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CARBON CREEK COAL BASIN

PROGRESS REPORT

1971 FIELD SEASON

UTAH INTERNATIONAL INC.

Mineral Exploration & Development Dept.

Salt Lake City, Utah

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ABSTRACT

An area of approximately 15 square miles immediately west of Carbon Creek, in the Peace River Area of Northeastern B.C., was investigated during the summer of 1971 to evaluate the metallurgical coal potential of the Carbon Creek Coal Basin. Nine stratigraphic core holes were drilled totaling 6752 feet. About 2300 feet of coal-bearing Gething Formation were tested. Nineteen miles of road were constructed to reach the drill sites.

This preliminary drilling program indicated that numerous coal seams are present in the Lower Cretaceous Gething Formation. Twelve principal coal seams greater than 4.0 feet in thickness and thirty-two coal seams with thicknesses greater than 2.0 feet are present in a relatively undisturbed, erosionally dissected, structural basin trending generally northwest parallel to Carbon Creek. Dips in the area of greatest interest are generally eastward at less than 10° while at the western edge of the property they exceed 20°.

A geologic map was prepared from drill hole data. A veneer of glacial debris and heavy overgrowth obscures bedrock, limiting field surface mapping. Utilizing Utah's new topographic base map the inferred coal bed outcrops are shown for the twelve principal coal seams and three prominent sandstone marker beds.

An area of approximately 5 square miles, defined by drilling and geologic mapping as potentially mineable, is located between Seven Mile Creek and Ten Mile Creek,

The washed medium volatile bituminous coal of Carbon Creek has a calorific value, on a natural basis, ranging from 12,000-14,000 Btu, with an ash content between 2%-8% and sulfur content generally less than 1%. Coking properties,

as determined by the A.S.T.M., "Standard Method of Test for Free-Swelling Index of Coal", are moderately good. Coal seams of potential interest had FSI indices ranging from 1.5 to 7.0. Coal seams 2.0-4.0 feet thick have an average free-swelling index of 5.0.

Total in-place reserves for coal greater than 4.0 feet in thickness to a maximum depth of 2,000 feet are estimated at approximately 300 million tons. The recoverable reserves on 10 coal seams at a 5.0-1 stripping ratio are estimated at approximately 25 million tons. These reserves are north of the North Fork of Eleven Mile Creek to about 1 1/2 miles north of Seven Mile Creek.

During Utah's 1972 exploration program, additional drilling is planned in the area of greatest potential between Seven Mile and Ten Mile Creeks. Exploratory drilling will be extended to the southeast part of the Carbon Creek block. Two exploratory stratigraphic core holes are planned on the East Mt. Gething block, 1 1/4 miles west of W.A.C. Bennett Dam. Field reconnaissance work is also planned on the Adams Syncline and Dunlevy Syncline blocks.

INTRODUCTION

Early in 1971, Utah International Inc., formerly Utah Construction & Mining Co., negotiated with Trend Exploration Ltd., a Colorado Corporation*, the transfer of 143 coal licenses covering 89,753 acres in northeastern British Columbia. Contiguous with 55 Trend licenses in the Carbon Creek area are 10 coal leases, totaling 6400 acres, acquired through negotiation with the Burns Foundation Ltd., of Calgary.

This report is a presentation of geological data resulting from Utah's 1971

* Our resources transferred from one U.S. company to another!! Was this the kind of Canada the Socreds wanted?

exploration investigation of the potential metallurgical coal resources on a portion of the Carbon Creek coal properties. The exploration program had the following objectives:

1. To gain, by diamond core drilling, a further understanding of the Gething Formation stratigraphy and its coal potential in the Carbon Creek area.
2. To determine the agglomerating characteristics of the coal.
3. To obtain unweathered coal core samples suitable for laboratory and washability studies.

Location

The Carbon Creek coal property, one of four acreage blocks acquired by negotiation with Trend Exploration Ltd., lies near the Williston Reservoir, formerly Peace River, in northeast British Columbia. The property is about 20 miles west of the W.A.C. Bennett Dam and from 3 to 15 miles south of the main part of the reservoir. Chetwynd is 45 miles to the southeast while MacKenzie is 40 miles to the southwest (see Plate 1 and Plate 2).

Physical Features

The Carbon Creek Coal Basin is situated in the Foothills Belt of the Rocky Mountains. The tree covered slopes exhibit moderate relief, rising from the lake level at 2200 feet MSL to peak elevations exceeding 6000 feet. The highest elevation on the property is 5300 feet MSL between Nine Mile Creek and Ten Mile Creek.

Carbon Creek flows northward through the license area to Williston Reservoir. Four prominent tributaries flow eastward into Carbon Creek on the property. These are Seven Mile, Nine Mile, Ten Mile and Eleven Mile Creeks, the names being apparently derived from their distance from the former Peace

River. The watershed to the east of Carbon Creek is more restricted and the streams are smaller, with the exception of Mc Allister Creek whose watershed drains the southern part of the coal licenses. Numerous springs and intermittent streams cause very soft ground conditions in May and June.

Prominent flat-topped terraces have formed near the 2500 foot elevation along Carbon Creek. The terrace material is glacial till and stream-laid silt, sand, gravel and boulders which has effectively hidden bedrock and made drilling through this material difficult.

The area is heavily forested up to a timberline of approximately 5500 feet. Hillside species are lodgepole pine, white and black spruce, western white spruce and alpine fir. Cottonwood, aspen, birch and alder and larger coniferous varieties are found in valley bottoms and seepage areas.

Wildlife is generally concentrated at lower elevations. Evidence of beaver, fisher, squirrel and marten was observed during the summer along with black bear, grizzly bear, moose and lynx. The streams are populated with grayling, Dolly Varden and a few Rainbow trout.

This area is undeveloped and uninhabited. Although several traplines exist in the area, no logging, agriculture, grazing activities or economic ventures are present.

Climate

The climate may be regarded as extreme in this remote area of northeastern British Columbia. Summer temperatures are comfortable with cool nights. The temperature closely approached 100° for a few days in August. The winters, of course, are unbearably cold with considerable snow and constant

sub-zero temperatures sometimes reaching -50°F. Williston Reservoir is frozen for five months out of the year, with ice breakup about mid-May.

A superabundance of rainfall hindered our activities in June and July but the local inhabitants reported it was above normal.

Accessibility

No roads have been constructed into the Carbon Creek area. The John Hart Highway, connecting Prince George and Chetwynd, is about 25 miles to the south. Access may be attained by boat, float plane or helicopter. From Dunlevy Landing (10 miles northwest of the W.A.C. Bennett Dam) to Carbon Creek the distance is about 25 miles by boat. The float plane base in MacKenzie is 50 miles away and a helicopter may be summoned from Ft. St. John, 75 miles to the east.

EXPLORATION HISTORY

Investigations in the past by various parties aroused interest in the coal deposits of the Carbon Creek Basin. Listed in chronological sequence are previous investigations and reports resulting from these earlier ventures.

1910 Discovered and named by Cowper Rochfort with David Barr and George McAllister, upon recognizing coal float at mouth of Carbon Creek and tracing it to its source.

1914 Surveyed and appraised by A.B. Christie for Lord Rhonda.

1921 Investigated for Rochfort by American International.

1928 Explored by Belz for Stuart and Batten of Vancouver, with maps, geology, and samples with analyses.

1942 Rochfort and Wrigley took hand samples.

1943 Norman Stines for Burns Foundation with maps, plats, geology, samples with analyses, and quantitive estimate confirming and extending the work of Belz.

1944 Howells for Burns Foundation, exploration, topographic mapping, new stations, samples, maps, analyses.

1945 Howells for Burns Foundation, further explorations, additional stations, photos, bridge, new river trail, three dimensional map in color, sample analyses. Most thorough survey yet made. Confirms Belz and Stines.

1944-45. Geological investigations of the Carbon Creek-Mount Bickford map area to obtain information on coal resources by W.H. Mathews. Data published by B.C. Dept. of Mines, 1947.

1950-51. Last of a series of investigations and reports made by Howells and Davidson on Carbon Creek properties, now controlled by Burns Foundation Ltd.

Early 1970. Trend Exploration undertook study of potential coking coal areas in northeastern B.C. Application for 690,000 acres by Trend to be removed from the Peace River Coal Reserve, resulted in the staking of 143 coal licenses, a total of 89,753 acres in Trend's behalf. The licenses are staked in four (4) areas designated as Carbon Creek (55 licenses) Adams Syncline (16 licenses), East Mt. Gething (28 licenses) and Dunlevy Creek (44 licenses). Work consisted of helicopter assisted field studies of coal potential and mapping by Trend geologists.

55
16
28
44
143
153

Sept. 11-13, 1970. Inspection of potential coking coal properties by Utah personnel J.J. Reiff and J.E. Phebus.

June 14-September 24, 1971. Drilling exploration program by Utah International Inc.

1971 FIELD SEASON

Logistics

As the Carbon Creek exploration area is not serviced by roads, all equipment was transported by water to the initial camp site. Early in June, Williston

Lake Navigation Ltd., contracted to supply bulldozers and marine services, barged two bulldozers to the landing site. After some preliminary difficulties, including temporarily losing one of the bulldozers in the lake, they built a barge unloading site and a clearing in the woods for the camp. The trucks, drill equipment and camp materials were loaded on a barge near MacKenzie and towed 110 miles to the Carbon Creek landing by two tugboats, arriving in the morning of June 16.

Several days were spent constructing the tent camp on the west side of the Carbon Creek inlet about a half mile north of Seven Mile Creek. Utah personnel stayed in a 50 foot trailer while the drillers had four-man plywood and canvas tents. Electricity was provided by a diesel generator. Spring water was available nearby and a water heater was supplied for hot showers. In short, the camp facilities made life in the woods quite comfortable and the food, prepared by Canadian Longyear's cook, was excellent.

We retained one of the tugboats full time to deliver drilling supplies, fuel and groceries from Dunlevy Landing to camp. As it turned out, this was a more continuous project than was originally planned. Large quantities of fuel and drilling mud were consumed during the field season and mechanical breakdowns of every conceivable kind necessitated many trips back and forth to civilization by the tug and barge. Floating logs on the lake and log jams in the Carbon Creek inlet would have made the work hazardous or impossible for a smaller boat.

Communication from the Carbon Creek area to the outside world is possible by radio or radiotelephone. A single-side band radio from Northern Thunderbird Air was loaned to us so that we could talk to their MacKenzie sea-plane base. They were able to provide fairly reliable float plane service on short

notice. Mobil radiotelephones will not work near the lake in the Carbon Creek inlet because of surrounding mountains, but by driving up to higher elevations communication was possible with the Hudson Hope and Chetwynd operators.

Road Construction

The rainy weather made road construction a very sticky and expensive business for the first five weeks of the 1971 season. The bulldozers spent much of their time pulling each other out of mud holes or cutting ditches so the road surface could drain. The road to the first drill site remained impassable to four wheel drive vehicles until after the hole was completed. The drillers had to hike up the hill or ride a bulldozer to get to work. When the hole was finished one of the trucks, carrying the geophysical hole logger, was dragged to the drill site by bulldozer. This was the first truck to leave the camp site almost a month after the work began. The excessive rain raised the lake level more than anticipated and necessitated moving the camp farther up the hill on July 29 although, just 6 weeks earlier, the original camp site was 25 feet above the lake level.

Given more favorable weather conditions road construction should be relatively easy in this area. The trees, mostly spruce and lodgepole, average less than six inches in diameter and have very shallow, poorly developed root systems. A bulldozer can cut a swath through these trees very rapidly. Disposal of the slash was more of a problem. Growth is so dense that walking through the woods is often difficult. Thus, even though the trees are small, considerable quantities of slash must be burned or buried. The dozer operators buried as much as possible in the road bed but in places the excess was windrowed and burned. Leaning trees pushed into standing timber were sawed

down, a rather dangerous job which adds to the cost of road-building since slashers with power saws must be employed full-time. The Forest Service has rigid standards concerning road building practices which must be followed. The local Ranger, Lorne McQueen of Chetwynd, seemed generally pleased by the appearance of our roads at the end of the field season.

The roads crossed numerous water courses which involved either burying culverts or building bridges. We discovered, after several sad experiences, that corrugated steel culverts are far superior to those built out of logs. We have had better success with log bridges as we have experienced no bridge failures to date. Bridges were built over Seven and Ten Mile Creeks and both forks of Eleven Mile Creek. In addition, the bridge abutments for the Carbon Creek crossing were constructed. A pair of 36 inch culverts were utilized at the Nine Mile Creek crossing.

Rain and bulldozer breakdowns resulted in delays in road and drill site construction. On July 15, at Utah's request, Peter and Paul Demeulemeester Ltd. brought a D-7 to the area and a D-8 arrived later in the month. The four bulldozers worked around the clock until August 12 trying to keep ahead of the drill. Several Indian slashers, provided by Demeulemeester, worked the last two months of the project.

A total of nineteen miles of main and access road was constructed in 1971 with the main road from the initial landing site to the Carbon Creek bridge measuring about 15 miles. It is anticipated that the road will be in reasonably good shape when we arrive back in the exploration area in 1972. Some areas will have to be reworked, especially on north facing slopes near the main creeks where mud slides may be expected.

The total cost of road and bridge building and slashing was $115,660 for 1971.

This approximates $6100 per mile of road. 1972 road costs are estimated to be in the $4000-$5000 per mile range.

Drilling

Canadian Longyear Ltd. was contracted to supply one skid-mounted "44" diamond drill capable of drilling HQ core (2 1/2" diameter). Drilling commenced July 4 and terminated on September 18 with nine holes cored to depths as follows:

Drill Hole	Total Depth (feet)
1	824
2	830
3	887
4	996
5	657
6	677
7	617
8	737
9	527
	6752

The drill crews worked three 8 hour shifts per day averaging about 120 feet for each full drilling day. Coring began at bedrock after casing was set through the unconsolidated overburden which ranged from 0 to 187 feet in depth. During the first half of the season drilling water was obtained from nearby springs. In the middle of August, when conditions became drier, it was necessary to haul water in a 500 gallon tank mounted on a Unimog (Daimler-Benz diesel) truck. Nearly 20 tons of drilling mud and lost circulation materials (Tannex, Cellex, Quik-Seal and Caustic Soda), costing $9057, were consumed during the drilling program.

The drill and associated equipment was moved from hole to hole by bulldozer, usually a D-7 with winch. A normal move took all day with all seven Longyear people helping.

Total direct drilling charges were $105,970 or about $15.70/foot. The same

rate per foot is an appropriate figure to use in estimating 1972 drilling costs.

Core Analysis and Probing

The drill holes were probed with a Gearhart-Owens Y-logger measuring gamma, resistivity and spontaneous potential. For some unknown reason, possibly chemical reactions involving drill hole additives, the resistivity and S.P. logs were essentially worthless. The gamma log correlated very well with the lithologic log and the two are shown together on Plate 3.

As core recovery approximated 99% the actual lithologic description of the core itself was relatively easy. The core was placed in wooden boxes holding fifteen feet of core and hauled back to camp. All the core from the first five holes was saved for future reference and is now stored in the rented quonset-type warehouse in Hudson Hope.

Field Reconnaissance

Outcrops are very rare in interfluve areas so most geologic information is derived from drill holes or rocks dug up during road construction. Outcrops are more plentiful along stream channels. Several two or three man reconnaissance trips were made along the creek bottoms draining the west side of the Carbon Creek Basin to measure sections, strikes and dips. It was possible to correlate some of the coal seams and thick sandstones with similar strata seen in nearby drill holes.

Topographic Mapping

A topographic map of the Carbon Creek area was prepared under contract by Burnett Resource Surveys Ltd. of Burnaby, B.C. The aerial photography, scale 1"=2640 feet, was flown by the survey company after the cessation of

Utah's exploration activities so the roads and drillsites could be used for horizontal and vertical control. The roads were surveyed (theodolite and stadia rod) by D.O. Birkholz. Additional map control included governmental and military survey points, coal license corner positions, and Williston Lake water levels measured daily by B.C. Hydro at the W.A.C. Bennett Dam. The new map is used as the base for Plate 4.

Ecological Study

B.C. Research, an independent group supported by the British Columbia Research Council, conducted an ecological survey of the Carbon Creek area to monitor the existing environment. The survey included a study of wildlife, fish, vegetation, water quality, and stream bed and soil samples. The two-man field team made three trips to the area during the summer of 1971. This survey was performed to provide a base against which any subsequent environmental changes due to exploration activities or mine development may be compared.

Demobilization

On September 18, drilling operations were completed and Canadian Longyear personnel began preparations for leaving the area. The drill was winterized and left on location at D.H. 9. All camp furnishing were packed and loaded on the barge. The wooden tent frames were left in place for use in 1972. The bulldozers and trucks were put aboard the barge on September 25th and everything transported to Dunlevy Landing. Many kinds of supplies (tools, barrels, hose, etc.) were stored in Utah's warehouse.

Williston Lake Navigation Ltd.

There were instances when difficulties were encountered with Williston Lake Navigation Ltd. They did not live up to their contractural obligations on

several counts. They never posted a performance bond, their bulldozers were old and overpriced and in very poor mechanical condition. They used unauthorized subcontractors and were delinquent in meeting their payroll and bills. In general, Williston Lake Navigation, Ltd., was far inferior to our other contractors, Canadian Longyear and Demeulemeester.

BRITISH COLUMBIA REGULATIONS

Immigration. American citizens arriving in Canada to work for an extended length of time must obtain authorization for entry through the Manpower Division of the Canadian Department of Manpower and Immigration. A letter of introduction to this department from the company will assist in obtaining a non-immigrant Arrival-Departure Record from the Canadian Immigration Officer at the port of entry. Care should be taken to insure that the initial place of entry into Canada is designated at a location where an Immigration Officer is on duty. Not every port of entry has an Immigration Officer.

Canada Customs. Only those items intended solely for personal use may be brought into Canada duty free. Experience indicates that almost anything can be taken into Canada. However, items such as tape recorders, rifles, personal auto, etc., should be registered with U.S. Customs prior to Canadian entry to insure proper re-entry into the United States.

Items to be taken into Canada for company use are not duty-free. It is recommended that purchase or rental be made in Canada. Certain materials, such as geophysical-electronic well probes, must be cleared and bonded by custom brokers to insure that they will not be sold in Canada. Clearance arrangements can be made through Utah's custom broker in Vancouver.

Adanac Customs Brokers Ltd.
1690 West 2nd Ave.
Vancouver 9, B.C.
Phone 604-732-8611

Report of Exploration Work on Coal Licenses. A 1971 directive pertaining to Section 8, Coal Mines Regulation Act requires the filing of a report of planned exploration work to the Minister of Mines and Petroleum Resources accompanied by seven (7) maps. This report is required annually and prior to the start of the exploration work. One copy of this report is to be sent to the District Inspector of Mines and one copy to the District Forest Ranger at the same time the original is submitted to the Minister of Mines. A follow-up report should be sent to the Chief Inspector of Mines (using the same report form) describing the actual work performed at the conclusion of the work program, or at the time of filing of the next annual report with the Minister, whichever is first.

Notification of the Chief Inspector of Mines. Section 7 of the Coal Mines Regulation Act requires that the Chief Inspector of Mines be notified of our work plans. A letter outlining our proposed work and a map should satisfy this requirement.

Reclamation Report. In compliance with the provisions to Section 8 of the Coal Mines Regulation Act, a reclamation report is to be filed with the Minister of Mines and Petroleum Resources covering the nature and present uses of the land, effects of exploration work on the environment and potential use of the land. If the report is approved, by the various departments of government, a permit will be issued authorizing the exploration work to commence or continue. The report is required only once but the permit must be renewed yearly. A security bond must usually be posted to insure that the reclamation work is done.

Cutting Permit. Upon receipt of the above "Report of Exploration Work" by the District Forester, issuance of a Cutting Permit from the Forest

Service with regulations and conditions will be received by Utah. Since frequent inspection visits are made by the local Forest Rangers, these regulations and conditions should be adhered to.

Campfire Permit. A campfire permit is easily obtained through any Forest Ranger. The period of time permitted is generally contingent upon the forest conditions.

Burning Permit. To burn slash and other debris a burning permit is required. Again, this permit is issued by any Forest Ranger, but conditions are most stringent depending upon the local forest conditions.

Summary of Exploration and Development Work Performed in 1971 - Non-producing Coal Properties. All companies engaged in mineral exploration in British Columbia are requested to submit in triplicate, at the climax of the exploration season, with an accompanying map, a Summary of Exploration activities. This report is furnished to the Mineralogical Branch, Department of Mines and Petroleum Resources. Information on the form is intended to provide a yearly record of exploration work done on individual properties in British Columbia.

Coal Licenses and Leases. Rights to Crown coal may be acquired by license or lease under the Coal Act. Licenses are issued for areas of one square mile. The fee for a license and its annual renewal is $25. The annual rental fee is 50 cents per acre which may be rebated if development work totaling $7.50 per acre is done each year. A lease may be acquired when coal production reaches 10,000 tons per annum.

GEOLOGY

General Stratigraphy

The stratigraphic sequence of rocks in the Carbon Creek Coal Basin consists entirely of sediments ranging in age from Late Jurassic to Early Cretaceous. The succession consists of Jurassic sandstone and shale and Early Cretaceous conglomerate, sandstone, siltstone, mudstone, shale and coals. The environment of deposition was transitional with neritic marine, shoreline and deltaic deposits represented.

According to Stott (1967) the Upper Jurassic shales intertongue with and grade upward into the sandstones of the Monteith Formation of the Lower Cretaceous Minnes Group. The overlying sediments of marine siltstones, sandstones, and mudstones are included in the Beattie Peaks and Monach Formations and an "unnamed" transitional sequence containing some coal and carbonaceous material. After a period of erosion the Minnes Group was disconformably overlain by sediments of the Lower Cretaceous Bullhead Group. This unit consists of the basal conglomerates of the Cadomin Formation and the overlying coal-bearing Gething Formation. The general lithology and thicknesses of the sedimentary sequence are shown in the table of formations (Figure 1).

Descriptions of the formations, their lithologic variations, and problems of correlation are contained in the literature listed in the selected bibliography. Only the coal-bearing Gething Formation will be reviewed in this report.

Gething Formation

Mathews (1947) described the coal-bearing rocks of the Carbon Creek Coal Basin as a non-marine part of the Bullhead Group overlying the marine

Figure 1.

Table of Formations

Carbon Creek Coal Basin

*after Stott, 1968 and Matthews, 1947

Series	Group	Formation	Thickness	Lithology
Holocene			0-187'	Alluvium
Pleistocene				Terraced drift Glacial till
	erosional surface			
Lower Cretaceous	Bullhead Group	Gething	2300'+	Fine to coarse grained, grey, calcareous, carbonaceous sandstone, coal, carbonaceous shale, and conglomerates
		Cadomin	600'±	Sandstone, coarse grained to massive conglomerate, containing chert and quartzite pebbles
	erosional unconformity			
	Minnes Group	"unnamed"transition beds	1000'-1500'±	Sandstone, fine grained, brown, laminated, crossbedded; coal
		Monach	300'-430'	Sandstone, well-sorted, fine grained
		Beattie Peaks	750'-1200'	Shales, shaly sandstones and sandstone
		Monteith	1000'	Sandstone, fine - to coarse grained, quartzose
Upper Jurassic		Fernie		Chiefly shale, sandy near top

Monach Formation. These strata consist of an alternating sequence of sandstone, siltstones, mudstones, shales and coals with a few intercalated lenticular beds of conglomerate.

Sandstones in the formation occur in units of less than an inch thick up to 90 feet and are fine to medium grained, generally carbonaceous, medium to dark gray, weathering to a light tan-gray, and laminated. Crossbedding is common in many of the sandstones and most are of medium scale, low-angled and wedge-shaped. Convoluted bedding, burrows and graded bedding is common. Ripple marks are visible on many exposed weathered sandstone slabs. Occasionally, fossilized log impressions are observed in sandstone exposures.

The sands were deposited in meandering fluvial channels which must have destroyed coal bed continuity in places. No field evidence of coal cut-outs were observed. Intraformational breccias, usually dark gray shale fragments in a lighter gray sandstone matrix, are present indicating slump and/or remobilization during deposition of the coal-bearing sediments.

Carbonaceous shales, mudstones and siltstones are typical of the finer-grained sedimentary rocks. Shale units are from one inch to several tens of feet thick and are commonly associated with coal seams. The mudstones are blocky to rubbly and show little lamination. Thin-bedded siltstones, often showing graded bedding, are commonly interbedded with the shales. In general the colors range from light gray siltstones to grayish black carbonaceous shales.

Conglomerates in the Gething section occur in beds from several inches to seven feet in thickness. These beds generally have a sharp basal contact. Grain size is mostly granule to pebble size consisting of gray and light blue quartz and quartzite and black chert cemented in a siliceous clayey

matrix. The rounded to subrounded grains are moderately sorted.

Plant material is abundant within the formation and is especially abundant in the shales. Carbonized grass blades and finely macerated carbonaceous debris from ferns, cycads and conifers are represented.

Numerous coal seams are distributed throughout the Gething Formation but are more abundant in the upper part. The seams are described in detail in the section on Coal Geology.

The thickness of the Gething Formation in the Carbon Creek area is uncertain but as defined by Utah's 1971 coring program, more than 2300 feet of section is indicated. Mathews (1947) noted a thickness of nearly 4500 feet but his section included the Cadomin Formation and the "unnamed" transition beds above the Monach Formation. Due to a major erosional unconformity at the base of the Cadomin Formation an unknown thickness of "unnamed" transition beds exist. According to Stott (1968) the lower contact of the Gething forms no persistent stratigraphic horizon but lies above different conglomeratic beds of the Cadomin from place to place. Therefore the Gething-Cadomin contact is drawn arbitrarily where conglomerates and grits disappear, coarse sandstone become rare, and medium to fine sandstone, shale, and coal beds become common. For these reasons, it is not yet possible to quote accurate thicknesses of the Gething and Cadomin Formations.

Neither the upper nor lower limits of Gething were encountered in drilling during our 1971 exploration program. An occurrence of upper Gething strata lies on the structurally undisturbed hill between Nine and Ten Mile Creeks approximately 1 1/2 miles west of Carbon Creek. This section was tested

by D.H.'s 4 and 8 but 150-200 feet of stratigraphically higher coal-bearing beds may lie between these two drill holes. These higher beds are also present in the vicinity of Eleven Mile Creek immediately west of Carbon Creek. This area has been disturbed by faulting and folding and may be of limited economic potential.

Sections of middle Gething were encountered in D.H.'s 2,3,5,6,7, and 9. These beds are most widespread in the Carbon Creek Basin.

Lower Gething strata were found in D.H.'s 1 and 3. Coal is less abundant in this part of the section and the sands are coarser-grained. No apparent contact with Cadomin-type sediments was seen in these holes.

Correlation of Drill Holes

A gamma-ray log stratigraphic cross-section (Plate 3) was constructed to help correlate coals and define lateral facies variations in the Carbon Creek area. It is quite obvious that considerable lateral variation occurs between individual sandstone and shale units, that thicknesses change rapidly, and that beds are lenticular and have a limited extent. It is also apparent that intervals vary between major seams.

Correlation of the sections is aided by the presence of two massive sandstone members in the upper 900 feet of Gething Formation. The thicker seams (2.0'+) and thinner coal zones correlate very well from borehole to borehole. A questionable correlation may exist between D.H.'s 2,9,3, and 1 but the present correlation best fits the structural control available.

Structure

The Carbon Creek Coal Basin is a broad synclinal structure located in the Inner Foothills Belt of the Rocky Mountains. The Foothills Belt is generally

characterized by complex folds and major west-dipping thrust faults. Relatively simple structural conditions are recognized in the Carbon Creek area as compared to the more complex structures within this deformed belt.

The Carbon Creek structure is an asymmetrical basin approximately 8 miles wide and 20 miles long. The fold axis trends N 20° W. The northern part of the structure, north of Ten Mile Creek, is a simple synclinal fold plunging gently southeastward. The southern part of the basin is more complex with several subsidiary flexures and faults. The main structure loses its identity in the Mc Allister Creek area. East of Carbon Creek, where much of the topography is expressed as an erosionally dissected dip slope, the coal-bearing sediments dip westerly from 20° to 45°. Dips are more gentle on the western flank of the basin, west of Carbon Creek, increasing to as much as 20° near the western edge of the structure. (See Plate 5, Structure Section)

The central part of the basin is complicated by a high-angle, westward dipping thrust fault zone trending N 10° W. This fault zone was seen near the confluence of the North and South Forks of Eleven Mile Creek and also along Ten Mile Creek about 1/2 mile west of Carbon Creek. In general, gentle dips on the hanging wall may be contrasted with much disturbance of strata on the footwall. Stratigraphic displacement is unknown. The fault zone is lost beneath glacial alluvium north of Ten Mile Creek. (See Plate 4, Geologic Map)

Approximately two miles west of Carbon Creek between Ten Mile Creek and the North Fork of Eleven Mile Creek, a high-angle eastward-dipping reverse fault was discovered during access road construction from D.H. 5 to D.H. 6. (See Geologic Map) From photo study, this fault appears to trend northwestward and loses its identity about 1000 feet north of Ten Mile Creek.

Southward from the road exposure on top of the hill, this fault crosses North Fork of Eleven Mile Creek about 1000 feet upstream from the North Fork Bridge. The fault may continue from here southeastward toward the Monach. Displacement on this fault is questionable, but may be in the neighborhood of 200-400 feet.

COAL GEOLOGY

Distribution of Coal Beds

The coal of the Carbon Creek area occurs in many beds of varying thickness, approximately 100 beds or horizons, distributed throughout the known thickness of the Gething Formation. Thirty-two beds range in thickness from two feet to fourteen and a half feet with twelve beds greater than four feet in thickness. Individual beds change markedly in both thickness and quality between the drill holes. These factors along with varying bed intervals and lack of outcrop make field correlation difficult, except where beds may be traced with respect to their position with prominent marker beds.

The stratigraphic distribution of the coal beds throughout the known thickness of the Gething is best shown by the gamma-ray stratigraphic cross-section (Plate 3). Numerous coal beds of economic potential occur in the upper 900 feet of the formation with two beds of interest in the lower 400 feet of the known coal measures.

Correlation and numerical identification of the coal beds are shown in Plate 6. Coal beds and correlative bed occurrences one foot thick and greater have been numerically identified in ascending order with numbers 10-59. Numbers 1-9 have been reserved for identification of coals as they become known in future drilling of the lower coal measures.

As noted by Mathews (1947), many seams in the Carbon Creek field are exposed in the central part of the basin between the mouths of Ten Mile Creek, (approximately one mile west of Carbon Creek) and McAllister Creek. Nine seams locally exceeding four feet in thickness are present in about 650 feet of strata within this area. The area, however, is folded and faulted rendering coal bed correlation nearly impossible and the mining potential questionable. No correlations have been made from this area with the coal occurrences between Seven Mile and Ten Mile Creek.

Potential Mining Area

Through Utah's 1971 drilling operations sufficient data was acquired on the upper Gething Formation to define a potential multiple seam mining area of approximately 5 square miles between Seven Mile Creek and the North Fork of Eleven Mile Creek, approximately one-half to 3 miles west of Carbon Creek. Within this area, coal beds from number 40 to number 59 have their maximum extent. The areal distribution of this important part of the upper Gething Formation is best illustrated on the geologic map (Plate 4).

Physical Properties

The coals of the Gething Formation in the Carbon Creek area are banded, moderately hard, medium to brightly lustrous, friable to brittle, consisting of vitrain bands alternating with attritus and minor amounts of fusain. Cleat, without secondary mineralization, is common in most seams. Occasionally, pyrite mineralization is present on cleat faces or as small lenses and often as finely disseminated grains throughout an interval within a bed.

The beds are often irregular in thickness, often exhibiting partings of

bony coal, carbonaceous shale or carbonaceous siltstone. Occasionally, fine grained carbonaceous sandstone and, rarely, brecciated mudstone and siltstone occur as partings within a seam (Plate 7).

The coals are interbedded with shale, siltstone and sandstone. The roof material may consist of any clastic sediment, but is most often a competent shale or siltstone. The floor rocks consist of strong carbonaceous shales, siltstones or sandstones.

All important coal beds cored were megascopically examined to define major benches or zones which may be useful to establish correlations of the individual seams. The characteristics or variations of a coal bed were recorded; thickness of benches or zones and a guesstimated percentage of their constituents (vitrain, attritus, bone or shaly coal, fusain, and cleat mineralization). The thickness of partings was noted and their position within the seam measured. These changes in bed characteristics are helpful in developing the depositional history of a coal bed and predicting the seam's quality.

Chemical Properties

Ninety-one coal samples recovered from coring operations were sent to Utah's Palo Alto laboratory for proximate analyses, FSI tests and washability studies. The results of these tests have been previously forwarded by Palo Alto as a supplement to this report.

As a means of identifying each sample, Figure 2 shows the assigned bed number with the corresponding coal sample from drill holes 1-9. In Appendix II, on Tables A-L, Palo Alto analyses have been combined on the twelve principal seams for comparison of bed quality.

Figure 2.

Sample No.	D.H. 1	D.H. 2	D.H. 3	D.H. 4	D.H. 5	D.H. 6	D.H. 7	D.H. 8	D.H. 9
1	24	49	36	58	47	47	46	59	34?
2	15	48	34	56	44	45	45	58	33
3	14	47	33		43	44	44	57	32
4	22	46	31	55	42	43	42	56	31A
5	21	44	30	54	40	41	40	55	31
6	19	42	28	53	39	40A	39	54	30
7	18	40	27	52	38	40	37	53	28
8	16	39	25	51A		39		52	
9	11		22	51		38		51	
10			20	47		31		50	
11			18	46				49	
12				45				48	
13				44				47	
14				42				46	
15				40				44	
16				39				43	

Bed Numbers

Table showing assigned bed number with the corresponding coal samples from DRILL HOLES 1-9

The ninety-one samples show a wide range of calorific value from 7949 to 14659 Btu for medium volatile bituminous coal on an as-received basis. The sulfur content of the samples varies within narrow limits and is generally less than 1.0%. Moisture content on a natural basis ranges between 1.0 to 3.0%. Percentage of ash is generally high because of the shale partings and the added portion of roof and floor material which was included in the sample. During washability tests ash content generally ranged between 2.0-8.0%. Volatile matter on a dry basis ranged from 20% to approximately 30%. The average analyses of the principal coal seams is tabulated in Figure 3. See: 71(4)A Confidential Analysis File Section I (pages i and ii)

Field Free Swelling Index Testing

During the megascopic examination of a coal bed representative samples were taken of each bench or zone. Sealed and identified in plastic bags, these samples were pulverized to a -60 mesh fraction and field tested, in duplicate, for their free swelling index according to techniques devised by the American Society of Testing Materials. Proportionate samples of each zone were combined making a gross bed sample for further FSI testing. The fired coke buttons were compared with standard swelling profiles and recorded with the corresponding swelling index number. A relative button hardness was also recorded. This procedure was carried out on all coal samples before forwarding to Palo Alto for controlled laboratory proximate analyses and washability studies. No other quality testing was carried out in the field.

Principal Coal Beds

The following descriptions cover the thicker and more persistent beds of potential economic interest recognized in the explored Carbon Creek Area.

for

FIGURE 3.

HEAD SAMPLE

AVERAGE PALO ALTO ANALYSES OF PRINCIPAL COAL BEDS

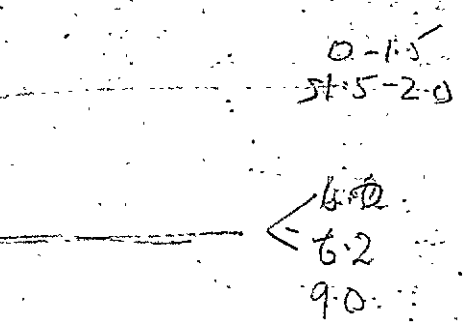
REFER TO : PR - CARBON CREEK 71 (4) A
CONFIDENTIAL ANALYSIS FILE
(pages i and ii of section I)

The principal beds have been mapped on the geologic map (Plate 4) by projection of drill hole data using all recorded structural control. As previously noted, many thin beds are present, however because of their relative unimportance they are not mentioned in detail.

Coal Bed 14: Bed 14 is stratigraphically the lowest potentially economic coal bed encountered in the 1971 coring operations. Present in the northernmost drill hole (D.H.-1), Bed 14 is 9.0' thick, mostly bright, hard to friable, with .7' total partings. A .2' shale parting is found 2.8' from the base of the coal and a .5' zone of hard fine grained bony coal occurs 1.5' from the top. The continuity and thickness of this bed is questionable. No known correlative coal exposures of this seam have been investigated. Mathews (1947) reported a 5.0' coal bed at the mouth of Seven Mile Creek and a 5.4' coal exposure in a tributary east of Carbon Creek immediately northeast of the mouth of Seven Mile Creek. Whether these coal occurrences are Bed 14, 15 or lower beds has not been investigated. The bed has been projected in its inferred outcrop area on Seven Mile Creek with respect to its stratigraphic position to Bed 15 (Plate 4).

Field coking tests on the various megascopically inspected benches of the seam showed the following FSI characteristics:

Bench	FSI
0-1.58'	6
1.58-2.0 '	1
2.0 -3.58'	7
3.58-5.33'	6
5.33-6.0 '	2 1/2
6.0 -6.33'	1
6.33-9.0 '	7 1/2



A gross sample had an average FSI of 5 with a button hardness moderately soft. Table A shows the proximate analyses and washability tests performed on this bed. Unusual FSI determinations resulted from the washability tests

on this coal (see "Other Research Observations", Report of Laboratory Studies on core samples from Carbon Creek Prospect, 1971 by Burchert and DoFoo).

Coal Bed 15: Coal Bed 15, also encountered in D.H.-1, is 100' above Bed 14. This coal is quite uniform in character having a high percentage of bright to medium luster, attrital coal. No significant partings are present in the seam at this location. The coal bed is mapped in an indefinite outcrop belt along the west edge of Williston Reservoir, crossing Carbon Creek and then trending southeastward for an unknown distance, on the east side of the syncline. A 60" coal exposure was measured by Burns exploration parties on Seven Mile Creek, 2.2 miles from its mouth. Bed 15 has been correlated with this exposure and mapped by projection on the north and south valley slopes of Seven Mile Creek.

Field coking tests performed on three megascopically inspected benches are as follows:

Bench	FSI
0-1.33'	3 1/2
1.33-2.25'	2
2.25-8.0 '	2

A 3 FSI was recorded on the fired gross sample with a hard button. Palo Alto proximate analysis and washability tests are shown in Table B.

Coal Bed 31: Bed 31 is approximately 700' above Bed 15. This seam was encountered in drill holes 3, 6 and 9 with a range of thickness from 5.9' to 6.0'. Shale and sandstone partings are present in this seam (Plate 7), with an increase in number of individual impure layers from the north to the south. In D.H.-3, a thin shale parting .05' thick is present in the middle of the seam, while 3200' southwest in D.H.-9, total partings have increased to .9' with a 1.3' section of impure bony

coal in the upper half of the bed. In D.H.-6, 1.8' of total partings are distributed throughout the seam with the thickest coal segment only 1.5'.

From our present studies, this bed may be regarded as having the greatest areal distribution in the area investigated. The outcrop of Bed 31 has been mapped on the hillslope north of Seven Mile Creek, on the south side of Seven Mile Creek and in the vicinity of D.H.-6 on the north valley wall of the North Fork of Eleven Mile Creek. Because Bed 31 was not encountered in the drill holes between D.H.-6 and D.H.-9, (deeper than drilled total depths) the bed was not mapped in this area. However, by assumption, the bed should be continuous from the Seven Mile Creek area southward to the area between Ten Mile Creek and the North Fork of Eleven Mile Creek.

Field coking characteristics of this seam were very uniform on the gross samples. Only one FSI test was run on D.H.-6 because of the many partings. The high ash content is shown by the analyses in Table C. Washability tests indicate that in a specific gravity media of 1.400, a cumulative average 79.75% weight is recoverable with the float averaging an FSI of approximately 6.5. An average natural basis sulfur content was less than 1.0%.

D.H.-3		D.H.-9		D.H.-6	
Bench	FSI	Bench	FSI	Bench	FSI
0 - 1.66	4	0 - 1.1	8 1/2	0 - 6.0	6 1/2
1.66 - 2.6	2	1.3 - 1.8	Shale parting		
2.16 - 2.85	5	1.8 - 3.1	3 1/2		
2.85 - 4.42	4 1/2	3.1 - 3.5	Shale parting		
4.42 - 5.22	7	3.5 - 5.9	6		
5.22 - 5.67	1				
5.67 - 6.0	8				
Gross Sample		Gross Sample			
0 - 6.0	6	0 - 5.9	7		

Coal Bed 40: Stratigraphically 400' to 430' above Bed 31, Bed 40 was intersected in drill holes 2,4,5,6, and 7. This coal is overlain by a

massive sandstone unit 70 to 90 feet thick associated with thin-bedded shales and siltstones. Bed 40 varies in thickness from 3.6'-7.0' with comparatively thin clastic partings to a split seam 13.4' thick having a 5.6' shale parting.

Seam characteristics in D.H.'s 2,4 and 5 are relatively uniform. The seam thickness varies from 5.0 to 7.0' with shale partings ranging from .2'-.9' respectively, .6 to 2.0' from the top of the bed. Below the parting a 4.0' to 4.1', undisturbed, hard, bright attrital coal zone with a 20% to 40% banded vitrain content is characteristic. In D.H.-7 Bed 40 is only 3.6' thick with a 2.0' section of bony coal and a .3' shale parting.

Southward in D.H.-6, Bed 40 is 5.0' thick having a .3' foot parting .8' from the base. This bed is quite uniform and similar in character to Bed 40 in D.H.-2,4, and 5. However, the shale parting in the upper part of the seam has increased to 5.6', with the upper bench (40A) increasing to 2.8'.

Field coking test results as shown below were performed on the respective benched samples. As seen in the FSI values it is evident that Bed 40 and Bed 40A (upper bench) is most uniform in coking characteristics. This bed with an average FSI value of approximately 7 has a moderately strong button.

DH-6	DH-5	DH-7	DH-4	DH-2
Bed 40A FSI	Bed 40A FSI	Gr. Sample FSI	Upper Bench FSI	Upper Bench FSI
0.0-1.5 - 6 1/2	0 -1.5 - 7 1/2	0 - 2.6 6	0.0 - .8 6	0 - .6 5
1.5-2.8 - 7 1/2	1.5-2.0 - 7 1/2			
Gross Sample 7 1/2				
2.8-8.4 Shale	2.0-2.9 Shale		.8-1.0 Shale	.6-1.1 Shale
Bed 40	Bed 40			
8.4-12.3 - 7 1/2	2.9-4.5 7		1.0-5.0 7	1.1-2.4 2 1
12.3-12.6-- 6 1/2	4.5-5.8 4			2.4-4.0 6 1
12.6-13.4 - 7	5.8-7.0 7 1/2			4.0-5.2 6
Gross Sample 7 1/2	Gr. Sample 7 1/2	Gr. Sample 6	Gr. Sample 7	Gr. Sample 6

Palo Alto proximate and washability tests for Bed 40 are shown in Table D.

Coal Bed 46: This coal bed is approximately 240 feet above Bed 40, overlying a persistent cyclical stratigraphic section of 4 to 8 thin coal beds (Plate 3). Encountered in drill holes 2,4,7, and 8, Bed 46 varies in thickness from 3.3 feet to 7.0 feet. Partings within this bed vary from a .9' shaly sandstone, .5' from the bottom of the seam, a .15' shale .9' from the top of the bed, to a 4.0' section of bony coal. Correlations are rendered difficult by variations within this seam.

Lateral extent of Bed 46 appears to be confined to the area north of Ten Mile Creek. Though the stratigraphic section in which Bed 46 occurs was cored in drill hole 5 and 6 only a slightly carbonaceous shale zone was encountered.

The FSI results on the various benches in Bed 46 are shown as follows. This bed showed moderately good coking properties with a moderately strong button strength.

D.H.-2		D.H.-4		D.H.-7		D.H.-8	
Bench	FSI	Bench	FSI	Bench	FSI	Bench	FSI
0 -4.1'	5	0 -0.6'	7	0 -0.9'	3 1/2	0 -4.0'	2
4.1-5.0'	parting	0.6-6.2'	3 1/2	0.9-1.05'	parting	4.0-6.0'	7
5.0-5.5'	6 1/2	6.2-7.0'	6	1.05-2.9'	5 1/2	Gr. Sample	3 1/2
Gr. Sample	5	Gr. Sample	4	2.9-3.3'	4 1/2		
				Gr. Sample	5 1/2		

Table E shows Palo Alto tests performed on Bed 46.

Coal Bed 47: The interval between Bed 47 and Bed 46 varies from 22.0' in D.H.-8 to 52.0' in D.H.-4, a horizontal distance of approximately one mile. This coal bed ranges in thickness from 0.0' in a stratigraphic

equivalent section in D.H.-7 to 6.5' in D.H.-2. Bed 47 is not mapped in the western portion of the upper Gething outcrop belt between Seven Mile and Ten Mile Creeks because of the seam's questionable existence. In D.H.-7, no evidence of Bed 47 is present, other than a carbonaceous shale section. Coal absence is most likely due to non-deposition of coal-forming material in this area or possibly because of an interval thickening between Bed 46 and 47 with the drill site location below the Bed 47 outcrop. With the general thinning of Bed 47, westward toward D.H.-4, the assumption of non-deposition is regarded as most likely.

Thin shale partings are present in the lower half of the seam with a 3.0' bony coal section in the upper portion at D.H.-8. No partings were recorded in Bed 47 at D.H.-4 or D.H.-6.

The results of the field coking tests performed on samples from Bed 47 are shown below. These values indicating the poor coking quality of the seam were confirmed by Palo Alto analyses. Table F shows the Palo Alto analyses on Bed 47.

D.H.-2		D.H.-4		D.H.-5		D.H.-6	D.H.-8	
Bench	FSI	Bench	FSI	Bench	FSI	Bench	Bench	FSI
0 -.75	1 1/2	0 - 2.7	5	0 -1.0	1	weathered	0 -3.0	1 1/2
.75-1				1.0 -2.6	1	coal	3.0 -4.7	6
1.3 -3.3'	1 1/2			2.6 -4.8	1	non-	Gr. Sample	2
3.5 -3.8	6 1/2			4.8 -5.1	1	agglomerating		
4.3 -5.6	6 1/2			Gr. S.	1	bed		
6.1 -6.5	5							
Gr. Sample	2 1/2							

Coal Bed 51 and 51A: Coal Bed 51, as well as the coals above Bed 51 were encountered only in drill holes 4 and 8. One hundred and thirty feet above Bed 47, coal Bed 51 overlies a section containing several thin coal beds which attain a maximum individual bed thickness of 1.4 feet.

Coal Bed 51 totaled 11.9' in D.H.-8, consisting of 2 distinctive benches.

An upper bench 4.6' thick is comprised of two distinct zones, an upper 2.2' of very dirty coal with approximately 75% bony material, while the lower zone 2.4' thick is predominantly a high percentage attrital coal consisting of less than 5% bony material. This upper 4.6' bench of Bed 51 is tentatively correlated with a clean 5.2' seam in D.H.-4 which is identified as Bed 51A. (See Stratigraphic Cross-Section, Plate 3).

A shale split separates the upper bench from the lower bench. In D.H.-8, this shale interbed is 1.9' thick but the interval, which is comprised of shale and sandstone, increases to 32.4' in D.H.-4. The lower bench of coal varies in thickness from 5.4' in D.H.-8 to 2.3' in D.H.-4. Only the upper .5' of coal in this bench from D.H.-8 was relatively free of bony material. The remaining 4.9' zone contains an estimated 25% bony material.

Lateral extent of Bed 51 and 51A is questionable beyond the area north of Nine Mile Creek and south of North Fork of Eleven Mile Creek. The bed is shown as split immediately west of D.H.-4 in its inferred outcrop, elsewhere the bed is mapped as a single seam. As in the lower seams, previously discussed, Bed 51 is mapped by projection of drill hole data and structural control.

Field coking tests performed on Beds 51 and 51A are shown below, with Palo Alto analysis of bed quality shown in Table G.

D.H.-4

Bed	Bench	FSI
51A	0.0 -5.2'	3
51	32.4'- split	
	0.0 -2.3'	3

D.H.-8

	Bench	
Upper -	[0 -2.2	1
	[2.2-4.6'	3
	4.6-6.5'	Shale split
Lower -	[6.5-7.1'	6
	[7.1-11.9'	1
	Gross sample	3.5

Coal Bed 52: Varying from 34.3' above Bed 51A in D.H.-4 to 59.5' above Bed 51 in D.H.-8, Coal Bed 52 is overlain by a section of alternating coals, a massive sandstone ranging in thickness from 125-150 with associated bedded conglomerates and a 20.0 foot thick section of roof shale. This bed ranges in thickness from 6.6' to 7.7' with shale partings totaling .5' to 1.65' interbedded throughout the coal. The general seam character consists of a moderate to fairly high percentage of banded vitrain and attrital coal content. Noticeable pyrite mineralization is common along the cleat faces within this seam.

Lateral extent of Bed 52 is shown on the geologic map underlying the uppermost massive sandstone. A coal exposure 5.0 feet thick was measured on Nine Mile Creek by the Burns Foundation parties and is tentatively correlated with Bed 52. Additional field investigation of this exposure is planned to verify this correlation.

Shown below are the field results of FSI testing conducted on the various zones in Bed 52:

D.H.-4

Bench	FSI
0 - .8'	1
.8 - 1.2'	5 1/2
1.2 - 4.3'	4 1/2
4.3 - 5.0'	4
5.0 - 6.6'	5
Gr. Sample	5

D.H.-8

Bench	FSI
0 - 1.2	2
1.2 - 1.7	5
1.95 - 2.85	3 1/2
3.10 - 4.55	5
4.05 - 5.35	5
5.85 - 7.35	2
7.35 - 7.7	2
Gross Sample	4

Although field FSI results are normal for a moderate quality coking coal, the relatively high percentage of sulfur (>1%) may be detrimental to the potential of this seam as a marketable coking bed. Palo Alto results on proximate and washability tests are given in Table H.

Coal Bed 54: Bed 54 varies in thickness from 4.6' containing a 1.5' zone of bony coal in the middle portion of the seam to 5.1' with .3' total partings interbedded in the upper third of the seam. The seam's physical properties are quite varied from a hard to a medium soft attrital coal, dull to sooty and mixed with thin vitrain bands.

This coal bed overlies an upper Gething massive sandstone (Plate 5) by 20' to 25', and is mapped on the hillslope between Nine Mile and Ten Mile Creeks. South of Ten Mile Creek the stratigraphic section containing Bed 54 is present but the inferred outcrop has not been mapped.

North of Nine Mile Creek only the lower portion of the uppermost massive sandstone is present. The stratigraphic section containing coal beds above this sandstone unit has been removed by erosion.

The field coking tests performed on Bed 54 indicated an FSI of 1.5 as compared to the standard ASTM swelling profiles. The poor coking character is also established by Palo Alto analysis. Cleaning tests performed on the -1 X 28" mesh size fraction indicated an FSI of 2 to 2.5 in a 1.3 specific gravity wash. Table I shows Palo Alto analysis of Bed 54.

Coal Bed 55: Interbedded sandstones, siltstone and shale in an interval 21.0' to 24.0' thick separate Bed 55 from Bed 54. The seam thickens gradually to the west from 4.8' in D.H.-8 to 5.0' in D.H.-4. No significant partings are present in this bed which consists of a high percentage of bright to medium lusterous attrital coal with a moderately high percentage of thin-banded vitrain.

This seam is shown in an inferred outcrop belt, on the hillslope between Nine and Ten Mile Creeks.

Results of field coking tests indicated a swelling index of 2-2.5, which also compare to Palo Alto results shown in Table J. Low FSI values experienced in the washability tests on Bed 55 samples from D.H.-4 may be attributed to partial bed oxidation, whereas in D.H.-8 Bed 55 was slightly deeper and may not have been affected by oxidation.

Coal Bed 58: Coal Bed 58, though less than 4.0' thick, is included in this report because of its continuity between D.H.-4 and D.H.-8, shallow depth and general uniform thickness. The bed thickens from 3.0' in D.H.-8 to 3.5' in D.H.-4, and overlies a 82-86 foot section of several thin-bedded coals and shales.

Areal distribution of Bed 58 is limited to an area between Nine and Ten Mile Creek.

Results of field free swelling tests as substantiated by Palo Alto results indicate Bed 58 to be a moderately ppor to poor coking seam. In D.H.-4, the low index is probably related to oxidized coal. Table K gives Palo Alto laboratory results on Bed 58.

Coal Bed 59: Only one occurrence of Bed 59 was encountered in 1971 drilling operations. In D.H.-8, this bed has a gross thickness of 14.5 feet with a net coal thickness of 8.7' upon removal of the interbedded partings. The areal distribution of the seam is restricted to the area between Nine and Ten Mile Creeks. An occurrence of a thick coal exposure was uncovered in road construction on the north slope of Ten Mile Creek valley at elevation 3640. This exposure is tentatively correlated as Bed 59.

The results of the field coking tests indicated a moderately low FSI of 3.5.

A high ash content is attributed to the interbedded shale and siltstone parting within the seam. Table L shows Palo Alto proximate analysis and washability tests.

RESERVES

Estimates of in-place coal reserves in this report are based on (1) a recoverable thickness of 4.0 feet and (2) coal with a cover of less than 2000 feet. On the accompanying coal reserve estimate chart, Figure 4, the estimated coal in-place is given followed by the estimated recoverable coal at 5.0-1 and 10.0-1 strip ratios, expressed as cubic yards of overburden per ton of coal. All figures shown are in thousands of net tons.

The in-place figures are broken down into "measured", "indicated" and "inferred" categories. All estimates of "measured" reserves include beds for which positive information is available as to thickness and lateral extent. The outer limit of a block of measured reserves is usually about 1/4 mile from the last point of definite information.

Reserves classified as "indicated" are computed partly from specific measurements and partly from the projection of visible data for considerable distances on geologic evidence. The points of observation are approximately 1 mile apart, or as much as 1 1/2 miles for beds of known continuity.

"Inferred" reserves are those for which estimates are based largely on broad knowledge of the geological characteristics of the bed, supported by few or no actual exposures or measurements. These reserves are beyond the limits defined for measured and indicated reserves, but only in areas where there is good evidence for believing that coal in the thickness and of the rank, is actually present.

Figure 4.

COAL RESERVE ESTIMATES

1971 Explored Area - Carbon Creek, B.C.

Bed Number	Coal In-Place in Thousands of Net Tons				Recoverable Reserves			
	Measured	Indicated	Inferred	Totals	Acres	Strip Ratio 5.0-1	Acres	Strip Ratio 10.0-1
59	1,570	3,510	---	5,080	215	3,290	353	5,080
55	1,730	4,370	1,080	7,180	308	2,770	546	4,910
54	1,900	4,160	1,550	7,610	250	1,940	477	3,710
52	4,090	14,500	6,180	24,770	533	5,840	834	9,355
51A	1,380	4,550	---	5,930	138	1,530	203	2,260
51	1,610	14,620	8,270	24,500	326	3,970	549	6,680
47	3,260	23,600	370	27,230	202	2,000	331	3,250
46	4,170	20,600	---	24,770	156	1,650	262	2,740
40	6,100	34,750	3,480	44,330	213	2,440	466	5,380
31	4,050	27,610	21,340	53,000	128	1,380	293	3,160
15	2,730	34,660	20,890	58,280				
14	2,030	12,470	18,600	33,100				
Grand Total	34,620	199,400	81,760	315,880	2,469	26,810	4,314	46,525

Recoverable coal reserves are based on estimates derived from individually mined seams. Highwalls range from 55 feet to 100 feet at 5:0-1 strip ratio and 100 feet to 180 feet at 10:0-1 strip ratio, each depending upon the thickness of coal to be removed.

No effort was made to estimate the recoverable reserves on a multiple seam operation.

Summary of Estimated Reserves

The total volume of coal in-place within the area covered in this investigation is estimated to be over 300 million tons. These reserves are calculated on the 12 principal coal seams.

The total estimated recoverable coal at a 5:0-1 stripping ratio is approximately 25 million tons on about 2500 acres. Approximately 45 million tons of recoverable coal may be realized having a strip ratio of 10:0-1 on about 4,300 acres. Because of the lack of sufficient data to reliably project Bed 14 and 15 outcrops, no recoverable reserves were calculated for these seams.

1972 EXPLORATION PROGRAM

Efforts in coal exploration during 1972 will be directed toward additional core drilling in the west-central portion of the Carbon Creek area to further define the limits, quality and reserve potential of the upper Gething coals. Closer spaced drilling is planned in this potentially favorable area between Seven Mile and Ten Mile Creeks.

Road building will be continued southward on the east side of Carbon Creek to the McAllister Creek area where exploratory drilling will commence. Traverses up tributaries on the east side of Carbon Creek will be made to

help define the lower Gething coal potential.

An exploratory drilling program of two stratigraphic core holes will be conducted on the East Mt. Gething licences. Field reconnaissance is planned for the Adams Syncline and Dunlevy Creek Syncline (Plate 2) licences for their coal potential.

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APPENDIX I

Photo 1. Equipment being loaded on barge at MacKenzie for towing to Carbon Creek. June 15, 1971

Photo 2. "Black Tusk" tugboat owned and operated by Roy Campbell, Vancouver, contracted to Utah's project by Williston Lake Navigation Ltd.

Photo 3. Utah's first "Muddy Campsite" at beginning of project. Site moved to higher elevation due to encroaching Williston Lake waters.

Photo 4. Dense forest through which roads must be constructed. An un-obstructed view about 50 to 100 feet.

Photo 5. Road construction in vicinity of D.H.-9. Two "Cats" always worked together in muddy areas.

Photo 6. Removal of slash is generally by burying. Excessive amounts of slash is burned.

Photo 7. A segment of finished road, between D.H.'s 4-8, on hill between Nine and Ten Mile Creeks. Carbon Peak in background.

Photo 8. Seven Mile Creek bridge, all timber construction, decked with 3"X12" planking.

Photo 9. On access road to D.H.-6, looking southeasterly, main road in center crossing hilltop into Carbon Creek Valley. High peaks are Beattie Peaks on right, Mt Frank Roy center, and Mt McAllister on left.

Photo 10. Canadian Lonyear's skid-mounted "44" diamond drill on drillsite #9. Unimog water truck in background.

Photo 11. Falls on North Fork of Eleven Mile Creek at major fault zone. Note gently dipping strata at falls and nearly vertical beds at lower edge of photograph.

Photo 12. Late winter conditions near mouth of Seven Mile Creek. Note alluvial terrace ± 200' above frozen Williston Reservoir. Second campsite just right of center on level terrace.