BLACK THUNDER—ATLANTIC RICHFIELD COMPANY'S FIRST COAL MINE

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ABSTRACT

The popular image of surface coal mining is changing. Highly trained and well-compensated mining technicians operate modern equipment in pleasant surroundings to extract low-sulfur coal from the ground. Scientific methods are used to reclaim the mined-out land, and even the needs of the native pronghorn antelope are not overlooked. The purpose of this paper is to describe Atlantic Richfield's first surface coal mine — Black Thunder — and some of the features that we feel make it unique.

The Black Thunder mine is located in Wyoming's Powder River Basin, about 50 miles south of Gillette. The coal deposit outcrops the eastern edge of the property and slopes downward as it moves west, reaching a depth of almost 300 feet on the westernmost boundary. The coal, which is sub-bituminous, lies in a seam nearly 70 feet thick.

The mining method employed is referred to as truck and shovel (Figure 1). First, the topsoil is measured for depth, removed by graders, and stockpiled. If it is stockpiled for more than a growing season, it is revegetated. Next, an electric shovel with a 27 cubic yard bucket removes the overburden. Diesel electric end dump trucks haul 170-ton loads of the overburden to a mined-out area for land reclamation which includes recontouring and revegetation.

Following the overburden shovel are two coal shovels working the coal face on each of two 35 foot high benches. These shovels can use a 40 yard bucket because the coal is less dense than the overburden. Bottom dump trucks haul the coal in 170-ton loads to the plant for processing.

The whole operation moves forward according to a predetermined "mine plan" which is scheduled to last for 40 years at a rate of 20 million tons of coal per year.

During this time, the advancing pit will always have an open area of about 50 acres. The back side of the pit is constantly being filled, contoured, covered with topsoil and reseeded with selected native grasses. Since the overall level of the land is lowered (due to removal of the coal), very careful planning is required to maintain drainage. (Early environmental studies determined that the native pronghorn antelope required hilly terrain to maintain their health. This was included in the reclamation planning).

From the mine high-wall, the trucks carry the coal (some pieces as large as a desk) to the plant. Here it is dropped into a primary crusher which reduces the size to 8 inches and smaller. A six foot wide conveyor belt carries the coal to a secondary crusher where it is further reduced to 2 inches, and smaller. From the secondary crusher the coal moves through a train-loadout building, where it is sampled, and it can either be directly loaded into a train or sent to storage (Figure 2).

The coal-handling facility is capable of processing 5,000 tons per hour and at the same time can load a unit train at the same rate. Liberal use of baghouses (particularly at coal transfer points) minimizes fugitive dust. Several devices protect equipment from tramp metal — a large electromagnet removes ferrous material from the conveyor just before the coal enters the secondary crusher, and a non-ferrous metal detector located after the primary crusher shuts down the system when necessary. Both devices have operated successfully in protecting the system.

A review of the flow sheet (Figure 2) and the site plan (Figure 3), gives an idea of the plant facility and material flow. From the truck dump hopper/primary crusher, the coal moves in a straight line to the slot storage building. When going into storage the direction of the coal is changed 90 degrees (a transfer point), and the coal enters a gallery located at the top of the 760 foot long slot. The conveyor in that gallery is equipped with a device (tripper) which turns the belt upside-down, dropping the coal to the storage area below. The tripper can be controlled to place the coal into any part of the storage. The building is covered to minimize fugitive dust. It holds 100,000 tons of coal.

Underneath the V-shaped walls of the slot storage is the equipment to reclaim the coal and transport it to loadout. As indicated in the flow sheet, a device called a rotary plow forces the coal from between a shelf and a splitter (which forms the seal) onto a conveyor going to the train loadout.

As shown on the site plan, a large portion of the one mile square site is enclosed by the rail loop. Unit trains of 100 or more cars enter the loop in a counter clockwise direction. As the train approaches the loadout, a scanning device reads the car number and a load cell in the track weighs each car and stores the information in a microcomputer. The plant central control room overlooks the track underneath the loadout surge bin. As each hopper car passes beneath the line, an operator "flood" loads it (by means of a hydraulic slide valve) with 100 tons of coal in less than a minute. The train moving at a constant speed of about 0.5 MPH passes by a second scanner and over another load cell, thereby determining the amount of coal loaded into each car. A printout device records that data, which is used for billing purposes.

Support facilities on site include a four high-bay shop, a 10,000 square-foot warehouse, a changehouse for 250 men and women, a 16,000 square foot administration building, a utility building (housing a central coal-fired heating plant together with portable water treating, fire pump, etc.), and an aerated sewage treating plant and settling ponds. A decorating consultant was used to select building colors which best fit the mood of the countryside (Quaker Brown and Sand were chosen). The initial ancillaries were designed to accommodate a 10-million ton-per-year mine and will be expanded to permit operations at double that rate.

The coal-processing facility incorporates several features which we believe are new to that industry. These include the use of programmable controllers in the instrumentation package as well as the use of silicon controlled rectifiers (SCR's) in the starting circuits for the 1200 horsepower conveyor drive motors.

Programmable controllers are certainly not new to process industries and their virtues have been documented before. Several features, though, made their application at Black Thunder economically appealing as well. These included the long distances (up to 1500 feet) for remote Input/Output (I/O) multiplexing, the large number of I/O devices (8100), the ease of reprogramming the control timing sequences, and the inexpensive reliability (two standby processors were installed)

One of the conveyor requirements was the ability to start while fully loaded with coal. A "soft" start (bringing up to speed over a short time period) is needed to avoid overstressing the belt material. The method chosen to accomplish this task is a device called a silicon controlled rectifier (SCR). This device allows a sudden inrush of current to overcome the starting inertia of the system but backs off as soon as that task is accomplished and "ramps" the current up for the "soft" start. To the best of our knowledge, this application was the first of its type. After overcoming some initial problems, the SCR's were brought on line and have performed well.

A "grass roots" facility of the size of Black Thunder presents many interesting challenges, but when coupled with the remote location, weather, and boomtown environment of the Powder River Basin, these challenges can become major problems.

To attract and hold qualified craftsmen and operations personnel, Atlantic Richfield built the town of Wright, Wyoming, some 10 miles to the west of Black Thunder. Initially Wright was little more than a trailer camp with water, a sewage treating plant, power, limited telephones, a post office, and cable TV.

By the end of 1978, it had grown to a community of over 800 people. It included 50 permanent homes, the largest covered shopping center in Wyoming, three churches, a new elementary school, a telephone exchange, and most of the amenities of its nearest neighbor, Gillette, 40 miles to the north.

Although the facilities at Wright certainly helped attract and retain craft labor, many construction workers commuted from Gillette and Casper, Wyoming, 100 miles to the south of Wright. Job turnover averaged about 30 percent, and in winter months sometimes exceeded 100 percent. Despite this, and a winter when the temperature never rose above freezing for over two months, the job was completed on schedule and within budget.

The stockpiling and reclaiming facility, commonly referred to as the "slot storage," was one of the major facilities constructed as part of the Black Thunder Mine. The slot is basically an elongated pit extending approximately 70 feet below grade. Plan dimensions of the slot are approximately 110 feet by 760 feet at the top. Walls of the slot are sloped at 50 degrees to the horizontal, down to a depth of approximately 50 feet. The sloping walls were planned as essentially self-supporting with a 4-inch cover of shotcrete, reinforced by wire mesh. From a depth of approximately 50 feet to 70 feet, the walls of the building (the "reclaim" tunnel) are vertical and retained by a continuous, reinforced concrete wall (see Figure 5).

The subsurface conditions at the site of the slot storage consist of shallow overburden soils of residual origin overlying predominantly shale bedrock of the Wasatch Formation. Siltstone and sandstone are interbedded with the shale. Shale, siltstone, and sandstone strata in the formation are lenticular; and the correlation of a particular stratum between bore holes was very difficult. A carbonaceous shale stratum of varying thickness (0-50 feet) was encountered during the drilling under the north half of the structure at a depth of 35-40 feet. The water table at the site was also observed to be approximately 30-40 feet, but the rate of water movement was more than compensated by evaporation while the excavation was open. Normal water levels for the area are 70-80 feet.

Shearing strengths of the Wasatch Formation shales are normally very erratic, and the carbonaceous shales are difficult to test in general. After extensive testing and evaluation, results indicated that there should be few, if any, construction problems with the slot. But once the slot tunnel had been opened, a block of the carbonaceous shale (2 feet x 7 feet x 20 feet) "slipped" and fell into the excavation. Subsequent investigations brought to light a trend of convergence of the slot walls. It was determined that the inclined slot walls were sliding along the carbonaceous shale layer, and equipment was installed to monitor any movement of the slopes. While the movement was not so great as to anticipate a major slope failure, redesign of the facility was required to prevent any long-term instability problems.

After an extensive slope stability analysis was completed, it was determined that the dewatering system shown in Figure 5 had to be installed. This required over-excavating the slot walls by 20 feet and replacing the material with a lime-treated fill. At the natural grade and fill interface, a crushed rock and filter cloth drain system was installed. This structural fill zone and dewatering of the carbonaceous shale layer stabilized the slopes and provided for completion of the facility with a minimum of delay.

Another unique feature of the slot storage was the use of Reinforced Earth™ panels to construct the "bath tub" ends of the building as shown in Figure 4. These 4-foot by 6-foot panels of precast reinforced concrete are designed to provide a retaining wall effect by use of a modified tie-back system. The panels were set in place, one at a time, and backfilled with tamped fill. Each panel has three 30-foot galvanized steel straps which project into the fill and provide the lateral stability (through shear force on the soil).

The main advantage of the above system was the speed with which the ends could be placed. In the case of Black Thunder, this translated into real dollars.

Since the first trainload of coal left for Texas on December 14, 1977, about three million tons have been shipped to utility plants in Texas, Nebraska, and Oklahoma. By the mid-1980's, Black Thunder will be shipped over 20 million tons per year which translates to a 140,000 barrel per day (BPD) oil equivalent.

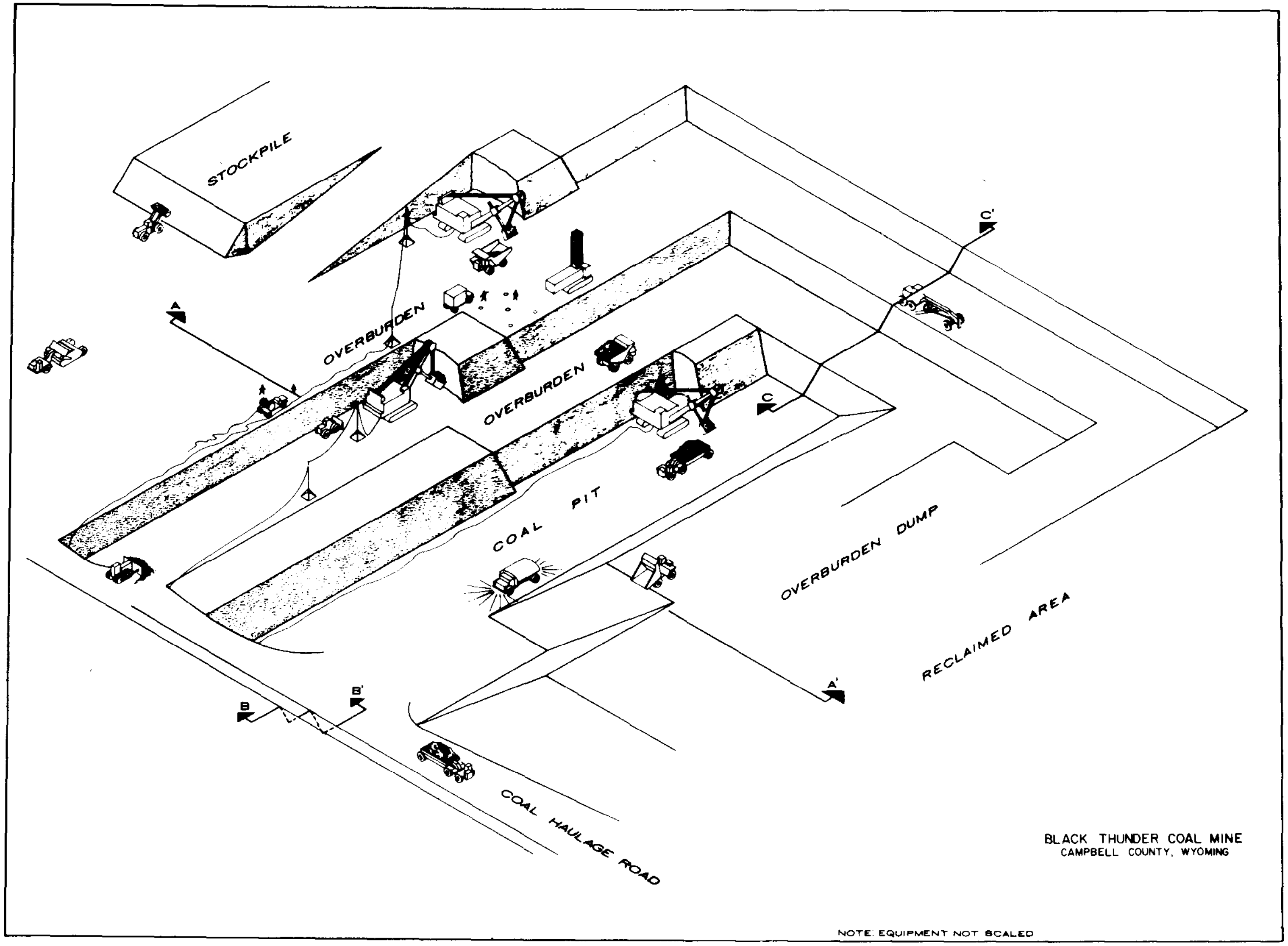

FIGURE 1 DIAGRAMMATIC VIEW OF MINING OPERATION

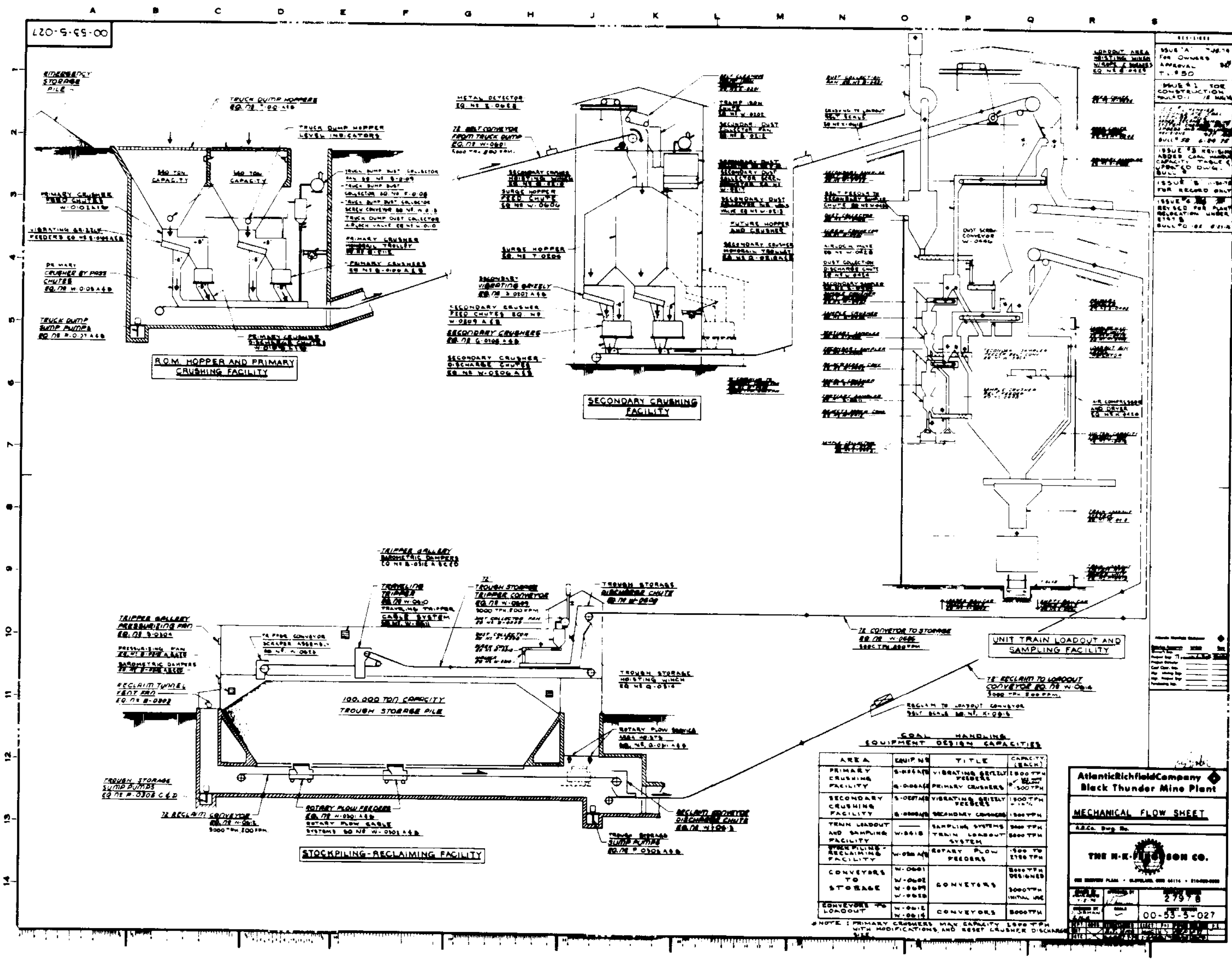

FIGURE 2—BLACK THUNDER FLOW PLAN DRAWING NO. 00-52-1-048

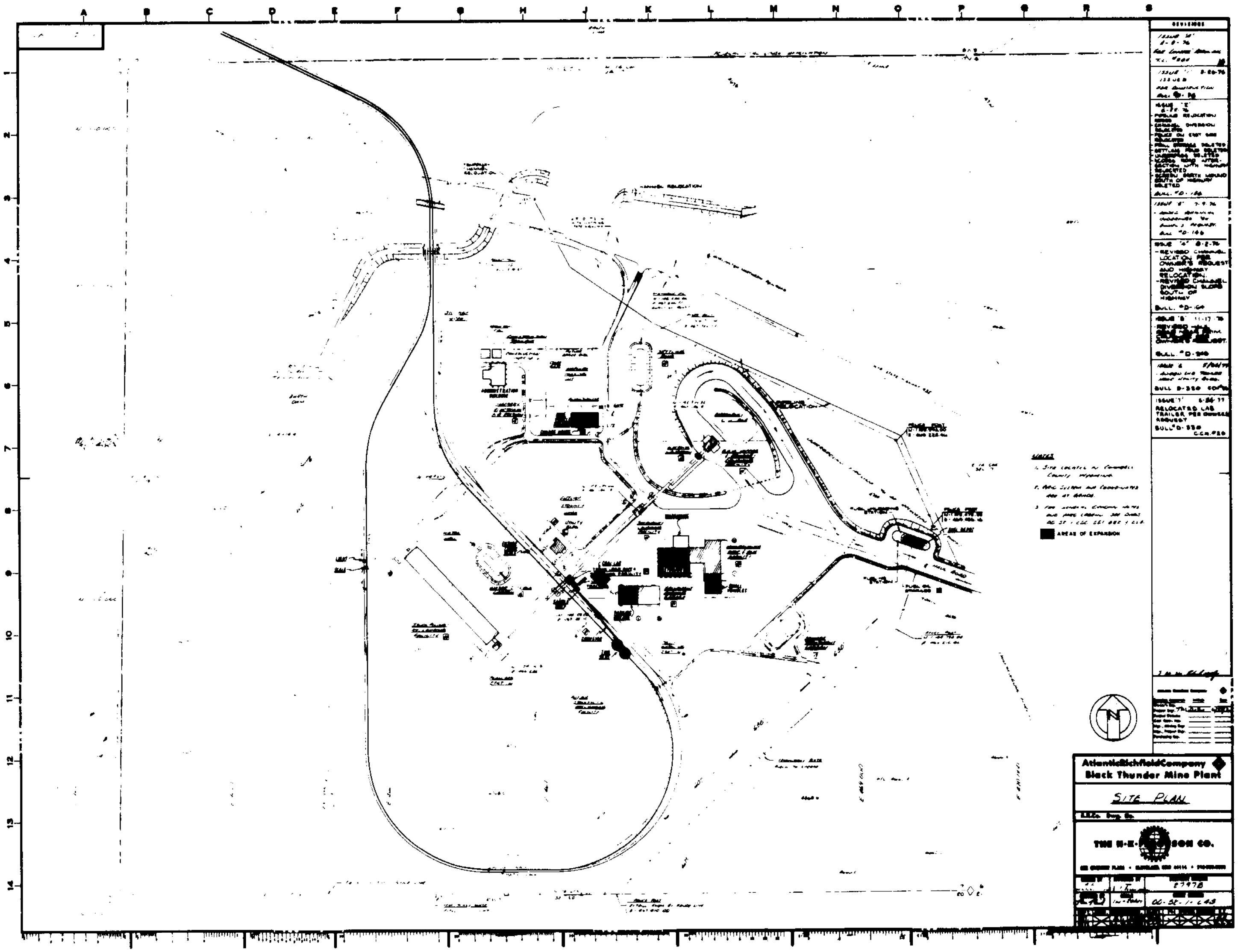

FIGURE 3 –BLACK THUNDER SITE PLAN—DRAWING
NO. 00-53-5-027

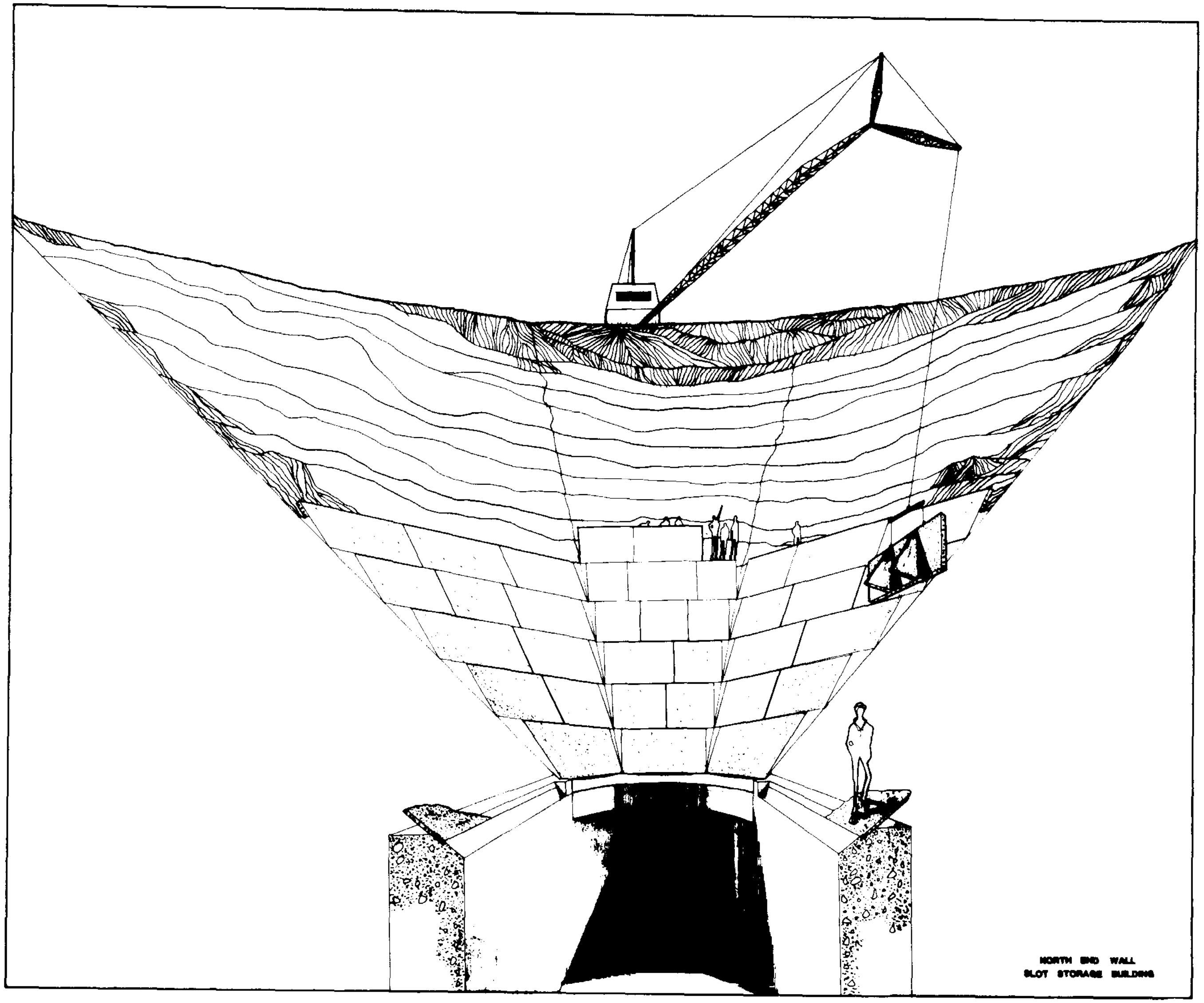

FIGURE 4—SLOT STORAGE REINFORCED EARTH ENDWALL

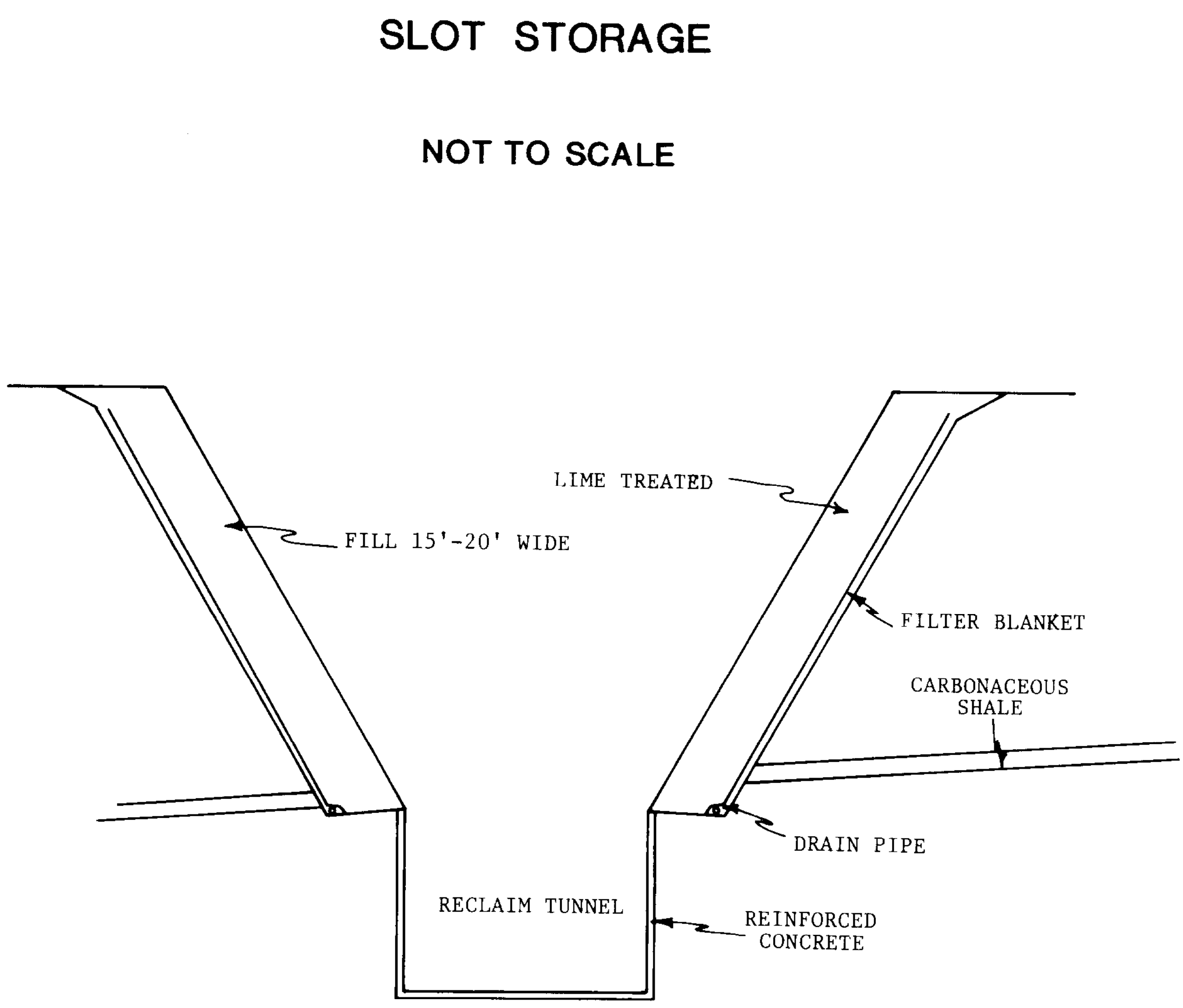

FIGURE 5 –SLOT STORAGE PROFILE
SITE PICTURES