



The environment and coal development in the San Juan Basin, New Mexico

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THE ENVIRONMENT AND COAL DEVELOPMENT IN THE SAN JUAN BASIN, NEW MEXICO

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INTRODUCTION

In 1952 when the gas and oil boom came to the San Juan Basin, environmental issues were not a major developmental consideration of the energy producing industries. Now, a little over twenty years later, the entire future of mineral and energy producing endeavors is based on the acquisition of environmental clearances from regulatory agencies. The present energy producing effort in northwest New Mexico to be tested by the rigors of environmental regulation is the development of the Fruitland coals of the San Juan Basin.

This paper is not intended to be a self-styled environmental impact statement but rather it is intended to familiarize the reader with environmental conditions in the San Juan Basin and to show that the basin, in comparison with other coal bearing environments, will exhibit minimal environmental degradation after surface mining. That is to say, on a national scale, the development of the San Juan Basin coal lands presents a high ratio of environmental benefits compared with environmental liabilities. The effects on renewable and non-renewable resources altered by energy development should be beneficial in terms of biological productivity and scientific information.

In describing the environmental setting of the area, the San Juan Basin illustrates a gradient or ecocline of environmental conditions along an imaginary line bisecting the basin in a northeast direction. The basin can be categorized into several community types by analyzing varying environmental conditions along this line which is depicted on Figure 1. Line A-B, shown as a surface cross-section on Figure 2, traverses the major surface features and habitats of the basin, and crosses the area between Dulce and Chaco Canyon, New Mexico.

ENVIRONMENTAL SETTING

Topography

The San Juan Basin, a physiographic subdivision of the Colorado Plateau, lies in northwestern New Mexico at the edge of the cool temperate desert grassland biome. The northeast and east flanks of the basin are characterized by high mesas composed of resistant sandstones and shales of the San Jose Formation, ranging in elevation from 6500 to approximately 8000 feet above sea level. This broken land is laden with steep slopes and precipitous canyons with narrow valley floors. Drainages in this region consist of both ephemeral sandy bottomed washes and perennial riparian environments (Maker, et al., 1973).

The southwestern flank of the basin is a relatively featureless rolling plain ranging in elevation from 5500 to 6500 feet. This plain is frequently dissected by badland areas developed on the soft sands and shales of the Cretaceous Fruitland and Kirtland formations. These badlands usually occur along established drainages. Relief in the badlands is abrupt, many times approaching 100 feet. Drainages in this portion of the

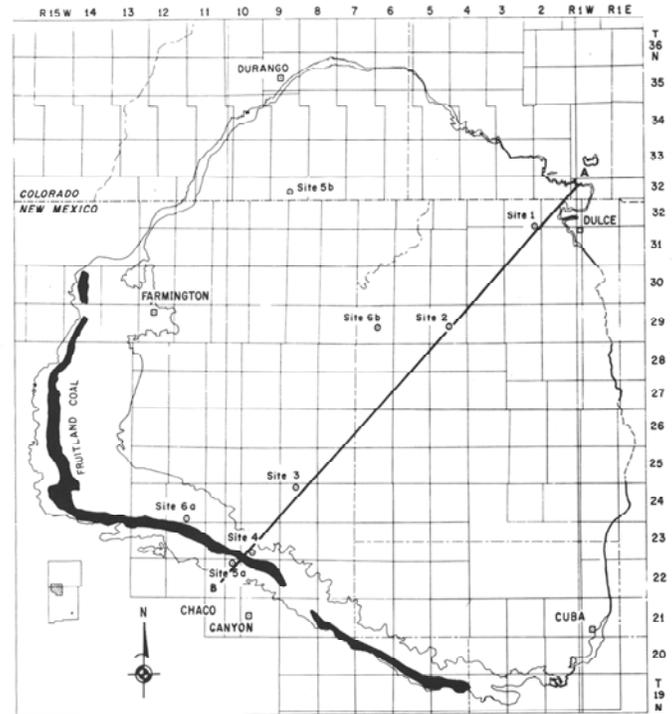


Figure 1. Index map of the San Juan Basin. Outcropping rocks rimming the basin are the Fruitland Formation-Kirtland Shale, undivided. Shaded area is the outcrop of the coal-bearing part of the Fruitland Formation. Trace of surface cross-section line A-B (fig. 2) and site locations are shown. Map is after Fassett and Hinds (1971).

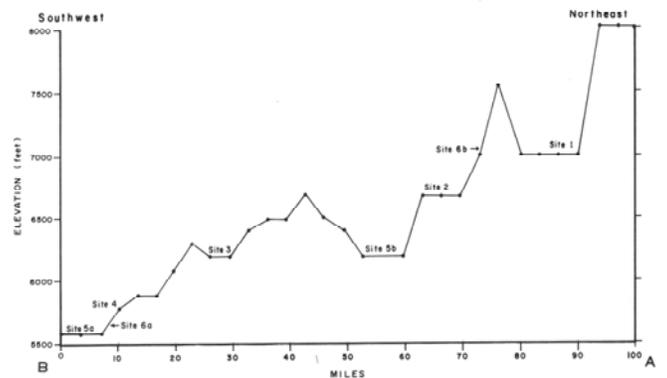


Figure 2. Surface cross section across the San Juan Basin from the vicinity of Dulce, New Mexico, to south of Chaco Canyon. Trace of cross section is shown on Figure 1. Numbered site locations are shown.

basin, such as the Chaco River and its tributaries, are characteristically wide, flat, sandy bottomed washes.

Climatology

The climate of the San Juan Basin exemplifies large annual and diurnal fluctuations in temperature, sparse precipitation, low relative humidity, moderate to severe winds and little cloudiness (U.S. Dept. of Commerce, 1965).

The range in temperature and precipitation across the basin from A to B (fig. 1) is significant because of topography and orthographic lifting. The mean annual temperature ranges across the basin from 43.8°F (Dulce) to 50.5°F (Chaco Canyon). Temperature extremes have been documented to range from -48°F to 102°F in the northeast (Dulce) to from -24°F to 106°F in the southwest (Chaco Canyon). The growing season ranges from approximately 90 frost free days near point A to 139 frost free days near point B. Lower elevations in the basin such as Farmington may experience 170 frost free days.

Precipitation across the basin also varies greatly. The northeast flank has a mean total precipitation of 17 inches per year while the southwestern areas average 8 inches per year. The form in which this precipitation falls is subject to several meteorological and physiographic parameters. In the San Juan Basin, the majority of precipitation falls in the form of rain during highly intense thunderstorms, usually in July and August. Snow fall occurs from November through April and ranges from 61 inches near Dulce to 18 inches near Chaco Canyon; this snow fall contains little moisture as reflected in the total precipitation figures.

Drainage

The San Juan Basin encompasses parts of two large watersheds, the San Juan River Basin and the Rio Grande basin. These two watersheds are separated by the Continental Divide which runs along the east and southeast flanks of the geologic basin. Most of the San Juan Basin is in the San Juan River Basin. Surface water in the area is limited to perennial streams and ephemeral drainages during periods of runoff following brief thunderstorms. Perennial streams include the Pine, Animas, La Plata, Navajo and Piedra Rivers; all tributaries to the San Juan River. The major ephemeral drainages, all arising in New Mexico, include La Jara Creek, Gobernador Canyon, Carion Largo and the Chaco River. The southeast portion of the basin, which lies in the Rio Grande drainage, is drained by the Rio Puerco, also an ephemeral stream (New Mexico State Engineer Office, 1967).

Ground water in any appreciable quantities is very deep and hard to find. Except in shallow alluvium along valley floors and shallow sandstones in the San Jose and Nacimiento formations, water is of poor quality, many times unfit for human as well as livestock consumption. It is a general assumption that deeper aquifers, though containing larger quantities of water, yield poor quality water. The best possibility for large quantities of water lies in the Morrison Formation and Entrada sandstones which range in depth from 5000 to 6000 feet towards the center of the basin. Water from these units, however, may be of poor quality.

Vegetation

The floral makeup of the San Juan Basin is exemplary of much of the southwestern high desert areas. For purposes of

simplicity, only "pure" types will be discussed; "pure" meaning those communities or types that are extensive in nature and are characterized by a few principal species. Those that are mixtures of types or form edge communities (ecotones) will be bypassed. Under these criteria, six types, two of which are named by land form, have been delineated with their locations plotted on Figure 1 and 2 in order of occurrence across the basin (VTM Colorado, 1975), to wit: pine/oak/mixed shrub woodland (site 1); pinyon/juniper woodland (site 2); sagebrush/grassland (site 3); saltbrush/grassland (site 4); riparian/wash woodland (site 5a and 5b); and badland/rockland (site 6a and 6b).

The occurrence of vegetative communities in this portion of the country is a function of many environmental parameters; mainly, climate, soils and topography (primary elevation and aspect). On the high mesa and canyon country of the northeast flank of the basin above 7000 feet, the pine/oak/mixed shrub woodland can be found (site 1, fig. 3). This type usually occurs on north facing slopes or in small canyons where light and moisture regimes are most advantageous to plant growth. Principal species include ponderosa pine (*Pinus ponderosa*), pinyon pine (*Pinus edulis*), Gambel oak (*Quercus gambelii*), bitterbush (*Purshia tridentata*), mountain-mahogany (*Cercocarpus montanus*), and muttongrass (*Poa fendleriana*). In terms of productivity this type has value for grazing, timber production, wildlife and recreation.

The pinyon/juniper woodland communities (site 2, fig. 4) are a common type in the San Juan Basin. This vegetative cover occupies the draws and rock outcrops of lower elevations where moisture is apparent, and the mesa tops and canyon slopes from 7000 to 8000 feet. The flora considered here is usually supported by shallow soils where bedrock containing needed moisture is not far beneath the surface. Juniper, which is more tolerant to water deficiencies and intolerant to shade compared with pinyon, occurs in pure stands on south facing slopes. Principal species include pinyon pine, juniper (*Juni-perus ostpeosperma*), black sagebrush (*Artemisia nova*), rabbit-brush (*Chrysothamnus nauseosus*) and Indian ricegrass (*Ory-zopsis hymenoides*). This type produces grazing, wildlife habi-tat and utility wood.



Figure 3. Pine/oak/mixed shrub woodland.

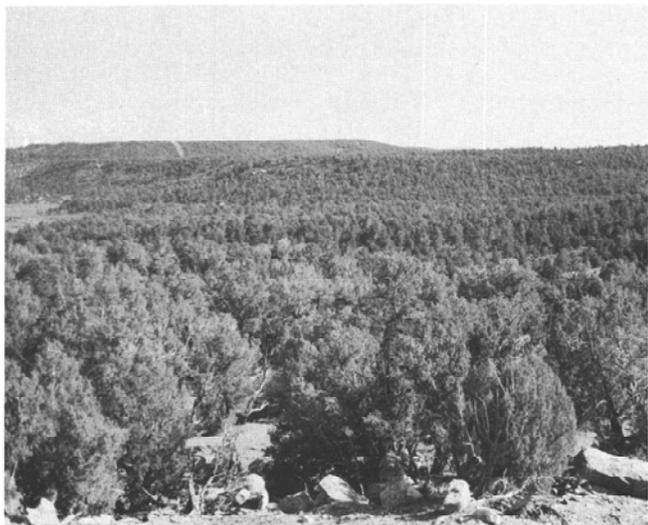


Figure 4. Pinyon/juniper woodland.

The sagebrush/grassland communities (site 3, fig. 5) occur in relatively deep alluvium where alkaline salts are not prohibitive. These areas occur in canyons and small valleys to the northeast and on rolling lowlands to the southwest where the moisture holding capacity of the soil is optimum. Principal species include big sagebrush (*Artemisia* spp.), rabbitbrush, winterfat (*Eurotia lanata*), western wheatgrass (*Agropyron smithii*), cheatgrass (*Bromus tectorum*) and blue grama (*Bouteloua gracilis*). This type is of importance for livestock grazing.

The fourth extensive vegetative type consists of the saltbush/grassland communities. These occur primarily on the lowlands (site 4, fig. 6) where alkaline and sodic conditions are evident. Soils tend to range from sandy loams to clay, and precipitation is at its minimum where this type occurs. Principal species in the saltbush/grassland communities are four-winged saltbush (*A. triplex canescens*), Mormon tea (*Ephedra viridis*), rabbit-brush, galleta (*Hilaria jamesii*), sand dropseed (*Sporobolus crytandrus*) and alkali sacaton (*Sporobolus airoides*). The principal land use in these areas is the grazing of livestock.

The riparian/wash woodland communities (site 5a and 5b, fig. 7) exist where moisture is apparent year long, or at least appears periodically during runoff events. Along perennial streams with deep sandy alluvial soils, this type is well developed and supports a diversity of plant species; those drainages that are ephemeral support little vegetation and are often characterized by wide, flat, sandy bottomed washes bordered by greasewood. The perennial as well as ephemeral drainageways, that consist of clayey, poorly drained bottom lands or areas where subsurface water evaporates at the surface, exhibit salt concentrations and are highly alkaline.



Figure 5. Sagebrush/grassland.

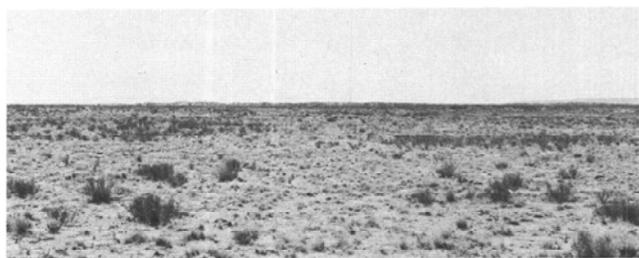


Figure 6. Saltbush/grassland.

Plant species common to this type are Fremont's cottonwood (*Populus fremontii*), tamarisk (*Tamarisk pentandra*), black greasewood (*Sarcobatus vermiculatis*), willow (*Salix* spp.), rabbitbrush and cheatgrass. This type represents the most productive vegetative community in the basin because of the presence of water to support growth. However, the highly developed communities occupy limited areas along perennial streams such as the San Juan, Animas, Pine and Piedra rivers. Land uses include intense irrigated agriculture, livestock grazing, wildlife habitat and recreation. The perennial streams mentioned previously support substantial fisheries.

The last major type is composed of two land form conditions—badlands and rocklands (site 6a and 6b, fig. 8). The majority of badland areas occur in the non-marine shales of the Fruitland, Kirtland and Nacimiento formations in the southwest portion of the basin. Rockland conditions are frequent along the eroded edges of the resistant sandstones of the Ojo Alamo and San Jose formations. The badland formations are composed of saline and high sodium clay shales and are highly erodable. Their surfaces are extremely friable and support little or no vegetation. Much of the vegetation that does exist is comprised basically of Russian thistle (*Salsola kali*) and black greasewood. The rockland areas that appear along mesa edges and steep canyon walls are very rugged sites, and may support varied forms of vegetation such as juniper, mountain-mahogany, squawcurrent (*Ribes* spp.), rabbitbrush, sorrel (*Rumex* spp.), side-oats gramma (*Bouteloua curtispindula*) and three awn (*Aristida* spp.). Rockland sites tend to be more mesic than badland areas due to the water contained and transferred through the sandstone bedrock. Land uses of the badland areas are limited to rock and fossil hunting and aesthetic enjoyment; badlands are of little value to livestock and wildlife. Rockland areas afford habitat but limited grazing because of the nature of the terrain.

Wildlife

The wildlife of the San Juan Basin is varied, typical of an area that is made up of many vegetation types. The published ranges of over 100 bird species, 30 mammals and 30 reptiles overlap the basin. The northeast flank of the basin supports substantial populations of large herbivores such as the mule deer (*Oa'ocolleus hemionus*), and elk (*Cervus canadensis*). Elk are primarily found in the pine/oak/mixed shrub habitats where water, forage and cover are prevalent. Deer can be found over much of the basin but primarily exist in the pine/oak/mixed shrub, pinyon/juniper, rockland and riparian types where browse is abundant. The Pronghorn (*Antilocapra americana*) occupy the flat rolling lands to the west and southwest portions of the basin. Populations are low and prime habitat is not extensive.

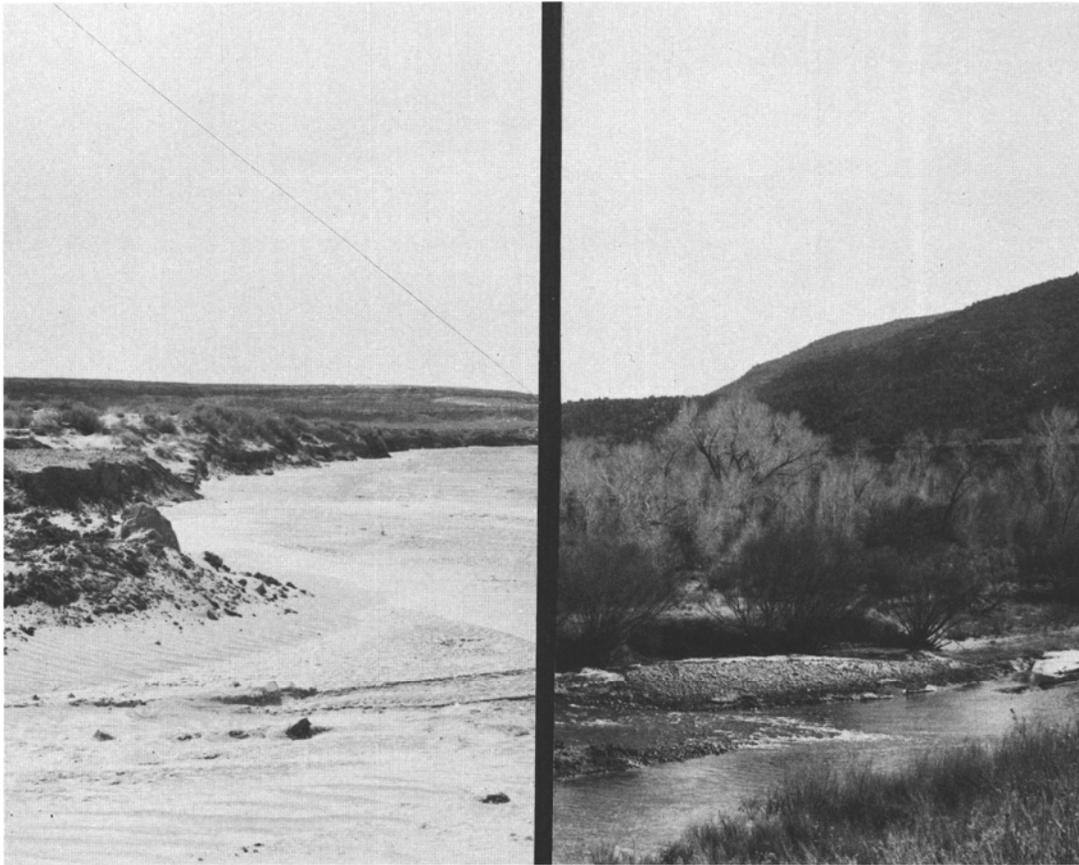


Figure 7. Riparian/wash woodland.

Waterfowl frequent the San Juan River drainage, and nesting areas are provided by the riparian habitat adjacent to the river. Navajo Dam, located on the San Juan River in the northernmost part of New Mexico, is utilized by waterfowl as a stopping point in spring and fall migrations. Limited surface water in the rest of the basin limits waterfowl use. Many small mammals and rodents occupy the basin and constitute, along with reptiles and avifauna, the major faunal element in the southwestern half of the basin. Rare and endangered species have a possibility of occurring in the basin, the most likely being bird species such as the peregrine falcon (*Falco peregrinus*) and bald eagle (*Haliaeetus leucocephalus*). The peregrine falcon generally exists and nests along cliffs and rocky outcrops which are abundant in the northeastern part of the basin. The bald eagle is occasionally seen along the perennial waterways of the basin. The black-footed ferret (*Mustela nigripes*) may exist in the prairie dog towns of the western half of the basin but no sightings have been recorded since 1918 (Bureau of Land Management, 1975).

Coal Development

Coal development in the San Juan Basin is and will continue to occur in the Fruitland Formation. This Formation contains approximately 4.5 billion tons of strippable low sulphur sub-bituminous steam coal. The 4.5 billion ton figure was obtained by using 150 feet as the maximum recovery depth and by estimating the area that can be mined by surface techniques in the area shaded in Figure 1. Because of its low sulphur content utility companies burning this coal will be better able to meet air quality emission standards. An estimate of the total

acreage to be disturbed over a 50 year period by surface mining is approximately 170,000 acres. This figure is a maximum based on a 150 foot recovery line and assuming 165 miles of out-crop. It must be noted that because of the nature of the coal beds, i.e., weathered areas, shaleouts, etc. not all of this 165 miles of outcrop will be mined.

In speaking of environmental impacts of coal development in the San Juan Basin, we shall relate environmental situations here to similar cases in other coal producing areas of the United States where coal development is also a vital segment of the economy.

Air Quality

The major air quality concern of the coal mining industry is the problem of fugitive dust created by mining activities. This dust or particulate emission from dragline operations, coal crusher, stockpile and tippie is measured in terms of total suspended particulates (TSP). Because particulate emissions are ground level releases, TSP concentrations reach a maximum near the mining activity and decrease downwind. Consequently, the impact is primarily a local effect and TSP concentrations at greater distances from the mine will not change significantly. This, coupled with the sparse population of the Fruitland coal area, lessens the impact of emission of particulates to a minor localized problem that is abated by the watering of hauling roads and the construction of coal storage facilities.

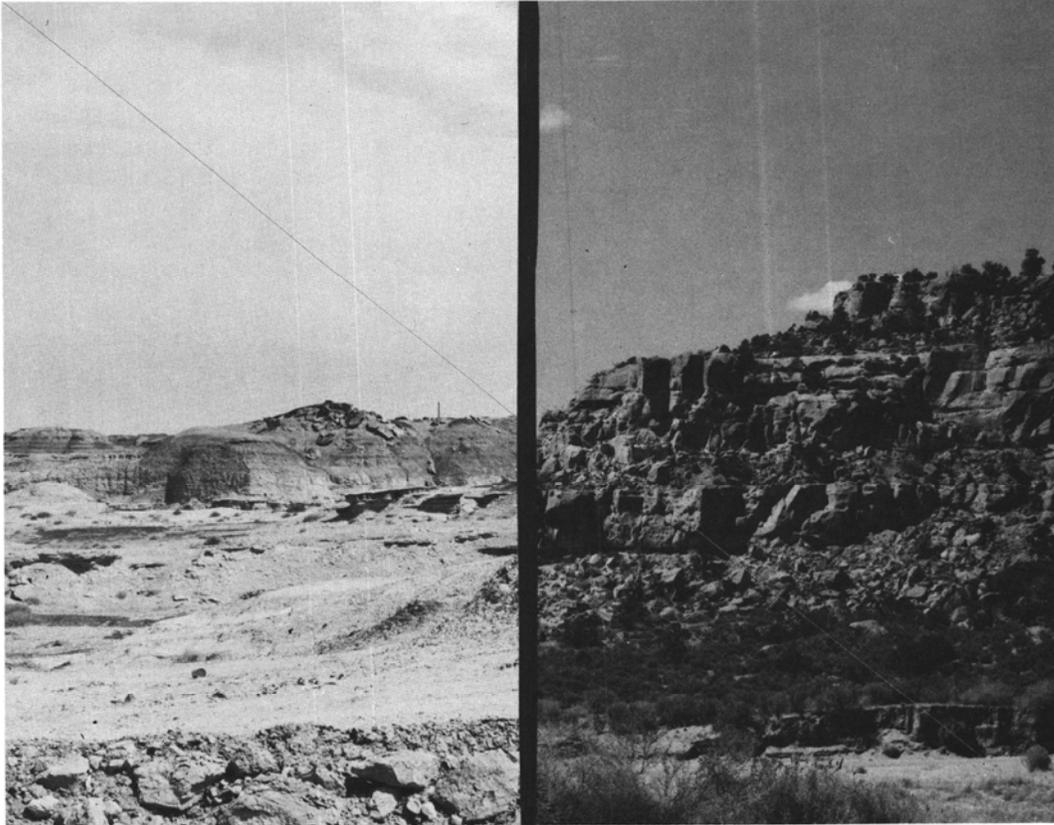


Figure 8. Badland/rockland.

Soils and Vegetation

Soils in the proposed mining areas will be disrupted; however, usable topsoil is stockpiled for use in reclamation processes and provides as adequate a growth medium as existed previously. In many parts of this region overburden material may be a better growth medium than the existing surface material. Badlands, for example, exhibit impervious and highly sodic soils. These areas, when proper reclamation techniques are applied after mining, have an excellent chance of being more productive than they originally were.

Existing vegetation will be disrupted, but today's reclamation plans constitute a commitment for the revegetation of lands to comparable productivity, cover and forage value. Lands in the Fruitland Formation are relatively unproductive compared to lands on a national scale. Figures 5, 6 and 8, sagebrush/grassland, saltbush/grassland and badlands/rocklands types, respectively, show vegetation characteristic of the lands to be mined. A study (Gould, et. al., 1977) covering 51,360 acres of the Fruitland Formation area indicated the average carrying capacity for livestock was 280 acres per animal unit year (AUY, the amount of forage needed to support a cow and a calf for one year), i.e., it would take one square mile to support 2.3 cattle per year. In southern Wyoming coal lands, production averages approximately 168 acres per AUY or 3.8 cows per square mile (Bureau of Land Management, 1974), and in eastern coal lands biomass production is many times greater, promoting both timber harvesting and intense row crop agriculture. Therefore, the net loss in productivity during

the first few years of reclamation is much greater in other environments than in the San Juan Basin.

The intensity of reclamation efforts, however, is inversely proportional to a site's previous productivity. This means that to overcome the factors that make lands unproductive, such as lack of precipitation, unsuitable soils, etc., reclamation practices must be intensified to establish environmental conditions that previously prevailed. It has been shown, however, in the Fruitland coal area that reclamation can be successful. Utah International Inc., now mining on the Navajo Indian Reservation, annually surveys good undisturbed range lands and finds on the order of 50,000 grass plants per acre, and less than 3000 shrubs per acre. On their 1975 revegetated mined lands, seeded four-wing saltbush densities in 1976 were as high as the upper levels of shrub concentrations on the open range, and in most cases densities exceeded what can be expected to survive after stabilization. Grasses per unit area (predominantly *Alkali sacaton*) were also generally as high and in many cases higher than on open range lands (Utah International Inc., 1977). Reclamation practices, then, are expected to be fruitful in the San Juan Basin.

Hydrology

The prime limiting factor in the Southwest for life systems is water. For the mining industry (not processing industries) this lack of water is more of an advantage than a disadvantage. As compared with the problems faced by eastern coal producers, such as acid drainage and excess water in pits or in deep mine

shafts, the western surface miners are more fortunate. But problems do exist. Western miners are charged with the destruction of shallow aquifers and the increasing of sediment loads in perennial and ephemeral streams. Fortunately, the water relationships in the San Juan Basin pose no major problems for the coal industry. Water tables, except adjacent to drainageways, are very deep. Aquifers containing substantial quantities and marginal quality water are three to six thousand feet below the surface, thereby eliminating the problem of mine pits intersecting them. Disruption of small, shallow, low yield aquifers along ephemeral streams should be of limited severity, and discharges from these aquifers should be easy to handle because of the better quality of these waters.

Surface waters increase in turbidity (suspended solids) during intense thunderstorms, and the relationship between turbidity and storm intensity is proportional. This is a natural phenomenon in this region because ground cover is sparse and much mineral soil is exposed to the elements, promoting this action. Mining should not increase this action if mitigating structures such as discharge ponds, water bars and berms can be used effectively. Rechanneling ephemeral drainageways around mining areas can lessen the effect of suspended solid pickup that may be caused by mining, and can eliminate the leaching of overburden material into surface channels.

Fauna Impacts

The wildlife disturbed by coal development consists mostly of small mammals, reptiles, and raptors who prey on these species. Few antelope and deer inhabit this portion of the Fruitland coal area because of habitat restrictions; they should be impacted little. Because raptors prefer rock ledges and mesa country for nesting, few if any endangered species in this category will be effected. Raptors will, however, lose those hunting grounds to mining until reclamation is completed. The possibility of black-footed ferrets being present in this mining area is remote.

Land Use

The traditional economic land use in the Fruitland coal area has been agricultural use in the form of livestock grazing. Impacts on grazing should be minimal. If we assume the average carrying capacity for livestock to be 280 acres to support a cow and a calf for one year as mentioned previously, and use eight as the number of mines that will be in operation in this area in the next ten years, each disturbing approximately 300 acres per year, the carrying capacity loss in number of cows displaced per year will be nine. If we then assume a time span of ten years for successful reclamation, the maximum number of cows that would be displaced at any one time would be approximately 90. It must be noted, the 90 cows displaced is a "ball park" figure; range production in the Southwest varies greatly with precipitation changes from year to year. This estimated loss in livestock production is not a large price to pay for millions of tons of steam coal.

Archeological and Paleontological Considerations

The San Juan Basin has been the home of ancient peoples for a long period of time. Because of the type of environment that exists here, dry and warm, this area has a very low potential for developing mature soils or surface humus that obscures the locating of artifacts. Therefore, surface artifacts, those not covered by aeolian sands, are easily found by the trained eye.

What will happen to these archeological and paleontological artifacts when further coal development comes to the San Juan Basin? Companies are required to survey and mitigate at their expense all significant sites on lands that will be disturbed. Industry, then, is actively funding the acquisition of archeological knowledge that would otherwise remain undetected and sacrificed to the passage of time. This means that energy development is not destroying our past but enhancing its definition.

SUMMARY

The San Juan Basin offers a site for coal development where compromise with environmental factors is achievable. In relation to other coal lands, the basin represents an area where minimal environmental degradation will result from energy development. No major quantities of water will be impaired, no rivers will run red from acid drainage, nor will the present air quality of the basin be destroyed. Significant wildlife habitat will not be altered and the low productivity of the land has a chance of being increased. New archeological and paleontological knowledge will be gathered where before no funds existed for surveying and excavation. Taxes, royalties and employment in the state will be increased. And, finally, millions of tons of low sulphur steam coal for conversion into electrical energy will be made available.

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