilight
2.4 ft(.7m)	106 ft(32m)	6874 ft(2095m)	Twilight
1.8 ft(.6m)	163 ft(50m)	6817 ft(2078m)	Twilight

Well Name: 416-7-1 — Township 4 N. Range 16 W. Sec.7

Company: N.M.B.M.M.R. — Footage: 4000 ft(1219m) E. of W. line

Quadrangle: Cerro Prieto — 4300 ft(1310m) N. of S. line

County: Cibola — Field: Salt Lake

Total Depth: 77 ft(23m) — Elevation: 6870 ft(2094m)

Mineral Ownership: F — Surface Ownership: P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	77 ft(23m)	6870 ft(2094m)

Coal

Thickness	Depth	Elevation	Zone
1.5 ft(.5m)	33 ft(10m)	6837 ft(2084m)	Rabbit

PROXIMATE AND ULTIMATE ANALYSES OF COALS FROM THE SALT LAKE FIELD

(on as received basis)

Sample	V.M.	F.C.	H2O	Ash	C	H	N	S	O
				ANTELOPE ZONE					
517-34-1 (170'-175')	35.65	42.45	2.14	19.76	58.98	4.48	1.15	.68	12.81
517-34-1 (190'-195')	28.57	28.73	1.56	41.14	41.34	3.59	.76	.62	10.99
				CERRO PRIETO ZONE					
416-31-1 (48'-56.5')	33.39	44.28	10.86	11.47	61.64	4.39	1.12	.91	9.61
417-3-1	30.81	31.04	10.24	27.91	46.02	3.65	.97	.78	10.43
417-13-1 (168'-172.5')	36.15	40.15	3.36	20.34	57.89	4.42	1.08	.89	12.02
417-14-1 (135'-142.2')	36.61	44.90	8.62	9.87	63.78	4.78	1.35	.73	10.87
417-23-1 (31'-36.8')	29.86	31.11	6.67	32.36	46.27	4.41	.93	.58	8.78
				RABBIT ZONE					
516-19-1 (89'-93.3')	36.10	44.90	2.72	16.28	61.10	4.62	1.14	1.10	13.04
516-30-1 (181'-187.5')	35.61	43.15	2.35	18.89	60.27	4.52	1.24	.75	11.98
517-24-1 (31'-34.5')	39.50	47.52	2.38	10.60	66.10	4.95	1.26	1.04	13.67
517-25-1 (117'-124.5')	36.29	42.48	1.80	19.43	59.59	4.47	1.00	.81	12.90
517-25-3 (70'-73.6')	36.73	40.71	2.45	20.11	57.48	4.53	1.14	1.56	12.73

2.4 ft(.7m)	53 ft(16m)	6817 ft(2078m)	Rabbit

BTU VALUES AND RANK

	As Received	Moist, Mineral-matter Free	
ANTELOPE ZONE			
517-34-1			
170-175	10223	13206	high volatile bituminous B
517-34-1			
190-195	7168	13173	high volatile bituminous B
CERRO PRIETO ZONE			
416-31-1	10739	12308	high volatile bituminous C
417-3-1	8228	11891	high volatile bituminous C
417-13-1	10101	13037	high volatile bituminous B
417-14-1	11303	12696	high volatile bituminous C
417-23-1	8174	12710	high volatile bituminous C
RABBIT ZONE			
516-19-1	10624	12970	high volatile bituminous C
517-24-1	11574	13128	high volatile bituminous B
516-30-1	10445	13206	high volatile bituminous B
517-25-1	10339	13173	high volatile bituminous B
517-25-3	10127	13128	high volatile bituminous B

Well Name: 416-7-2 Township 4 N. Range 16 W. Sec. 7

Company: N.M.B.M.M.R. Footage: 3800 ft(1158m) E. of W. line

Quadrangle: Cerro Prieto 500 ft(152m) N. of S. line

County: Catron Field: Salt Lake

Total Depth: 211 ft(64m) Elevation: 6845 ft(2086m)

Mineral Ownership: F Surface Ownership: P

Formation	Depth	Thickness	Elevation
Upper Moreno Hill	000	50 ft(15m)	6845 ft(2086m)
Moreno Hill Middle Sand	50 ft(15m)	42 ft(13m)	6795 ft(2071m)
Lower Moreno Hill	92 ft(28m)	119 ft(36m)	6753 ft(2058m)

Coal

Thickness	Depth	Elevation	Zone
2.8 ft(.9m)	106 ft(32m)	6739 ft(2054m)	Rabbit
2.0 ft(.6m)	127 ft(39m)	6718 ft(2048m)	Rabbit

Well Name: 416-10-1 Township 4 N, Range 16 W, Sec.10

Company: N.M.B.M.M.R. Footage: 200 ft(60m) E. of W. line

Quadrangle: Cerro Prieto 3800 ft(1158m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 272 ft(83m) Elevation: 6920 ft(2109m)

Mineral Ownership: F Surface Ownership: P

Formation	Depth	Thickness	Elevation
Upper Moreno Hill	000	122 ft(37m)	6920 ft(2109m)
Moreno Hill Middle Sand	122 ft(37m)	25 ft(8m)	6798 ft(2072m)
Lower Moreno Hill	147 ft(45m)	125 ft(38m)	6773 ft(2064m)

Coal

Thickness	Depth	Elevation	Zone
2.1 ft(.6m)	252 ft(77m)	6668 ft(2032m)	Cerro Prieto

Well Name: 416-18-1 Township 4 N. Range 16 W. Sec.18

Company: N.M.B.M.M.R. Footage: 4000 ft(1219m) E. of W. line

Quadrangle: Cerro Prieto 2400 ft(732m) N. of S. line

County: Catron Field: Salt Lake

Total Depth: 116 ft(35m) Elevation: 6790 ft(2070m)

Mineral Ownership: F Surface Ownership: P

Formation	Depth	Thickness	Elevation
Moreno Hill middle sand	000	25 ft(8m)	6790 ft(2070m)
Lower Moreno Hill	25 ft(8m)	91 ft(28m)	6675 ft(2067m)

Coal

Thickness	Depth	Elevation	Zone
3.0 ft(.91m)	38 ft(12m)	6752 ft(2058m)	Rabbit

Well Name: 416-22-1 Township 4 N. Range 16 W. Sec. 22

Company: N.M.B.M.M.R. Footage: 1550 ft(472m) E. of W. line

Quadrangle: Cerro Prieto 4700 ft(1433M) N. of S. line

County: Catron Field: Salt Lake

Total Depth: 280 ft(85m) Elevation: 6810 ft(2076m)

Mineral Ownership: F Surface Ownership: P

Formation	Depth	Thickness	Elevation
Upper Moreno Hill	000	250 ft(76m)	6810 ft(2076m)
Moreno Hill middle sand	250 ft(76m)	30 ft(9m)	6780 ft(2067m)

Coal

Thickness	Depth	Elevation	Zone
3.0 ft(.9m)	212 ft(65m)	6598 ft(2011m)	Twilight
2.2 ft(.7m)	217 ft(66m)	6593 ft(2010m)	Twilight
2.0 ft(.6m)	244 ft(74m)	6566 ft(2001m)	Twilight

Well Name:417-3-1 Township 4 N. Range 17 W. Sec. 3

Company:N.M.B.M.M.R. Footage: 1400 ft(427m) E. of W. line

Quadrangle: Cerro Prieto 2800 ft(853m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth:233 ft(71m) Elevation:6870 ft(2094m)

Mineral Ownership:P Surface Ownership:P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	215 ft(65.5m)	6852 ft(2088m)
Atarque	215	233 ft(71m)	6870 ft(209?m)

Coal

Thickness	Depth	Elevation	Zone
4.3 ft(1.3m)	37 ft(11m)	6833 ft(2083m)	Cerro Prieto
1.2 ft(.4m)	49 ft(15m)	6821 ft(2079m)	Cerro Prieto

Well Name:417-13-1 Township 4 N. Range 17 W. Sec. 13

Company:N.M.B.M.M.R. Footage:3200 ft(975m) E. of W. line

Quadrangle:Cerro Prieto 4000 ft(1219m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth:247 ft(75m) Elevation:6870 ft(2094m)

Mineral Ownership:F Surface Ownership:P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	247 ft(75m)	6870 ft(2094m)

Coal

Thickness	Depth	Elevation	Zone
2.5 ft(.8m)	76 ft(23m)	6794 ft(2071m)	Rabbit
4.2 ft(1.3m)	168 ft(51m)	6702 ft(2043m)	Cerro Prieto

TABLE 4

COMPARISON OF SALT LAKE COALS TO OTHER NEW MEXICO COALS

a) dry basis

	SALT LAKE		DATIL		FRUITLAND		CREVASSE CANYON		GALLUP	
NO. of samples	14		24		225		156		129	
	AVG	S.D.	AVG	S.D.	AVG	S.D.	AVG	S.D.	AVG	S.D.
V.M.	36.6	3.7	37.0	5.6	33.8	2.4	43.6	1.6	44.1	2.8
F.C.	42.5	6.9	44.2	9.8	39.9	3.5	49.3	2.4	49.7	3.8
ASH	22.4	11.0	18.4	10.2	27.1	5.6	10.9	2.0	9.9	3.5
C	58.4	8.1	60.2	12.8	55.7	10.6	66.9	2.9	71.2	8.0
H	4.6	.4	5.2	0.8	5.7	0.7	6.0	0.3	6.7	0.9
N	1.1	0.2	1.1	0.2	1.0	0.2	1.2	0.0	1.3	0.1
O	12.2	1.6	23.8	9.1	26.6	4.3	23.0	2.7	23.9	4.5
S	.9	0.4	0.6	0.2	0.9	0.2	0.8	0.1	0.7	0.1
b) dry ash free basis										
V.M.	46.5	12.2	46.1	13.9	47.2	6.2	48.9	3.0	48.7	4.2
F.C.	53.3	14.7	53.9	17.0	54.6	9.0	55.2	3.8	54.9	5.3
C	75.8	22.2	74.0	23.2	75.2	22.8	76.9	5.7	78.7	11.0
H	6.0	1.7	6.4	1.9	7.9	2.2	6.9	.6	7.3	1.2
N	1.5	0.4	1.4	0.4	1.4	0.4	1.4	0.1	1.4	0.2
O	21.7	11.0	30.4	13.0	37.1	11.7	27.0	3.7	26.3	5.5
S	1.1	0.5	.7	0.3	1.3	0.3	0.9	0.1	0.8	0.1

Well Name: 417-14-1 Township 4 N. Range 17 W. Sec. 14

Company:N.M.B.M.M.R. Footage: 1950 ft(594m) E. of W. line

Quadrangle:Cerro Prieto 3000 ft(914m) N. of S. line

County: Catron Field: Salt Lake

Total Depth: 248 ft(76m) Elevation: 6810 ft(2076m)

Mineral Ownership:F Surface Ownership:P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	248 ft(76m)	6810 ft(2054m)

Coal

Thickness	Depth	Elevation	Zone
2.0 ft(.6m)	53 ft(16m)	6757 ft(2060m)	Rabbit
6.2 ft(1.9m)	135 ft(41m)	6675 ft(2035m)	Cerro Prieto
2.0 ft(.6m)	213 ft(65m)	6597 ft(2011m)	Antelope

Well Name: 417-23-1 Township 4 N. Range 17 W. Sec. 23

Company: N.M.B.M.M.R. Footage: 1000 ft(305m) E. of W. line

Quadrangle: Cerro Prieto 4150 ft(1265m) N. of S. line

County: Catron Field: Salt Lake

Total Depth: 229 ft(70m) Elevation: 6740 ft(2054m)

Mineral Ownership:F Surface Ownership:P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	229 ft(70m)	6740 ft(2054m)

Coal

Thickness	Depth	Elevation	Zone
5.8 ft(1.4m)	31 ft(93)	6709 ft(2042m)	Cerro Prieto
4.5 ft(1.37m)	91 ft(27.7)	6699 ft(2042m)	Cerro Prieto
3.0 ft(.9m)	107 ft(33m)	6633 ft(2022m)	Cerro Prieto

Well Name: 418-11-1 Township 4 N. Range 18 W. Sec. 11

Company: Private Footage: 3000 ft(914m) E. of W. line

Quadrangle: Fence Lake 5000 ft(1524m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 430 ft(131m) Elevation: 7330 ft(2234m)

Mineral Ownership: F Surface Ownership: P

Formation	Depth	Thickness	Elevation
Fence Lake Gravel	00	47 ft(14m)	7330 ft(2234m)
Upper Moreno Hill	47 ft(14m)	185 ft(56m)	7283 ft(2220m)
Moreno Hill Middle sand	232 ft(71m)	33 ft(10m)	7098 ft(2164m)
Lower Moreno Hill	265 ft(81m)	222 ft(68m)	7065 ft(2153m)

Coal

Thickness	Depth	Elevation	Zone
1.8 ft	135 ft	7195 ft	Twilight
2.0 ft	311 ft	7019 ft	Rabbit
2.0 ft	398 ft	6932 ft	Cerro Prieto
2.0 ft	432 ft	6898 ft	Cerro Prieto

Well Name:516-19-1 Township 5 N. Range 16 W. Sec.19

Company: N.M.B.M.M.R. Footage: 1300 ft(396.2m) E. of W. line

Quadrangle: The Dyke 500 ft(152.4m) N. of S. line

County: Valencia Field: Salt Lake

Total Depth: 267 ft(81.4m) Elevation: 7300 ft(2225m)

Mineral Ownership: Federal Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	267 ft(81m)	7300 ft(2225m)

Coal

Thickness	Depth	Elevation	Zone

Well Name: 416-27-1 Township 4 N. Range 16 W. Sec. 27

Company: N.M.B.M.M.R. Footage: 2200 ft(671m) E. of W. line

Quadrangle: Cerro Prieto 3000 ft(914m) N. of S. line

County: Catron Field: Salt Lake

Total Depth: 250 ft(76m) Elevation: 6810 ft(2076m)

Mineral Ownership: F Surface Ownership: P

Formation	Depth	Thickness	Elevation
Upper Moreno Hill	000	250 ft(76m)	6810 ft(2076m)

Coal

Thickness	Depth	Elevation	Zone
No coal			

Well Name: 416-31-1 Township 4 N. Range 16 W. Sec. 31

Company: N.M.B.M.M.R. Footage: 2600 ft(793m) E. of W. line

Quadrangle: Cerro Prieto 2600 ft(793m) N. of S. line

County: Catron Field: Salt Lake

Total Depth: 262 ft(80m) Elevation: 6690 ft(2039m)

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	262 ft(80m)	6690 ft(2039m)

Coal

Thickness	Depth	Elevation	Zone
9.5 ft(2.9m)	48 ft(15m)	6642 ft2025m)	Cerro Prieto
1.2 ft(.4m)	67 ft(20m)	6623 ft(2019m)	Cerro Prieto

Well Name: 516-22-1PVC
Township 5 N, Range 16 W, Sec.22

Company: N.M.B.M.M.R.
Footage: 3100 ft(942m) E. of W. line
4300 ft(1311m) N. of S. line

Quadrangle: The Dyke

County: Valencia
Field: Salt Lake

Total Depth: 270 ft(82m)
Elevation: 7300 ft(2225m)

Mineral Ownership: Federal
Surface Ownership:

Formation	Depth	Thickness	Elevation
Fence Lake gravel	000	91 ft(28m)	7300 ft(2225m)
Upper Moreno Hill	91 ft(28m)	179 ft(55m)	7209 ft(2197m)

Coal

Thickness	Depth	Elevation	Zone
1.5 ft(.5m)	115 ft(35m)	7185 ft(2190m)	Twilight
1.2 ft(.4m)	126 ft(38m)	7058 ft(2151m)	Twilight
2.8 ft(.9m)	175 ft(53m)	7125 ft(2172m)	Twilight

Well Name: 516-30-1
Township 5 N, Range 16 W, Sec. 30

Company: N.M.B.M.M.R.
Footage: 1950 ft(594m) E. of W. line
1900 ft(579m) N. of S. line

Quadrangle: The Dyke

County: Valencia
Field: Salt Lake

Total Depth: 250 ft(76m)
Elevation: 7300 ft(2225m)

Mineral Ownership: Federal
Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	250 ft(76m)	7300 ft(2225m)

Coal

Thickness	Depth	Elevation	Zone
2.0 ft(.6m)	121 ft(37m)	7179 ft(2188m)	Rabbit
6.5 ft(2m)	181 ft(55m)	7119 ft(2170m)	Rabbit
2.4 ft(.7m)	268 ft(82m)	7032 ft(2143m)	Cerro Prieto

Well Name: 516-31-1 Township 5 N, Range 16 W, Sec. 31

Company: N.M.B.M.M.R. Footage: 2700 ft(823m) E. of W. line

Quadrangle: Cerro Prieto 1700 ft(518m) N. of S. line

County: Valencia Field: Salt Lake

Total Depth: 263 ft(80m) Elevation: 7020 ft(2140m)

Mineral Ownership: Federal Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	243 ft(74m)	7020 ft(2140m)
Atarque	243 ft(74m)	20 ft(6m)	6777 ft(2066m)

Coal

Thickness	Depth	Elevation	Zone
1.5 ft(.46m)	104 ft(32m)	6916 ft(2108m)	Rabbit

Well Name: 517-1-FE Township 5 N, Range 17 W, Sec. 1

Company: N.M.B.M.M.R. Footage: 2000 ft(610m) E. of W. line

Quadrangle: The Dyke 3650 ft(1113m) N. of S. line

County: Valencia Field: Salt Lake

Total Depth: 294 ft(90m) Elevation: 7200 ft(2195m)

Mineral Ownership: Federal Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	294 ft(90m)	7200 ft(2195m)

Coal

Thickness	Depth	Elevation	Zone

Well Name: 517-1-2 Township 5 N, Range 17 W, Sec. 2

Company: N.M.B.M.M.R. Footage: 3800 ft(1158m) E. of W. line

Quadrangle: The Dyke 2000 ft(610m) N. of S. line

County: Valencia Field: Salt Lake

Total Depth: 281 ft(85.6m) Elevation: 7210 ft(2197m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	266 ft(81m)	7210 ft(2197m)
Atarque	266 ft(74m)	15 ft(4.6m)	6944 ft(2115.9m)

Coal

Thickness	Depth	Elevation	Zone

Well Name: 517-3-FE Township 5 N, Range 17 W, Sec. 3

Company: N.M.B.M.M.R. Footage: 4000 ft(1219m) E. of W. line

Quadrangle: The Dyke 4500 ft(1372m) N. of S. line

County: Valencia Field: Salt Lake

Total Depth: 108 ft(33m) Elevation: 7020 ft(2140m)

Mineral Ownership: Federal Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	108 ft(33m)	7020 ft(2140m)

Coal

Thickness	Depth	Elevation	Zone

Well Name: 517-4-1 Township 5 N. Range 17 W. Sec. 4

Company: N.M.B.M.M.R. Footage: 500 ft(152m) E. of W. line

Quadrangle: Fence Lake 1800 ft(549m) N. of S. line

County: CIBOLA Field: Salt Lake

Total Depth: 400 ft(122m) Elevation: 6980 ft(2128m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	253(77m)	6980(2128m)
Atarque	253(77m)	32(10m)	6727(2050m)
Rio Salado Tongue	285(87m)	115(35m)	6695(2041m)

Coal

Thickness Depth Elevation Zone

Well Name: 517-5-1 Township 5 N. Range 17 W. Sec. 5

Company: Private Footage: 4600 ft(1402m) E. of W. line

Quadrangle: Fence Lake 3700 ft(1128m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 400 ft(122m) Elevation: 6980 ft(2128m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	0.0	160 ft(49m)	6980 ft(2128m)
Atarque	160 ft(49m)	47.5ft(14m)	6820 ft(2078m)
Rio Salado Tongue	207.5ft(63m)	192.5ft(59m)	6772.5ft(2064m)

Coal

Thickness Depth Elevation Zone

Well Name: 517-13-1 Township 5 N. Range 17 W. Sec. 3

Company: N.M.B.M.M.R. Footage: 1200 ft(366m) E. of W. line

Quadrangle: The Dyke 3900 ft(457m) N. of S. line

County: Valencia Field: Salt Lake

Total Depth: 516 ft(157m) Elevation: 7120 ft(2170m)

Mineral Ownership: Federal Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	232 ft(71m)	7120 ft(2170m)
Atarque	232 ft(71m)	24 ft(7m)	6888 ft(2099m)
Rio Salado Tongue	256 ft(78m)	260 ft(79m)	6864 ft(2092m)

Coal

Thickness	Depth	Elevation	Zone

NO COAL

Well Name: 517-24-1 Township 5 N. Range 17 W. Sec. 24

Company: N.M.B.M.M.R. Footage: 2000 ft(610m) E. of W. line

Quadrangle: The Dyke 1500 ft(457m) N. of S. line

County: Valencia Field: Salt Lake

Total Depth: 277 ft(84m) Elevation: 7225 ft(2202m)

Mineral Ownership: Federal Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	277 ft(84m)	7225 ft(2202m)

Coal

Thickness	Depth	Elevation	Zone
3.5 ft(1m)	31 ft(9m)	7194 ft(2193m)	Rabbit
2.2 ft(.7m)	90 ft(27m)	7135 ft(2175m)	Rabbit
3.3 ft(1m)	101 ft(31m)	7124 ft(2171m)	Rabbit

Well Name: 517-7-1 Township 5 N. Range 17 W. Sec. 7

Company: Private Footage: 2000 ft(610m) E. of W. line

Quadrangle: Fence Lake 7000 ft(1372m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 640 ft(m) Elevation:6990 ft(2131m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	0.0	390 ft(119m)	6990 ft(2131m)
Atarque	390 ft(119m)	50 ft(15m)	6600 ft(2012m)
Rio Salado Tongue	440 ft(134m)	200 ft(61m)	6550 ft(1996m)

Coal

Thickness Depth Elevation Zone

Well Name: 517-9-1 Township 5 N. Range 17 W. Sec. 9

Company: Private Footage: 1500 ft(457m) E. of W. line

Quadrangle: Fence Lake 4500 ft(1372m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 355 ft(108m) Elevation: 6980 ft(2128m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	0.0ft	25 ft(8m)	6980 ft(2128m)
Atarque	25 ft(8m)	58 ft(17.6m)	6955 ft(2120m)
Rio Salado Tongue	58 ft(17.6m)	355 ft(108m)	6897 ft(2101m)

Coal

Thickness Depth Elevation Zone

Well Name: 517-27-2 Township 5 N. Range 17 W. Sec. 27

Company: N.M.B.M.M.R. Footage: 600 ft(183m) E. of W. line

Quadrangle: The Dyke 2000 ft(610m) N. of S. line

County: Valencia Field: Salt Lake

Total Depth: 250 ft(76m) Elevation: 7150 ft(2179m)

Mineral Ownership: Federal Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	271 ft(83m)	7150 ft(2179m)

Coal

Thickness	Depth	Elevation	Zone
3.0 ft(.9m)	136 ft(41m)	7014 ft(2138m)	Rabbit

Well Name: 517-27-3 Township 5 N. Range 17 W. Sec. 27

Company: Valencia Footage: 3100 ft(945m) E. of W. line

Quadrangle: The Dyke 3600 ft(1097m) N. of S. line

County: Valencia Field: Salt Lake

Total Depth: 526 ft(161m) Elevation: 7150 ft(2179m)

Mineral Ownership: Federal Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	232 ft(71m)	7150 ft(2179m)
Atarque	232 ft(71m)	53 ft(15m)	6910 ft(2106m)
Rio Salado Tongue	285 ft(87m)	241 ft(73m)	6865 ft(2092m)

Coal

Thickness	Depth	Elevation	Zone
NO COAL			

Well Name:517-31-1 Township 5 N. Range 17 W. Sec. 31

Company:N.M.B.M.M.R. Footage:3000 ft E. of W. line

Quadrangle:Fence Lake SW 4900 ft N. of S. line

County:Cibola Field: Salt Lake

Total Depth:547 ft Elevation:7145 ft

Mineral Ownership:F Surface Ownership:P

Formation	Depth	Thickness	Elevation
Fence Lake gravel	000	45 ft	7145 ft
Upper Moreno Hill	45 ft	177 ft	7100 ft
Moreno Hill middle sand	222 ft	35 ft	6923 ft
Lower Moreno Hill	257 ft	390 ft	6888 ft

Coal

Thickness	Depth	Elevation	Zone

Well Name: 517-34-1 Township 5 N. Range 17 W. Sec. 34

Company: N.M.B.M.M.R. Footage: 100 ftE. of W. line

Quadrangle: Cerro Prieto 2950 ftN. of S. line

County: Valencia Field: Salt Lake

Total Depth: 277 ft Elevation: 6910 ft

Mineral Ownership: Federal Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	204 ft	6910 ft
Atarque	204 ft	35 ft	6706 ft
Rio Salado	239 ft	38 ft	6671 ft

Coal

Thickness	Depth	Elevation	Zone
3.2 ft	170 ft	6740 ft	Antelope
2.0 ft	191 ft	6719 ft	Antelope

Well Name: 517-25-1 Township 5 N. Range 17 W. Sec. 25

Company: N.M.B.M.M.R. Footage: 2000 ft(610m) E. of W. line

Quadrangle: The Dyke 2000 ft(610m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth:263 ft(80m) Elevation: 7340(2237m)

Mineral Ownership:F Surface Ownership:P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	263 ft(80m)	7340(2237m)

Coal

Thickness	Depth	Elevation	Zone
1.4 ft(.4m)	44 ft(13m)	7327 ft(2233m)	Rabbit
1.2 ft(.4m)	81 ft(25m)	7324 ft(2232m)	Rabbit
7.5 ft(2.3m)	112 ft(34m)	7335 ft(2233m)	Rabbit
3.8 ft(1.1m)	193 ft(59m)	7339 ft(2233m)	Cerro Prieto

Well Name: 517-25-3 Township 5 N. Range 17 W. Sec. 25

Company: N.M.B.M.M.R. Footage: 4700 ft(1433m) E. of W. line

Quadrangle: The Dyke 4100 ft(1250m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 252 ft(77m) Elevation: 7340 ft(2237m)

Mineral Ownership: Federal Surface Ownership: Private

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	252 ft(77m)	7340 ft(2237m)

Coal

Thickness	Depth	Elevation	Zone
3.6 ft(1.1m)	70 ft(21m)	7270 ft(2216m)	Rabbit
1.2 ft(.37m)	74 ft(23m)	7266 ft(2215m)	Rabbit
3.1 ft(.91m)	100 ft(30m)	7240 ft(2207m)	Rabbit

Well Name: 518-1-1 Township 5 N, Range 18 W, Sec. 1

Company: Private Footage: 3000 ft(914m) E. of W. line

Quadrangle: Fence Lake 200 ft(61m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 360 ft(110m) Elevation: 6950 ft(2118m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	175 ft(53m)	6950 ft(2118m)
Atarque	175 ft(53m)	50 ft(19m)	6775 ft(2065m)
Rio Salado	225 ft(75m)	135 ft(41m)	6725 ft(2050m)

Coal

Thickness Depth Elevation Zone

Well Name: 518-3-1 Township 5 N, Range 18 W, Sec. 3

Company: Private Footage: 3300 ft(1005m) E. of W. line

Quadrangle: Fence Lake 2400 ft(732m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 340 ft(104m) Elevation: 6935 ft(2114m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	195 ft(59m)	6935 ft(2114m)
Atarque	195 ft(59m)	50 ft(15m)	6740 ft(2054m)
Rio Salado	245 ft(75m)	90 ft(27m)	6690 ft(2039m)

Coal

Thickness Depth Elevation Zone

Well Name: 518-6-1 Township 5 N, Range 18 W, Sec. 6

Company: Private Footage: 1100 ft(535m) E. of W. line

Quadrangle: Rincon Hondo 2100 ft(640m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 193 ft(59m) Elevation: 7040 ft(2146m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Fence Lake gravel	000	97 ft(30m)	7040 ft(2146m)
Lower Moreno Hill	97 ft(30m)	17 ft(5m)	6943 ft(2116m)
Atarque	114 ft(42m)	25 ft(8m)	6926 ft(2111m)
Rio Salado Tongue	139 ft(42m)	54 ft(16m)	6901 ft(2103m)

Coal

Thickness	Depth	Elevation	Zone
1.5 ft	102 ft	6938 ft	Antelope

Well Name: 518-11-1 Township 5 N, Range 18 W, Sec. 11

Company: Private Footage: 4900 ft(1494m) E. of W. line

Quadrangle: Fence Lake 700 ft(213m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 700 ft(213m) Elevation:6990 ft(2131m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	0.0	375 ft(114m)	6990 ft(2131m)
Atarque	175 ft(53m)	50 ft(15m)	6615 ft(2016m)
Rio Salado Tongue	225 ft(42m)	275 ft(84m)	6565 ft(2001m)

Coal

Thickness	Depth	Elevation	Zone

Well Name: 517-26-1 Township 5 N. Range 17 W. Sec. 26

Company: N.M.B.M.M.R. Footage: 600 ft(183m) E. of W. line

Quadrangle: The Dyke 2000 ft(610m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 280 ft(85m) Elevation: 7200 ft(2195m)

Mineral Ownership: Federal Surface Ownership: Private

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	280 ft(85m)	7200 ft(2195m)

Coal

Thickness	Depth	Elevation	Zone
2.6 ft(.8m)	162 ft(49m)	7038 ft(2145m)	Rabbit
3.4 ft(1m)	188 ft(57m)	7012 ft(2137m)	Rabbit

Well Name: 517-27-1 Township 5 N. Range 17 W. Sec. 27

Company: N.M.B.M.M.R. Footage: 4300 ft(1311m) E. of W. line

Quadrangle: The Dyke 4900 ft(1494m) N. of S. line

County: Valencia Field: Salt Lake

Total Depth: 290 ft(88m) Elevation: 7150 ft(2179m)

Mineral Ownership: Federal Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	290 ft(88m)	7150 ft(2179m)

Coal

Thickness	Depth	Elevation	Zone
3.5 ft(1m)	33 ft(10m)	7117 ft(2169m)	Rabbit
2.2 ft(.7m)	99 ft(30m)	7051 ft(2149m)	Rabbit

Thickness Depth Elevation Zone

Well Name: 518-17-1 Township 5 N. Range 18 W. Sec. 17

Company:N.M.B.M.M.R. Footage: 1600 ft E. of W. line

Quadrangle: Rincon Hondo 2500 ft N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 369 ft Elevation: 7220 ft

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Fence Lake gravel	000	92 ft	7220 ft
Lower Moreno Hill	92 ft	277 ft	7128 ft

Coal

Thickness	Depth	Elevation	Zone
2.0 ft	303 ft	6917 ft	Antelope

Well Name: 518-28-1 Township 5 N. Range 18 W. Sec. 28

Company: N.M.B.M.M.R. Footage: 3400 ft E. of W. line

Quadrangle: Rincon Hondo 3700 ft N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 606 ft Elevation: 7435 ft

Mineral Ownership: F Surface Ownership: P

Formation	Depth	Thickness	Elevation
Fence Lake Gravel	000	60 ft	7435 ft
Upper Moreno Hill	60 ft	150 ft	7375 ft
Moreno Hill Middle sand	210 ft	20 ft	7225 ft
Lower Moreno Hill	230 ft	376 ft	6995 ft

Coal

Thickness	Depth	Elevation	Zone

Well Name: 518-29-1 Township 5 N. Range 18 W. Sec. 29

Company: Private Footage: 3500 ft(1067m) E. of W. line

Quadrangle: Rincon Hondo 400 ft(122m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 295 ft(90m) Elevation: 7460 ft(2274m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Fence Lake Gravel	000	55 ft(17m)	7460 ft(2274m)
upper Moreno Hill	55 ft(17m)	170 ft(52m)	7405 ft(2257m)
Moreno Hill middle sand	225 ft(69m)	40 ft(12m)	7235 ft(2205m)
Lower Moreno Hill	265 ft(81m)	30 ft(s9m)	7195 ft(2193m)

Coal

Thickness	Depth	Elevation	Zone
1.5 ft(.5m)	155 ft(47m)	7305 ft(2227m)	Twilight
2.0 ft(.6m)	170 ft(52m)	7290 ft(2222m)	Twilight
1.5 ft(.5m)	178 ft(54m)	7282 ft(2220m)	Twilight

Well Name:518-29-1A Township 5 N. Range 18 W. Sec. 29

Company: Private Footage: E. of W. line

Quadrangle: Rincon Hondo N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 495 ft(151m) Elevation: 7640 ft(2329m)

Mineral Ownership: Surface Ownership:

Formation	Depth	Thickness	Elevation
Fence Lake Gravel	000	57 ft(17m)	7460 ft(2274m)
Upper Moreno Hill	57 ft(17m)	183 ft(56m)	7403 ft(2256m)
Moreno Hill middle sand	240 ft(73m)	25 ft(3m)	7220 ft(2201m)
Lower Moreno Hill	265 ft(81m)	230 ft(70m)	7195 ft(2193m)

Coal

Well Name: 518-31-1 Township 5 N. Range 18 W. Sec. 31

Company: Private Footage: 3600 ft(1097m) E. of W. line

Quadrangle: Moreno Hill 3100 ft(945m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 390 ft(119m) Elevation: 7500 ft(2286m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Upper Moreno Hill	000	140 ft(43m)	7500 ft(2286m)
Moreno Hill middle sand	141 ft(43m)	25 ft(8m)	7359 ft(2243m)
Lower Moreno Hill	166 ft(51m)	125 ft(38m)	7193 ft(2192m)

Coal

Thickness	Depth	Elevation	Zone

Well Name:518-33-1 Township 5 N. Range 18 W. Sec. 33

Company:Private Footage: 1600 ft(488m) E. of W. line

Quadrangle:Fence Lake 2800 ft(853m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 375 ft(114m) Elevation: 7290 ft(2222m)

Mineral Ownership:P Surface Ownership:P

Formation	Depth	Thickness	Elevation
Fence Lake gravel	000	55 ft(17m)	7290 ft(2222m)
Upper Moreno Hill	55 ft(17m)	30 ft(9m)	7235 ft(2205m)
Moreno Hill middle sand	85 ft(26m)	35 ft(11m)	7205 ft(2196m)
Lower Moreno Hill	120 ft(37m)	255 ft(78m)	7170 ft(2185m)

Coal

Thickness	Depth	Elevation	Zone
1.3 ft(.4m)	250 ft(76.2m)	7040 ft(2146m)	Rabbit
1.6 ft(.5m)	207 ft(63m)	7083 ft(2160m)	Rabbit

Well Name: 519-19-1

Township 5 N. Range 19 W. Sec. 19

Company:Private

Footage: 800 ft(244m) E. of W. line

Quadrangle: Cantaralo Spring

1600 ft(488m) N. of S. line

County: Cibola

Field: Salt Lake

Total Depth: 490 ft(149m)

Elevation:7190 ft(2192m)

Mineral Ownership:P

Surface Ownership:P

Formation	Depth	Thickness	Elevation
Fence Lake gravel	000	80 ft(24m)	7190 ft(2192m)
Upper Moreno Hill	80 ft(24m)	37 ft(11m)	7110 ft(2167m)
Moreno Hill middle sand	117 ft(36m)	20 ft(6m)	7073 ft(2156m)
Lower Moreno Hill	137 ft(42m)	73 ft(22m)	7053 ft(2150m)
Atarque	210 ft(64m)	45 ft(14m)	6980 ft(2128m)
Rio Salado	255 ft(78m)	235 ft(72m)	6935 ft(2114m)

Coal

Thickness	Depth	Elevation	Zone
2.0 ft(.6m)	167 ft(51m)	7023 ft(2141m)	Twilight

Well Name: 519-21-1 Township 5 N. Range 19 W. Sec. 21

Company: Private Footage: 1800 ft(549m) E. of W. line

Quadrangle: Rincon Hondo 200 ft(61m) N. of S. line

County: Cibola Field: Salt Lake

Total Depth: 500 ft(152m) Elevation: 7260 ft(2213m)

Mineral Ownership: P Surface Ownership: P

Formation	Depth	Thickness	Elevation
Fence Lake Gravel	000	70 ft(21m)	7280 ft(2219m)
Upper Moreno Hill	70 ft(21m)	201 ft(61m)	7190 ft(2192m)
Moreno Hill Middle sand	271 ft(83m)	26 ft(8m)	6989 ft(2130m)
Lower Moreno Hill	297 ft(91m)	48 ft(15m)	6963 ft(2122m)
Atarque	345 ft(105m)	50 ft(15m)	6915 ft(2108m)
Rio Salado	395 ft(120m)	105 ft(32m)	6865 ft

Coal

Thickness	Depth	Elevation	Zone
1.5 ft	301 ft	6959 ft	Antelope

Well Name: 519-30-1

Company: Private

Quadrangle: Rincon Hondo

County: Cibola

Total Depth: 395 ft

Mineral Ownership: P

Township 5 N, Range 19 W, Sec. 30

Footage: 1800 ft E. of W. line

4900 ft N. of S. line

Field: Salt Lake

Elevation: 7220 ft

Surface Ownership: P

Formation	Depth	Thickness	Elevation
Fence Lake gravel	000	115 ft	7220 ft
Upper Moreno Hill	115 ft	145 ft	7105 ft
Moreno Hill middle sand	260 ft	60 ft	6960 ft
Lower Moreno Hill	320 ft	75 ft	6900 ft

Coal

Thickness	Depth	Elevation	Zone
1.2	250	6970 ft	Twilight

Well Name: 616-33-1

Company: N.M.B.M.M.R.

Quadrangle: The Dyke

County: Cibola

Total Depth: 280

Mineral Ownership: Federal

Township 6 N. Range 16 W. Sec. 33

Footage: 3650 E. of W. line

3300 N. of S. line

Field: Salt Lake

Elevation: 7220

Surface Ownership:

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000	280 ft	7220 ft

Coal

Thickness	Depth	Elevation	Zone
2.5 ft	40 ft	7180 ft	Rabbit
2.4 ft	82 ft	7138 ft	Rabbit
3.8 ft	96 ft	7124 ft	Rabbit
1.6 ft	111 ft	7109 ft	Rabbit

Well Name: 617-33-1

Company: Private

Quadrangle: Fence Lake

County: Cibola

Total Depth: 390 ft

Mineral Ownership: P

Township 6 N. Range 17 W. Sec. 33

Footage: 3400 ft E. of W. line

5100 ft N. of S. line

Field: Salt Lake

Elevation: 6950 ft

Surface Ownership: P

Formation	Depth	Thickness	Elevation
Lower Moreno Hill	000 ft	190 ft	6950 ft
Atarque	190 ft	25 ft	6760 ft
Rio Salado	215 ft	175 ft	6735 ft

Coal

Thickness	Depth	Elevation	Zone

Well Name:720-9-1

Company: Private

Quadrangle: Venadito Camp

County: Cibola

Total Depth:195 ft

Mineral Ownership:P

Township 7 N. Range 20 W. Sec. 9

Footage:4300 ft E. of W. line
4600 ft N. of S. line

Field: Salt Lake

Elevation:6430 ft

Surface Ownership:P

Formation	Depth	Thickness	Elevation
Bidahochi(?)	000 ft	49 ft	6430 ft
Upper Moreno Hill	49 ft	62 ft	6381 ft
Moreno Hill middle sand	111 ft	24 ft	6319 ft
Lower Moreno Hill	135 ft	60 ft	6295 ft

Coal

Thickness	Depth	Elevation	Zone
5.0 ft	147 ft	6283 ft	Antelope

R17W | R16W

T5N / T4N

T5N / T4N

R17W | R16W

o 516-19-1
170'

o 516-30-1
265'

o 417-3-1 o
45'

o 417-14-1
135'

o 417-23-1
100'

o 417-13-1
165'

o 416-10-1
250'

o 416-22-1
240'

o 416-31-1
57'

250'

200'

150'

100'

50'

OPEN FILE – 145

OVERBURDEN ISOPACH CERRO PRIETO ZONE

Contour Interval 50'

Scale 1:48000

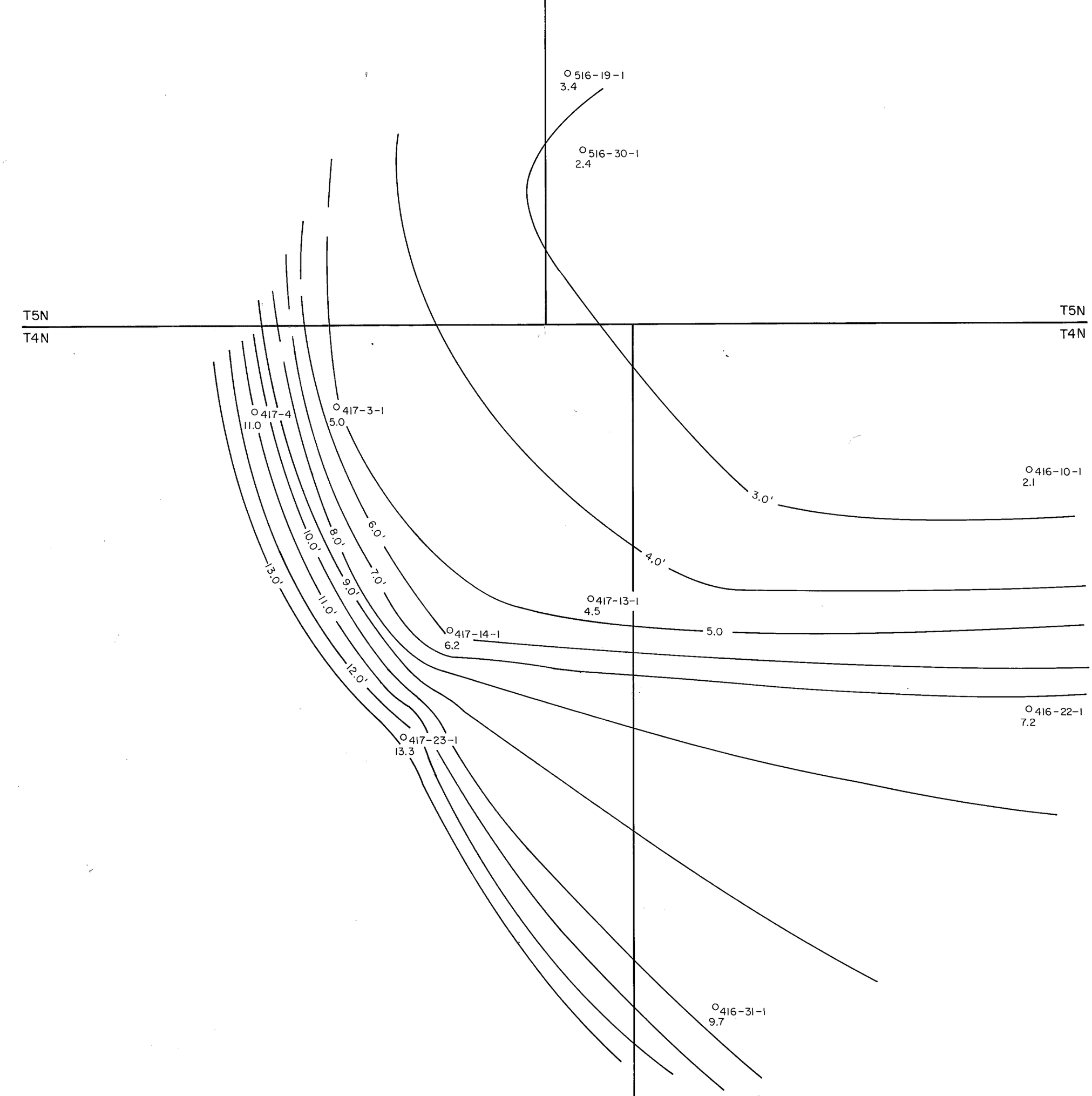
Drawing No. 1 of 11

R17W | R16W

T5N / T4N

T5N / T4N

R17W | R16W



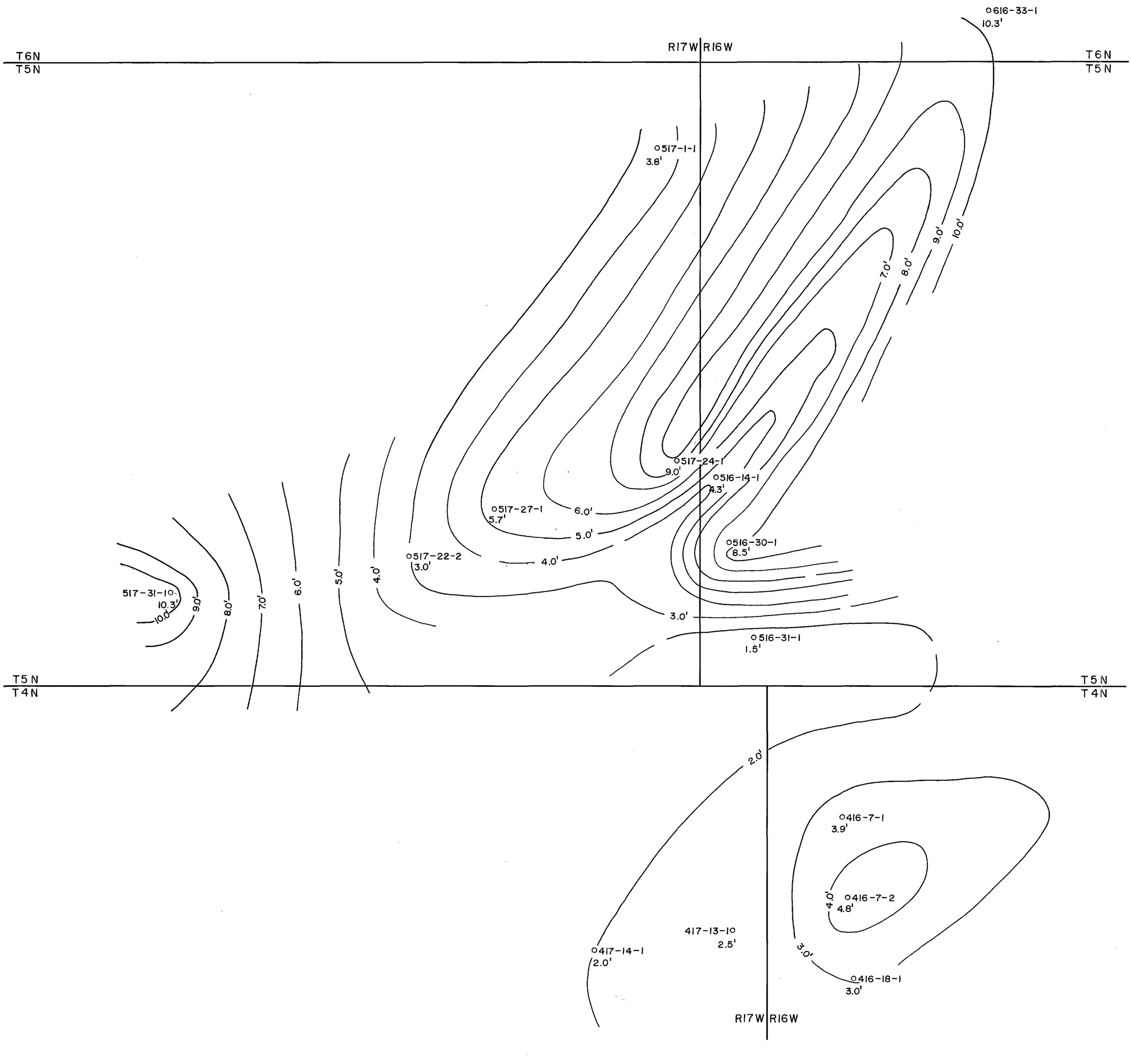
R17W | R16W

OPEN FILE – 145

COAL ISOPACH CERRO PRIETO ZONE

Contour Interval 1.0'

Scale 1:48000 | Drawing No. 2 of 11



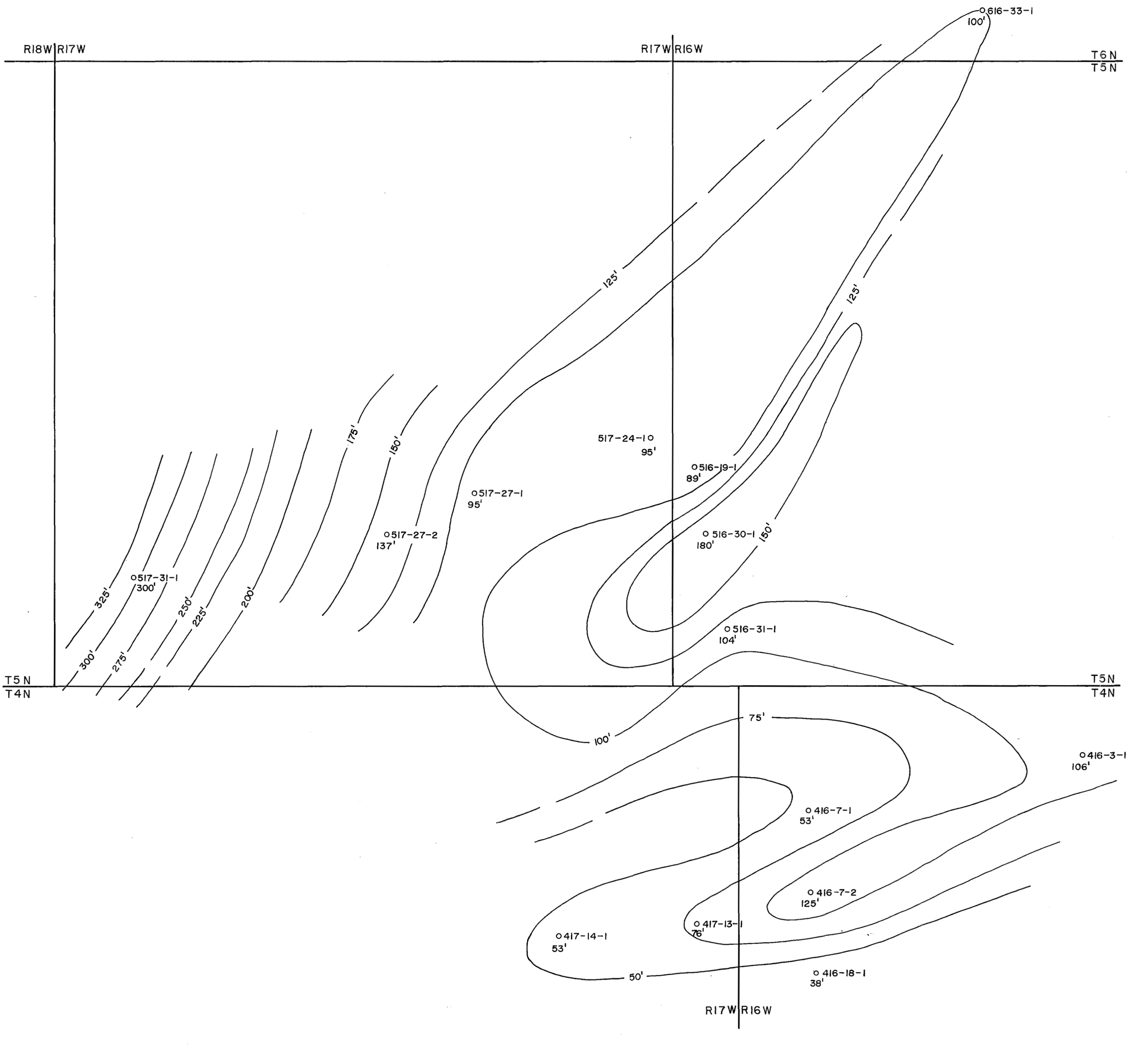
OPEN FILE – 145

COAL ISOPACH RABBIT ZONE

Contour Interval 1.0'

Scale 1:48000

Drawing No. 3 of 11

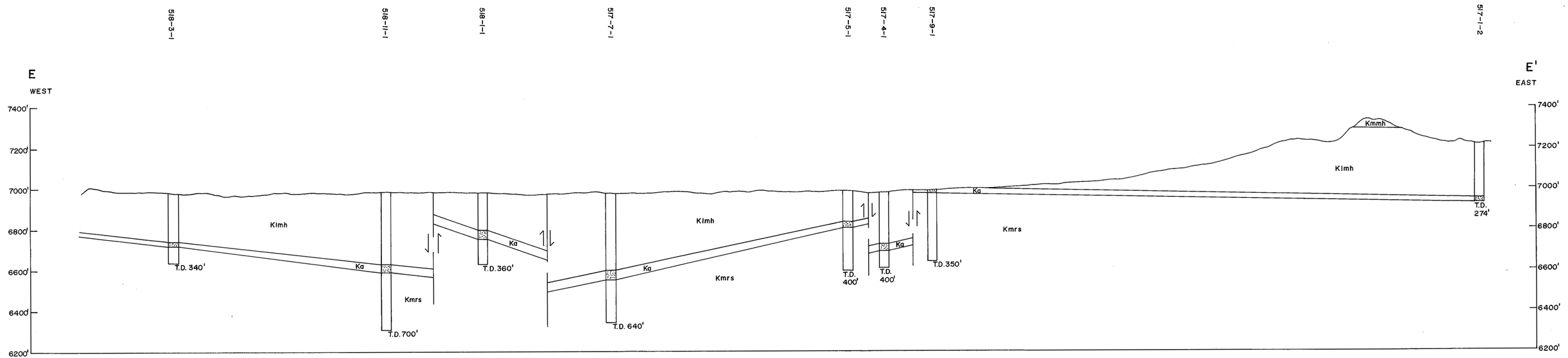


OPEN FILE — 145

OVERBURDEN ISOPACH RABBIT ZONE

Contour Interval 25'

Scale 1:48000 | Drawing No. 4 of 11

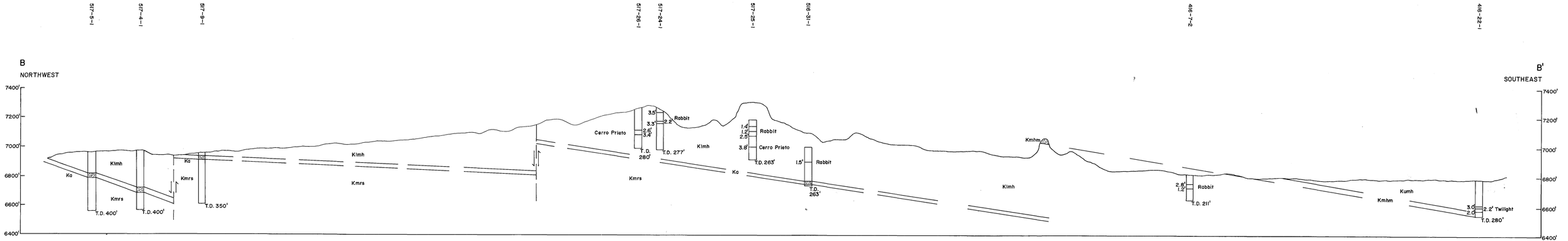


OPEN FILE – 145

CROSS-SECTION E–E'

Horiz. Scale 1:48000 Vert. Scale 1"=300'

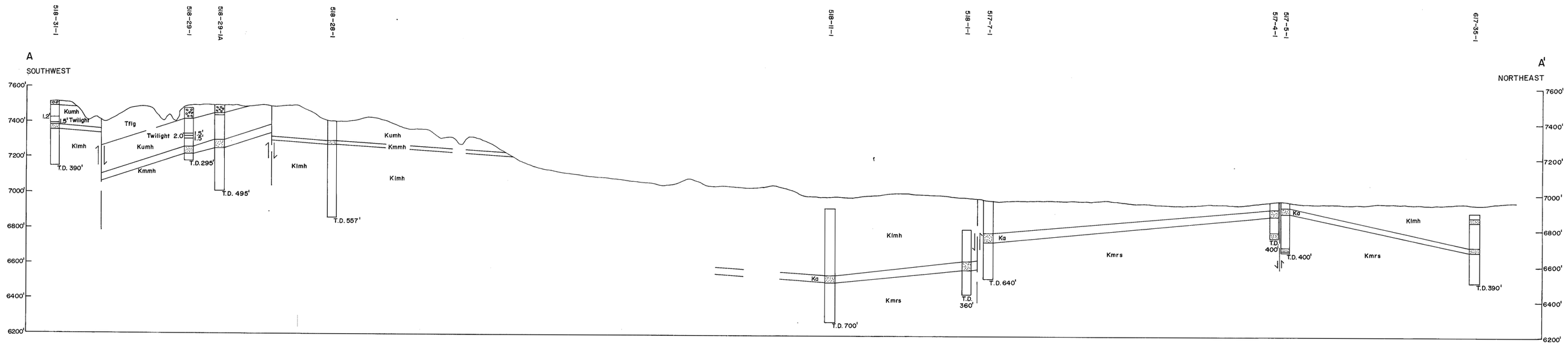
Drawing No. 5 of 11



OPEN FILE – 145

CROSS-SECTION B–B'

Horiz. Scale 1:48000 Vert. Scale 1"=300' | Drawing No. 6 of 11

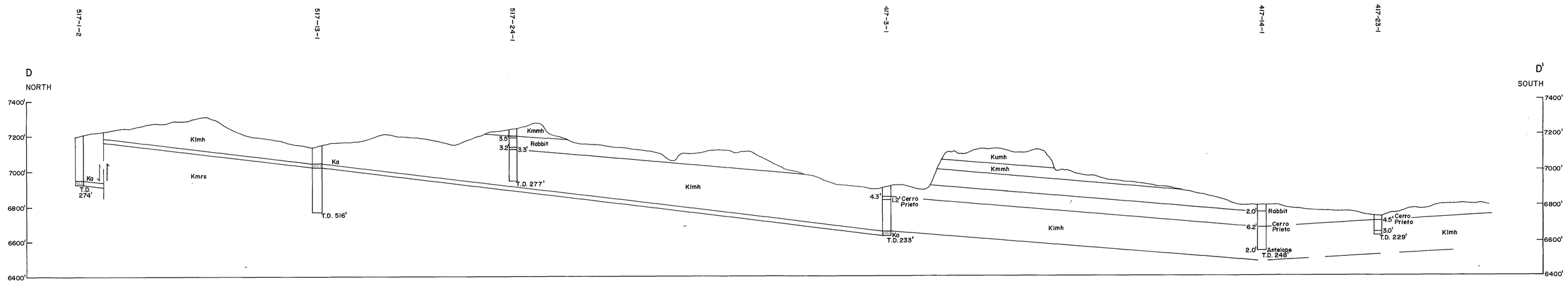


OPEN FILE – 145

CROSS-SECTION A–A'

Horiz. Scale 1:48000 Vert. Scale 1"=300'

Drawing No. 7of11

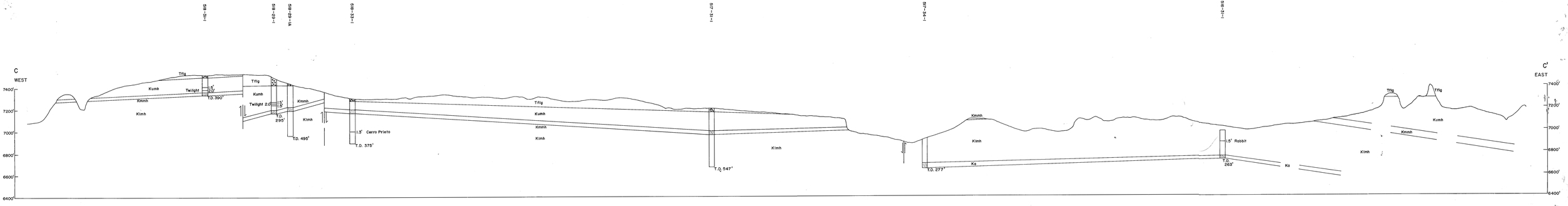


OPEN FILE – 145

CROSS-SECTION D–D'

Horiz. Scale 1:48000 Vert. Scale 1"=300'

Drawing No. 8of11



OPEN FILE – 145

CROSS-SECTION C–C'

Horiz. Scale 1:48000 Vert. Scale 1"=300' | Drawing No. 9 of 11

OPEN FILE — 145

CONTOUR MAP TOP OF MIDDLE SAND OF MORENO HILL FORMATION

Contour Interval 50'

Scale 1:48000	Drawing No. 10 of 11

R20W R19W | R19W R18W | R18W R17W | R17W R16W

T6N / T5N

T5N / T4N

R20W R19W | R19W R18W | R18W R17W | R17W R16W

520-3-1
6735'

520-13-1
6960'

519-19-1
6980'

519-30-1
6960'

519-21-1
6915'

6950'

6900'

518-6-1
6926'

6900'

6850'

6800'

6750'

518-31-1

518-33-1

518-3-1
6740'

518-1-1
6775'

518-11-1
6615'

517-7-1
6600'

6650'

418-11-1

617-33-1
6760'

517-5-1
6830'

517-4-1
6727'

517-9-1
6955'

517-1-2
7120'

7100'

7050'

7000'

6950'

517-13-1
6888'

517-27-1
6915'

517-26-1
6930'

6900'

6850'

6800'

517-34-1
6706'

6750'

6700'

516-31-1
6777'

6600'

6650'

6550'

417-8-1
6470'

6500'

6450'

OPEN FILE – 145

CONTOUR MAP TOP OF ATARQUE

Contour Interval 50'

Scale 1:48000 | Drawing No. 11 of 11