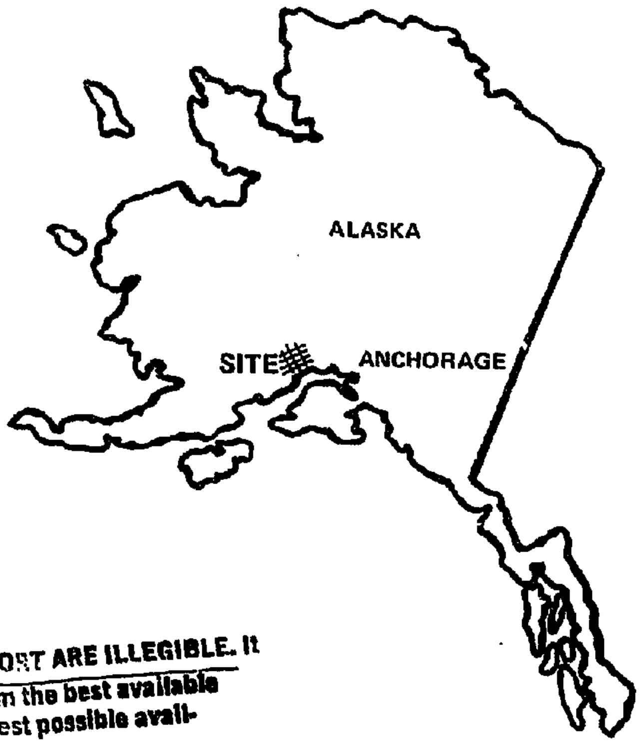
COAL TO METHANOL FEASIBILITY STUDY BELUGA METHANOL PROJECT

DOE GRANT DE-FG01-80RA-50299

FINAL REPORT

VOLUME I
TECHNICAL



COOK INLET REGION, INC.
AND
PLACER AMEX INC.

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TASK CROSS REFERENCE

The organization of this report does not follow the sequence of Tasks 1.00 through 9.00 in the Statement of Work and Study Schedule stipulated in the CIRI/Placer Proposal of 25 April, 1980. It has been found more convenient and orderly to arrange the subject matter as now presented in Volumes I through V.

To enable those concerned to review the study findings with respect to the associated assigned tasks, the following cross referenced tabulation is provided.

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INTRODUCTION TO THE PHASE I FEASIBILITY STUDY

PROJECT DESCRIPTION

Cook Inlet Region, Inc. (CIRI) and Placer Amex Inc. (PLACER) propose to develop a commercial scale coal-to-methanol operation located close to coal deposits in Kenai Peninsula Borough, Alaska, on the west side of Cook Inlet. The plan of the sponsors provides for participation in the venture by additional equity partners and financial assistance from the U.S. Synthetic Fuels Corporation.

The overall concept envisions utilization of low sulfur, high volatile sub-bituminous coal from Alaska's Beluga coal field as feed for a process plant which will produce fuel grade methanol at the rate of 54,000 barrels per day, and distribution of the product to existing and potential markets on the U.S. West Coast.

The Beluga Area is estimated to contain over one billion tons of coal recoverable by surface mining methods. For the purposes of the feasibility study, two areas, containing approximately 500 million tons of recoverable, low-sulfur coal, have been planned for surface mining. An extremely low average sulfur content of less than 0.2% and a location adjacent to deep coastal waters make the Beluga Area unique among known world coal deposits.

Two separate deposits of subbituminous coal are located in the Beluga Area on state and private coal lands held under lease by Placer Amex Inc. The geology of these two deposits, and estimates of these coal quantities and qualities are presented in this Volume I.

It is proposed to extract a total of 8.5 million tons of coal annually from the two mines. Each mine has sufficient reserves to produce 4.25 million tons per year for more than 30 years, the period covered by the current study. Both are surface mines. Capps would use shovels and trucks plus draglines to remove overburden. Chuitna West would use shovels and trucks, excavating in benches down to a maximum depth of about 600 feet.

Mining plans and estimates are based upon current geologic data plus assumptions regarding certain items, such as continuity of coal seams, slope stability, other geotechnical factors and governmental regulations. Additional data are required to support a more comprehensive study and for final mine design.

The process plant will be located on the west side of Cook Inlet at a point approximately 60 miles southwest of Anchorage and 25 miles southeast of the coal mines. An adequate volume of process and cooling water is available from subsurface and surface water supplies in the near vicinity, and the processing complex will be in close proximity to an existing oil pipeline and marine tanker transport system which, with planned terminal modifications and provisions for storage, can be used for loading and shipment of the methanol product to the markets.

The project encompasses development of the mines, construction of a railroad from mines to plant; a construction camp, town site, air strip and related infrastructure; construction of the process plant proper, construction of a barge dock, and installation of all required processing and ancillary facilities, auxiliaries and utilities.

The principal processes involved in the production of methanol from coal are coal gasification, syngas upgrading and methanol synthesis. For these processing stages, it is intended to use only commercially proven technology and equipment with demonstrated potential for further improvement in efficiency, namely Winkler fluid-bed gasifiers, Allied Chemical's "Selexol" process for acid gas removal, Air Resource's "Lo-Cat" process for sulfur recovery, and the ICI low pressure process for methanol synthesis. The selection of these processes and the guidelines established for design of the plant are aimed at maximizing the possibility for future increases in production capacity with minimum additional capital investment.

The methanol complex is planned to come on-stream in late 1987 and to achieve its rated capacity in 1988.

PURPOSE OF STUDY

This feasibility study, which constitutes Phase I of the project, has been carried out by CIRI/PLACER pursuant to the terms of Department of Energy Grant DE-FG01-80RA-50299. The objectives of the study are to resolve questions of plant design, establish estimates of capital costs, operating costs, and working capital requirements; survey fuel prices and markets, assess the marketability of the proposed methanol product; and confirm the economic viability of the project. These tasks are to be done at sufficient levels of accuracy to provide a sound basis for decisions with respect to proceeding with the further phases of the project.

SCOPE OF STUDY

The work to be done is divided into nine principal tasks as detailed in the April 25, 1980 CIRI/PLACER proposal to the Department of Energy. These are listed in the volumes under the heading Task Cross Reference, which indicates those parts of this report in which each specification is fulfilled.

COAL MINING

1. GEOLOGY OF THE COAL DEPOSITS

Summary

Coal for the proposed coal to methanol plant will be produced from two deposits designated the Capps and Chuitna West Areas (see Figure 1). Together, they contain 490,422,000 tons of geologic reserve that is considered to be potentially recoverable coal. Portions of these reserves are not considered as minable for purposes of this study.

At Chuitna West, there are 163,111,000 tons considered to be minable with a waste to recoverable coal ratio of 7.1 bank cubic yards (BCY) per ton. Five minable seams occur at Chuitna West. The M bed is the most prominent of the five, containing over 50 percent of the total tonnage. Coal reserve estimates for the Chuitna Area were made using computer modeling methods.

The Capps Mine contains an estimated 223,527,000 recoverable tons of coal, with a waste to coal ratio of 6.9 BCY per ton. The minable tonnage at Capps is contained in two seams. The lower of the two (Waterfall Seam) accounts for more than 80 percent of the total reserve. Both the Waterfall and overlying Capps Seam contain clay partings that must be removed during mining. Manual modeling methods were used to prepare estimates of minable coal in the Capps Area. Those reserves were checked by computer.

Additional drilling in both areas is needed in order to raise the confidence level of the tonnage estimates and to extend the reserve area for Chuitna West. Additional exploratory data could expand the reserve tonnage as well as firm up presently estimated reserves.

Location

Both the Capps and the Chuitna West deposits lie within the Beluga Coal Field situated west of Anchorage across the Cook Inlet. The Capps Area is located in Township 14 North, Range 14 West, Sections 10 through 16 and 21 through 28. Chuitna West is approximately 6 miles southeast of the Capps Area on the west side of the Chuitna River in Township 12 North, Range 13 West, Sections 3, 4 and 5, and in Township 13 North, Range 13 West, Sections 26 through 35. The Chuitna River canyon forms the eastern boundary of the coal deposit at Chuitna. The Capps Area is bordered on the north by the Capps Glacier and on the east and northeast by Quaternary-aged landslide and glacial outwash deposits. To the west, thick volcanic deposits overlie the Capps coals.

Topography at both areas consists of rolling terrain incised by tributaries to the Chuitna River or by the Chuitna River. Surface elevation ranges from an average of about 1,500 feet above sea level at Chuitna West to an average of about 2,000 feet at Capps. Maximum relief at Chuitna West is about 200 feet, and at Capps is about 600 feet.

Both areas are drained by the Chuitna River or its tributaries. Portions of the Capps Area also drain toward Capps Glacier or to tributaries of Chichantna River then (by way of Beluga Lake) into the Beluga River.

Figure 1 shows the general location of the two project areas.

General Geology

The coal bearing Tyonek Formation of the Tertiary Kenai Group contains all the minable coal in the Capps and Chuitna regions. The lithology of the intercoal strata is generally represented by poorly consolidated shales, siltstones, sandstones and conglomerates. Occasional well-indurated calcareous lenses occur randomly throughout these units.

In the Chuitna West Area, there are five potentially minable coal beds. These five have been designated from stratigraphically lowest to highest as Q bed, O bed, M bed, K bed and G bed. These subbituminous coals range in thickness from 5 to 54 feet. The thickest and economically most important is the M bed. In addition to the five economically recoverable seams, another seam, P, occurs between O and Q. This seam is composed of three benches, each averaging about 3 feet thick, separated by two partings both averaging 7 to 8 feet thick. Data for this zone are sparse and of poor quality. This coal would probably be recovered during actual mining since it would have to be excavated prior to mining the Q bed. However, because of the lack of good quality drilling data and the indicated thin benches, this coal has been considered as waste for purposes of this study.

Two economically recoverable coal beds are present at Capps. These are the Waterfall Seam overlain by the Capps Seam which range in thickness from 6 to 46 feet. The Waterfall Seam is the thickest and most extensive.

Figure 2 shows a generalized stratigraphic section for both the Capps and Chuitna West Areas.

Overlying the Kenai Group are recent sand and gravel, glacial till and outwash deposits.

Muskeg has accumulated in portions of each area. In flatter, less well-drained areas, this material is typically saturated with water. It averages 1 to 2 feet thick over most of the mining area but may be as thick as 10 feet in isolated locations. No known permafrost areas occur at either Capps or Chuitna West.

Methods of Investigation

Topographic Mapping

Topographic maps for both areas at a scale of 1" = 400' with a 10 foot contour interval were provided by project sponsors. These maps were used as the base for geologic mapping, mine design and overburden volume calculations.

Drilling

All drilling at Chuitna West and recent drilling at Capps was done under the supervision of Placer Amex. Drilling in the early 1960's at Capps was supervised by Utah Construction and Mining Company. Drilling was carried out during several drilling seasons. The earliest drilling began in the early 1960's. The final drilling season for which data were received was 1977.

The Paul Weir Company (Weirco) participated in planning exploratory drilling and was presented with a set of geophysical logs run in the drill holes. All geologic information concerning coal bed geometry was derived from these geophysical logs. Borehole locations were determined in the field using aerial photographs. These locations were transferred to the topographic maps and the maps forwarded to Weirco.

In the Chuitna West Area, 83 drill holes were completed and included in the geologic data base. Of these, 12 are core holes, 67 are rotary holes with geophysical logs; 4 are rotary holes without geophysical logs.

There are 61 drill holes in the Capps data base, 36 rotary holes with geophysical logs and 25 coal core holes. The bulk of the drilling has been completed in the south and eastern portions of the deposit in earlier efforts to prove up 100 million tons reserve. The northwestern area has had limited drilling to date.

Exhibits A and B show the location of each drill hole in the project areas.

Geophysical Logging

Generally, only one geophysical curve per borehole was run. At Chuitna, this was an uncalibrated natural gamma ray curve. At Capps, the geophysical log was normally a resistivity curve with the more recent logs showing the same kind of gamma curve as those at Chuitna.

More sophisticated geophysical logs would be desirable than the single curve (either resistivity or gamma) logs provided to date. For more accurate interpretation of coal tops and bottoms, a log with three curves is recommended: (1) gamma-gamma density, (2) resistivity and (3) high-quality gamma.

The accuracy of any geologic model is very sensitive to the quantity and quality of the basic data used. The level of confidence in the ability to predict the physical and chemical conditions of coal occurrence is proportional to the density of reliable subsurface data. Before the finalization and implementation of detailed mining and utilization plans, additional drilling, logging, coring, sampling and analyses will be required.

Table No. 1 shows the density of exploration drill holes at both the Capps and Chuitna West Areas. Note that one drill hole in the Capps Area provides data for estimating more than 63 million tons of coal in-place in the Waterfall Seam.

Data Processing

Geophysical data were encoded and entered into a computer data file by Placer Amex. The data file contained information concerning drill hole location, coal seam identification, depth to coal, coal thickness and lithology of intercoal bed strata. After interpreting the geophysical logs, Weirco's geologists compared their data to a printout of the computer file and made changes to the file to bring it into agreement with the Weirco interpretation. The resulting edited data base was used to produce geologic models of the two mining areas.

Two geologic models were created for each area: one manual model and one computer model. The manual model was constructed using classical geologic techniques, i.e., plotting of drill hole data, drawing of structure contour, coal isopach, and overburden isopach maps. As well as the drill hole data, the geologists' knowledge and judgment of trends beyond the available drilling information were automatically incorporated into the manual model. Materials volume estimates (coal and waste) for the manual model were made by measuring areas of equal thickness on the appropriate isopach map and multiplying by a factor to obtain coal tons (1,800 tons per acre-foot) or waste cubic yards.

This manual model was used as a standard to compare to the computer-generated model. Computer modeling was done because of the time and cost savings resulting from a decrease in the number of manual calculations to determine coal and waste quantities.

All computer modeling was done using Placer Amex's computer facilities and software. Weirco provided engineering and geologic supervision.

During computer modeling, a series of grid cells, each 100 feet on a side, were generated across the 1" = 400' base map of the Chuitna and Capps Areas. Individual cells had assigned to them values for coal thickness and depth of coal burial. These values were determined by interpolation, using drill hole data, nearby holes having more influence than those more distant. Adjustments to the model were accomplished by assigning reasonable values to pseudo data points. The ratio of pseudo data points to total data is small. That procedure was deemed advisable to compensate, at least in part, where actual data points were limited.

Volume calculations for coal and waste were made for each grid cell. The results of these calculations were stored in computer memory.

Cross sections, coal isopach, overburden and interburden isopach maps were computer-generated.

Results of Investigation

Chuitna West Area

As previously stated, there are five minable coal beds in the Chuitna West Area (see Figure 2). These five beds are persistent and of minable thickness across the entire property, except at shallow depths of cover where erosion has removed portions of all seams.

A southerly plunging, roughly north-south trending anticline at Chuitna West, has deformed the otherwise gently dipping coal seams. Exhibit C shows a series of computer-generated cross sections that have been manually arranged in an isometric view to demonstrate the extent of the anticlinal feature within the Chuitna West Area. The coal beds dip as much as 30 degrees on the flanks of the anticline.

Existing drill hole data suggest that no major faulting occurs within the area. One drill hole (7408C), however, penetrated the K bed twice, indicating that a low angle reverse fault existed in the vicinity of the drill hole. Since the drilling density in the area of 7408C is insufficient to further define the extent of the faulting, it was assumed to be a feature of local extent.

Noncoal strata in the Chuitna West Area are generally soft with occasional hard calcareous lenses. Surface glacial deposits could contain erratics (boulders), the number, size and distribution of which cannot be determined using currently available data.

The G bed is stratigraphically the highest coal bed. It subcrops over a large portion of the area. Exhibits D and E are the computer-generated structure and net coal isopach maps, respectively. The G bed averages 21.9 feet thick, with no identifiable removal partings. A total of 17 drill holes penetrated the G Seam.

Coal tonnage in the G bed has been estimated at 29,951,000 recoverable tons. For the G bed as well as all other minable beds, recoverable tons were calculated after assuming a coal loss during mining of 0.25 foot each at top and bottom of a coal bench. Only coal within about 1/4 mile of a drill hole was included in the estimated tonnage. Exhibit E shows the limits of the area for which coal tonnage in the G bed was estimated.

The K bed lies approximately 200 feet below the G bed. It covers 1,402 acres and averages 21.6 feet thick. The K bed has been eroded at depth along the southeast and southwest outcrop area. Exhibit F shows net coal isopachs as well as the limits of the K bed coal. Exhibit G shows structure contours on top of the K bed. Within the project area, the K bed contains 53,250,000 recoverable tons.

The K bed was intersected in 32 drill holes. No persistent partings were found in the K bed, although 5 drill holes did intersect partings of plus 1 foot in thickness. All parting material has been included as waste.

The M bed is the most significant bed in the Chuitna West Area. It contains 54 percent of all of the coal on the property and covers nearly twice as many acres (2,081) as any other seam. It subcrops along either side of the central ridge of the anticline. Lying about 260 feet below the K bed, the M bed has a net coal average thickness of 38.6 feet. Drilling has intersected the M bed at 34 locati ns. Partings occur in about one-third of the drill holes. Net parting thickness ranges up to 4 feet. This parting material has been included with the waste.

There are 142,792,000 recoverable tons of coal in the M bed.

Exhibits H and I show coal isopachs and top of seam structure, respectively, for the M bed.

The O bed averages 8.8 feet thick and covers an estimated 1,414 acres. The interval between the M and O beds averages 96 feet. Excessive depth (plus 600 feet) limits the potentially surface-minable area of the O bed to the vicinity of the anticlinal axis and to the northwest corner of the property. Exhibits J and K show the structure and coal isopachs, respectively. The O bed represents less than 10 percent of the total coal tonnage in the Chuitna Area. We estimate that there are 21,044,000 recoverable tons of coal in the O bed. No identifiable significant partings occur in the seam.

The lowest minable coal bed is designated Q. The Q bed lies about 725 feet stratigraphically below the G bed and averages 85 feet below the O bed. The Q bed represents the smallest proportion of minable coal, 7 percent of the total available tons. This seam ranges between 8 and 14 feet thick and averages 10 feet thick. It does not subcrop in the project area except on the north edge of the property on the valley wall of the Chuitna River. The potential surface-minable area of the Q bed (1,185 acres) is even smaller than that for the O bed because of the additional incremental depth of cover.

We estimate that there are 19,858,000 recoverable tons of coal in the Q bed.

Exhibits L and M show structure on top of the Q bed and net coal isopachs, respectively.

Table No. 2 summarizes the coal tonnage estimates for the Chuitna West Area.

The coal tonnage estimates are based on a coal density factor of 1,800 tons per acre-foot. This estimate includes all coal between the 20 foot cover line and the lease boundary. It is limited to an area within approximately 1/4 mile from a borehole with a geophysical log. The individual seam maps show the extent of the area included in the estimate.

Recoverable tonnage was computed by subtracting 1/2 foot of coal from the net coal thickness (total seam height, minus partings, equals net thickness).

The estimates presented in Table No. 2 are derived by totaling the values for individual computer-generated grid cells. In order to verify that the computer model had been properly constructed and that the algorithms used were proper for estimating coal tonnage, we compared the computer estimates to our manually derived estimates.

Using manual methods, we calculated that there are 275,965,000 tons of coal in place in the Chuitna West Area. The computer estimate for total tonnage is 273,062,000, a difference of 2,903,000 tons. The percent change from the manual model to the computer model is minus 1.05 percent. Agreement to within ±10 percent is considered to be good and to within ±5 percent to be excellent because the tolerance* for coal reserve estimating is normally accepted at ±20* percent (U.S. Geological Survey Bulletin 1450-A and other authorities).

For the manual model, 1,924,816,000 BCY are estimated for waste material quantities. The computer model indicates 1,926,077,000 BCY, a difference of 1,261,000 BCY. The percent range from a manual model to the computer model was 0.06 percent. This is excellent agreement.

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* This tolerance is between the estimate and the actual real value. Tolerance between estimates based on the same data should be 5 percent or less.

Capps Area

In the Capps Area, there are two minable coal beds. These are the Waterfall Seam and the Capps Seam. Where the two overlie one another, they are separated by an average interval of about 220 feet.

The Capps deposit is roughly circular-shaped in plan view, with the Waterfall and Capps Seams outcropping on the north, east and south sides. On the west side, lava flows have buried the coal under a considerable thickness of igneous rock. Mining through the lava flows is not proposed.

The coal strata dip generally to the northeast. No major faulting was discovered in the area.

Exhibit N is a series of east-west computer-generated cross sections through the Capps Area showing the two coal beds.

Strata other than coal are relatively soft clastic rocks, ranging in grain size from clay to large gravel. As at Chuitna West, the number, size and distribution of glacial erratics are not known. Thickness of the glacial till averages 30 feet and ranges to a maximum of 150 feet. Near the Waterfall Seam subcrop along the southern and eastern boundaries of the deposit, there appears to be little or no glacial till.

Drill hole spacing in the northern half of the resource area is sparse (see Exhibit B). A lower level of confidence has been assigned to the coal tonnage estimates for the less well-drilled area (see Table No. 3), although the two coal seams have been projected to assumed subcrops at the northern edge of the coal deposit.

The Capps Seam covers approximately 1,867 acres and averages 12.6 feet thick. The seam typically contains one parting which averages 3.6 feet thick.

On the west side of the resource area, two drill holes (7604 and 7608) show no coal at depths where the Capps Seam is projected. The coal has been replaced by sand. This area has been isolated and is shown on Exhibit O, the net coal isopach map.

Exhibit P shows the structure contour lines on top of the Capps Seam. The depth of cover over the Capps Seam ranges from almost nothing at the subcrop to about 280 feet. Exhibit Q shows the overburden isopach map (constructed by cross plotting surface topography with coal structure).

Parting thickness isopachs are shown on Exhibit R.

We estimate that there are 38,928,000 recoverable tons of coal in the Capps Seam. Of this total, 78 percent or 30,478,000 tons are substantiated by drilling. The remaining 8,450,000 tons are located in the area of low drilling density.

The Waterfall Seam contains 82 percent of all of the coal in the Capps Area. This seam covers over 4,000 acres and averages 25.6 feet thick. Net parting thickness (usually in two benches) ranges from less than 1 foot to more than 24 feet (see Exhibit S).

Exhibit T shows the structure contours on the Waterfall Seam.

The net coal isopachs are shown on Exhibit U.

There are an estimated 184,599,000 recoverable tons of coal in the Waterfall Seam. Associated with this tonnage, there are 1,552,998,000 BCY of waste material. Exhibit V shows the thickness of the overburden/interburden waste material associated with the Waterfall Seam.

Table No. 3 presents the Capps and Waterfall Seam tonnage estimates.

The values presented in Table No. 3 include all coal in the Capps and Waterfall Seams from the subcrop to the edge of the igneous deposits on the west side of the property.

Coal in Category A represents coal from the area with the higher density and more uniform distribution of drilling information. Category B contains coal from the area where tonnage is less well represented by drilling (see Table No. 1). Exhibits O and U show the areas which contain Categories A and B tonnages.

Values shown on Table No. 3 are derived from the manual model.

After completing the manual geologic model, the computer model was constructed. A comparison between the two shows an 8 percent difference in total coal tonnage between the manual and the computer models.

2. COAL QUALITY ESTIMATES

Chuitna West Area

There have been so few samples cored in the Chuitna West Area that any estimate of the coal quality should be limited to the volume of coal in the immediate vicinity of the hole location. Two prominent beds (M and K) have been identified along with a number of lesser beds of varying continuity and thickness (grouped under Miscellaneous). The weighting factor used in averaging the analysis has been the thickness of the individual core sections grouped together. No attempt has been made to adjust the following quality values for mining dilution:

Bed	M	K	Miscellaneous
Equilibrium Moisture, % (a)	23	24	26+
Ash, % (a.r.) (b)	14.2	13.6	18.2
Volatile Matter, % (a.r.)	35.4	36.6	34.3
Fixed Carbon, % (a.r.)	27.4	25.8	21
Sulfur, % (a.r.)	0.14	0.21	0.18
Btu/lb. (a.r.) (b)	7600	7530	6550
Btu/lb. (d.c.b.) (c)	9875	9910	8910
Btu/lb. (M.A.F.) (d)	12110	12070	11850
HGI @ 21% Moisture level	51	45	50

Note:

(a) Used in adjusting analyses to as-received (a.r.) bases.
(b) a.r. = as-received.
(c) d.c.b. = dry coal basis.
(d) M.A.F. = Moisture, Ash Free.

Capps Area

Less than one-half of the Capps Area has been sufficiently cored to make possible a final accurate projection of the coal quality. If the assumption is made that the quality of the unknown area would be similar to that considered adequately cored, then the estimates in Table No. 4 of the "as-received" coal quality from the Capps Area can be made. In making use of the estimates, it should be kept in mind that coal from the Waterfall bed will be much more variable in quality than that from the Capps bed, although coal from the latter bed will generally be of lower grade. This is the reason that an estimate of the variability (± one standard deviation(s)) is shown wherever sufficient data were available for its determination. In the Capps Area, the Waterfall bed contains approximately 80 percent of the recoverable coal. So "average" values, although not projected, will tend to be more closely represented by the Waterfall bed than by the Capps bed.

Table No. 4 shows the average coal characteristic values for the two seams in the Capps Area.

3. MINING - CAPPS AREA

Coal Reserves

The Capps Area coal reserves are on the order of 223 million tons of coal in place in both the Capps and Waterfall Seams. Recoverable or minable coal is approximately 94 percent of in-place reserves. Of the total reserves, about 70 percent are considered to be in Category A or relatively well proven as to their existence.

In this instance the total reserves (Category A plus Category B) are sufficient for a nominal mine life in excess of 50 years at 4.25 million tons annually. The current study covers 30 years, so there is little doubt that enough coal exists at the deposit to support at least that much mining.

General Mining Plan and Possible Alternatives

The nature of the deposit is such that only surface mining methods (stripping) could recover a relatively large portion of the coal reserves.

Alternative Mining Methods

Consideration was given to the use of bucket wheel excavators, scrapers, shovels with trucks, draglines and conveyor transport of materials within the mine area. There is not sufficient information on the type of overburden to provide a high degree of confidence that bucket wheel excavators could be successfully employed, although there is a reasonable chance that they could dig at least a large percentage of the material. That same lack of information casts a degree of doubt on the stability of certain strata to: (a) serve as a base for roads for heavy-duty haulage, and (b) maintain slope angles conducive to dragline stripping. However, road bases can be built using such materials as crushed rock or gravel. Dragline cuts can be limited in depth, and highwall angles can be adjusted (within limits) to allow for at least slight variations in slope stability.

Belt conveyors were considered for the movement of both spoil and coal within the mine. Conveyors would require: (a) in-pit crushing for coal, (b) frequent moving and extending for both coal and spoil, and (c) spreading mechanism for spoil. Belt conveyors would probably be favored in conjunction with bucket wheel excavators for overburden removal. Additionally, belt conveyors might be used along with trucks for certain kinds of transport, such as gathering haulage by trucks to belt conveyor feeders.

An alternative mining plan that probably warrants further consideration would be to try to mine the deposit by advancing up dip or on the strike. One problem in that regard is how to get early high-volume mining at low cost because the up-dip method could result in several years of low output and higher cost mine development.

An alternative coal loading method could be tracked backhoes working on coal, particularly if a soft parting or underclay makes difficult pavement in which to work front-end loaders.

Mining Plan Chosen

For purposes of this study, the mining method selected utilizes scrapers, shovels, trucks, draglines and front-end loaders. The use of the various items is described as follows:

1. Scrapers. Initial overburden removal along the southern and south-eastern edge of the deposit is proposed, using twin-engine-wheeled scrapers, usually removing overburden to a maximum depth of 40 feet above the Waterfall Seam. Scraper stripping is projected to uncover about 10 million tons of Waterfall Seam coal over a period of 5 years. Scrapers would also be used to remove partings in both seams and to remove topsoil ahead of other excavators, where necessary, and to deliver that topsoil to final land reclamation zones or to topsoil stockpiles. Scrapers would be useful in related activities, such as road building and drainage control.

2. Shovels and End-Dump Trucks. Electric shovels would remove all overburden (except topsoil as explained above) overlying the Capps Seam. Total interval between the Capps and Waterfall Seams, while slightly variable, averages about 220 feet. Shovel cuts would normally be

in 40 to 50 foot vertical lifts. Shovels would also remove overburden below the Capps Seam down to a horizon about 110 feet above the Waterfall Seam. Shovel spoil would be loaded into end-dump trucks for haulage to previously mined areas and dumped above the dragline spoil. Such spoil disposal would, in effect, accomplish the major reclamation grading of returning most of the land to approximate original contour. Up to 30 million cubic yards of shovel spoil will be dumped just off the mining site initially, mostly to the south of the coal deposit area.

3. Draglines. Electric draglines would remove the lower 110 feet of overburden lying immediately above the Waterfall Seam. That spoil would be cast into the adjacent previously mined pit after the coal had been removed. Draglines would normally work on a bench 70 to 80 feet above the top of the Waterfall Seam making cuts 100 to 140 feet wide. The "extended bench" method is proposed, wherein the dragline operating bench is extended toward the spoil side of the cut with a portion of the spoil being rehandled. The estimated quantities of rehandle spoil vary from zero at up to 80 feet of dragline excavating depth to about 42 percent at 110 feet of depth. Most of the dragline digging would be below the base of the machine. However, "chop cuts" with depths up to 30 feet above the dragline operating bench would normally be dug.

4. Front-End Loaders and Coal Hauling Trucks. Essentially, all coal would be loaded with front-end loaders (or tracked backhoes could be used, either instead of or supplemental to front-end loaders. See Alternative Mining Methods) into coal hauling trucks of either the tractor-trailer type or the unitized body, bottom-dump type. For this study, it is considered that thicker partings (0.5 foot or more) within either of the two coal seams would be removed by scrapers as described in (1) above. The coal is relatively hard and will require drilling and blasting before loading. While coal seam thicknesses are variable, up to 50 or more feet, coal would normally be loaded out in benches. Usually the coal benches are separated by partings. Coal would be hauled in or along the pit to one of several main coal haulage roads then to the coal dump/crushing/stockpiling/train loading facility near the southeastern part of this mining area.

5. Dozers. Either track-type or wheeled dozers will work as auxiliary machines with scrapers, shovels, draglines and front-end loaders. Dozers will also work independently or with other machines in road building, levelling spoil at truck dumps, land reclamation, drainage control and other jobs.

6. Other Mining Equipment. Mobile drills will be used for drilling the coal for blasting. The coal is expected to be the most competent strata to be excavated. It is assumed that the overburden

and partings within the coal seams will not require blasting. Explosive trucks will be used for loading blast holes with a mixture of ammonium nitrate and fuel oil (ANFO). Graders will be used for road maintenance. Pumps will be used as required for dewatering pit areas. Service trucks will be used for fueling and lubricating other equipment, for tire care, for delivering supplies and parts, and for occasional field welding. Farm-type equipment (tractors, harrows, seeders, mulchers, etc.) will be used in final land reclamation. Small 4-wheel-drive vehicles will be used by supervisory, engineering, safety and environmental monitoring personnel.

Mining Sequence

1. Preparation for Mining. Water control structures (ditches, levees, ponds) will be established to divert as much surface drainage as is practicable from mining areas and to provide temporary impoundment for drainage from areas that are to be disturbed by mining and related activities. Such work will be continued as necessary as the mine expands. Premining access roads will be built to the early mining locations, and coal haulage roads will be built from the coal truck dump to selected early mining areas. Roads will be extended as the mine advances. Electric power will be distributed to sites for use by primary excavators (shovels and draglines) with future power service extended as the mine progresses.

2. Initial Mining. The first mining is proposed in the outcrop zone of the Waterfall Seam in the southeastern portion of the deposit. That early mining will be by wheeled scrapers where depth of cover is generally less than 40 feet. At about the same time, one electric shovel will begin making an outcrop cut along the Waterfall Seam along the steep escarpment at the eastern edge of the deposit. In addition to uncovering coal, the scrapers and shovel will be preparing areas for future excavating by draglines. In all mining areas, topsoil will first be removed and either stockpiled outside the mining area (initially) or (later) placed on the surface as part of the final reclamation grading. Most spoil material from scrapers and shovels in the first 3 years of mining will be placed off site to the south of the coal deposit. That material could be used to backfill coal haulage roads through the mining area upon completion of mining, some 50 to 55 years in the future. Quantity is on the order of 26 million to 30 million cubic yards.

3. Expansion of Mining. For long-range mine development, it is proposed to establish coal haulage roads at approximately the level of the bottom of the Waterfall Seam. Wherever possible, those roads are projected to "quarter the dip" in such a manner as to have maximum coal haulage gradients of 6 percent. Additionally, those roads are spaced at intervals of about one-half mile. Those criteria are general guidelines and are not rigidly adhered to in planning the mine. However, they are used to establish zones of work for draglines which have less mobility than other proposed excavators.

Maps of mining projections (Exhibits CC, DD and EE) show the sequence of proposed excavation in three different stratigraphic zones.

4. Description of Mining. Except for outcrop cuts by scrapers and shovels, the overburden lying within 110 feet above the Waterfall Seam is proposed to be moved by draglines. Each dragline would have a boom length of 285 feet and a bucket capacity of 25 cubic yards. Each dragline would work on a level bench 70 to 80 feet above the Waterfall Seam, with that level bench changing elevation as required to follow the dip and with the dragline walking up or down short ramps as required. Eventually, there would be four draglines, one projected to start work in each of the following project years: +1, +3, +5 and +12. The draglines would operate on simple casting (without rehandle) up to about 80 feet of overburden depth. At more than 80 feet, the "extended bench" or "semibridging" technique is proposed, whereby the operating level is extended toward the spoil side temporarily, thus requiring varying percentages of the spoil to be rehandled, depending upon depth of overburden and dip. The amount of rehandle is estimated to vary from zero to about 42 percent. Exhibit BB presents a typical cross section through an active mining zone and shows, diagrammatically, which overburden would be removed by shovel/truck and which by dragline. Exhibit AA also presents a pictorial or conceptual view of typical mining operations.

The total interval between the Capps and Waterfall Seams is about 220 feet plus or minus 20 feet. The overburden lying above 110 feet over the Waterfall Seam up to the bottom of the Capps Seam would be removed by electric shovels loading into end-dump trucks of 120 tons capacity. Mostly those trucks would dump that material on top of previously cast dragline spoil, thereby helping to reclaim the land to approximate original contour. Shovel cuts would be taken in lifts up to about 50 feet and in widths and lengths as required to keep ahead of the draglines. The shovels would be moved from one location to another to accomplish that objective and to remove overburden from above the Capps Seam (see below). There would eventually be a total of three shovels, with one starting to work in each of years: -1, +2 and +5. Quarry-type electric shovels are proposed, each equipped with a 20 cubic yard dipper.

Above the horizon of the Capps Seam, the depth of overburden varies from zero to about 280 feet. That material would all be removed by the same shovels and in the same manner as explained above. That excavation, as well as the loading out of coal from the Capps Seam, would necessarily keep ahead of any excavation at lower horizons.

Quality control of the coal product is largely by selective loading in the various pits. There are expected to be significant differences in quality between the two coal seams and probably also laterally within the same seam.

Partings within both the Capps and Waterfall Seams would be removed by scrapers. The annual volumes are estimated to vary from about 800,000 to 2,670,000 cubic yards for a total of almost 38 million cubic yards in the first 30 years of mining. In estimating those quantities (and the accompanying coal quantities), it has been assumed that 0.25 foot of coal would be lost at each interface of coal and overburden or coal and parting, and that those coal quantities lost would be added to the parting volume.

Mining progress would be generally from the southeast toward the northwest. The four primary mining zones, one assigned to each of the four draglines, would advance "en echelon." Thus, at least in certain instances, spoil being hauled by trucks can be hauled from one zone to another on gradients that are not excessively steep. However, part of the spoil haulage would remain within the zone from which it is excavated, being hauled across an earth "bridge" spanning the dragline cut to a dumping point above the dragline spoil. Additionally, roadway ramps at about 10 percent grade would connect excavating benches and spoil dumping benches as required for such cross pit haulage. An alternative to trucking spoil could be conveyor haulage with attendant feeders, stackers and spreaders. Further study of conveyor transport, even with numerous conveyor relocations, appears justified.

Further understanding of the mining method sequences of operations and direction of advance can be gained by study of the following drawings: Exhibit BB, a diagrammatic cross section and Exhibit AA, a conceptual view of a portion of the mine.

Coal would all be delivered by bottom-dump trucks to a dump hopper from which it would be fed to a crusher then to a covered stockpile. A covered stockpile would reduce wind-blown coal dust and prevent snow contamination of the coal, thus reducing handling problems of frozen coal. Unit trains would be loaded from the stockpile. The stockpile at the Capps Mine would have a total capacity of 150,000 tons and would have the capability of holding coal of two different quality ranges. Blending, if needed, would be at the methanol plant.

Coal haulage distances initially will be relatively short, as little as 0.5 mile in early mining. As mining develops, those distances become progressively greater until in year 30 part of the coal is being trucked more than 3 miles. Additionally, most of the coal is hauled up grade, with vertical lift gradually increasing, until at the end of 30 years of mining a portion of the coal will be lifted 800 to 900 feet. Most of the main coal haulage roads will be located at or near the bottom of the Waterfall Seam and will be extended as that seam is mined. Temporary roads will be in the active mine pits. Coal haulage roads from the Capps Seam (which contains less than 20 percent of the total recoverable coal) will follow various routes, usually feeding into the main road system.

Land Reclamation

A mode of backfilling the mined areas will be established at the earliest practicable date, which will be approximately 3 years after initial mining. That backfilling will consist of trucks dumping shovel spoil on top of dragline spoil in such a manner as to return the ground surface to approximate original contour. Final grading will be smoothing by dozers then spreading a layer of topsoil, if required.

Suitable vegetation will be established on the reclaimed surface, using farm-type equipment and methods. Surface preparation would consist of disking, fertilizing, seeding and mulching. Most of the vegetation would probably be grasses and low bushes, similar to what exists in the premining state.

Support Facilities for Mining

Coal Handling

The truck dumping hopper, coal crushers, conveyors, stockpile and rail loading requirements were specified by the Paul Weir Company and have had conceptual designs prepared by the Davy McKee

Corporation. Davy McKee drawings Nos. 5530-601-P-001 through P-003 are referred to for further details. Davy McKee drawing No. 5530-601-Y-001 is a schematic presentation of coal handling facilities at Capps Mine. The section "Description of Mining" explains in general the operation of those facilities. Further in that regard, the overall capacity of coal handling facilities is such that the maximum proposed mine output of 7.5 million tons per year could be handled. Coal would be crushed to a 6 inch top size. Provisions are included for coal sampling (according to American Society for Testing Materials specifications) as trains are loaded. Sampling would be at a transfer point between two conveyors. Coal storage capacity would be 150,000 tons in a covered storage barn-type structure. Trains would be loaded at a rate of 4,000 tons per hour on a loop track.

Mine Buildings

Davy McKee has provided conceptual design and layout for offices, changehouse, shops, warehouse, equipment services, water and sewage treatment, fire protection, parking and related items. Those are presented in some detail on Davy McKee drawings Nos. 5530-601-P-004 through P-008. A bus station is provided at the mine site. Buses (and perhaps some private vehicles) will deliver workers to the mine. A brief description of the facilities follows:

1. Coal Mine Office/Changehouse - 18,000 square feet. The mine offices for supervisory, engineering and clerical personnel that are located at the mine are provided as are meeting rooms, first aid, records storage, coal sample preparation and toilet facilities. The changehouse provides lockers for up to 531 persons (464 men and 67 women) with separate lockers for clean and dirty clothes, shower rooms and toilet facilities.

2. Equipment Washing Facility - 4,900 square feet. Mobile equipment such as trucks, graders, scrapers, etc., can be driven through spray arches and/or manually scrubbed or steam cleaned then rinsed and dried with hot air.

3. Battery and Filter Service Shop - 2,700 square feet. This building provides facilities for servicing batteries and air filters. The battery service, which includes battery charging and storage, is separately ventilated. Tools and light fixtures in the battery shop will be explosion proof.

4. Utilities Building - 7,200 square feet. A coal fired boiler, water treatment associated with steam generation and air compressors are housed at this location. Steam is used for heating the

mine buildings and for cleaning equipment. Compressed air is used to operate tools and is piped to outdoor equipment parking areas for use in starting certain large diesel engines.

5. Water/Sewage Treatment - 3,000 square feet. This facility will treat local water for potable water supply. Additionally, sanitary waste water will be treated. An adjacent outdoor aerobic digestor, aeration basin and clarifier are being provided.

6. Shop and Warehouse Building - 63,000 square feet. This building will contain the indoor facilities required at the Capps Mine for equipment maintenance and a warehouse for parts and supplies. The mine shop will perform functions such as inspections, diagnosis, tune-ups, lubrication, tire and oil changing and minor repairs on the more mobile items of mining equipment. Overhauls of engines, transmissions, wheel units and other components will be at the central shop facility, located near the Chuitna West Mine. Additionally, the Capps Mine shop would do most welding on items such as shovel dippers, dragline buckets, truck beds, dozer blades, etc. Shop bays will be sufficiently large to hold the largest items of mobile equipment and still provide adequate working space on all sides. The 40' x 60' bays could, in certain instances, each hold one unit of large equipment or two units of smaller equipment. Two 50' x 60' bays could each hold up to three units of smaller (support) vehicles.

A total of 16 bays are provided, two of which would be assigned to heavy welding. A clear aisle (20 feet wide) is provided lengthwise through the center of the building. One side of the building is high enough to raise the bodies of 120 ton end-dump trucks. The shop would have two travelling overhead bridge cranes, each covering seven of the large equipment and welding bays. Each crane will have a 25 ton main hoist and a 5 ton auxiliary hoist. The service truck bays will have a 2 ton travelling, underslung crane. Tool modules would be located adjacent to each maintenance bay.

A supervisor's office and a toilet facility will be located in the building between the shop and warehouse areas.

The warehouse portion of the building (140' x 120') will be for storing tires, various supplies, repair parts and equipment components. Materials can be received either by rail or by truck.

7. Fire Protection. A fire protection system is provided with a pond being the source of water which is distributed by pumps through a piping loop circuit around the fixed major mine facilities. The buildings will have sprinkler systems and there are exterior fire hydrants at various points. Additionally, a fire truck is to be kept at the mine.

Electric Power Distribution at Capps Mine

Davy McKee provided a conceptual design of electric power distribution, which is presented diagramatically, on their drawing No. 5530-601-N-001. The following paragraphs describe the electric power facilities at Capps Mine:

The incoming 161KV power at the mine site is transformed to 4,160 volts for the coal handling equipment and to 69,000 volts for transmission to the mine pit for the mining machinery.

The main transformer at the Capps Mine is a three winding transformer rated 30 MVA. The 4,160 volt secondary winding and the 1,000 KVA transformer supply the medium voltage starters for the coal conveyors and the rotary plow, an approximate load of 4,800 KW.

The 480 volt transformer supplies coal handling motors smaller than 200 horsepower, lighting, overhead cranes, truck engine heaters, machine tools and other miscellaneous loads.

The Capps mining machinery loads of approximately 21,500 KW are supplied by individual transformers for each dragline and each shovel. There is a 480 volt transformer at each location for power for pumps and auxiliaries.

Capital Costs

Capital costs were estimated as of mid-1981 with no provision for escalation. Those costs are included in Table No. 5.

Items Covered

Capital cost estimates for mining include mining equipment, construction of fixed facilities at the mine, auxiliary equipment required for direct support of mining, premining expenses of such items as initial mine roads, initial drainage revision, a pro-rata portion of a gravel plant for road surfacing and a pro-rata portion of the cost of a central administrative office and a central shop. The gravel plant facility is not specifically located. It is assumed that it will be in a deposit of glacial gravel, possibly at Capps Mine or Chuitna West Mine or some other location readily accessible to the road system serving both mines. The central administration office, shop and warehouse are proposed to be located adjacent to Chuitna West Mine.

Items Excluded

Mining costs incurred in project year -1 are excluded. Those costs are included in Table No. 5 as operating costs and are proposed to be charged as such. There will be no coal shipped in that year, although approximately 3.8 million tons of coal will be uncovered, thus establishing an initial pit inventory of coal. Exploration costs are excluded, whether spent before the current study or proposed for the future, although further exploration and development drilling are definitely needed. The cost of establishing an initial inventory of parts and supplies is excluded. Interest costs are excluded.

Initial Capital

The amount of money expended in years -4 through -1, except exploration and cost of uncovering the first 3.8 million tons of coal (as explained above), is sufficient to get the mine to its design capacity. On that basis those expenditures might be considered as "initial capital." That amount is estimated to be $167,591,000. However, considerably more expenditures are needed after year -1, for expansion of mining and for replacements of capital items in order to sustain the design output.

Expansion and Replacement Capital

Essentially the mining capacity depends upon the amount of overburden that can be removed in relationship to the effective ratio of cubic yards of overburden per recoverable ton of coal. The nature of the deposit and the proposed mining schedule are such that mining is proposed to start in relatively low ratio areas and progressively move into higher ratio zones. Thus more primary excavators along with the necessary support equipment must be brought on line as the mine expands. Estimates of capital expenditures take those dates of proposed acquisition into account.

Replacements of capital equipment are also considered. Those replacements are based either on hours of use or on estimated years of life. The current study covers a period of 30 years of mining. The fixed facilities and the electric shovels and draglines are estimated to last for at least that period of time and are thus considered as "life-of-mine" items. Preproduction mining costs are proposed to be capitalized for years -4 through -2.

Capital Contingencies

Small items of equipment and other miscellaneous capital costs, too numerous to list, as well as possible underestimations of cost of certain items, are covered by a contingency factor of 10 percent.

Those contingencies have been applied "across the board," i.e., to equipment, facilities and preproduction mining costs prior to year -1.

Operating Costs

Major operating cost estimates for labor (and labor-related costs), materials, parts and supplies were estimated. Those costs were broken down annually for years -1 through +15 then by 5 year periods through year +30. Additionally, the costs were estimated by major work categories and by certain groups of materials and supplies. The costs of reclamation and black lung taxes were also included. All costs were estimated in 1981 dollars with no provision for future inflation, escalation or future governmental regulations. Table No. 5 includes a summary of those costs for Capps and Chuitna West Mines combined. Details are omitted for proprietary reasons.

Excluded from operating costs are royalties to landowners, state mining license tax, property taxes, income taxes, interest cost on borrowed money, electric power costs, any infrastructure costs (as related to town site, the main access road, port facilities or the railroad), cost depletion and depreciation. Depreciation would be approximately $2.71 per ton weighted average through year 30, arrived at by dividing the total estimated capital ($368,344,000) by the projected coal output (136 million tons).

Mining Personnel

Estimates were made of mining personnel required in years -1 through 30. That estimate was by grades of production labor, maintenance labor, salaried exempt and salaried nonexempt employees. The total number of employees varies from 208 in year -1 to 545 in year 14. Those numbers include persons assigned to the central administration and central shop.

The production and maintenance labor grades are based upon the labor contract at the Usibelli Coal Mine near Healy, Alaska and wage rates used for estimating labor costs are comparable to wages specified in that contract, plus a 35 percent allowance for all of the various fringe benefits and payroll overhead.

4. MINING - CHUITNA WEST AREA

Coal Reserves

The Chuitna West Area minable coal reserves are on the order of 163 million tons in five seams to an approximate maximum depth of 600 feet below the surface.

The proposed mining would remove 119 million tons in the first 30 years and more would probably be mined in succeeding years. The entire deposit has a potential life of 40 years at 4.25 million tons per year. Portions of the Chuitna West reserve are being excluded from early mining plans until field experience determines actual buffer areas required to protect the Chuitna River system.

General Mining Plan and Possible Alternatives

Surface mining only is proposed. Underground methods would be prohibitively expensive and wasteful of natural resources.

Alternative Mining Methods

Consideration was given to the use of bucket wheel excavators, scrapers, shovels with trucks and conveyor transport of materials within the mine area. There is not sufficient information on the type of overburden to provide a high degree of confidence that bucket wheel excavators could be successfully employed. In fact, there is evidence of occasional lenses or bands of hard sandstone, although those strata probably constitute a very small proportion of the total material to be moved. Additionally, the size and occurrence of hard boulders in the glacial till are not known.

The nature of the deposit is such that a relatively deep hole will be dug in an area limited by lease boundaries, the Chuitna River and geologic factors. The use of draglines was not given serious consideration.

Belt conveyors were considered for the removal of both spoil and coal. Conveyors were chosen for removing coal from the deeper portions of the mine to the stockpiling facility. Conveyors were (for this study) not employed for spoil removal due to concern over the possible sticky nature of the overburden and the climatic conditions. Over the life of the mine most spoil will be used for backfill. If bucket wheel excavators could be used to dig the overburden then belt conveyors would have to be given further consideration.

Mining Plan Chosen

This first phase mining feasibility study uses the mining method of shovels loading into end-dump trucks to remove both overburden and coal. The topsoil material would be removed with scrapers, initially stockpiled, later spread on the surface as a step in land reclamation.

Use of the various items of major mining equipment is described as follows:

1. Scrapers. Twin-engine wheel scrapers would remove topsoil, assist in road building and in drainage control.

2. Shovels and End-Dump Trucks. Electric shovels would excavate vertical lifts of about 50 feet, selectively removing both overburden and coal. Initially, the spoil would all be dumped off site and the coal would be hauled to the crushing/stockpiling/train loading facility just off the mine site at the southwestern corner. Horizontal slices would be removed in successive 50 foot vertical lifts. With strata lying at various dips up to 30 degrees, the shovels would, at different times during the digging of any given horizontal slice, alternately be in overburden and in coal. The same shovel would be used for both. The same basic end-dump trucks are proposed for hauling spoil, coal, and the ash and sludge from the plant operations. Eventually a total of seven shovels will be used, each with a dipper capacity of 20 cubic yards. Total truck requirements build up during the off-site dumping period to a maximum of 65 units. As the backfill mode is phased in, this total drops to between 30 and 40 trucks over the remaining project years.

3. Dozers. Crawler and rubber-tired dozers would assist scrapers, drills and shovels, level spoil at truck dumps, build roads and drainage structures and do other general work. Each shovel would have a dozer assigned for cleanup work. Additionally, during coal loading, the dozer would be pushing coal down dip to the shovel. In the few instances where partings exist within

a coal seam, that material will be selectively dozed to the shovel operating level for future loading into spoil haulage trucks.

4. Other Mining Equipment. Mobile, track-mounted drills will be used to drill the coal for blasting. Explosive trucks will be used for loading blast holes with ammonium nitrate and fuel oil (ANFO). Graders will be used for road maintenance. Pumps will be used as required for dewatering pit areas. Service trucks will refuel and lubricate the less-mobile equipment, service tires, deliver parts and supplies and do occasional field welding. Farm-type equipment (tractors, harrows, seeders, mulchers, etc.) will be used in final land reclamation. Small 4-wheel drive vehicles will be used by supervisory, engineering, maintenance, safety and environmental monitoring personnel.

Mining Sequence

1. Preparation for Mining. Surface drainage will be diverted away from the proposed mining area insofar as practicable by means of ditches and levees. Temporary impoundment of drainage from disturbed areas, including off-site spoil piles, will be provided by sediment ponds. Drainage and sediment control work will continue as the mine expands. Premining access roads will be built to the early mining and spoil disposal locations. Roads will be extended and relocated as required by progress of mining.

Electric power will be distibuted to sites for use by primary excavators (shovels) with future power facilities extended as the mine advances.

2. Initial Mining. First mining is proposed in the southern portion of the coal leases. Topsoil will be removed by wheeled scrapers at both the mining area and the off-site spoil disposal area and stockpiled. Shovels will excavate in vertical lifts of up to 50 feet, loading spoil into end-dump trucks for disposal off site. All of the spoil for the first 5 years of mining will be hauled off site. That procedure allows for establishing a deep open cut to approximately 600 feet below the existing surface. The sides of that cut would be benched at 100 foot vertical intervals with 100 foot horizontal benches. Highwall slopes between benches would be at about 45 degrees and overall pit slopes would be at not more than 30 degrees, a slope which at this time is assumed to be sufficiently stable and safe for mining operations.

3. Expansion of Mining. The deep pit described above would advance to the north. Backfilling of the pit would begin after establishing sufficient area at the bottom of the pit for the required mining operations at that level. Even when backfilling begins most spoil would be hauled off site in gradually decreasing quantities until the end of year 9, after which all spoil would be returned to previously excavated areas. A total of seven shovels will be working on 14 levels, each loading overburden

or coal as it is encountered. Ramps would be built connecting adjacent mining levels for truck haulage. The 100 foot wide benches would serve as truck haulage roads for both coal and spoil. Spoil would normally be trucked to final disposal dumps, either off-site or to backfilling points. Coal would be trucked either (a) to the permanent crushing station near the stockpile at the rail loading point (during the first 3 years) or (b) to in-pit crushing stations (from year 4 onward) from which belt conveyors would elevate and transport the coal to the stockpile. The in-pit truck dumps, crushers and accompanying conveyors would be moved occasionally (approximately annually) as mining advances. Even in later years coal mined from the shallower levels could be trucked to the permanent coal handling facility at the surface, in case of a conveyor outage.

Beyond the initial pit other pits will be developed to the north and northwest and later toward the southeast. The relatively large pit in the southeastern portion of the deposit will only partially be mined within the first 30 years. The entire deposit has a potential mine life of approximately 40 years at 4.25 million tons per year, assuming mining to 600 feet of depth, keeping coal removal within lease boundaries and avoiding excavating in the steep slope zone of the Chuitna River gorge. Exhibit FF is a pictorial or conceptual view of Chuitna West Mine at an advanced stage.

4. Description of Mining. The preceding sections on Initial Mining and Expansion of Mining have described the proposed operations in a general way. A few other explanations are as follows:

(a) It is assumed that 20 cubic yard electric shovels will be able to dig the overburden material without drilling and blasting, even though exploration drilling indicates the presence of a few minor lenses of sandstone. Those are expected to be relatively unconsolidated and to constitute a small percentage of the total material to be excavated.

(b) The coal will require drilling and blasting as well as being pushed down dip with a dozer to a shovel for truck loading. There are relatively few partings of impurities within the coal seams at Chuitna West. Where they do exist they would be selectively dozed off the top of the coal for loading separately.

(c) Water will be collected in sumps at various mining levels and pumped out of the mine to holding ponds for clarification, testing and (if necessary) for treatment before being released to the natural drainage system of the area. All clear water discharges will be into the Chuitna River drainage system, with no affected water going into the Nikolai Creek system. Results of ongoing fishery studies may require changes in proposed discharge plans.

(d) It is assumed that the overburden material will support the weight of shovels and the traffic of trucks, with the addition of crushed rock or gravel for road surfacing. That rock would be applied in varying quantities as needed depending on such factors as natural conditions, amount of traffic and relative life of any given section of road.

Quality control of the coal product is accomplished by selective loading of the various coal seams. There are indications of quality and grindability variations between seams. However, the mining operations will be such that coal from two or more seams could be produced simultaneously (or at least from more than one seam within a relatively short time). It is assumed that variations in quality of coal produced on a day-to-day basis from Chuitna West will be of a minor nature.

Further understanding of the general mine layout and of sequence of mining can be gained by reference to Exhibits FF through LL.

Coal would be delivered to the crushing/stockpiling/rail loading facility by end-dump trucks initially, later by conveyors from in-pit crushers. The stockpile of crushed coal will have a total capacity of 100,000 tons. Train loading from that stockpile is proposed at a rate of 4,000 tons per hour.

Ash Disposal

Ash from the methanol plant and from boilers will be returned to Chuitna West Mine in side-dump railway cars. That ash will be dumped on the ground then loaded by front-end loader into end-dump trucks for delivery to an active spoil dumping point where it will be covered by mine spoil. For the first 9 years of mining that disposal will be in the off site spoil pile. After that time the ash will be part of the backfill in previously mined areas. Also, at about year 9 or 10, it will be advantageous to move the rail dumping point for ash to the north to reduce the ash trucking distance in later years.

It is assumed that the ash (a portion of which might have previously been "sludge") will be in a form and of a sufficiently low moisture content that will not adversely affect the stability of spoil piles and will be capable of supporting truck traffic. In fact, there is a chance that part of the ash (boiler "bottom ash" plus some fly ash) might be used as a road surfacing material.

Land Reclamation

Prior to mining, topsoil will be removed from 400 acres of the initial mining area and from 230 acres of land at the off-site spoil disposal location. That topsoil will be stockpiled.

The off-site spoil pile will contain approximately 250 million cubic yards of material, will be built in layers up to 50 feet thick and the sides of the pile will be sloped and benched. Slopes between benches will be 20 degrees and benches will be 60 feet wide. Thus the average overall slope will be 14 degrees. The slopes and benches of the spoil pile will be finally graded, covered with topsoil and seeded as the spoil pile grows in height. Upon completion of off-site spoil dumping (about year 9), the final surface and upper slopes of the pile will be graded, covered with topsoil and seeded. Actually spoil grading and compaction will be done by dozers at the truck dump points as the pile grows.

Backfilling of the pit to approximately original contour will begin about year 6. Backfilling will be in benches from the bottom upward, maintaining slopes and benches similar to those described for the off-site spoil. As areas being backfilled reach their final elevation those areas will be reclaimed by grading, topsoil spreading and seeding.

Farm-type equipment is proposed for final preparation of the surface for seeding. That seeding would be done in conjunction with mulching and fertilizing. Seeding will necessarily be on a seasonal basis.

One possible exception to grading backfilled areas to original contour will be that surface drainage will be controlled so that as little water as possible flows into the active mine pit.

Support Facilities for Mining

Coal Handling

The truck dumping hopper, coal crusher, conveyors, stockpile and rail loading requirements were specified by the Paul Weir Company and have had conceptual designs developed by the Davy McKee Corporation. Davy McKee drawing No. 5530-602-Y-001 is a schematic presentation of those facilities. Davy McKee drawings Nos. 5530-602-P-001, -002 and -003 are referred to for further details. The section of this report on "Description of Mining" explains in general the operation of those facilities. Additionally, the overall capacity of coal handling facilities is such that the maximum proposed mine output of 4.25 million tons per year can be accommodated. Coal would be crushed to 6 inches top size initially by the permanent facility, later by in-pit crushers as previously explained. Provisions are included for coal sampling at a conveyor transfer point (according to specifications of American Society for Testing Materials) as trains are loaded. Coal stockpile capacity would be 100,000 tons in a covered storage barn-type structure. Covered storage would reduce wind-blown dust and prevent snow contamination of the coal, thus reducing handling problems of frozen coal. From that stockpile trains would be loaded at a rate of 4,000 tons per hour.

Mine Buildings

Davy McKee has provided conceptual design and layout for offices, changehouse, shop, warehouse, equipment services, water and sewage treatment.

fire protection, parking and related items. At the Chuitna West Mine location those facilities have been expanded to include a central shop for major overhauls and rebuilding of equipment components and for central supervisory, engineering, purchasing and accounting offices that would serve Capps Mine as well as Chuitna West Mine. Those designs are presented on Davy McKee drawings Nos. 5530-602-P-004, -005, -006, -007, -008, and -009. One change from what is shown on those drawings is: additional change room and bathing facilities will be needed in years 3 through 15 in varying amounts due to increases in projected personnel requirements at Chuitna West Mine (from earlier preliminary estimates). Those increased bathing and change room requirements are proposed to be met by installing module-type prefabricated units as needed. A brief description of the facilities follows:

1. Coal Mine Office/Changehouse - 18,000 square feet. The 18,000 square feet apply to the permanent structure as designed and do not include the temporary changehouse modules described above. The permanent changing rooms will handle 464 men and 67 women (531 persons) with separate lockers for clean and dirty clothes, shower rooms and toilet facilities. That building would also contain offices for Chuitna West Mine supervisory, engineering and clerical personnel as well as meeting rooms, a first aid room, records storage and coal sample preparation

2. Equipment Washing Facility - 4,900 square feet. Mobile equipment such as trucks, graders, scrapers, etc. can be driven through spray arches and/or manually scrubbed or steam cleaned then rinsed and dried with hot air.

3. Battery and Filter Service Shop - 2,700 square feet. This building provides facilities for servicing batteries and air filters. The battery service, which includes battery charging and storage, is separately ventilated. Tools and light fixtures in the battery shop will be explosion proof.

4. Utilities Building - 7,200 square feet. A coal fired boiler, water treatment associated with steam generation and air compressors are housed at this location. Steam is used for heating the mine buildings, central shop and central administration building and for cleaning equipment. Compressed air is used to operate tools and is piped to outdoor equipment parking areas for use in starting certain large diesel engines.

5. Water/Sewage Treatment - 3,000 square feet. This facility will treat local water for potable water supply. Additionally, sanitary waste water will be treated. An adjacent outdoor aerobic digestor, aeration basin and clarifier are being provided.

6. Shop and Warehouse Building - 63,000 square feet. This building will contain the indoor facilities required at the Chuitna West Mine for equipment maintenance and a warehouse for parts and supplies. The mine shop will perform functions such as inspection, diagnosis, tune-ups, lubrication, tire and oil changing and minor repairs on the more mobile items of mining equipment.

Overhauls of engines, transmissions, wheel units and other components will be at the central shop facility, located in an adjacent building. Additionally, the mine shop would do most welding on items such as shovel dippers, truck beds, dozer blades, etc. Shop bays will be sufficiently large to hold the largest items of mobile equipment and still provide adequate working space on all sides. The 40' x 60' bays could, in certain instances, each hold one unit of large equipment or two units of smaller equipment. Two 50' x 60' bays could each hold up to three units of smaller (support) vehicles. A total of 16 bays are provided, two of which would normally be assigned to heavy welding. A clear aisle, 20 feet wide will run lengthwise through the center of the building. One side of the building is high enough to raise the bodies of 170 ton end-dump trucks, even though 120 ton units are used in this study. The shop would have two travelling overhead bridge cranes, each covering seven of the large equipment and welding bays. Each crane will have a 25 ton main hoist and a 5 ton auxiliary hoist. The service truck bays will have a 2 ton travelling, underslung crane. Tool modules would be located adjacent to each maintenance bay.

A supervisor's office and a toilet facility will be located in the building between the shop and warehouse areas.

The warehouse portion of the building (140' x 120') will be for storing tires, various supplies, repair parts and equipment components. Materials can be received either by rail or by truck.

7. Fire Protection. A fire protection system is provided with a pond being the source of water which is distributed by pumps through a piping loop circuit around the fixed major mine facilities. The buildings will have sprinkler systems and there are exterior fire hydrants at various points. Additionally, a fire truck is to be kept at the mine.

Electric Power Distribution at Chuitna West Mine

Davy McKee provided a conceptual design of electric power distribution which is presented diagramatically on their drawing No. 5530-602-N-001. The following paragraphs describe the electric power facilities at Chuitna West Mine:

The incoming 161KV power at the mine site is transformed to 4,160 volts for the coal handling equipment and to 69,000 volts for transmission to the mine pit for the mining machinery.

The main transformer at the Chuitna West Mine is a three winding transformer rated 20 MVA. The 4,160 volt secondary supplies medium voltage starters for the coal conveyors, the rotary plow and a 1,000 KVA, 480 volt transformer approximate load of 4,500 KW.

The 480 volt transformer supplies coal handling motors smaller than 200 horsepower, lighting, overhead cranes, truck engine heaters, machine tools and other miscellaneous loads.

The Chuitna mining machinery loads of approximately 12,000 KW are supplied by two transformer stations each consisting of a 15 MVA, 69 KV to 6.9 KV transformer, and a 2,000 KVA, 6.9 KV to 480 volt transformer. Each of those two transformer stations could supply power to the seven mining shovels at the mine so that, in effect, there would be 100 percent standby transformer capacity. The 480 volt power would be primarily for mine pumps. Emergency power for pumps and shovel moving is provided in the form of two 750 KW diesel generators.

Capital Costs

Capital costs were estimated as of mid-1981 with no provision for escalation. Those costs are included in Table No. 5.

Items Covered

Capital cost estimates for mining include mining equipment, construction of fixed facilities at the mine, auxiliary equipment required for direct support of mining, premining expenses such as initial mine roads, initial drainage revision, a pro-rata portion of a gravel plant for road surfacing material and a pro-rata portion of the cost of a central administrative office and a central shop. The gravel plant facility is not specifically located. It is assumed that it will be in a deposit of glacial gravel, possibly at Capps Mine or Chuitna West Mine or some other location readily accessible to the road system serving both mines. The central administration office, shop and warehouse is proposed to be located adjacent to Chuitna West Mine.

Ash disposal equipment and facilities located at the mine are included. The ash plus a quantity of "stabilized sludge" from the methanol plant and from boilers is proposed to be delivered by rail to Chuitna West Mine where it will be distributed and covered within the mine spoil disposal system.

Items Excluded

Mining costs incurred in project year -1 are excluded. Those costs are shown on Table No. 5 as operating costs and are proposed to be charged as such. There will be no coal shipped in that year, although approximately 288,000 tons uncovered, thus establishing an initial pit inventory of coal. Exploration costs are excluded, whether spent before the current study or proposed for the future, although further exploration and development drilling are definitely needed.

Initial Capital

The amount of money to be expended in years -4 through -1, except exploration and cost of uncovering the first 288,000 tons of coal (as explained above), is considered to be "initial capital." That amount is estimated to be $156,101,000. However, those expenditures in the case of Chuitna West Mine will not be sufficient to either reach or to sustain the design capacity of the mine; namely, 4.25 million tons annually. That rate of output is projected to be reached in year 5 and capital expenditures by the end of year 5 are estimated to be $220,098,000. By the end of year 2 all seven of the proposed major excavators (20 yard shovels) will have been put into service. Preproduction costs prior to year -1 are proposed to be capitalized.

Expansion and Replacement Capital

Beyond year 5 the required capital expenditures are mostly for replacement of equipment with minor expenditures needed for extension of facilities. Those replacements and extensions are accounted for in capital estimates. Replacements are based either on hours of use or on estimated years of life. Fixed facilities and the electric shovels are estimated to last at least through year 30 and are thus considered as life-of-mine items.

Capital Contingencies

Small items of equipment and other miscellaneous capital costs, too numerous to list, as well as possible underestimations of cost of certain items, are covered by a contingency factor of 10 percent.

Those contingencies have been applied "across the board," i.e., to equipment, facilities and preproduction mining costs prior to year -1.

Operating Costs

The major operating cost estimates for labor (and labor-related costs), materials, parts and supplies were estimated. Those costs were broken down annually for years -1 through +15 then by 5 year periods through year +30. Additionally, the costs were estimated by major work categories and by certain groups of materials and supplies. The items of reclamation and black lung taxes were also included. All costs were estimated in 1981 dollars with no provision for future inflation, escalation or future governmental regulations. Table No. 5 includes a summary of those costs for Capps and Chuitna West Mines combined. Details are omitted for proprietary reasons.

Ash burial costs are included in operating costs of Chuitna West Mine. Those costs average $0.45 per ton of coal mined at Chuitna West over a 30 year period or about $0.64 per cubic yard of ash.

Excluded from operating costs are royalties to landowners, state tax, property taxes, income taxes, interest cost on borrowed money, electric power costs, any infrastructure costs (as related to town site, the main access road, port facilities or the railroad), cost depletion and depreciation. Depreciation would be approximately $3.35 per ton weighted average through year 30, arrived at by dividing the total estimated capital ($398,717,000) by the projected coal output (119 million tons).

Mining Personnel

Estimates were made of mining personnel required in years -1 through 30. That estimate was by grades of production labor, maintenance labor, salaried exempt and salaried nonexempt employees. The total number of employees varies from 173 in year -1 to 748 in year 5. Those numbers include persons assigned to the central administration and central shop.

The production and maintenance labor grades are based upon the labor contract at the Usibelli Coal Mine near Healy, Alaska and wage rates used for estimating labor costs are comparable to wages specified in that contract, plus a 35 percent allowance for all of the various fringe benefits and payroll overhead.

Table No. 5 presents a summary for the combined mines of estimates of production, personnel, capital costs and operating costs. Estimates were made for each mine separately and by numerous items and work categories. Previous sections of this report have discussed those estimates and presented summarized results.