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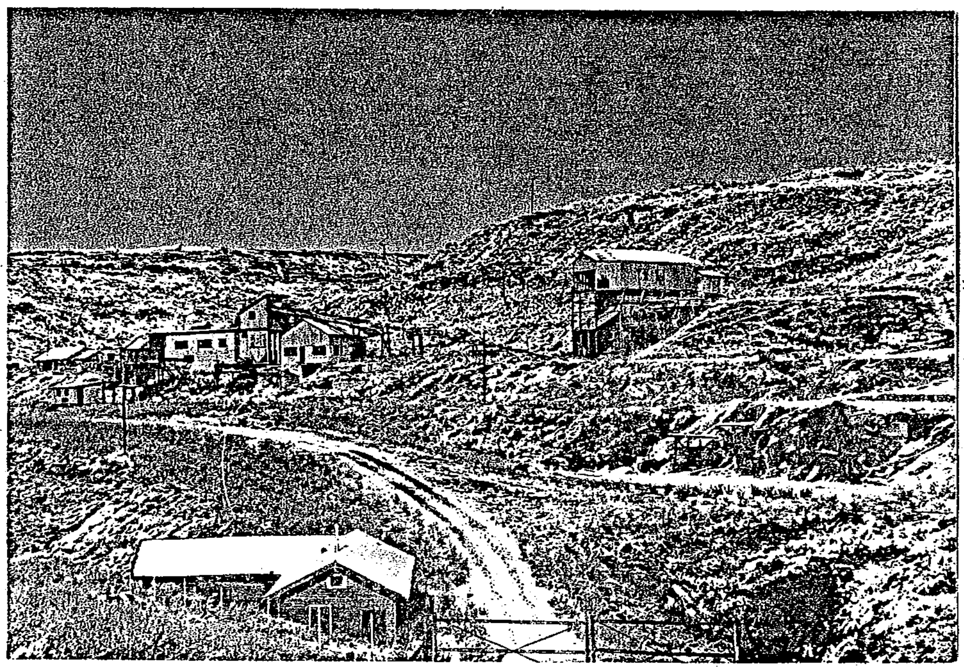
RECLAMATION RECOMMENDATIONS

Red Lodge Coal Field - RED LODGE, MT.

Phase I Report

VOLUME 2



Prepared for:

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6.0 Appendix

6.1 Historical Data on the Red Lodge Coal Field

The following report was prepared by Robert A. Murray of Western Interpretive Services, Inc., P. O. Box 6467, Sheridan, Wyoming, 82801; phone (307) 674-6215.

6.1.1 Introduction

This study is a narrative introduction to the history of underground mines in the Red Lodge and Bear Creek areas of Montana, combined with a summary of historical, geological and engineering commentary obtained from technical works, documentary materials and information on the field. It accompanies a large volume of maps, mine plans and other data presented to Kiewit personnel at meetings during the project along with briefings on research findings submitted while the work was in progress.

The primary goal of this project has been to supply that technical information as quickly as possible for use by other project specialists, so that they might use it in their own various components of the Phase I Reclamation Study on certain of these properties. Emphasis has been on the assembly of data on underground conditions and data that would help those specialists understand probable conditions in the field.

This study is not a comprehensive history of these mines, nor does it even attempt to deal in any depth with the history of the mining towns of Bearcreek, Washoe or Red Lodge, nor with the structural history of surface workings at the mines. Those topics are the subject of separate study by Paul Anderson of the Mineral Research Center in Butte, Montana, working under a different contract. Mr. Anderson and the undersigned maintained frequent communication throughout the project and planned our respective work to avoid unnecessary duplication of effort and travel.

Particular thanks are due to the staffs of the Historical Society of Minnesota, to the personnel of the Meridian Minerals and Land

Company, to those of the library, archives and photo-library of the U. S. Geological Survey, and the public libraries in the region.

Bob Wylie of Billings was helpful on recent operations in the field.

Really special thanks are due to James R. Brophy, Sr., one of the finest informants we have ever interviewed. His contact with the field extends from his childhood thru recent times and he graciously shared a wealth of data and commentary with us for the project.

The investigator on this project, Robert A. Murray, has an A.B., M.S., and is currently a Ph.D. Candidate in history, with significant amounts of work in geography, economics and sociology. He has 35 years of professional experience in history and related fields. The last 15 years of this work have been as a consultant on history-related projects. This includes work at many mining areas as well as context work on the whole span of Montana history.

6.1.2 Early History of the Region

The historical record for this part of Montana begins in 1802, when Charles LeRaye wintered with a small trading party among the Crows in camps on Clark's Fork and the Stillwater River.[1] The Francois Larocque party in 1805 and the William Clark party in 1806 bypassed this area by a wide margin.[2] John Colter, Joseph Dickson and Forrest Hancock ranged up and down Clark's Fork in the Fall of 1806.[3] From that time onward into the 1850's trappers and traders came and went along the main streams of the region with some frequency, but they did not create any permanent trading stations closer than those on the Yellowstone some 90 miles and more to the northeast.[4]

Lt. Henry Maynadier, with one wing of Captain William F. Raynold's army mapping expedition came down Clark's Fork in the Spring of 1860, and prepared the first generalized maps of main topographic features such as the Bear Tooth Range.[5] Within the next two years, gold-seekers came to the valleys of western Montana in large numbers and created an eastward-moving Montana frontier that reached the Gallatin Valley in 1863.[6] Prospectors and placer-men moved restlessly out beyond that frontier, and in the Summer of 1866 a very large force of these men, led by Jefferson Standifer, prospected for gold in all the streams along the foot of the Bear Tooth Range.[7]

One of these men was James "Yankee Jim" George found the coal seams exposed on the east side of Rock Creek at that time. There was no accessible market, so many years elapsed before any attempt could be made to utilize this coal.[8]

Settlement began along Clark's Fork with the coming of open-range cattlement to the area in 1879-1880.[9] Two years later the Northern Pacific Railroad completed its main line up the Yellowstone Valley and over Bozeman Pass and set off a whole new wave of settlement in the region.[10] Increased prospects of a market for railroad and domestic fuel stirred the interest of Montana pioneers.

6.1.3 Opening Up the Field, 1882-1889

At this point, "Yankee Jim" George told N. B. Black and Walter Cooper of Bozeman about the coal deposits. These men secured a significant area of coal land and brought together additional capital from Sam Word, Samuel Hauser and other investors. In 1882, they took two wagon-loads of coal to Billings for promotional purposes.[11] At this time the railroad obtained coal for the middle of its long line from the Chesnut Mines near Bozeman.[12] But the promoters persisted, and organized the Rocky Fork Coal Company with the aid of major eastern investors including Henry Villard. Villard at this time substantially controlled the Northern Pacific system.[13]

In December of 1884, the Post Office Department opened a post office at Red Lodge. The Postmaster was also the agent in charge of the Rocky Fork Coal Company properties.[14]

The Rocky Fork and Cooke City Railway Company began construction of a line from Laurel, on the Northern Pacific toward Red Lodge in October of 1887. This line reached completion in March of 1889.[15] With railroad construction underway, development of the mines began insofar as that was possible until the rails could bring in heavy equipment and construction supplies. Using hand-steel and blackpowder, the miners pushed exploratory tunnels east of Rocky Fork into the main coal seams. Then, when the railroad came in, commercial mining got underway. In 1889, some 6,000 tons of coal were shipped out from these mines and production expanded rapidly beyond that point.[16]

6.1.4 Reorganization and Expansion

The Northern Pacific Railroad ran into financial trouble in the early 1890's. In 1896, the company reorganized as the Northern Pacific Railway Company.[17] The new company held 3,154 out of 20,000 shares of the Rocky Fork Coal Company and individuals connected with the railroad owned much of the rest.[18] In March of 1898, the Railway Company sent in two mining men to examine the property. Based on their findings, the Company decided to buy up these mines as fast as they could.[19]

The previous year, the Northern Pacific Railway Company set up a wholly-owned subsidiary called the Northwestern Improvement Company to manage all of its lands and businesses other than the rail line itself.[20] So, the NWI began to buy up stock in the Rocky Fork Coal Company and by October of 1903 held all of that stock. They then dissolved the older company and held these mines as a division of NWI.[21]

NWI invested a great deal of money in expanding these mines into the largest coal producer in Montana. Output rose from 232,361 tons in 1896 to over 400,000 tons in 1901 and over half a million tons a year for the rest of that decade. Then from 1910 to 1923, production jumped to generally over 800,000 tons of coal a year, and exceeded a million tons in 1917 and 1920.[22]

In 1922, Lochren Donnelly of the Northern Pacific prepared a study on alternative coal development possibilities on other Northern Pacific lands. He projected a much lower coal cost could be attained by stripping coal from shallow deposits on Rosebud Creek, some 30 miles off the main line in eastern Montana. The work could be done by a contractor using non-union labor and this would avert the possibility of strikes. In late 1923, Foley Brothers Company contracted to operate the mines at what became known as Colstrip. They began mining in late summer of 1924, and over their first five years brought out 3,000,000 tons of coal.[23] As production rose at Colstrip, it was cut back at Red Lodge. Finally in 1932, the NWI produced only 54,000 tons of coal at Red Lodge and closed down the operations. Over the years from 1896 to 1932, these mines yielded nearly 21,000,000 tons of coal.[24]

6.1.5 Opening Up the Bear Creek Coal Field

By the turn of the Century, other companies were interested in developing portions of these coal seams that were exposed over in the

Bear Creek drainage. They moved slowly due to the lack of rail transportation.

The Montana Coal and Iron Company (organized in 1889) started taking out some coal from what was essentially exploration and development work in 1900, hauling it over the hill to Red Lodge in wagons.[25] Over the next few years, they worked their mine (the Smith Mine) for three or four months per year and shipped an average of 100 car-loads of coal from Red Lodge each season.[26] NWI discussed the possibility of purchasing Montana Coal and Iron Company. They did buy some stock in it, but never moved to get the rest and remained minority stockholders in it for some years.[27]

Principal organizer of the MC&I was Elijah Smith of Boston, along with a number of Billings area businessmen. The Smith family remained active in the company for many years.[28]

The Northern Pacific built a branch line to Bridger, Montana in 1903. At that point, a promoter named S. A. Hall planned a new rail line. He called it "The Yellowstone Park Railroad" and intended to run the line from Bridger to Belfry and Bearcreek, then on up into the Bear Tooth range through Clark's Fork Canyon to the Cooke City silver/lead mines and on to the Park. A number of his grandiose plans did not find backers, but with the help of the coal developers in the Bear Creek portion of the field, the line was built to Bearcreek in 1906 and extended to Washoe in 1907. This set off a period of expanded coal development.[29]

The Amalgamated Copper Company (soon to be renamed the Anaconda Copper Company) opened its Washoe Mine in 1907, but did not immediately begin to ship coal because of the slump that year in its copper business.

The International Coal Company (probably a subsidiary of the Valley Camp Coal Company of West Virginia) shipped 100 tons a day in 1907. The Bear Creek Coal Company was the largest of the 1907 period operations, getting out about 400 tons a day.[30] James Francis Brophy, a West Virginia coal developer, came out in 1906 to open mines for his Smokeless and Sootless Coal Company.[31]

Each of these companies operated in the district for a number of years, with the general peak of activity here like that of the NWI mines being around the First World War, when the coal market was very strong and serious competition from other fuels had not yet developed. The mines in the Bear Creek area suffered from depressed conditions of market in the 1920's, from increased competition from natural gas and hydroelectric power in the 1930's.[32] Some of them went through a substantial revival in the Second World War years.

Mining on the Bear Creek side of the field suffered a heavy blow in 1953 when the Northern Pacific shut down its Bridger branch and the Montana Southern and Western stopped serving the mines. Of the sizeable operations, only the Brophy mines remained active after that year and on into 1967.[33] There was renewed interest in the field in the coal boom years of the 1970's, and some new exploration work, but this now appears to have peaked out and the quiet hills around Bearcreek and Red Lodge contrast sharply to the busy mines and towns that once worked here.

We should now turn to an examination of what the available plans and documents tell us about the specifics of mining in the major operations here.

6.1.6 The Northwestern Improvement Company Mines

As we noted above, the Rocky Fork Coal Company started serious development work on this property in 1887, driving tunnels into the bluffs east of Rocky Fork. By the time commercial production got underway in 1889, these tunnels ("entries" in coal-mining language) gave access to seams 1, 2, 3, 4, and 5.

The plan of work followed was to drive rooms out to the north (uphill side) of each tunnel, leaving supporting pillars standing between the rooms. Thus, the coal could move downhill all the way to the end of the tunnels.

To expand the work on each seam of the more important Number 3 and 4 seams, "slopes" were run down from the surface following the dip of the seam. Then additional "levels" were run eastward parallel to the initial tunnel for each seam, but with each at a lower elevation on the seam. Then rooms were run off above each entry in the same fashion as on the top level.[34]

In the earliest work of the 1887-1889 period, rooms were turned off at right angles to the course of the entries. The entries were crooked in some segments. This threw the far ends of the rooms too close together in some instances, narrowing the pillars which were already too thin. As a result, pressures on the floor were too high and "creep" or floor-heaving occurred frequently in these workings.[35]

At this early time, haulage was primitive. Mules dragged the mine cars up the fairly steep slope in the rooms from the entries. Loaded cars were let down with a rope, snubbed around a post.[36] In the early 1890's, a compact hoist came into use that made it possible to move cars easily up and down double-tracks in the rooms.

In the first workings, mules pulled the cars on down the entries. A cable-car type tow cable on the tracks pulled the trains of cars up the slopes to the surface entry of the mine.[37]

In this room and pillar mining, very little timber was used. Long-lived workings, like the slopes and the haulage entries were timbered where it appeared necessary. "Props" were used in the rooms where there might be roof hazards.

Mining engineers, Alo Ronald and John Kangley, examined the Rocky Fork Coal Company mines in the late Summer and Fall of 1889. They were both highly critical of the angle and spacing of rooms, of certain tunneling practices and of mine ventilation. Some corrective measures were evidently put into effect not long after their visit.[38]

Work moved along rapidly. The main Number 4 tunnel extended over 6,500 feet from its opening by March of 1894. Coal in the #4 seam above that tunnel appears to have been some of the first coal taken out of the mine. Mine plans show that the rooms east of 139 on this level had caved to the surface near the outcrop by 1904.[39]

The 1st level down from the main #4 tunnel was open before 1894, and it extended east 110 rooms when it ran into some problem and work was stopped on this level by September of 1896. Some of the coal east of the problem area was later removed by extending longer rooms from the next level down.

The 2nd level of the #4 also went east in this same period and became one of the most important workings. This tunnel reached a point about two miles from its mouth by 1898. The third level down of the #4 reached a comparable point by late 1899.

Then a 4th level was pushed eastward in 1901 and the 5th level down was begun that same year. There was a reluctance to work below the 5th level until easier-to-recover coal had been taken from the higher levels. This was due not only to the haulage cost, but to water that necessitated sumps and pumping stations at this level and below.[40]

With the takeover by NWI in 1903, that company made a strong effort to expand production, but many problems arose. In December of 1906, Superintendent Pettigrew reported squeezes developing on the 4th and 5th levels of the #4 vein.

Earlier that year two fires the same day took the lives of eight men and these fires were attributed to spontaneous combustion in the older workings, due again to squeeze. C. R. Claghorn, in overall charge of the operation, said, it was because of the old problem of too thin pillars, to not drawing pillars after working out the rooms. He recommended drawing pillars and breaking the roof on retreat from the rooms. This would take the foot-of-pillar pressure off the clay floor.

The problem with the older workings continued into 1907. On August 8th that year, Claghorn reported that he had anticipated caving in the 3rd level east of #4, and drove a connection around the danger area. At the same time he sealed off some older areas of the mine.[41] He also re-timbered some entries, replaced timbers in the #2 and #4 slopes and added electric powered haulage equipment.[42]

In October of 1907, Claghorn reported bottom heaving problems in both the #4 and 4½ veins east, due to the same old problem. On the 4th level of both the #4 and #5 veins east, the miners were plagued by high temperatures, black damp and occasional fires. Claghorn sealed off some of the old rooms on those levels.[43]

The #2 vein had been worked roughly parallel to the work on #4 and suffered from some of the same problems. Its slope, however, was the scene of an arsonist-set-fire on November 20, 1908, that burned out the timbering from 1200 feet of the slope, which then caved in. Six men were killed fighting the fire.

The 1½ seam started in 1905, with coal taken from the outcrop above the "Water Level 1½ East Tunnel". This work stopped 2600 feet in when they ran into a bad roof and dirty coal. The 1st level east on this seam was mined largely between 1909 and 1920, and the pillars pulled from 1921-1923. There was some mining across this same time span at lower levels on this seam.

In 1906-1910, rock-tunnels were driven to connect some of the workings on comparable levels in the several seams. These are shown on the plans.[44]

The West Side and Sunset Mines

As early as 1898, the Rocky Fork Coal Company extended its workings west of the slopes, out under Rock Creek and on under parts of the town of Red Lodge. From 1898 to 1900 they worked the #4 seam on the 1st level west, and by 1912, were working down to the 6th level on that side. Water was a constant problem on the west side and extensive sumps and pumping systems were needed to keep it out of those workings.

Around 1901-1902, the Sunset Mine put down a slope from surface workings northwest of the town of Red Lodge that extended southwest from the surface plant. The NWI acquired that property in 1907, bought land for a much larger plant and expanded these workings rapidly. Levels were run off east and west of the Sunset Slope. The east levels of Sunset were ultimately connected at several points with the western-most workings of the old NWI, making a honeycomb of workings strung out for over three miles from west to east and over a mile north to south.[45]

Mining engineer, James R. Brophy, Sr., in our interviews with him, stated that from 1907 onward, the NWI mines were conducted with a very great attention to details of good maintenance. They were kept clean, rock-dusted daily, well-drained and carefully mined.[46]

Pillars were drawn over large areas and excellent surveys were made to update maps of the workings.

As we indicated above, mining scaled down steadily here in the late 1920's, for Colstrip coal could be had for $1.50 per ton, compared to a cost of $2.48 at the NWI. In 1932 after the close of mining, the company quickly sold off its miner's houses in Red Lodge, fairly sure sign they didn't intend to reopen these workings.

6.1.7 The Bear Creek Area Mines

Mining history of the properties in this drainage is not nearly so well-documented as that of the NWI. More companies were involved and their records have in some cases been lost. But we did uncover sufficient basic mine plans that, along with the excellent interviews with Mr. Brophy have untangled most of the history of these workings.

The Bear Creek Coal Company

This company started construction on a large plant in 1905 and 1,600 feet of entries driven on the #2 and #3 seams. They had several thousands of tons of coal stockpiled from this development work when C. A. Fisher examined the mine in 1905. From the very outset, they had electric lighting and motor haulage. A number of early pictures show their extensive surface plant with a number of stone-masonry structures.[47]

Brophy indicates that this company worked on into the early 1920's, and simply ran out of recoverable, saleable coal since they were surrounded by other operations on the directions where there was coal.[48]

The Montana Coal and Iron Company

This company began doing development work on their Smith mines as early as 1900, taking out a little coal each season in the course of development and hauling it to Red Lodge. Two main events made this company and the Bear Creek and other companies have an incentive for development here. In the Summer of 1906, Congress passed a law that would by 1908 make it impossible for the railroads to sell coal on the commercial market. Soon the plans for the Yellowstone Park Railroad were announced. From late 1906 onward, development moved ahead quickly at Bear Creek.

The MC&I mined almost continuously from 1907 to 1953, and their workings are fairly well documented in the drawings we have at hand. Their work technique was different than that of most of the other operators in the field. They used the Goodman Track Loader, which required more space than the equipment used in other mines. One informant says that the company "was run by bookkeepers, without a real mining-man in charge". They worked the seams in five room blocks and did not practice pillar extraction. But their plan of work produced thin pillars and they had much more trouble with squeeze and collapse of workings than did the other companies.[49]

The company after starting development on the Smith mines bought up a mine opened by a man named Flaherty and named it the Foster Mine. Ultimately, the company extended both sets of workings until they met, working out a very extensive area. Most of the mining on the Foster end of this complex occurred after 1917.[50]

The Smith Mine is best known for the great explosion there in 1943 that killed 73 miners. After that disaster, the company opened up access to the #2 from another direction through the workings of a small mine called the Lamport Mine.

The #3 and #4 workings of the MC&I broke through to the surface, creating some subsidence in the NW¼ of Section 6 at one time. After the 1953 closure, part of the Foster workings were leased for a short time for pillar extraction by "a Belgian". Also in the mid-1950's, Sam Carpenter and John Reed leased the MC&I and did a small amount of mining of domestic coal.[51]

The Anaconda (Washoe) Mines

When the Anaconda people opened these mines in 1906, they used the same room-and-pillar methods as most other operators in the district did. They shut these mines down in 1938 after completing some pillar extraction and salvage of equipment following a bad fire in their #2 slope that resulted in extensive caving in from the #1 seam.[52]

Smokeless and Sootless Coal Co. (and The Brophy Coal Company)

These mines were among the longest-lived in the district. James Francis Brophy was a mining engineer with a degree from Ohio State and extensive experience in West Virginia. James R. Brophy, Senior, son of James Francis, was born at Bearcreek and worked with the family business and as we indicated above later had his own company, The Brophy Coal Company here in 1940-1967.

Their first mining was in the #2 seam behind the tipple location, with the first coal shipped in 1908. In 1909 they made another entry into the #2 "by the old office" location.

The Smokeless and Sootless Coal Company ran continuously from opening until 1932. Then for a time in the 1930's the Homer Coal Company leased the property for production of domestic coal. After that it was leased by a group of miners for a short time. Then in 1940, with the coal market picking up again after the Depression, James R. Brophy leased the property from his family and founded his Brophy Coal Company.

They mined in the #1 and #2 seams and the #3 and #4 seams, with their last mining done in the #4.

James Francis Brophy introduced the 1st electric coal cutting equipment to the district around 1907. They introduced roof-bolting to the west in the 1940's. James R. Brophy, Sr., wrote the roof-bolting section of Montana's Mine Safety Laws. They used roof bolts in combination with planks and over much of their mining in the closing years of production, they salvaged the planks for reuse.

Brophy reports that their company pulled some pillars in the NE¼ of Section 1 in the #2 seam and in only about 3 areas in the last mining in the #4 seam.[53]

In 1978, the Bear Tooth Coal Company (a joint venture between Portland General Electric Company and Jim Joyce) leased the Brophy mines and did limited development on them. Bob Wylie of Billings served as manager for part of this work. He says that in 1979 they spent most of their time rebuilding equipment and took the continuous-miner underground in late July of that year. By the Spring of 1980 when he left, they had shipped a small amount of coal, but the operation shutdown in September of 1980.[54]

The "Burns Mine"

This was a small scale operation run by Robert "Bob" Burns from some point in the 1920's on property leased from MC&I. It ran until 1932, when Burns moved to operate small wagon mines on other leased tracts up Scotch Coulee.[55]

The International Coal Company

According to Brophy, this organization took coal mostly from the #3 seam, with several other openings into the #5 and #6 seams and also into the #4 farther up the coulee. Good plans are available for this mine in 1911, and they only ran until around 1916-1917 when a major fire destroyed much of their surface workings.[56]

Interview with Buela Owens Aug 1985

no — This mine did not burn as stated. Mr + Mrs Owens lived there until 1922 while he managed the mine. An arsonist did manage to burn some buildings at other mines about these years. Shirley Zupan.

Other Known Mines

Brophy has pointed out a number of small "wagon mine" operations for domestic coal. The present Highway Mine is one of these. There were several old openings into the #5 and #6 seams in Section 32, a shallow opening into the #4 and the NW¼ of Section 5, another wagon-mine into the #5 and #6 up Virtue Gulch, another small mine into the #4 just east of the center of the West ½ of Section 30, and the Kolarich Mine in the coulee in the SE¼ of Section 25. None of these had a high level of development.[57]

6.1.8 Underground Conditions in the District

As we indicated above, James R. Brophy, Sr. seems to be the most knowledgeable possible informant on the nature of the ground conditions, the behavior of abandoned workings and the mining practices in the whole district. The following description of resulting conditions and probabilities is based on our lengthy interviews with him.

The eight principal seams mined here commercially each generally have a sandstone roof and a clay floor. The top two feet of the floor in the stronger areas is of relatively hard clay, with a layer of much more fluid clay beneath it. So long as pillars are large enough to spread the weight on the hard clay and not break it, floors can be very stable.

We have already noted the errors of practice in some of the early mines. The largest subsidence areas appear closely related to those early and very troubled workings.

The tendency to floor-heave or "squeeze" was not uniform over the whole district. Brophy believes that the entire area has long been subject to stresses generated in "waves" out from the foot of the Bear Tooth Overthrust of the mountains. He says that floor heave on the #4 seams generally starts most frequently along what he calls pressure zones. These follow parallel to the strike of the veins. Pressure seems highest on the down-dip-side of these pressure-wave areas.

The axis of the syncline mapped by Brophy is one pressure zone. There is another in the #4 seam in Section 1, and another in the #2 in the NE¼ of Section 35.

Brophy says that despite the amount of floor-heaving present in certain areas it would generally take a roof subsidence to close up workings completely. In some cases the sandstone might bow down to touch the floor at the center of a room when pillars have been taken out. Major barrier pillars may even break in this circumstance.

But generally, where roofs were broken or have collapsed the spaces may simply be filled with unconsolidated loose rock fill, but the distance to the surface in most cases will prevent surface subsidence in areas where it has not already occurred in the #3 seams.

In the #2, there is a tendency for the sandstone and shale to cave down to a watermark in the stone 42 feet above the coal. For the most part he does not believe that the #2 workings have squeezed in areas above the groundwater table. They are probably open over large areas.

The Groundwater Situation

On maps supplied to us, Brophy has mapped the line across the district below which the old workings are filled with water. At one time he and his father did a dewatering study on the district, and pinpointed a location where a ten inch casing would drain off large areas of the old workings. He commented that casings should be locked in the rock with bentonite instead of concrete because of the chemistry of these formations.

As to condition of the groundwater, Brophy commented that when his mine was in operation some of his miners took mine water home to Red Lodge for domestic use, finding it superior to the then available city water. He also noted that the water supply of Red Lodge includes a well or wells extending into the old workings deep beneath the town.

At present water from portions of the NWI workings in the bench land drains out through those workings to Rock Creek.

On the eastern part of the district, a large area of some of the eastern NWI, the Washoe and the Brophy all drain down through the Brophy workings where he holed thru to the Washoe deliberately in order to get better drainage of water that was coming in on his work in the #3 seam.

Brophy pointed out that the dike thru the district probably channels some of the drainage thru the formations keeping it above the dike.

The fault line mapped by Brophy for the project is scissors fault, with the north end having about 80 feet of throw, the south end about 22 feet of throw, and the apex of the fault about at the Smith Mine.

Brophy's comment on runoff from slack piles was that the material itself really was pretty good filter material.

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24 Coal Production tables, op.cit.

also: Howard Elliott files, Box 8, 3E 4.6F, file number 11, Northwestern Improvement Co., folders 7, 8, & 9, "Coal Matters", 1918-1927, Minnesota Historical Society.

25 N. H. Darton, "The Coals of Carbon County, Montana", in Contributions to Economic Geology, 1906, Part II. U.S.G.S. Bulletin 316, Washington, D.C., 1907, pp. 189-190.

26 C. A. Fisher, origin l mss. notebook, accession #2726 of 1904, U. S. Geological Field Records, Denver.

27 "History and Present Operations..." op.cit.

28 ibid., also: C. A. Fisher, "Development of the Bear Creek Coal Fields, Montana", in: Contributions to Economic Geology, 1905, U.S.G.S. Bulletin 285, Washington, D.C., 1906, pp. 269-270.

also: MC&I records at Smith Mine Headquarters building, Bearcreek.

29 C. A. Fisher, in U.S.G.S. Bulletin 285, op.cit.

30 E. G. Woodruff, original mss. notebook, Accession 110-A, 1907, L-12, "Red Lodge Coal Field" in the U.S.G.S. Field Files, Denver, Colorado.

31 Interview with James R. Brophy, Sr., Dec. 9 & 10, 1982.

32 ibid. also original MC&I files.

33 Brophy interviews.

34 Based on analysis of mine plans in Meridian Minerals and Land Company files, Billings, Montana. There are roughtly a hundred plans and maps in those files on this field.

35 Alo Ronald, letter to John Kangley, September 25, 1889, in Special Reports file, 3.A.5.2.F, Northern Pacific Records, Minnesota Historical Society, St. Paul.

36 John Kangley, letter to T. F. Oakes, Nov. 6, 1889, in file, ibid.

37 ibid.

38 ibid. and Ronald, op.cit.

39 1904 Mine plan, op.cit.

40 Mine plans, op.cit.

41 Letter Claghorn to Howard Elliott, August 8, 1907, Presidents Subject File #6, Folder #3.

42 ibid. also Claghorn to Elliott, October 11, 1907, same file.

43 ibid.

44 There is a whole series of letters, Claghorn to Elliott in the files cited above, detailing all this work, and they check out very well with notes and details on the plans of the period.

45 ibid. also: Red Lodge Picket, January 31, 1908.

46 Brophy interviews.

47 Fisher, op.cit.

48 Brophy interviews.

49 ibid.

50 ibid. also: Smith Mine Plans, State Mine Inspector's Office, Helena, Montana.

51 Brophy interviews.

52 ibid.

53 ibid.

54 Interview with Bob Wiley, Billings, Montana, October 1982.

55 Brophy interviews.

56 ibid. also: plan of International Mines, Meridian files.

57 Brophy interviews and Brophy composite plan.

6.1.10 Other Sources, Not Specifically Cited Above, But Used As Part of the Context Materials for This Study

Note:

In order to avoid duplication in a paper of this scope, we are not listing below all the sources specifically cited in support of various points in the text above. For full citations of those, see the footnotes.

Major Sets of Documentary Resources We Found Useful

By far the largest body of documents relevant to the Red Lodge/Bear Creek Coal Fields are the files of the Northwestern Improvement Company. These consist of 136 boxes (about 200 linear feet of file drawer) of records in the Archives and Manuscripts Division of the Minnesota Historical Society, St. Paul, Minnesota. They have been heavily indexed in several different ways. Microfilms of original company cross-index cards are available for use in the reading room of the Society at the Archives. Additionally, the archivists there have prepared index volumes (about 20 feet of shelf of these) that provide further access to the various files. We have cited the directly important papers above. A historian working with the overall story of the mines or communities involved would do well to examine the collections first hand, as there is much beyond the technical mining data we were looking for.

The original notebooks and sketch maps of U.S.G.S. personnel in the Field Records Branch of the U.S.G.S. Library in Denver should usually be checked when doing research on a major mining property. We have cited some specific items above that contain both technical and other data on this field beyond that which we used on the points involved.

The U.S.G.S. Photo-Library has some interesting photos of the Bear Creek Coal Company's surface plant, c.1907.

The Montana State Bureau of Mines has in its early years dealt mostly with hardrock and placer deposits of metallic minerals. We did secure unique plans of both the Smith and Foster Mines from that repository.

The Montana Historical Society in Helena has a large uncataloged volume of records of the Montana Coal and Iron Company, but a check of these by Paul Anderson revealed that they were primarily accounting records.

The Library of Meridian Minerals and Land Company, Billings, Montana contains many useful publications on the area, but its most important holdings are its files of maps and mine plans, nearly 100 in number. Of these about half are of the NWI in various seams and stages of mining. The others are of other major mines in the area.

The files of the Brophy Coal Company and the earlier Smokeless and Sootless Coal Company were apparently destroyed by vandalism to a great degree some years ago. James R. Brophy, Sr. does have blue-print copies of a number of NWI and other maps that also exist in the Meridian collections. More important, he has several unique maps prepared by himself and his father of great importance to understanding the Bear Creek field. Then for this project, he prepared maps to show areas where each major seam has been worked-out in the country east of Rocky Fork and on through the Bear Creek country.

A vast quantity of Montana Coal and Iron Company files remain in their buildings at Smith Mine, highly vulnerable to vandalism.

Specialized Geological Publications

(Segments of some of these are cited above, but we list the overall studies here, since they often contain other articles that help to place the field in context).

U.S.G.S. Bulletins #285, 316-C, 341, 641, 822A.

U.S.G.S. Circular #53: John X. Combon, Donald M. Brown, Helen F. Pulver and Dorothy A. Taylor, "Coal Resources of Montana", 1949.

U.S. W.P.A. & Montana School of Mines, Bibliography of Geology & Mineral Resources of Montana, Butte: Montana School of Mines, 1942.

The Biennial Reports of the Montana Bureau of Agriculture, Labor and Industry contain much that would be of interest to a social or economic historian working with coal mining history on this area, but not much technical detail of use for this project.

Montana Highway Department, Montana City Plats and Aerial Photos, Helena, 1971.

G. L. Decker, et.al., The Montana Automated Data Processing System for Soil Inventories, Research Report #89 of the Montana Experiment Station, 1975.

Montana Water Resource Atlas, Bozeman: Montana State University, 1981.

John J. Donahue, Montana Water Quality Bibliography, 1974-1977, Helena: Department of Health and Environmental Science, 1977.

Montana's Production, A Statistical Summary of the State's Industries, 1930-1938, Montana State University, 1938.

Ivan A. Given, Mechanical Loading of Coal Underground, N.Y.: McGraw-Hill, 1943.

Howard N. Eavenson, Coal Through the Ages, N.Y.: American Association of Mining Engineers.

"History, Including Production Statistics, Geology and Mine Disasters of the Coal Fields of Montana", Montana, The Magazine of Western History, V. 23, #4, October 1973, pp. 18-31.

John M. Pinchock (compiler), Index Map and Bibliography of Coal Studies in Montana, Special Publication #71, Butte: Montana State Bureau of Mines, 1976.

E. H. Gilmour and G. G. Dahl, Jr., Montana Coal Analyses, Special Publication #43, Montana State Bureau of Mines, 1967.

Joe H. Rawlins, Geologist, Red Lodge-Bear Creek Coal Partners Report, Billings, Montana, February 1976.

U. S. Bureau of Mines Technical Paper #529, 1932.

J. P. Rowe, Montana Coal and Lignite Deposits, University of Montana Bulletin #37, Geological Series #2, Missoula, 1906.

George Darrow, "The Bear Creek Coal Field", Field Book of the 5th Annual Field Conference, Billings Geological Society, Billings, Montana, 1954.

Frank L. Gaddy, "Roof Control" in (Samuel M. Cassidy, ed.) Elements of Practical Coal Mining, N.Y.: Society of Mining Engineers, 1973.

Floyd W. Parsons, "Montana's Great Coal Fields and Its Collieries", Engineering and Mining Journal, November 23, 1907.

Floyd W. Parsons, "The Operation of Coal Mines in Montana", Engineering and Mining Journal, December 7, 1907.

Floyd W. Parsons, "Coal in Montana", Mining and Scientific Press, December 24, 1904.

J. P. Rowe, "Montana Coal Mines", in Mines & Minerals, V. 27, #11, June 1907.

J. P. Rowe, "The Montana Coal Fields", Mining Magazine, March 1905.

Walter H. Weed, "Notes on the Coal Fields of Montana", Montana School of Mines Quarterly, V. 12, pp. 128-ff.

Walter H. Weed, "The Coal Fields of Montana", Engineering and Mining Journal, May 14 and May 21, 1892.

Report of the Governor's Special Committee to Investigate the Smith Mine Disaster, Helena, 1943.

6.1.11 General Context History Sources

We have done an intensive search of library sources for technical data in this study, and have used a large number of items for context on the area. There seems to be little need to list all of these in a technical study such as this paper. For thos who wish to branch off into social and economic history on these mining communities, the following will be useful points of departure.

Robert A. Murray, Jerry Sanders, Russell W. Bessette, and Anne McGeorge, "Red Lodge Area" in: "Historic Sites Inventory and Evaluation of Nine Large Sample Tracts in Montana", unpublished mss. prepared for Bureau of Land Management, 1976. Contains a ten page bibliography on the Red Lodge area.

T. E. Butler, Carbon County, Montana, Its Resources and Its Future, a supplement to the Red Lodge Republican/Picket, 1909.

Rex C. Myers, Montana: A State and Its Relationship With Railroads, 1864-1970, Missoula, Montana, 1972.

Arnon Gutfeld, Montana's Agony: Years of War and Hysteria, 1917-1921, Gainesbille: University Presses of Florida, 1979.

William L. Land and Rex C. Myers, Montana, Our Land and People, Boulder: Pruett Press, 1979.

Coburn Johnson, Bibliography of Montana Local Histories, Helena: Montana Library Association, 1977.

"History of Coal Mining Town", Montana, The Magazine of Western History, V. 11, #3, July 1961.

E. S. Topping, Chronicles of the Yellowstone (Robert A. Murray, ed.), St. Paul: Ross & Haines, 1968.

6.2 HYDROLOGY

6.2.1 Terms of Reference

In the Department of State Lands (DSL), State of Montana requests for proposals (part III.B.) the State outlined the type of surface water, groundwater, and mine drainage analyses needed to complete the study objective. As stated "all mines in the study area discharging mine drainage and those showing evidence of seasonal drainage will be identified and plotted on the base maps. Discharge rates and chemical analysis of mine drainage will be measured at the identified site four (4) separated times during this study".

Further, "local landowners will be contacted to determine the existence of shallow aquifer wells. Well logs should be obtained for all eligible study wells. A complete chemical analysis will be performed on groundwater samples taken from horizons potentially affected by surrounding mine drainage. The well locations will be numbered and plotted on the base maps".

In the successful bid submitted by KM&E, this requirement will be met as stated:

> "KM&E will provide qualified hydrologists to sample water sources in the area for potential pollution from mine workings. This will be accomplished by sampling water in both Rock Creek and Bear Creek at strategic locations to isolate the source and magnitude of the pollution.
>
> Water wells and springs in the area will be sampled to assess the extent of any groundwater pollution and determine baseline quality parameters. A search will be made for drill logs for all applicable wells. The location of all sample sites will be accurately identified on a topographic map.

Any sources of active mine discharge will be located and the discharge rate determined as well as sampled.

The water samples will be collected and analyzed in accordance with DSL's 1977 Water Resources Guidelines. Field parameters checked will include dissolved oxygen, temperature, specific conductance, and pH. The samples will then be field acidified, filtered, and transported to our Sheridan lab for further analysis.

We estimate a total of 20 surface water samples and 8 groundwater samples will be sufficient for an analysis of potential water pollution. If the DSL determines more samples are necessary, the price will be negotiated outside of this contract".

Dick Juntunen (DSL) was notified in writing on November 5, 1982, that the frequency of surface water quality sampling was to be modified from 4 to 2 times during the study, which was accepted by Mr. Juntunen.

6.2.2 Literature Search

A literature search and several interviews were conducted with private individuals to ascertain information on the hydrology and water quality of the Red Lodge and Bearcreek, Montana area.

A groundwater inventory of Carbon County, Montana (Montana Water Resources Board, 1969) was conducted which depicts conditions of groundwater availability in Carbon County and points out areas where data was lacking or inadequate. The report indicates 307 wells filed with the Montana Water Resources Board in 1969, over half of which were completed in the Clarks Fork-Rock Creek alluvium. Only 24 of the wells were completed in underlying bedrock with the remaining wells completed in alluvium along perennial streams.

The average thickness of alluvium in the County is 30 feet. Alluvium in the Clarks Fork valley is slightly thicker than along Rock Creek or elsewhere in the County.

In the vicinity of Red Lodge, an exposure near the mountain front is composed of about 200 feet of terrace gravel and till resting on gently tilted Tertiary sedimentary rocks. The lower 60 feet of this deposit is coarse gravel derived from crystalline rock. Along Rock Creek the reported thickness of terrace gravels is 7 to 115 feet with 15 to 50 feet being common. Twenty-five wells were reported to be completed in this aquifer in the County and yields were significant and ranged up to 3,000 gpm.

The Fort Union formation is a sequence of sandstone, shales, clays, and coal beds ranging in thickness of from about 600 to more than 8,500 feet. The shales and clays are impervious and do not yield water readily, but the sandstones are regional sources of groundwater. Coal beds can also be aquifers and some old mine workings in the vicinity of Red Lodge are known to be filled with water. The Fort Union formation does provide water for low yielding wells.

The listing of wells reported in this publication was updated in October 1982. The Montana Department of Natural Resources and Conservation-Water Right System (DNRC-WRS) was searched and wells and springs in the study area listed. A further explanation of the findings of this search will be discussed in a following section. In addition, Pacific Railroad Company files kept at Meridian Coal in Billings, Montana were searched for water well listings and several wells reported. The quality of these files is poor and will also be discussed in a following section. Rob Wiley, a Mining Engineer for IntraSearch, was helpful in obtaining this water well information.

Since many water wells are drilled and water rights are either not applied for from the DNRC or not yet listed in the DNRC filing system, all water well drillers listed in the Billings, Montana phone book were contacted in writing. Out of the twelve well drillers contacted, only five replied. Only one of the well drillers who replied indicated that he had completed wells in the Red Lodge/Bearcreek area. This information will be evaluated in a following section.

KM&E also conducted several private interviews with people familiar with the area. Wayne VanVoast (Montana Bureau of Mines and Geology, Billings Office) was interviewed and indicated that he knew of few wells in the study area. He believed that quite a few alluvial wells were completed in Rock Creek alluvium, but doubted that the coal beds were presently being beneficially used. He indicated that springs in the area were common and that the town of Bearcreek piped drinking water in from a spring several miles away. He thought water was piped in because they could not find suitable water quality in the vicinity of the town.

Mrs. Cecil Blackler, the Mayor of Bearcreek, was interviewed by telephone. She discussed the town's water supply which was completed prior to WWI (replaced about 10-12 years ago) and indicated that the townspeople don't use local groundwater due to its poor quality. She knew of only one existing well which was owned by the Pfeifer family. The Pfeifer's apparently attempted to use the well for garden watering, but the quality was such that even the grass in their yard died. The Pfeifers could not be reached, but other townspeople indicated that the pump was in disrepair and the well had not been used for quite some time. They thought the well was "a couple of hundred" feet deep which would probably indicate completion in the Fort Union formation. She also recalled that a second well completion in the area was attempted, but the quality was too poor for use. Rose and Harry Kline, local residents, verified the information about the Pfeifer well supplied by Mrs. Blackler. Other local residents indicated that in the past several hand-dug water wells were completed in Bear Creek and Scotch Coulee alluvium, but since the installation of the town's water supply system, these were no longer necessary. Some evidence of these defunct "wells" can be found along Bear Creek.

Finally, Pat Markensen of the Montana Fish and Game Fisheries Division, Billings Office was contacted. He supplied KM&E a job progress report and a rough sketch of the Red Lodge, Montana area. This sketch located numerous seeps from old underground mine portals east of Rock Creek, which flow into the perennial stream. The Fish and Game Division sampled these seeps and analyzed flow, water temperature, color, taste, odor, dissolved oxygen, CO_2, H_2S, total alkalinity, and hardness.

6.2.3 Sampling Site Description

6.2.3.1 Red Lodge Area

All sampling site locations are depicted on Exhibits No. 5 & 6. Three water quality sampling sites were established on Rock Creek and streamflow was measured at the upstream and downstream sites. These sites were established upstream and downstream of two large gob piles (underground mine tailings) which come into contact with Rock Creek. Site #1 is located upstream of all mining disturbance, Site #2 is located between the gob piles, and Site #3 is located at the downstream end of the northern gob pile, just upstream of the irrigation diversion structure on Rock Creek.

The coal seams in the area generally dip to the west/northwest.

Along the east edge of Rock Creek, between sampling Sites #1 and #2, several underground mine portals and disturbance are located. Apparently, these underground mine cavities are saturated because, as a direct result of the dip of the coal seams, groundwater discharge is common. Exhibit No. 8 pictorially depicts the approximate location of these mine related seeps and sampling site locations (which are also shown on Exhibit No. 5).

As shown on Exhibit No. 8 some of the seeps come directly from underground mine portal openings while others are associated with mine related slumpage. Seven locations were previously sampled by the Montana Fish and Game Division, while KM&E chose three stratigically located sampling sites. The REA seep originates about midway up the slope from mine related slumps. The Montana Power seep is a combination of discharge from mine related slumping and direct discharge from underground mine portals in the various coal seams. The farm house portal seep is direct discharge from a mine portal which originates in sandstone. It must be deduced that this portal was an intermediate drift possibly for air circulation.

Recharge to the underground mines occurs in the SE quarter of Section 26, where subsidence is common. A spring, which probably originates from terrace gravels, flows down an ephemeral drainage and recharges the underground mines at two subsidence locations (Exhibit No. 5). Four sites were established, one of which was chosen for a full water quality analysis. Site RLTopC is located downstream of the spring and upstream of all subsidence. Flow and water temperature were measured at this site. Sampling Site RLTopB is located upstream of the second series of subsidence. A full water quality sample was collected and flow measured at this site. Just downstream of this site, flow diverges with one fork recharging the second series of subsidence holes and the other fork continuing downstream and eventually recharging the last series of subsidence (northerly most string). Site RLTopD is located about five feet upstream of direct recharge to the second string of subsidence holes. Flow and water temperature were measured at this site. Site RLTopA is located just upstream of recharge to the northerly most series of subsidence holes. Flow and water temperature were measured and no flow was observed downstream of this series of subsidence.

No water wells could be found which were completed in the coal seams mined and therefore no samples taken. Due to the high water bearing characteristics of Rock Creek alluvium and terrace gravels, it is probable that the coal seams are not beneficially used as a water supply.

6.2.3.2 Bearcreek, Montana Mining Area

The Bearcreek mining area was divided into four sub-areas: Virtue Gulch, Foster Gulch, Bear Creek, and Scotch Coulee. Sampling sites were located to:

a. Sample groundwater.

b. Full surface water quality analysis upstream and downstream of mine impact areas.

c. Field water quality analysis (specific conductance, pH, and water temperature). These sites are located in relation to specific gob piles, or mine related disturbance and are designated by a number followed by the letter A.

Only one existing water well could be located, but could not be sampled since the pump was not in working order and the owners could not be contacted.

Virtue Gulch Area

Four surface water sampling sites are located on Virtue Gulch (Exhibit No. 6), two for full water quality analysis, and two for field parameters only. Site #9 is located upstream of all inactive mining activity and downstream of the Brophy (Beartooth) mine. Sampling Site #10 is located downstream of mining activity about 100 feet upstream of the confluence with Bear Creek.

Sites 8A and 9A are located between Sites 9 and 10 and are situated downstream of two gob piles which contact the stream. Site 9A is located just upstream of the first major ephemeral tributary downstream of Site #9, while 8A is located upstream of Site #10, between mine tailings and a gob pile.

One groundwater sampling site was established. The Virtue Gulch Portal Seep sampling site is located SE,SE Section 31 where groundwater discharge occurs directly out of an underground mine portal.

Foster Gulch Area

Two sampling sites were established on Foster Gulch (Exhibit No. 6). Sampling Site #7 is located upstream of mine disturbance. Flow originates from a spring located along the west bank of the stream course. The source of the spring is coal. Site #8 is located downstream where flow infiltrates into underlying alluvium. All flow in the channel was a direct result of the spring originating in the coal seam.

Scotch Coulee Area

Four surface water sampling sites were established on Scotch Coulee (Exhibit No. 6). Sampling Site #4 is located upstream of the Smith Mine disturbance and downstream of the Washoe Dump disturbance. Sites 1A and 2A are located upstream and downstream of the Washoe Mine dump. Site 5A is located about 300 feet upstream of the Bear Creek confluence. Only field parameters were collected at sites 1A, 2A, and 5A to isolate possible impacts from specific mine disturbance.

Two groundwater quality sites were established (Exhibit No. 6). The Washoe Mine dump site is located to the north of the dump and a sample was collected from the flowing spring. Along the west bank of Scotch Coulee near the confluence with Bear Creek is a Smith underground mine portal. Discharge from this portal was sampled at the Smith Portal Seep site.

Bear Creek Area

Seven surface water quality sampling sites were established on Bear Creek, three for full water quality analysis (#5, #6, and downstream of the town) and four sites (#3A, #4A, #6A, and #7A) for field parameters only (Exhibit No. 6).

Sampling Site #5 is located upstream of significant mine disturbance near the town of Bearcreek's municipal water storage tank. Site #6 is located downstream of mine disturbance and upstream of the Virtue Gulch confluence. An additional sampling site was added during the second visit to the area. The Bearcreek Below Town site is located downstream of the town of Bearcreek to measure effects of the town on water quality.

Sites #3A and #4A were located upstream and downstream, respectively, of the Burns Mine tributary confluence. Site #6A is located downstream of the Scotch Coulee confluence and Site #7A is located downstream of the unnamed Coulee mine located south of Highway 308 and upstream of the Highway Mine tributary.

Two groundwater quality sites were established (Exhibit No. 6). Site BW (for Black Water) descriptively describes a large spring sampled near the Bear Creek Strip Mine. The source of the spring was coal.

Since seepage occurs along the entire length of the coal outcrop, it was impossible to measure the quantity of flow. To benefit the townspeople of Bearcreek, a water quality sample was collected from their drinking water supply. The site of sample collection was the Bearcreek Bar. Since the ultimate source of this supply is a spring, it was classified as a groundwater sampling site.

6.2.4 Methodology

Water quality samples were collected by facing the mouth of the sample bottle upstream and submerging the bottle to the stream bottom in order to collect a "depth-integrated" sample. Sample bottle acidification was conducted in accord with standard procedures for oil and grease, nutrient, and trace metal analyses. Dissolved trace metal samples were field filtered through a 0.45 Micron filter. All samples were stored in a cooler which was kept cold prior to delivery to the KM&E lab.

Streamgaging followed standard practices. A cloth tape was strung perpendicular to the stream. The entire section was divided into subsections, the number of which is determined by the size of the stream. Depth of water was measured for each subsection and velocity determined with velocity measuring instruments. Total flow was determined by summing the flow from each subsection.

Specific conductance was determined in the field with YSI (Model 33) and Beckman SoluBridge conductivity meters. Water temperature was measured with a mercury thermometer. The field pH was measured with Corning Model 610A-Expand Portable pH meters. Dissolved oxygen was measured in the field with a YSI Model 51B D.O. meter. Instrument calibration is conducted regularly to ensure accurate readings.

Lab analyses are conducted in accord with standard practices as outlined by the EPA - Methods for Chemical Analysis of Water and Wastes Manual. The Montana Department of State Lands 1977 Water Resources Guideline was used to determine the analyses to be performed. Total dissolved solids concentration was added to the list of analyses, the second time samples were collected, for impact analysis. In addition, total and dissolved silver concentrations were measured during the second sampling period for Rock Creek samples. This parameter was added since the large lead and silver mining district is located upstream in the headwater area of Rock Creek located in the Beartooth Mountains.

6.2.5 Results

6.2.5.1 Well and Spring Inventory

A water well and spring inventory was conducted for the Red Lodge coal field area. A listing of well and spring water rights was obtained from the DNRC for the study areas and is enclosed at the end of this report. Locations of water rights are depicted on Exhibits Nos. 5 and 6.

A listing of wells and lithologic logs was also obtained from Pacific Railroad Company files, but none of the wells listed were in the study area.

A survey of local water well drilling companies (all 12 listed in the Billings phone book) resulted in the location of one additional well near the confluence of Foster Gulch and Bear Creek. However, a field reconnaissance of the area failed to locate the well. Since the respondent failed to indicate the name of his company, no further contact was made regarding this possible well. Since local residents could not recall any wells drilled in the Foster Gulch area, it is assumed that the well location was either misplotted or has been destroyed.

Interviews with Mrs. Blackler and Mr. and Mrs. Kline indicated that an existing well not listed by the DNRC is owned by the Pfeifer family (Exhibit No. 6). The Pfeifers could not be reached during the field reconnaissance however, and no litholog could be obtained. The well and pump are thought to be in disrepair and groundwater not put to beneficial use.

Several miscellaneous seeps and springs were located during the study and are listed below:

SITE	LOCATION	COMMENTS
Red Lodge underground mine seeps	NESE and SESE Section 27; T7S, R20E	Seeps from portal openings and mine related slumping (as discussed in the Sampling Site Description of this report)
Spring	SWSW Section 24; T7S, R20E	Shown on USGS Quad Map.
Spring	SWSE Section 26; T7S, R20E	Source: Rock Creek terrace gravels.
Foster Gulch Spring	NESE Section 7; T8S, R21E	Source: coal.
BW Spring	SWSE Section 6; T8S, R21E	Source: coal.
Smith Portal Seep	NWSE Section 6; T8S, R21E	Source: coal, discharge from Smith Mine portal.
Washoe Dump Spring	NENW Section 1; T8S, R20E	Source: unknown.
Virtue Gulch Springs	SWSE Section 31; T7S, R21E	Source: unknown.
Virtue Gulch Portal Seep	SESE Section 31; T7S, R21E	Source: coal, discharge from Virtue Gulch Mine portal.

6.2.5.2 Water Quality

A total of twenty (20) surface water quality samples and eight (8) groundwater quality samples were collected from the Red Lodge, Virtue Gulch, Foster Gulch, Scotch Coulee, and Bear Creek areas. The site locations are shown on Exhibits Nos. 5 and 6 and are listed as follows:

SITE	DATES OF SAMPLING	STREAM OR GROUNDWATER SOURCE	COMMENTS
1	10/19, 11/09/82	Rock Creek	Upstream disturbance.
2	10/18, 11/09/82	Rock Creek	Between gob piles.
3	10/18, 11/09/82	Rock Creek	Downstream of gob piles.
4	10/19, 11/10/82	Scotch Coulee	
5	10/19, 11/10/82	Bear Creek	Near water tank.
6	10/19, 11/10/82	Bear Creek	Upstream Virtue Gulch confluence.
7	11/11/82	Foster Gulch	Spring from coal.
8	11/11/82	Foster Gulch	Downstream of spring.
9	10/20, 11/08/82	Virtue Gulch	Upstream of inactive mining; downstream of Brophy (Beartooth) Mine.
10	11/19, 11/08/82	Virtue Gulch	Downstream of mine disturbance.
Bear Creek Below Town	11/11/82	Bear Creek	Downstream of Bearcreek, Montana.
BW	11/10/82	Coal	Near Smith Strip Mine, Surface Water Quality Analysis.
Smith Mine Portal Seep	11/10/82	Coal	From Smith underground mine portal discharge.
Virtue Gulch Portal Seep	11/10/82	Coal	From Virtue Gulch underground mine portal discharge.
RLTopB	11/10/82	Rock Creek Terrace Gravel	East bench.

SITE	DATES OF SAMPLING	STREAM OR GROUNDWATER SOURCE	COMMENTS
Washoe Dump Spring	11/10/82	Unknown	Northwest of dump.
REA Seep	11/11/82	Coal	Mine disturbance.
Farm House Portal Seep	11/11/82	Coal, Sandstone	Mine disturbance and underground mine portal discharge.
Montana Power Seeps	11/11/82	Coal	Mine disturbance and underground mine portal discharge.
Bearcreek Bar	11/11/82	Bedrock Springs	Bearcreek, Montana water supply.
1A*	10/20, 11/12/82	Scotch Coulee	About 3,800 ft. upstream of Site #4 and Washoe Dump.
2A*	10/20, 11/12/82	Scotch Coulee	About 2,000 ft. upstream of Site #4.
3A*	10/20, 11/12/82	Bear Creek	About 1,000 ft. downstream of Site #5, below Smith Mine.
4A*	10/20, 11/12/82	Bear Creek	About 1,800 ft. downstream of Site #5, downstream of Burns Mine tributary.
5A*	10/20, 11/12/82	Scotch Coulee	About 300 ft. upstream of Bear Creek confluence.
6A*	10/20, 11/12/82	Bear Creek	About 700 ft. downstream of Bear Creek and Scotch Coulee confluence.
8A*	10/20, 11/08/82	Virtue Gulch	About 2,000 ft. upstream of Site #10.
9A*	10/20, 11/08/82	Virtue Gulch	About 4,000 ft. upstream of Site #10.

*Limited Field Parameters Only

The surface water sites (1-6, 9, and 10) were sampled in mid-October and November 1982. Preceding the October sampling period was a heavy snowfall, particularly in the vicinity of Red Lodge, Montana.

During sample collection, snowmelt runoff was evident. Little or no snowmelt runoff occurred during the November sampling periods. The remaining surface and groundwater sites were sampled from November 8 to November 12, 1982.

All reduced field data are presented in Tables 6.2.1 thru 6.2.4. Sampling dates, time of sampling, units of measurement, etc., are presented on these tables.

Analytical lab results for all sites are presented at the end of this report. For comparison purposes, those sites sampled twice are presented in Tables 6.2.5 thru 6.2.13. Milliequivalent balances (cation meq/l minus anion meq/l) were close to zero (0) indicating that all predominant ions were analyzed and also indicating very good analytical precision.

Table 6.2.1 - Hydrological Field Parameters
(1st Visit)

Site	Stream	Date	Time	Temp. (oC)	Conductivity (Mmhos/cm)	pH	D.O. (ppm)	Flow (cfs)
1	Rock Creek	10/19/82	0900	1.0	88	7.65	12.5	161.93
2	Rock Creek	10/18/82	1700	2.0	72	7.4	10.7	------
3	Rock Creek	10/18/82	1532	2.0	108	7.8	11.2	177.86
4	Scotch Coulee	10/19/82	1300	3.0	920	6.7	12.4	0.39
5	Bear Creek	10/19/82	1400	4.0	370	6.7	10.7	0.79
6	Bear Creek	10/19/82	1600	5.0	980	6.8	10.8	1.38
7	Foster Gulch	10/19/82	1741	---	----	---	----	------
8	Foster Gulch	10/19/82	1758	---	----	---	----	------
9	Virtue Gulch	10/20/82	1311	6.0	825	---	10.3	0.032
10	Virtue Gulch	10/19/82	1700	4.0	1200	7.6	10.6	Low

Table 6.2.2 - Hydrological Field Parameters
(2nd Visit)

Site	Stream or GW Source	Date	Time	Temp. (°C)	Conductivity (Mmhos/cm)	pH	D.O. (ppm)	Flow (cfs)
1	Rock Creek	11/9/82	1010	1.0	100	7.70	12.3	128.19
2	Rock Creek	11/9/82	1045	1.0	100	8.3	11.8	------
3	Rock Creek	11/9/82	1205	1.0	120	7.38	12.6	144.71
4	Scotch Coulee	11/10/82	0940	1.0	1075	7.19	11.9	0.19
5	Bear Creek	11/10/82	1140	2.0	410	6.4	11.7	0.98
6	Bear Creek	11/10/82	1640	3.0	1000	6.4	11.4	2.00
7	Foster Gulch, Seep up	11/11/82	1145	4.0	5000	7.38	14.2	0.034
8	Foster Gulch, Seep down	11/11/82	1115	0.0	10,000	7.6	8.4	$9.8X10^{-5}$
9	Virtue Gulch	11/8/82	1535	2.0	900	6.85	12.9	0.038
10	Virtue Gulch	11/8/82	1500	1.0	1500	6.46	12.7	0.032
Bear Ck.below Town	Bear Creek	11/11/82	1630	0.0	1100	----	12.0	1.53
BW	Near Smith Strip Mine	11/10/82	1440	7.0	3500	6.5	5.5	-------
Smith Mine Portal Seep	From Smith Mine	11/10/82	0845	4.0	2988	7.48	----	0.006
Virtue G.Portal Seep	Portal down from subsidence	11/10/82	1030	7.0	1681	8.5	----	0.001
RL Top B	Alluvial Spring above RL Undergrounds	11/10/82	1500	4.0	349	6.97(?)	--	0.25
Washoe Dump Spring	Above Washoe Dump	11/10/82	1645	4.0	1500	6.4 (?)	--	0.008
REA Seep	East bank Red Lodge Undergrounds	11/11/82	1500	5.0	427	6.6 (?)	--	0.020
Farm House Portal Seep	Red Lodge Undergrounds	11/11/82	1530	11.0	550	6.42(?)	--	0.30
Montana Power Seeps	Red Lodge Undergrounds	11/11/82	1630	6.0	612	-----	--	0.29
Bear Creek Bar	Scotch Coulee Spring - drinking water supply for town	11/11/82	1647	10.0	220	-----	--	NA

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Table 6.2.3 - Intermediate Sites -- Field Parameters

(1st Visit)

Site	Stream	Comments	Date	Time	Temp (°C)	Conductivity (Mmhos/cm)	pH
1A	Scotch Coulee	About 3800' upstream of site #4 and Washoe Dump	10/20/82	1030	2.0	780	7.9
2A	Scotch Coulee	About 2000' upstream of site #4 upstream of 2 buildings and Washoe Dump	10/20/82	1111	1.0	700	7.9
3A	Bear Creek	About 1000' downstream of site #5 below Smith Mine	10/20/82	1123	3.0	500	7.8
4A	Bear Creek	About 1800' downstream of site #5 below Burns Mine Tributary	10/20/82	1134	3.0	540	8.0
5A	Scotch Coulee	About 300' upstream of Bear Creek confluence	Not sampled				
6A	Bear Creek	About 700' downstream of Bear Creek and Scotch Coulee confluence	10/20/82	1233	4.0	1200	8.3
7A	Bear Creek	About 1500' upstream of Virtue Gulch confluence	Omit -- Legal Problems				
8A	Virtue Gulch	About 2000' upstream of site #10	10/20/82	1340	4.0	1200	---
9A	Virtue Gulch	About 4000' upstream of site #10	10/20/82	1400	4.0	1300	---
Smith Portal Seep Site	GW Seep	500' upstream of 5A into Scotch Coulee	10/20/82	1213	5.0	5000	7.8

Table 6.2.4 - Intermediate Sites - Field Parameters
(2nd Visit)

Site	Stream or Spring	Comments	Date	Time	Temp. (°C)	Conductivity (Mmhos/cm)	pH	Flow (cfs)
RL Top A	Alluvial spring above Red Lodge undergrounds	Downstream site, above recharge to last set of sinkholes	11/10/82	1445	3.0	----	----	0.154
RL Top C	Alluvial spring above Red Lodge undergrounds	Upstream sinkhole recharge	11/10/82	1520	4.0	----	----	0.107
RL Top D	Alluvial spring above Red Lodge undergrounds	Recharge to middle set of sink-holes below site B. A+D Flow = B	11/10/82	1505	4.0	----	----	0.095
1A	Scotch Coulee	About 3800' upstream of site #4 and Washoe Dump	11/12/82	AM	1.0	900	----	-----
2A	Scotch Coulee	About 2000' upstream of site #4, 2 buildings & Washoe Dump	11/12/82	AM	1.0	900	----	-----
3A	Bear Creek	About 1000' downstream of site #5 below Smith Mine	11/12/82	AM	0.0	520	----	-----
4A	Bear Creek	About 1800' downstream of site #5 below Burns Mine tributary	11/12/82	AM	0.0	525	----	-----
5A	Scotch Coulee	About 300' upstream of Bear Creek confluence	11/12/82	AM	0.0	2300	----	-----
6A	Bear Creek	About 700' downstream of Bear Creek and Scotch Coulee Confl.	11/12/82	AM	0.0	1290	----	-----
8A	Virtue Gulch	About 2000' upstream of site #10 below Gob Pile	11/8/82	1630	3.0	1500	----	-----
9A	Virtue Gulch	About 4000' upstream of site #10	11/8/82	1610	3.0	1150	----	-----

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Table 6.2.5 - Water Quality Lab Results
Site #1 - Rock Creek Upstream of Mine Tailings

Chemical Parameter & Units (1)	Date 10/19/82	Date 11/09/82
Lab pH	6.95	7.15
Lab Specific Conductivity (Mmhos/cm)	42.5	58.1
Total Dissolved Solids		70.0
Total Suspended Solids	1.6	4.0
Turbidity (NTU)	0.38	0.65
Oil and Grease	1.0	1.0
Acidity	0.0	0.0
Calcium	7.82	13.4
Magnesium	2.07	2.68
Potassium	1.68	1.10
Sodium	2.30	1.84
SAR	0.2	0.1
Total Alkalinity	24.5	38.0
Bicarbonate Alkalinity	29.9	46.4
Carbonate Alkalinity	0.0	0.0
Chloride	4.00	1.50
Fluoride	0.09	0.18
Nitrate as N	0.79	2.36
Sulfate	5.59	6.72
Ortho-Phosphate	< 0.01	< 0.01
Milliequivalent Balance	0.70-0.73	1.00-0.99
Total Aluminum	0.3	0.9

Chemical Parameter & Units	Date 10/19/82	Date 11/09/82
Dissolved Aluminum	< 0.1	0.1
Total Cadmium	0.002	< 0.002
Dissolved Cadmium	< 0.002	< 0.002
Total Chromium	< 0.02	< 0.02
Dissolved Chromium	< 0.02	< 0.02
Total Copper	0.03	< 0.01
Dissolved Copper	< 0.01	< 0.01
Total Iron	0.91	0.57
Dissolved Iron	0.12	0.07
Total Lead	0.07	< 0.05
Dissolved Lead	< 0.05	< 0.05
Total Manganese	< 0.02	0.03
Dissolved Manganese	< 0.02	< 0.02
Total Mercury	< 0.001	< 0.001
Dissolved Mercury	< 0.001	< 0.001
Total Selenium	< 0.002	0.002
Dissolved Selenium	< 0.002	< 0.002
Total Vanadium	0.1	< 0.1
Dissolved Vanadium	< 0.1	< 0.1
Total Zinc	0.07	0.09
Dissolved Zinc	< 0.02	< 0.02
Total Silver		0.08
Dissolved Silver		0.01

(1) All units are mg/l unless otherwise noted.

Table 6.2.6 - Water Quality Lab Results
Site #2 - Rock Creek Between Tailing Piles

Chemical Parameter & Units(1)	Date 10/18/82	Date 11/09/82	Chemical Parameter & Units	Date 10/18/82	Date 11/09/82
Lab pH	7.02	7.27	Dissolved Aluminum	<0.1	<0.1
Lab Specific Conductivity	44.9	54.1	Total Cadmium	<0.002	<0.002
(Mmhos/cm)			Dissolved Cadmium	<0.002	<0.002
Total Dissolved Solids		66.0	Total Chromium	<0.02	<0.02
Total Suspended Solids	2.8	2.8	Dissolved Chromium	<0.02	<0.02
Turbidity (NTU)	0.57	0.43	Total Copper	<0.01	<0.01
Oil and Grease	<1.0	4.0	Dissolved Copper	<0.01	<0.01
Acidity	0.0	0.0	Total Iron	0.73	0.52
Calcium	8.82	10.8	Dissolved Iron	0.19	0.10
Magnesium	2.55	2.55	Total Lead	0.07	0.10
Potassium	1.63	0.30	Dissolved Lead	0.06	0.06
Sodium	2.30	2.30	Total Manganese	0.04	<0.02
SAR	0.2	0.2	Dissolved Manganese	0.02	<0.02
Total Alkalinity	30.0	36.0	Total Mercury	<0.001	<0.001
Bicarbonate Alkalinity	36.6	43.9	Dissolved Mercury	<0.001	<0.001
Carbonate Alkalinity	0.0	0.0	Total Selenium	<0.002	<0.002
Chloride	2.0	<0.50	Dissolved Selenium	<0.002	<0.002
Fluoride	0.07	0.11	Total Vanadium	<0.1	<0.1
Nitrate as N	0.93	2.59	Dissolved Vanadium	<0.1	<0.1
Sulfate	5.36	5.59	Total Zinc	0.03	0.07
Ortho-Phosphate	<0.01	<0.01	Dissolved Zinc	<0.02	<0.02
Milliequivalent Balance	0.79-0.79	0.86-0.89	Total Silver		0.03
Total Aluminum	0.4	1.0	Dissolved Silver		<0.01

(1) All units are mg/l unless otherwise noted.

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Table 6.2.7 - Water Quality Lab Results
Site #3 - Rock Creek Downstream of Mine Tailings

Chemical Parameter & Units(1)	Date 10/18/82	11/09/82
Lab pH	7.21	7.42
Lab Specific Conductivity (Mmhos/cm)	49.8	63.4
Total Dissolved Solids		82.0
Total Suspended Solids	2.0	2.0
Turbidity (NTU)	0.82	0.54
Oil and Grease	1.6	< 1.0
Acidity	0.0	0.0
Calcium	9.62	15.4
Magnesium	3.53	2.92
Potassium	1.64	0.30
Sodium	2.53	2.76
SAR	0.2	0.2
Total Alkalinity	33.0	40.0
Bicarbonate Alkalinity	40.3	48.8
Carbonate Alkalinity	0.0	0.0
Chloride	4.00	2.00
Fluoride	0.08	0.15
Nitrate as N	1.04	0.98
Sulfate	5.93	12.3
Ortho-Phosphate	<0.01	<0.01
Milliequivalent Balance	0.92-0.91	1.14-1.15
Total Aluminum	0.4	0.7

Chemical Parameter and Units	Date 10/18/82	11/09/82
Dissolved Aluminum	0.2	0.3
Total Cadmium	< 0.002	< 0.002
Dissolved Cadmium	< 0.002	< 0.002
Total Chromium	0.04	< 0.02
Dissolved Chromium	< 0.02	< 0.02
Total Copper	0.01	< 0.01
Dissolved Copper	< 0.01	< 0.01
Total Iron	0.46	0.70
Dissolved Iron	0.16	0.07
Total Lead	0.10	< 0.05
Dissolved Lead	0.07	< 0.05
Total Manganese	0.06	< 0.02
Dissolved Manganese	< 0.02	< 0.02
Total Mercury	< 0.001	0.002
Dissolved Mercury	< 0.001	< 0.001
Total Selenium	< 0.002	< 0.002
Dissolved Selenium	< 0.002	< 0.002
Total Vanadium	< 0.1	< 0.1
Dissolved Vanadium	< 0.1	< 0.1
Total Zinc	0.02	0.06
Dissolved Zinc	< 0.02	0.04
Total Silver		0.02
Dissolved Silver		0.01

(1) All units are mg/l unless otherwise noted.

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Table 6.2.8 - Water Quality Lab Results
Site #4 - Scotch Coulee

Chemical Parameter & Units (1)	Date 10/19/82	Date 11/10/82
Lab pH	7.89	7.88
Lab Specific Conductivity (Mmhos/cm)	680	601
Total Dissolved Solids		544
Total Suspended Solids	4.4	3.6
Turbidity (NTU)	2.7	1.0
Oil and Grease	< 1.0	< 1.0
Acidity	0.0	0.0
Calcium	58.8	54.5
Magnesium	26.8	31.3
Potassium	4.85	4.20
Sodium	98.9	92.0
SAR	2.7	2.5
Total Alkalinity	324	360
Bicarbonate Alkalinity	395	439
Carbonate Alkalinity	0.0	0.0
Chloride	7.00	6.00
Fluoride	0.27	0.57
Nitrate as N	0.89	<0.50
Sulfate	140	109
Ortho-Phosphate	<0.01	<0.01
Milliequivalent Balance	9.55-9.61	9.40-9.68

Chemical Parameter & Units	Date 10/19/82	Date 11/10/82
Total Aluminum	0.4	1.5
Dissolved Aluminum	0.2	0.4
Total Cadmium	<0.002	<0.002
Dissolved Cadmium	<0.002	<0.002
Total Chromium	<0.02	<0.02
Dissolved Chromium	<0.02	<0.02
Total Copper	0.01	<0.01
Dissolved Copper	0.01	<0.01
Total Iron	0.97	1.60
Dissolved Iron	0.17	0.13
Total Lead	0.11	<0.05
Dissolved Lead	0.09	<0.05
Total Manganese	0.05	<0.02
Dissolved Manganese	0.04	<0.02
Total Mercury	<0.001	<0.001
Dissolved Mercury	<0.001	<0.001
Total Selenium	<0.002	<0.002
Dissolved Selenium	<0.002	<0.002
Total Vanadium	<0.1	<0.1
Dissolved Vanadium	<0.1	<0.1
Total Zinc	0.05	0.02
Dissolved Zinc	<0.02	<0.02

(1) All units are mg/l unless otherwise noted.

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Table 6.2.9 - Water Quality Lab Results
Site #5 - Bear Creek-Upstream of Scotch Coulee Confluence

Chemical Parameter & Units[1]	Date 10/19/82	Date 11/10/82	Chemical Parameter & Units	Date 10/19/82	Date 11/10/82
Lab pH	7.78	7.40	Total Aluminum	0.6	0.7
Lab Specific Conductivity (Mmhos/cm)	285	234	Dissolved Aluminum	< 0.1	< 0.1
			Total Cadmium	< 0.002	< 0.002
Total Dissolved Solids		224	Dissolved Cadmium	< 0.002	< 0.002
Total Suspended Solids	6.0	20.8	Total Chromium	< 0.02	< 0.02
Turbidity (NTU)	6.5	3.4	Dissolved Chromium	< 0.02	< 0.02
Oil and Grease	< 1.0	< 1.0	Total Copper	0.01	0.03
Acidity	0.0	0.0	Dissolved Copper	< 0.01	0.01
Calcium	34.5	32.3	Total Iron	1.59	0.74
Magnesium	12.4	10.7	Dissolved Iron	0.46	0.10
Potassium	4.32	3.20	Total Lead	< 0.05	< 0.05
Sodium	27.6	26.7	Dissolved Lead	< 0.05	< 0.05
SAR	1.0	1.0	Total Manganese	< 0.02	< 0.02
Total Alkalinity	166	164	Dissolved Manganese	< 0.02	< 0.02
Bicarbonate Alkalinity	203	200	Total Mercury	< 0.001	0.002
Carbonate Alkalinity	0.0	0.0	Dissolved Mercury	< 0.001	< 0.001
Chloride	4.00	2.50	Total Selenium	0.003	< 0.002
Fluoride	0.18	0.32	Dissolved Selenium	0.002	< 0.002
Nitrate as N	1.13	2.70	Total Vanadium	< 0.1	< 0.1
Sulfate	28.8	27.2	Dissolved Vanadium	< 0.1	< 0.1
Ortho-Phosphate	< 0.01	< 0.01	Total Zinc	0.03	0.05
Milliequivalent Balance	4.05-4.06	3.73-3.98	Dissolved Zinc	< 0.02	< 0.02

(1) All units are mg/l unless otherwise noted.

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Table 6.2.10 - Water Quality Lab Results
Site #6 - Bear Creek-Upstream of Virtue Gulch Confluence

Chemical Parameter & Units [1]	Date 10/19/82	Date 11/10/82	Chemical Parameter & Units	Date 10/19/82	Date 11/10/82
Lab pH	8.20	8.14	Total Aluminum	0.5	2.5
Lab Specific Conductivity	705	611	Dissolved Aluminum	0.2	0.8
(Mmhos/cm)			Total Cadmium	< 0.002	< 0.002
Total Dissolved Solids		544	Dissolved Cadmium	< 0.002	< 0.002
Total Suspended Solids	4.0	3.6	Total Chromium	< 0.02	< 0.02
Turbidity (NTU)	5.4	2.4	Dissolved Chromium	< 0.02	< 0.02
Oil and Grease	< 1.0	1.6	Total Copper	0.03	< 0.01
Acidity	0.0	0.0	Dissolved Copper	< 0.01	< 0.01
Calcium	51.9	45.9	Total Iron	0.96	1.40
Magnesium	29.7	26.6	Dissolved Iron	0.63	0.18
Potassium	5.73	4.80	Total Lead	0.05	< 0.05
Sodium	120	117	Dissolved Lead	< 0.05	< 0.05
SAR	3.3	3.4	Total Manganese	0.03	0.04
Total Alkalinity	292	298	Dissolved Manganese	< 0.02	< 0.02
Bicarbonate Alkalinity	356	364	Total Mercury	< 0.001	< 0.001
Carbonate Alkalinity	0.0	0.0	Dissolved Mercury	< 0.001	0.001
Chloride	6.00	3.50	Total Selenium	0.003	< 0.002
Fluoride	0.24	0.41	Dissolved Selenium	< 0.002	< 0.002
Nitrate as N	0.93	1.42	Total Vanadium	< 0.1	< 0.1
Sulfate	215	181	Dissolved Vanadium	< 0.1	< 0.1
Ortho-Phosphate	< 0.01	< 0.01	Total Zinc	0.03	0.06
Milliequivalent Balance	10.37-10.51	9.70-9.88	Dissolved Zinc	< 0.02	< 0.02

(1) All units are mg/l unless otherwise noted.

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Table 6.2.11 - Water Quality Lab Results
Sites #7 and 8 - Foster Gulch Seep: Up- and Downstream of Principal Mine Disturbance

Chemical Parameter & Units (1)	Seep Upstream 11/11/82	Seep Downstream 11/11/82	Chemical Parameter & Units	Seep Upstream 11/11/82	Seep Downstream 11/11/82
Lab pH	8.06	7.95	Total Aluminum	1.9	4.3
Lab Specific Conductivity	2960	4980	Dissolved Aluminum	0.6	0.5
(Mmhos/cm)			Total Cadmium	<0.002	<0.002
Total Dissolved Solids	3360	5960	Dissolved Cadmium	0.002	<0.002
Total Suspended Solids	238	301	Total Chromium	0.02	0.07
Turbidity (NTU)	12	19	Dissolved Chromium	<0.02	<0.02
Oil and Grease	<1.0	<1.0	Total Copper	0.01	0.02
Acidity	0.0	0.0	Dissolved Copper	<0.01	<0.01
Calcium	41.7	144	Total Iron	1.80	1.18
Magnesium	29.8	300	Dissolved Iron	0.65	0.51
Potassium	13.4	18.9	Total Lead	<0.05	<0.05
Sodium	1080	1380	Dissolved Lead	<0.05	<0.05
SAR	31.2	15.0	Total Manganese	0.05	<0.02
Total Alkalinity	1740	1620	Dissolved Manganese	0.07	0.12
Bicarbonate Alkalinity	2130	1980	Total Mercury	0.004	0.001
Cabonate Alkalinity	0.0	0.0	Dissolved Mercury	0.002	<0.001
Chloride	13.0	20.0	Total Selenium	<0.002	<0.002
Fluoride	1.58	1.06	Dissolved Selenium	<0.002	<0.002
Nitrate as N	2.03	6.07	Total Vanadium	<0.1	0.4
Sulfate	808	2890	Dissolved Vanadium	<0.1	0.3
Ortho-Phosphate	0.04	<0.01	Total Zinc	0.07	0.06
Milliequivalent Balance	51.87-52.08	92.37-93.42	Dissolved Zinc	0.02	<0.02

(1) All units are mg/l unless otherwise noted.

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Table 6.2.12 - Water Quality Lab Results
Site #9 - Virtue Gulch: Upstream of Old Mine Disturbance

Chemical Parameter & Units[1]	Date 10/20/82	Date 11/08/82	Chemical Parameter & Units	Date 10/20/82	Date 11/08/82
Lab pH	8.00	7.96	Total Aluminum	0.6	0.6
Lab Specific Conductivity (Mmhos/cm)	620	517	Dissolved Aluminum	< 0.1	< 0.1
			Total Cadmium	< 0.002	< 0.002
Total Dissolved Solids		430	Dissolved Cadmium	< 0.002	< 0.002
Total Suspended Solids	4.8	6.4	Total Chromium	< 0.02	< 0.02
Turbidity (NTU)	24.0	2.1	Dissolved Chromium	< 0.02	< 0.02
Oil and Grease	< 1.0	< 1.0	Total Copper	0.02	0.04
Acidity	0.0	0.0	Dissolved Copper	< 0.01	< 0.01
Calcium	67.4	53.1	Total Iron	4.37	2.10
Magnesium	32.2	28.8	Dissolved Iron	0.13	< 0.05
Potassium	5.92	4.50	Total Lead	< 0.05	< 0.05
Sodium	69.0	73.6	Dissolved Lead	< 0.05	< 0.05
SAR	1.7	2.0	Total Manganese	< 0.02	< 0.02
Total Alkalinity	332	330	Dissolved Manganese	< 0.02	< 0.02
Bicarbonate Alkalinity	405	403	Total Mercury	< 0.001	< 0.001
Carbonate Alkalinity	0.0	0.0	Dissolved Mercury	< 0.001	< 0.001
Chloride	5.00	3.00	Total Selenium	0.003	0.003
Fluoride	0.53	0.91	Dissolved Selenium	0.003	< 0.002
Nitrate as N	1.47	2.59	Total Vanadium	< 0.1	< 0.1
Sulfate	113	81.6	Dissolved Vanadium	< 0.1	< 0.1
Ortho-Phosphate	< 0.01	< 0.01	Total Zinc	0.03	0.04
Milliequivalent Balance	9.16-9.19	8.33-8.47	Dissolved Zinc	< 0.02	< 0.02

(1) All units are mg/l unless otherwise noted.

Table 6.2.13 - Water Quality Lab Results
Site #10 - Virtue Gulch: Downstream of Old Mine Disturbance

Chemical Parameter & Units (1)	Date 10/19/82	11/08/82	Chemical Parameter & Units	Date 10/19/82	11/08/82
Lab pH	8.07	7.98	Total Aluminum	0.4	1.3
Lab Specific Conductivity (Mmhos/cm)	1070	903	Dissolved Aluminum	0.2	0.5
			Total Cadmium	< 0.002	0.002
Total Dissolved Solids		952	Dissolved Cadmium	< 0.002	< 0.002
Total Suspended Solids	6.0	9.6	Total Chromium	0.05	< 0.02
Turbidity (NTU)	5.5	0.82	Dissolved Chromium	< 0.02	< 0.02
Oil and Grease	< 1.0	< 1.0	Total Copper	0.03	< 0.01
Acidity	0.0	0.0	Dissolved Copper	0.01	< 0.01
Calcium	111	95.2	Total Iron	0.72	1.16
Magnesium	69.8	71.6	Dissolved Iron	0.39	0.10
Potassium	8.26	7.40	Total Lead	< 0.05	< 0.05
Sodium	94.3	101	Dissolved Lead	< 0.05	< 0.05
SAR	1.7	1.9	Total Manganese	0.02	< 0.02
Total Alkalinity	338	350	Dissolved Manganese	< 0.02	< 0.02
Bicaronbate Alkalinity	412	427	Total Mercury	0.004	0.003
Carbonate Alkalinity	0.0	0.0	Dissolved Mercury	0.003	0.002
Chloride	5.00	3.50	Total Selenium	< 0.002	< 0.002
Fluoride	0.49	0.85	Dissolved Selenium	< 0.002	< 0.002
Nitrate as N	1.26	< 0.50	Total Vanadium	< 0.1	< 0.1
Sulfate	417	377	Dissolved Vanadium	< 0.1	< 0.1
Ortho-Phosphate	< 0.01	< 0.01	Total Zinc	0.06	0.67
Milliequivalent Balance	15.60-15.65	15.23-14.99	Dissolved Zinc	< 0.02	< 0.02

(1) All units are mg/l unless otherwise noted.

6.2.6 Bearcreek, Montana Water Supply

A sample was collected from the town drinking water supply (Bearcreek Bar site). For those parameters analyzed, this supply meets applicable EPA standards for public drinking water supplies.

6.2.7 Department of Natural Resources and Conservation Water Rights System, Red Lodge Coal Field Well and Spring Water Rights

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DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
WATER RIGHT SYSTEM
WATER RIGHT LAND DESCRIPTION LISTING

W = well, D = spring
when well log available

WATER RIGHT NUMBER	LOT	BLK	SUBD	POINT OF DIVERSION QTR SCTN	SCTN	TWP	RGE	CNTY	W D	DPTH	RATE	VOLUME	ACRES	PRIORITY DATE
43D -W-026800-00				SESWSW	14	07S	19E	CA	D		1.88 C	50.72	2.00	0000 06-01-1911
43D -W-106857-00				SENWNE	25	07S	19E	CA	D		2.50 G	2.20		0000 00-00-1890
43D -W-106858-00				SWNWSE	25	07S	19E	CA	D		5.00 G	4.30		0000 00-00-1890
43D -B-044509-00				SWNWNE	34	07S	19E	CA	W		50.00 G			0915 04-30-1982
43D -C-011103-00				NWSWNE	1	07S	20E	CA	W	90	7.00 G			1310 01-24-1977
43D -C-024998-00	23		10WAG	NWNW	2	07S	20E	CA	W	30	14.00 G	1.50		1341 10-30-1979
43D -C-038386-00				SWNW	2	07S	20E	CA	W	30	25.00 G	1.50		0906 12-02-1981
43D -W-012622-00				S2NW	2	07S	20E	CA	D		.29 C	106.40	24.29	0000 09-05-1939
43D -W-038196-00				S2NW	2	07S	20E	CA	D		.42 C	3.50	1.00	0000 07-20-1937
43D -C-026949-00	2		10ULM	NENENW	2	07S	20E	CA	W	40	20.00 G	.53		1133 03-19-1980
43D -C-035475-00	24		10KEN	NESESW	2	07S	20E	CA	W	39	10.00 G	3.00		0851 08-25-1981
43D -W-043439-00				SENWNW	2	07S	20E	CA	D		1.00 C	360.00	40.00	0000 00-00-1925
43D -T-041811-00				SESWNW	2	07S	20E	CA	W					1015 12-04-1981
43D -C-036349-00				SWSENW	2	07S	20E	CA	W	30	25.00 G	1.50		0814 12-01-1981
43D -C-035882-00				NWNWSE	4	07S	20E	CA	W	39	90.00 G	5.02	2.00	0820 09-15-1981
43D -C-035845-00	17	1	10TIP	SENWNW	4	07S	20E	CA	W	87	10.00 G	1.50		0811 09-14-1981
43D -C-035365-00				NENENE	5	07S	20E	CA	W		12.00 G	3.00		0936 08-20-1981
43D -C-011971-00				NESESE	6	07S	20E	CA	W	185	5.50 G			1322 03-24-1977
43D -W-111377-00				NENWNW	7	07S	20E	CA	D		25.00 G	8.40		0000 00-00-1888
43D -W-111413-00				NENWNW	7	07S	20E	CA	D		.63 C	191.25	80.00	0000 05-15-1894
43D -W-111395-00				NWSESE	7	07S	20E	CA	D		50.00 G	34.00	40.00	0000 11-26-1921
43D -C-011972-00				SESENE	7	07S	20E	CA	W	50	9.00 G			1324 03-24-1977
43D -W-111397-00				SESENE	7	07S	20E	CA	W		10.00 G	1.55	1.50	0000 11-26-1921
43D -W-111362-00				SWSWNE	7	07S	20E	CA	D		75.00 G	8.40		0000 00-00-1888
43D -C-032964-00				NENE	8	07S	20E	CA	W	135	15.00 G	1.60		1105 05-08-1981
43D -C-033375-00			10PAL	SWSE	8	07S	20E	CA	D		2.50 G	2.01		1201 05-20-1981
43D -W-111376-00				NWSWSW	8	07S	20E	CA	D		.10 C	8.40		0000 00-00-1888
43D -W-114666-00				NWSWSW	8	07S	20E	CA	W		10.00 G	1.30	1.00	0000 06-01-1888
43D -C-032709-00	19		10PAL	SENESW	8	07S	20E	CA	W	40	20.00 G	5.69		0812 04-17-1981
43D -C-015273-00				W2NENW	8	07S	20E	CA	W		30.00 G	1.50		1400 09-20-1977
43D -W-019915-00				SWSENE	10	07S	20E	CA	D		.13 C	30.00	11.00	0000 07-20-1937
43D -C-034676-00					11	07S	20E	CA	W		25.00 G	1.50		1116 07-23-1981
43D -W-102574-00	006				11	07S	20E	CA	D		.08 C	1,830.00	1.29	0000 04-02-1954
43D -W-102687-00	001				11	07S	20E	CA	D		.08 C	27.00	1.30	0000 04-02-1954
43D -C-037279-00	9		10KEN	SW	11	07S	20E	CA	W		30.00 G	5.00		1030 10-26-1981
43D -C-016832-00	26		10KEN	SWNW	11	07S	20E	CA	W		25.00 G	1.50		1335 12-20-1977
43D -W-124055-00				SESWNE	11	07S	20E	CA	D		1.75 C	700.00	20.00	0000 08-30-1898
43D -C-019996-00				SWNWSE	11	07S	20E	CA	W	50	20.00 G	1.50		1139 08-22-1978
43D -W-043409-00				SWSWNW	13	07S	20E	CA	D		30.00 G	48.00	4.00	0000 04-01-1940
43D -W-020228-00	014				14	07S	20E	CA	D		5.00 G	1.00	.75	0000 04-02-1954
43D -C-016674-00	020			NW	14	07S	20E	CA	W		25.00 G	3.00		1352 12-16-1977
43D -C-025911-00	13		10KEN	NWNWNW	14	07S	20E	CA	W	38	30.00 G	1.50		1133 12-27-1979
43D -C-016774-00				NWSWNW	14	07S	20E	CA	W	14	70.00 G	1.50		1308 12-28-1977
43D -C-019349-00	1		10WH1	SWSWNE	14	07S	20E	CA	W	30	35.00 G	1.50		1333 07-03-1978
43D -C-046674-00					15	07S	20E	CA	D		45.00 G	2.00		1315 04-30-1982
43D -W-014948-00	001	001			15	07S	20E	CA	D		17.00 G	1.00		0000 04-02-1954
43D -W-010210-00				SESE	15	07S	20E	CA	D		2.50 C	1,800.00		0000 06-01-1969
43D -P-022438-00				SWSW	15	07S	20E	CA	W			2.00		1555 04-02-1979
43D -W-015902-00				NENWNW	15	07S	20E	CA	D		116.00 C	60.00		0000 04-02-1954
43D -C-034109-00				SESENE	15	07S	20E	CA	W	105	5.00 G	.05		1150 06-29-1981
43D -W-012616-00				NENWNW	15	07S	20E	CA	D		20.00 G	10.00	2.00	0000 04-02-1954

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DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
WATER RIGHT SYSTEM
WATER RIGHT LAND DESCRIPTION LISTING

WATER RIGHT NUMBER	LOT	BLK	SUBD	POINT OF DIVERSION QTR SCTN	SCTN	TWP	RGE	CNTY	W D	DPTH	RATE	VOLUME	ACRES	PRIORITY DATE
43D -C-023004-00				NESWSE	16	07S	20E	CA	W	42	10.00 G	1.50		1410 06-04-1979
43D -H-000077-00				SWNESW	16	07S	20E	CA	D		1.75 C			1130 12-07-1973
43D -T-017223-00				NWNW	17	07S	20E	CA	W		4.00 G			0000 10-09-1973
43D -C-023269-00				N2NW	17	07S	20E	CA	W	150	15.00 G	1.50		1424 06-22-1979
43D -B-016954-00				SENW	17	07S	20E	CA	W		1.00 G	5.00		1135 01-13-1978
43D -B-016955-00				SENW	17	07S	20E	CA	W		1.00 G	5.00		1136 01-13-1978
43D -C-016987-00				SENW	17	07S	20E	CA	W	110	5.00 G	1.50		1128 01-17-1978
43D -T-016953-00				SENW	17	07S	20E	CA	W		1.00 G	.39		1134 01-13-1978
43D -C-047393-00	4		10LZS	NWNWNW	17	07S	20E	CA	W		8.00 G	7.32	2.50	1202 04-30-1982
43D -C-027820-00			10COS	SWNENW	17	07S	20E	CA	W	39	60.00 G	5.50	5.00	1333 06-24-1980
43D -C-034113-00				SWNENW	17	07S	20E	CA	W	150	10.00 G	1.50		0837 06-30-1981
43D -C-032522-00				NENE	18	07S	20E	CA	W	135	15.00 G	1.50		0944 03-30-1981
43D -W-041844-00				SENESE	18	07S	20E	CA	D		.63 C	25.00	25.00	0000 00-00-1915
43D -C-017894-00				E2NW	19	07S	20E	CA	W		5.00 G	1.13		1627 03-08-1978
43D -C-015389-00				NWN2SW	21	07S	20E	CA	W	40	50.00 G	1.50		1555 09-28-1977
43D -C-011525-00				NESE	22	07S	20E	CA	W	31	20.00 G	1.50		1502 03-01-1977
43D -C-033381-00				NESE	22	07S	20E	CA	W		5.00 G	1.50		1130 05-20-1981
43D -C-042988-00				NESE	22	07S	20E	CA	W		5.00 G	1.00		1502 03-18-1982
43D -W-017012-00				SWSE	22	07S	20E	CA	W		29.00 G	18.00		0000 05-25-1972
43D -W-017203-00				S*SE	22	07S	20E	CA	D		14.00 G	1.00		0000 12-14-1945
43D -W-029353-00				NWSWSE	22	07S	20E	CA	D		10.00 G	5.05	2.00	0000 00-00-1921
43D -W-029354-00				NWSWSE	22	07S	20E	CA	D		10.00 G	5.00	2.00	0000 00-00-1921
43D -C-014744-00				SESWSE	22	07S	20E	CA	W	28	70.00 G	1.50		1320 08-19-1977
43D -C-021752-00				SWNENW	22	07S	20E	CA	W	32	20.00 G	1.60		1131 02-06-1979
43D -T-014599-00				SWSWSE	22	07S	20E	CA	W		10.00 G	11.16		1250 08-10-1977
43D -W-027981-00				SWSWSE	22	07S	20E	CA	D		55.00 G	5.20	2.00	0000 00-00-1889
43D -W-031247-00				NWSWNW	26	07S	20E	CA	W		30.00 G	1.03	5.00	0001 01-01-1948
43D -B-044017-00				NE	27	07S	20E	CA	W		25.00 G			0849 04-21-1982
43D -C-030811-00				NWNE	27	07S	20E	CA	W	30	20.00 G	3.00		0921 12-17-1980
43D -C-014622-00	15	26	10RLO	NWSE	27	07S	20E	CA	W		30.00 G	1.50		1100 08-11-1977
43D -C-030899-00				SENW	27	07S	20E	CA	W	40	20.00 G	1.50		0917 12-18-1980
43D -W-029355-00				NENENW	27	07S	20E	CA	D		1.25 C	40.00	8.00	0000 00-00-1921
43D -W-015044-00	002	055		NESWNE	27	07S	20E	CA	W		125.00 G	200.05		0000 11-30-1960
43D -W-031248-00				SESENE	27	07S	20E	CA	W		30.00 G	1.00		0001 01-01-1948
43D -W-013752-00				SESENW	27	07S	20E	CA	D		10.00 G	18.00	4.00	0000 08-19-1899
43D -W-025562-00				SWNENW	27	07S	20E	CA	D		1.25 C	40.00	103.00	0000 06-13-1952
43D -W-045738-00				SENENE	28	07S	20E	CA	W		200.00 G	26.00		0000 03-25-1936
43D -C-000405-00	8	5	10GPH		32	07S	20E	CA	W	73	4.00 G			0937 09-19-1973
43D -C-010447-00	17	8	10GPH		32	07S	20E	CA	W	170	1.50 G			1317 11-18-1976
43D -C-017924-00	8	2	10GPH		32	07S	20E	CA	W	62	15.00 G	1.50		1204 03-13-1978
43D -C-018825-00	6	5	10GPH		32	07S	20E	CA	W	130,	3.00 G	1.50		1128 05-26-1978
43D -W-117885-00	001	006			32	07S	20E	CA	D		3.00 G	4.84	1.07	0000 07-15-1963
43D -W-117886-00	001	006			32	07S	20E	CA	W		10.00 G	16.15	1.07	0000 07-01-1961
43D -C-009071-00				E2	32	07S	20E	CA	W	180	2.00 G			1330 08-02-1976
43D -C-017980-00	005	006		SWNE	32	07S	20E	CA	W	80	15.00 G	3.95	2.00	1128 03-21-1978
43D -C-025485-00	5	7	10GPH	SWNE	32	07S	20E	CA	W		10.00 G	3.00		1525 11-16-1979
43D -C-031323-00	2	2	10GPH	SWNE	32	07S	20E	CA	W	165	25.00 G	1.50		0900 01-22-1981
43D -C-039032-00	6	4	10GPH	SWNW	32	07S	20E	CA	W		7.00 G	4.00	1.50	1000 11-30-1981
43D -C-009223-00				NESENW	32	07S	20E	CA	W	90	7.50 G			1455 08-17-1976
43D -H-023149-00				NWNESW	32	07S	20E	CA	W		3.00 G			1155 09-05-1978
43D -W-029356-00	013	002		NWSWNE	32	07S	20E	CA	D		50.00 G	6.40	3.20	0000 00-00-1972

WATER RIGHT NUMBER	LOT	BLK	SUBD	POINT OF DIVERSION QTR SCTN	SCTN	TWP	RGE	CNTY	WD	DPTH	RATE	VOLUME	ACRES	PRIORITY DATE
430 -C-023551-00				NWNW	33	07S	20E	CA	W	60	5.00 G	3.00		1114 07-11-197
430 -W-006522-00				SESW	33	07S	20E	CA	W		15.00 G	4.00	1.50	0000 07-14-196
430 -C-013479-00				SWSESW	33	07S	20E	CA	W	60	15.00 G	1.50		1150 06-20-197
430 -W-006013-00	011	093			34	07S	20E	CA	D		.25 C	5.00	2.00	0000 06-17-193
430 -W-020216-00	C18				34	07S	20E	CA	D		.38 C	.66	.33	0000 00-00-189
430 -W-029300-00	011	A			34	07S	20E	CA	D		30.00 G	3.00	.17	0000 06-01-193
430 -W-032261-00	014				34	07S	20E	CA	D		250.00 G	1.50	.38	1550 05-01-192
430 -W-045736-00	003	064			34	07S	20E	CA	W		900.00 G	1,450.00		0000 05-26-196
430 -W-006228-00				NWSE	34	07S	20E	CA	W		100.00 G	10.00	3.00	0000 00-00-000
430 -W-111459-00	002	089		SWNW	34	07S	20E	CA	D		.08 C	3.20	.50	1425 06-28-196
430 -W-111460-00	007	084		SWNW	34	07S	20E	CA	D		.08 C	3.20	.50	1425 06-28-196
430 -C-016122-00				NENWSE	34	07S	20E	CA	W	27	60.00 G	1.50		1128 11-04-197
430 -W-020206-00	004	101		NWSENW	34	07S	20E	CA	D		10.00 G	1.00	.14	0000 01-28-194
430 -W-029360-00				NWSWNW	34	07S	20E	CA	D		5.00 G	1.75	.88	0000 00-00-191
430 -W-029359-00				SENWNW	34	07S	20E	CA	D		10.00 G	1.66	.17	0000 00-00-1917
430 -C-035709-00				SENWSW	34	07S	20E	CA	W	39	25.00 G	1.50		1156 09-08-1981
430 -W-130326-00				SESWNW	34	07S	20E	CA	D		900.00 G	1,460.00		0000 00-00-1934
430 -W-027181-00				SWNESW	34	07S	20E	CA	D		30.00 G	2.50	.50	0000 00-00-1900
430 -W-027194-00				SWNESW	34	07S	20E	CA	D		25.00 G	2.00	.50	1200 09-15-1972
430 -W-033340-00				SWNESW	34	07S	20E	CA	D		30.00 G	2.00	.75	0800 09-01-1924
430 -C-035737-00				SWNWNW	34	07S	20E	CA	D		10.00 G	1.50		0915 09-02-1981
430 -C-033647-00	6			SWNWSE	34	07S	20E	CA	W	38	40.00 G	1.50		1134 06-08-1981
430 -C-037275-00				NWNENENE	34	07S	20E	CA	W		20.00 G	.86		1025 10-23-1981
430 -W-031292-00				SWSWSE	35	07S	20E	CA	D		5.00 G	.42		0001 06-05-1933
430 -W-031291-00				W2W2SE	35	07S	20E	CA	D		5.00 G	.42		0001 12-01-1917
430 -C-025457-00				SENE	4	07S	21E	CA	W	205	5.00 G	3.00		1314 11-29-1979
430 -C-038536-00				SENE	4	07S	21E	CA	D		2.50 G	3.0?		1137 12-09-1981
430 -C-000666-00				SWNE	6	07S	21E	CA	W	82	10.00 G			0956 10-11-1973
430 -W-108345-00				NWNENW	15	07S	21E	CA	D		1.00 G	1.50		0000 07-02-1864
430 -C-027012-00				SESWNW	15	07S	21E	CA	W	122	10.00 G	7.61		1129 03-27-1980
430 -W-031294-00				SWSWSW	25	07S	21E	CA	W		7.00 G	7.00		0001 01-01-1964
430 -W-031287-00					33	07S	21E	CA	D		5.00 G	.42		0001 06-20-192
430 -W-031271-00				NENWSW	33	07S	21E	CA	D		3.00 G	1.00		0061 05-01-19
430 -W-031274-00				NWSESW	33	07S	21E	CA	D		3.00 G	1.00		0001 07-01-19
430 -C-005943-00				NENW	1	07S	22E	CA	W		5.00 G			1400 07-11-19
430 -T-006158-00				NENW	1	07S	22E	CA	W		.30 G	.10		1130 08-07-197
430 -T-006159-00				NENW	1	07S	22E	CA	W		5.00 G			1131 08-07-1975
430 -C-034677-00				SENW	13	07S	22E	CA	W	167	35.00 G	2.64		1330 07-22-1981
430 -C-037036-00				SWSENW	13	07S	22E	CA	W	150	15.00 G	2.40		1317 10-16-1981
430 -C-029241-00				NWNWNW	14	07S	22E	CA	W	59	99.00 G	5.00		1426 09-12-1980
430 -C-000135-00				NWNE	15	07S	22E	CA	W	63	25.00 G			1005 08-21-1973
430 -C-027727-00				SWNESE	23	07S	22E	CA	W	82	4.00 G	1.50		1348 06-23-1980
430 -C-039012-00					25	07S	22E	CA	W		50.00 G	18.40		1015 11-18-1981
430 -T-010020-00				SESE	25	07S	22E	CA	W		10.00			1034 11-01-1976
430 -C-004553-00					26	07S	22E	CA	W	37	40.00 G			1409 01-06-1975
430 -T-037337-00				NW	3	07S	23E	CA	W					1051 11-05-1981
430 -C-003658-00				NENW	3	07S	23E	CA	W	50	15.00 G			1054 09-17-1974
430 -C-012758-00				SWSW	3	07S	23E	CA	W	40	10.00 G			1305 05-11-1977
430 -C-018945-00					4	07S	23E	CA	W	26	2.00 G	1.50		1310 06-05-1978
430 -C-005157-00				E2SW	5	07S	23E	CA	W	33	40.00 G			1313 04-02-1975
430 -C-023961-00				SENE	5	07S	23E	CA	W	65	30.00 G	1.50		1121 08-08-1979

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DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
WATER RIGHT SYSTEM
WATER RIGHT LAND DESCRIPTION LISTING

WATER RIGHT NUMBER	LOT	BLK	SUBD	POINT OF DIVERSION QTR SCTN	SCTN	TWP	RGE	CNTY	W D	DPTH	RATE	VOLUME	ACRES	PRIORITY DATE
43D -C-031135-00	5	1	10LAM	NWNE	12	08S	19E	CA	W	47	6.00 G	1.50		0843 01-08-198
43D -C-003773-00				NxNW	12	08S	19E	CA	W	102	15.00 G			1505 11-12-197
43D -C-034366-00	3		10LAM	NWNWNE	12	08S	19E	CA	W	46	20.00 G	1.50		0833 07-14-198
43D -C-028232-00				SWSW	30	08S	19E	CA	W	44	40.00 G	1.50		1155 07-21-198
43D -C-024980-00				NWSWSW	34	08S	19E	CA	W	59	15.00 G	1.50		1325 10-29-197
43D -C-040414-00				SESENW	34	08S	19E	CA	W	60	12.00 G	1.50		1141 01-04-198
43D -C-015436-00	2				35	08S	19E	CA	W	40	50.00 G	1.50		1125 10-05-197
43D -C-015588-00	5		10SPC	SE	35	08S	19E	CA	W	30	25.00 G	1.50		1349 10-11-197
43D -C-001860-00				NENE	36	08S	19E	CA	W	27	10.00 G			1400 03-25-197
43D -C-027901-00	57		10FOR	NENE	36	08S	19E	CA	W	38	30.00 G	1.50		1307 06-27-198
43D -C-040421-00				NENE	36	08S	19E	CA	W		25.00 G	1.50		1119 12-21-198
43D -C-042242-00				NENE	36	08S	19E	CA	W		20.00 G	1.50		1554 03-01-198
43D -C-041097-00				NWSWNE	36	08S	19E	CA	W		4.00 G	.25		1115 01-11-198
43D -B-045140-00				SENENE	36	08S	19E	CA	W					1034 05-13-198
43D -C-006937-00				SENENE	36	08S	19E	CA	W	25	12.00 G			1520 11-07-197
43D -W-013893-00					1	08S	20E	CA	D		15.00 G	2.00	.25	0000 04-25-193
43D -W-010331-00				NWNW	1	08S	20E	CA	D		3.00 G	3.00	1.00	0000 07-01-193
43D -W-013899-00				SWSENW	1	08S	20E	CA	D		3.00 G	50,000.00		1900 08-15-195
43D -W-004932-00				SWSENE	2	08S	20E	CA	D		10.00 G	1.50	.23	0000 01-31-196
43D -W-033066-00				NWNWSW	3	08S	20E	CA	W		25.00 G	2.00	1.00	0001 07-01-194
43D -C-012004-00	37	1	10TIP		4	08S	20E	CA	W	125	10.00 G			1110 03-31-197
43D -C-022114-00	43	1	10TIP		4	08S	20E	CA	W	120	20.00 G	1.50		1157 03-16-197
43D -C-006959-00				N2	4	08S	20E	CA	W	125	8.00 G			1403 11-25-197
43D -C-033155-00				NENE	4	08S	20E	CA	W		30.00 G	1.53		1142 04-22-1981
43D -C-031151-00	6	2	10TIP	NENW	4	08S	20E	CA	W	96	25.00 G	1.50		0857 01-12-1981
43D -C-031279-00	15	1	10TIP	NENW	4	08S	20E	CA	W	100	25.00 G	1.50		0926 01-19-1981
43D -C-023656-00				SWNE	4	08S	20E	CA	W	48	90.00 G	14.28	6.00	1045 07-17-1979
43D -C-029630-00	11	1	10TIP	NWNENW	4	08S	20E	CA	W	79	20.00 G	.38		1115 04-23-1980
43D -C-031123-00	36	1	10TIP	NWSWNW	4	08S	20E	CA	W	96	10.00 G	1.50		0814 01-07-1981
43D -C-040857-00	31	1	10TIP	SENWNW	4	08S	20E	CA	W	110	20.00 G	1.50		1015 01-12-198
43D -C-019979-00				SWSWNE	4	08S	20E	CA	W	30	10.00 G	1.50		1255 08-21-197
43D -C-017709-00				NWSW	5	08S	20E	CA	W	30	30.00 G	1.50		1153 02-14-197
43D -C-003301-00				NESWNW	5	08S	20E	CA	W	150	10.00 G			1524 08-12-1974
43D -C-016405-00				NWNWSW	5	08S	20E	CA	W	90	18.00 G			1305 11-15-1976
43D -C-009334-00				SENWSW	5	08S	20E	CA	W	90	12.00 G			1330 06-30-1976
43D -C-028148-00			10	SENWSW	5	08S	20E	CA	W	29	25.00 G	1.50		1230 07-15-1980
43D -C-028259-00				NWNW	6	08S	20E	CA	D		5.00 G	1.50		1155 03-05-1980
43D -C-006557-00				SWSW	6	08S	20E	CA	W	162	20.00 G			1355 09-29-1975
43D -C-013106-00					9	08S	20E	CA	W	45	17.00 G			1325 05-27-1977
43D -C-032867-00	A3		10RLE		9	08S	20E	CA	W	38	30.00 G	1.50		1146 04-30-1981
43D -C-045841-00					9	08S	20E	CA	W		5.00 G	1.50		1629 04-19-1982
43D -C-000771-00				NWSW	9	08S	20E	CA	W	120	12.00 G			1016 10-23-1973
43D -C-028052-00				NWSW	9	08S	20E	CA	W	145	6.00 G	.38		1300 07-07-1980
43D -H-004118-00				NWSW	9	08S	20E	CA	W	29	.10 C			1537 11-04-1974
43D -W-010230-00	K-4			NWSW	9	08S	20E	CA	W		30.00 G	4.00		0000 00-00-0000
43D -C-041638-00	E-5		10WAP	N2NW	9	08S	20E	CA	W		5.00 G	1.50		1145 02-04-1982
43D -C-037029-00				NESWNW	9	08S	20E	CA	W		25.00 G	1.50		1002 10-22-1981
43D -W-006521-00				NESWNW	9	08S	20E	CA	W			2.00	1.00	0000 08-15-1963
43D -C-025429-00	12		10RLE	NWNWSW	9	08S	20E	CA	W		5.00 G	1.50		1114 11-27-1979
43D -W-005441-00				NWSENW	9	08S	20E	CA	W		35.00 G	3.00		0000 08-12-1970
43D -C-046703-00				SENWNW	9	08S	20E	CA	W	58	30.00 G	6.00		1150 04-30-1962

DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
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WATER RIGHT NUMBER	LOT	BLK	SUBD	POINT OF DIVERSION QTR SCTN	SCTN	TWP	RGE	CNTY	W D	DPTH	RATE	VOLUME	ACRES	PRIORITY DATE
430 -W-010248-00	OOD			SESWNW	9	08S	20E	CA	W		20.00 G	5.00	1.00	0000 05-17-1967
430 -W-007285-00	K-6			SWNENW	9	08S	20E	CA	W		30.00 G	3.00	.50	0000 10-26-1970
430 -C-018204-00				SWSENW	9	08S	20E	CA	W	77	20.00 G	1.50		1154 04-06-1976
430 -C-044926-00				SWSENW	9	08S	20E	CA	W		15.00 G	1.50		1425 04-15-1982
430 -C-021768-00	15	4	10RLE	SWSWNW	9	08S	20E	CA	W	48	4.00 G	1.50		1315 02-07-1979
430 -C-032919-00	E1		10WAP	SWSWNW	9	08S	20E	CA	W	37	30.00 G	.88		1119 05-05-1981
430 -W-031285-00				NENWSE	13	08S	20E	CA	D		5.00 G	1.00		0001 12-31-1900
430 -W-031284-00				NENWSW	13	08S	20E	CA	D		5.00 G	1.00		0001 12-31-1900
430 -W-031293-00				NENENW	14	08S	20E	CA	D		5.00 G	1.00		0001 12-31-1910
430 -W-031290-00				NENWNE	14	08S	20E	CA	D		5.00 G	1.00		0001 12-31-1910
430 -W-031283-00				NESWSW	14	08S	20E	CA	D		5.00 G	1.00		0001 12-31-1910
430 -W-031289-00				SWNESW	14	08S	20E	CA	D		5.00 G	1.00		0001 12-31-1910
430 -W-031268-00				NENESW	16	08S	20E	CA	D		5.00 G	1.00		0001 12-31-1910
430 -W-031246-00				NWSWNW	16	08S	20E	CA	W		50.00 G	10.00		0001 05-01-1964
430 -W-031286-00				SWNESE	16	08S	20E	CA	D		5.00 G	1.00		0001 12-31-1910
430 -C-014065-00	9		10WAD		17	08S	20E	CA	W		25.00 G	1.50		1335 08-12-1977
430 -B-022272-00				NESW	17	08S	20E	CA	W		25.00 G			1102 04-05-1979
430 -C-029642-00				NESW	17	08S	20E	CA	W	27	12.00 G	1.50		1415 09-18-1980
430 -W-102829-00				NESW	17	08S	20E	CA	W		15.00 G	2.40	.50	0000 12-01-1949
430 -C-009095-00				NWNE	17	08S	20E	CA	W	33	30.00 G			1335 08-04-1976
430 -C-019738-00	13	1	10POI	NWNE	17	08S	20E	CA	W		10.00 G	1.50		1056 08-02-1978
430 -C-019739-00				NWNE	17	08S	20E	CA	W		10.00 G	1.50		1057 08-02-1978
430 -C-033602-00				NWSE	17	08S	20E	CA	W	120	10.00 G	.63		0915 08-19-1980
430 -C-020131-00				SESW	17	08S	20E	CA	W		10.00 G	1.50		1450 09-01-1978
430 -H-032989-00				SESW	17	08S	20E	CA	W					1415 06-20-1980
430 -C-006919-00				SWNE	17	08S	20E	CA	W	35	10.00 G			1315 11-20-1975
430 -C-035321-00	9	2	10PO2	SWNE	17	08S	20E	CA	W		50.00 G	1.50		0956 08-18-1981
430 -C-045625-00	11	2	10PO2	SWNE	17	08S	20E	CA	W		15.00 G	1.00		0940 04-27-1982
430 -C-001842-00				NESWNE	17	08S	20E	CA	W	26	10.00 G			1210 03-21-1974
430 -C-022201-00	10	2	10POI	NESWNE	17	08S	20E	CA	W	34	30.00 G	1.50		1140 03-28-1979
430 -C-017955-00				SWSENE	17	08S	20E	CA	W	61	40.00 G	1.50		1111 03-16-1978
430 -C-035736-00			10PIN		19	08S	20E	CA	W		99.00 G	6.00		1030 09-02-1981
430 -W-010212-00				NESE	19	08S	20E	CA	W		16.67 G	40.00		0000 07-01-19[illegible]
430 -C-006336-00				NW	20	08S	20E	CA	W	58	10.00 G			1140 08-28-19[illegible]
430 -C-000922-00				E2NW	20	08S	20E	CA	W	80	12.00 G			1216 11-05-19[illegible]
430 -C-036517-00	1		10SAG	NENW	20	08S	20E	CA	W		8.00 G	1.50		1348 10-13-1981
430 -W-010213-00				NENW	20	08S	20E	CA	W		20.00 G	1.00		0000 06-15-1956
430 -C-023636-00				NWNW	20	08S	20E	CA	W	34	15.00 G	1.50		1342 07-16-1979
430 -C-019962-00	2			SWSW	20	08S	20E	CA	W	40	15.00 G	1.50		1145 08-18-1978
430 -C-045093-00					30	08S	20E	CA	W		5.00 G	.50		1600 04-15-1982
430 -C-046903-00					30	08S	20E	CA	W		5.00 G	1.38	.13	1445 04-30-1982
430 -C-037277-00				SW	30	08S	20E	CA	W		35.00 G	1.50		1130 10-23-1981
430 -C-040423-00				SW	30	08S	20E	CA	W	18	5.00 G	1.50		1045 12-28-1981
430 -C-043006-00	4			SW	30	08S	20E	CA	W		25.00 G	.50		1430 02-02-1982
430 -C-043007-00				SW	30	08S	20E	CA	W		2.50 G	1.50		0924 03-18-1982
430 -C-033428-00				NESW	30	08S	20E	CA	W		8.00 G	3.00		1155 04-30-1981
430 -C-035642-00				NESW	30	08S	20E	CA	W		5.00 G	3.00		1355 08-24-1981
430 -C-041107-00				NESW	30	08S	20E	CA	W		15.00 G	1.50		1609 02-02-1982
430 -B-041764-00				SWSW	30	08S	20E	CA	W					0826 02-26-1982
430 -C-011750-00				SWSW	30	08S	20E	CA	W	32	10.00 G			1355 03-17-1977
430 -C-038305-00				SWSW	30	08S	20E	CA	W		3.00 G	1.50		1027 11-13-1981

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DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
WATER RIGHT SYSTEM
WATER RIGHT LAND DESCRIPTION LISTING

WATER RIGHT NUMBER	LOT	BLK	SUBD	POINT OF DIVERSION QTR SCTN	SCTN	TWP	RGE	CNTY	WD	DPTH	RATE	VOLUME	ACRES	PRIORITY DATE
43D -C-040431-00				SWSW	30	08S	20E	CA	W		20.00 G	1.50		1342 01-04-1982
43D -C-040694-00				SENESW	30	08S	20E	CA	W		5.00 G	1.00		1016 01-12-1982
43D -C-040567-00				SWNESW	30	08S	20E	CA	W		14.00 G	1.00		1020 12-21-1981
43D -C-045072-00				SWSESW	30	08S	20E	CA	W		30.00 G	4.00		0930 04-07-1982
43D -C-010052-00				SWSWSW	30	08S	20E	CA	W	25	10.00 G			1325 11-04-1976
43D -C-034923-00				SWSWSW	30	08S	20E	CA	W		18.00 G	.50		1126 07-29-1981
43D -C-035685-00				SWSWSW	30	08S	20E	CA	W	40	5.00 G	.88		0922 09-04-1981
43D -C-030249-00				NWNW	31	08S	20E	CA	W	25	15.00 G	1.50		1321 11-07-1980
43D -C-026538-00				NENESW	36	08S	20E	CA	W	40	15.00 G	1.50		1124 02-13-1980
43D -W-031245-00				NESWNE	3	08S	21E	CA	W		30.00 G	1.00	5.00	0001 01-01-1948
43D -W-031270-00				SESESE	12	08S	21E	CA	W		7.00 G	7.00		0001 05-01-1945
43D -W-031279-00				SENENW	19	08S	21E	CA	D		3.00 G	1.00		0001 05-01-1950
43D -W-031276-00				SWNESE	20	08S	21E	CA	D		3.00 G	1.00		0001 05-01-1950
43D -W-031281-00				NENWNE	21	08S	21E	CA	D		3.00 G	1.00		0001 01-01-1950
43D -W-031277-00				SENENW	27	08S	21E	CA	D		3.00 G	1.00		0001 05-01-1945
43D -W-031280-00				SWSWSE	26	08S	21E	CA	D		8.00 G	8.00		0001 05-01-1950
43D -W-031273-00				SWSESW	35	08S	21E	CA	W		7.00 G	7.00		0001 01-01-1950
43D -C-025771-00	6			SWNW	2	08S	22E	CA	W	31	25.00 G	.30		1116 03-12-1980
43D -C-015157-00				SESESE	2	08S	22E	CA	W	55	60.00 G	3.00		1315 09-12-1977
43D -W-024124-00				SESENE	4	08S	22E	CA	D		5.00 G	5.88		0000 11-26-1920
43D -W-031278-00				SESENW	7	08S	22E	CA	W		10.00 G	1.50		0001 01-01-1946
43D -T-013665-00				SENWSE	11	08S	22E	CA	W					1115 06-22-1977
43D -W-004470-00	11	17			15	08S	22E	CA	W		15.00 G	2.00		0000 06-01-1937
43D -C-002800-00				NENE	15	08S	22E	CA	W	55	20.00 G	1.50		1138 05-23-1974
43D -C-003241-00				NENE	15	08S	22E	CA	W	81	15.00 G			1129 08-06-1974
43D -P-005681-00				NENE	15	08S	22E	CA	W	124	.22 C	150.00		1358 06-11-1975
43D -T-017220-00				NENE	15	08S	22E	CA	W		20.00 G			0000 00-00-0000
43D -W-020221-00				SENWNW	16	08S	22E	CA	D		2.50 C	600.03	180.00	0000 07-10-1903
43D -C-041099-00				NWSENE	27	08S	22E	CA	W		35.00 G	1.50		1520 02-04-1982
43D -W-031282-00				NWSENE	29	08S	22E	CA	D		10.00 G	10.00		0001 07-01-1945
43D -W-031275-00				NWSESW	31	08S	22E	CA	W		10.00 G	10.00		0001 05-01-1945
43D -W-011037-00				SESENE	36	08S	22E	CA	D		5.00 G	1.11		0000 06-15-1936
43D -W-020219-00				NESWSW	9	08S	23E	CA	D		5.00 G	6.00		0000 08-20-1919
43D -W-020220-00				NWNWNW	31	08S	23E	CA	D		10.00 G	6.00		0000 03-04-1920
43D -W-011012-00				NENWNE	36	08S	24E	CA	D		2.00 G	1.21		0000 01-01-1969
43N -W-122477-00				NESWNE	6	08S	25E	CA	D		1.122.00 G	8.00		0001 07-31-1930
43N -W-122491-00				NESWNE	6	08S	25E	CA	D		1.122.00 G	208.00	90.00	0000 09-16-189?
43N -W-122495-00				NESWNE	6	08S	25E	CA	D		1.122.00 G	1.50	.50	0000 09-16-189
43N -P-011772-00				SWSWSE	6	08S	25E	CA	W		4.020.00 G	3.115.00	1.067.00	1442 03-11-197.
43N -C-016875-00				SESESE	24	08S	25E	CA	W		20.00 G	1.50		1152 01-09-1978
43P -W-044644-00				NWNE	7	08S	29E	CA	D		30.00 G	10.50		1300 01-15-1962
43P -W-044643-00				SESESE	7	08S	29E	CA	D		500.00 C	10.50		0000 11-30-1960
43D -W-108344-00				SWNENE	15	09S	21E	CA	D		2.00 G	1.70		0000 00-00-1916
43D -W-112101-00				SWNESW	16	09S	21E	CA	D		5.00 G	2.52		0000 06-01-1968
43D -W-108347-00				NWNESE	17	09S	21E	CA	D		2.00 G	1.00		0000 00-00-1916
43D -W-108348-00				NWSWSW	21	09S	21E	CA	D		3.00 G	2.10		0000 07-02-1864
43D -W-108324-00				SESESE	27	09S	21E	CA	D		15.00 G	1.50		0000 00-00-1916
43D -C-009270-00					8	09S	22E	CA	W	42	8.00 G			1345 08-23-1976
43D -W-125691-00				NESW	8	09S	22E	CA	D		15.00 G	14.30		0000 00-00-1900
43D -W-002299-00				S2NE	6	09S	22E	CA	D		10.00 G	7.00		0000 02-00-1897
43D -H-021691-00				NWSESE	9	09S	22E	CA	W		10.00 G			1336 01-30-1979

6.2.8 Replies of the Five Drilling Companies Answering the KM&E Well Survey

RUSSELL DRILLING CO., INC.

Roger Russell
President

• CORE DRILLING • MINERAL EXPLORATION • SHALLOW OIL & GAS WELLS
• DEEP WATER WELLS

October 21, 1982

Mr. Jim Bowlby
Kiewit Mining & Engineering Co.
P. O. Box 3049
Sheridan, Wyoming 82801

Dear Mr. Bowlby:

We have not drilled any water wells in the area you indicated on the map enclosed with your recent letter. I am sorry I could not be of any assistance to you at this time.

If I can be of any help to you or your company on any of their future drilling projects, please feel free to contact me.

I am enclosing a recent company brochure for your information.

Sincerely,

Roger Russell

Roger Russell
President

RR:ljh
Enclosure

OCT 1982
RECEIVED
SHERIDAN MINING OFFICE

701-324-2714 (24 HR. NO.)
BOX 184
HARVEY, ND. 58341

406-248-1001
524 N. 32nd
BILLINGS, MT 59101

Kiewit Mining & Engineering Co.
P.O. Box 3049
Sheridan, Wyoming 82801
(307) 672-3401

October 18, 1982

Kal-Well Service
209 6th Avenue
Laurel, MT 59044

Gentlemen:

My name is Jim Bowlby and I am a hydrologist working on a project for the State of Montana's Department of State Lands. Montana has obtained federal money to develop an engineering reclamation plan to reclaim old abandoned surface and underground coal mines in the Red Lodge/Bearcreek, Montana, area.

My portion of the project includes an inventory of existing water wells in the area, defining the completion zone of these wells and water quality sampling of wells impacted by post mining. I am soliciting your help in an attempt to inventory existing wells in the area.

Without causing undue work for you or your Company, would it be possible to plot any wells on the enclosed map which your Company has drilled and please indicate if a well log is available? I realize that this might be a difficult task but your help in this matter could help to protect existing well owners and result in reclaiming this eyesore.

I have enclosed a self-addressed, stamped envelope to help you accomplish my request since the State has requested we complete our inventory in early November. Any help you might provide would sincerely be appreciated.

Sincerely,

KIEWIT MINING & ENGINEERING CO.

Jim Bowlby
Jim Bowlby
Hydrologist

JB:cyr
Enclosures

Dear Sir:
I have no wells in this area. Sorry I can not be of any help.

Ken Bever
owner

Kiewit Mining & Engineering Co.

P.O. Box 3049
Sheridan, Wyoming 82801
(307) 672-3401

October 18, 1982

Digger Drilling
3143 Prairie Drive
Billings, MT 59101

Gentlemen:

My name is Jim Bowlby and I am a hydrologist working on a project for the State of Montana's Department of State Lands. Montana has obtained federal money to develop an engineering reclamation plan to reclaim old abandoned surface and underground coal mines in the Red Lodge/Bearcreek, Montana, area.

My portion of the project includes an inventory of existing water wells in the area, defining the completion zone of these wells and water quality sampling of wells impacted by post mining. I am soliciting your help in an attempt to inventory existing wells in the area.

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Sincerely,

KIEWIT MINING & ENGINEERING CO.

Jim Bowlby

Jim Bowlby
Hydrologist

JB:cyr
Enclosures

Jim - I haven't ever drilled any wells in the Bearcreek area
Ted Bene

OCT 1982
RECEIVED
SHERIDAN MINING OFFICE

FROM

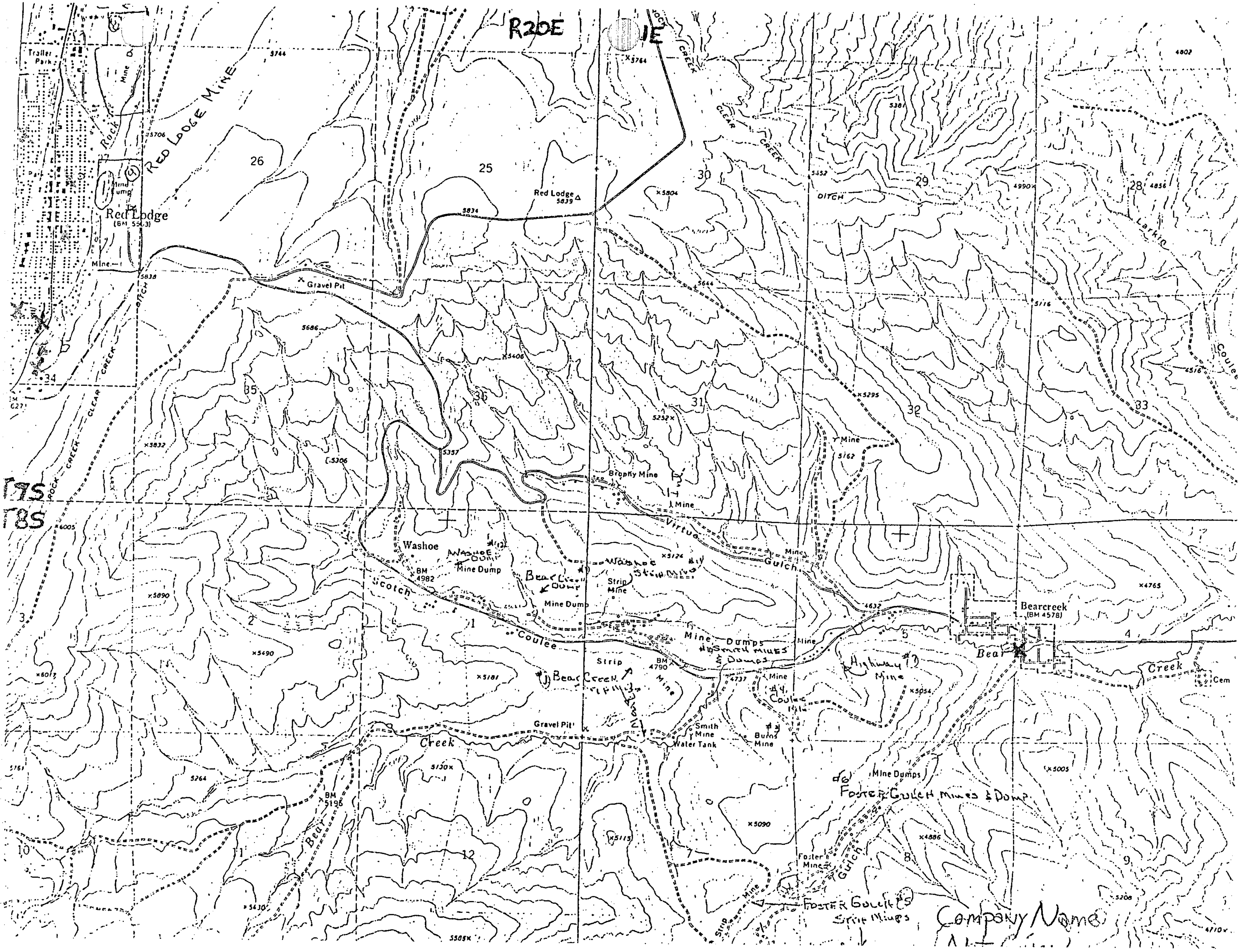
Memo SUNRISE DRILLING INC.

10/22/82

Dear Mr. Bowlby:

Our company has not drilled any water wells in the area you are seeking records on.

F. L. Waelick
Sunrise Drilling
Hysham, Mt. 59038


R20E
T7S
T8S
Red Lodge
(BM 5563)
Red Lodge Mine
Trailer Park
Rock Creek
Clear Creek
Gravel Pit
Red Lodge 5839
Washoe
Mine Dump
BM 4982
Scotch Coulee
Brophy Mine
Virtue Gulch
Strip Mine
Mine Dumps
Bearcreek
(BM 4578)
Bear Creek
Smith Mine
Water Tank
Burns Mine
Highway Mine
Mine Dumps
Foster Gulch Mines & Dump
Foster Mine
Foster Gulch Strip Mines
Gravel Pit
Cem
Larkin
Coulee
Ditch
Company Name

6.2.9 Analytical Lab Results for all Sampling Sites

- Raw Data -

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 11/3/82

Sample Identification Site #1 [illegible]
Sampling Time 10:20 AM
Location Rock Creek
Sampling Date 10/19/82
Analysis Date 10/20/82

****

Acidity	0.0 PPM	pH (Lab)	6.95
Alkalinity (as $CaCO_3$)	24.5 PPM	SAR	0.2
Ammonium (as N)	PPM	Specific Conductance	42.5 µmhos
Boron	PPM	Total Dissolved Solids	PPM
Oil and Grease	1.0 PPM	Total Suspended Solids	1.6 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	0.38

****

CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	0.39	7.82	Bicarbonate	0.49	29.9
Magnesium	0.17	2.07	Carbonate	0.0	0.0
Potassium	0.04	1.68	Chloride	0.11	4.00
Sodium	0.10	2.30	Flouride	<0.01	0.09
Total	0.70		Nitrate	0.01	0.79
			Sulfate	0.12	5.59
			Total	0.73	

****

mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum	0.3	<0.1	Manganese	<0.02	<0.02
Arsenic			Mercury	<0.001	<0.001
Barium			Molybdenum		
Cadmium	0.002	<0.002	Nickel		
Chromium	<0.02	<0.02	Selenium	<0.002	<0.002
Copper	0.03	<0.01	Vanadium	0.1	<0.1
Iron	0.91	0.12	Zinc	0.07	<0.02
Lead	0.07	<0.05			

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bawlb

Date 11/3/82

Sample Identification Site #2
Sampling Time 5:30 PM
Location Rock Creek
Sampling Date 10/18/82
Analysis Date 10/20/82

****

Acidity	0.0 PPM	pH (Lab)	7.02
Alkalinity (as $CaCO_3$)	30.0 PPM	SAR	0.2
Ammonium (as N)	PPM	Specific Conductance	44.9 µmhos
Boron	PPM	Total Dissolved Solids	PPM
Oil and Grease	<1.0 PPM	Total Suspended Solids	2.8 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	0.57

****

CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	0.44	8.82	Bicarbonate	0.60	36.6
Magnesium	0.21	2.55	Carbonate	0.0	0.0
Potassium	0.04	1.63	Chloride	0.06	2.00
Sodium	0.10	2.30	Flouride	<0.01	0.07
Total	0.79		Nitrate	0.02	0.93
			Sulfate	0.11	5.36
			Total	0.79	

****

mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum	0.4	<0.1	Manganese	0.04	0.02
Arsenic			Mercury	<0.001	<0.001
Barium			Molybdenum		
Cadmium	<0.002	<0.002	Nickel		
Chromium	<0.02	<0.02	Selenium	<0.002	<0.002
Copper	<0.01	<0.01	Vanadium	<0.1	<0.1
Iron	0.73	0.19	Zinc	0.03	<0.02
Lead	0.07	0.06			

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 11/3/82

Sample Identification Site #3
Sampling Time 3:44 PM
Location Rock Creek
Sampling Date 10/18/82
Analysis Date 10/20/82

****

Acidity 0.0 PPM

Alkalinity (as $CaCO_3$) 33.0 PPM

Ammonium (as N) PPM

Boron PPM

Oil and Grease 1.6 PPM

Ortho-Phosphate <0.01 PPM

pH (Lab) 7.21

SAR 0.2

Specific Conductance 49.8 µmhos

Total Dissolved Solids PPM

Total Suspended Solids 2.0 PPM

Turbidity (NTU) 0.82

****

CATIONS	meq/l	mg/l
Calcium	0.48	9.62
Magnesium	0.29	3.53
Potassium	0.04	1.64
Sodium	0.11	2.53
Total	0.92	

ANIONS	meq/l	mg/l
Bicarbonate	0.66	40.3
Carbonate	0.0	0.0
Chloride	0.11	4.00
Flouride	<0.01	0.08
Nitrate	0.02	1.04
Sulfate	0.12	5.93
Total	0.91	

****

mg/l	Total	Dissolved
Aluminum	0.4	0.2
Arsenic		
Barium		
Cadmium	<0.002	<0.002
Chromium	0.04	<0.02
Copper	0.01	<0.01
Iron	0.46	0.16
Lead	0.10	0.07

mg/l	Total	Dissolved
Manganese	0.06	<0.02
Mercury	<0.001	<0.001
Molybdenum		
Nickel		
Selenium	<0.002	<0.002
Vanadium	<0.1	<0.1
Zinc	0.02	<0.02

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 11/3/82

Sample Identification Site #4
Sampling Time
Location Scotch Coulee
Sampling Date 10/19/82
Analysis Date 10/21/82

****

Acidity	0.0	PPM
Alkalinity (as $CaCO_3$)	324	PPM
Ammonium (as N)		PPM
Boron		PPM
Oil and Grease	<1.0	PPM
Ortho-Phosphate	<0.01	PPM

pH (Lab)	7.89	
SAR	2.7	
Specific Conductance	680	µmhos
Total Dissolved Solids		PPM
Total Suspended Solids	4.4	PPM
Turbidity (NTU)	2.7	

****

CATIONS	meq/1	mg/1
Calcium	2.93	58.8
Magnesium	2.20	26.8
Potassium	0.12	4.85
Sodium	4.30	98.9
Total	9.55	

ANIONS	meq/1	mg/1
Bicarbonate	6.48	395
Carbonate	0.0	0.0
Chloride	0.20	7.00
Flouride	0.01	0.27
Nitrate	0.01	0.89
Sulfate	2.91	140
Total	9.61	

****

mg/1	Total	Dissolved
Aluminum	0.4	0.2
Arsenic		
Barium		
Cadmium	<0.002	<0.002
Chromium	<0.02	<0.02
Copper	0.01	0.01
Iron	0.97	0.17
Lead	0.11	0.09

mg/1	Total	Dissolved
Manganese	0.05	0.04
Mercury	<0.001	<0.001
Molybdenum		
Nickel		
Selenium	<0.002	<0.002
Vanadium	<0.1	<0.1
Zinc	0.05	<0.02

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 11/3/82

Sample Identification Site #5
Sampling Time
Location Bear Creek
Sampling Date 10/19/82
Analysis Date 10/21/82

****

Acidity 0.0 PPM
Alkalinity (as $CaCO_3$) 166 PPM
Ammonium (as N) PPM
Boron PPM
Oil and Grease <1.0 PPM
Ortho-Phosphate <0.01 PPM

pH (Lab) 7.78
SAR 1.0
Specific Conductance 285 µmhos
Total Dissolved Solids PPM
Total Suspended Solids 6.0 PPM
Turbidity (NTU) 6.5

****

CATIONS	meq/1	mg/1
Calcium	1.72	34.5
Magnesium	1.02	12.4
Potassium	0.11	4.32
Sodium	1.20	27.6
Total	4.05	

ANIONS	meq/1	mg/1
Bicarbonate	3.32	203
Carbonate	0.0	0.0
Chloride	0.11	4.00
Flouride	0.01	0.18
Nitrate	0.02	1.13
Sulfate	0.60	28.8
Total	4.06	

****

mg/1	Total	Dissolved
Aluminum	0.6	<0.1
Arsenic		
Barium		
Cadmium	<0.002	<0.002
Chromium	<0.02	<0.02
Copper	0.01	<0.01
Iron	1.59	0.46
Lead	<0.05	<0.05

mg/1	Total	Dissolved
Manganese	<0.02	<0.02
Mercury	<0.001	<0.001
Molybdenum		
Nickel		
Selenium	0.003	0.002
Vanadium	<0.1	<0.1
Zinc	0.03	<0.02

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 11/3/82

Sample Identification Site #6
Sampling Time
Location Bear Creek
Sampling Date 10/19/82
Analysis Date 10/21/82

****

Acidity 0.0 PPM
Alkalinity (as $CaCO_3$) 292 PPM
Ammonium (as N) PPM
Boron PPM
Oil and Grease <1.0 PPM
Ortho-Phosphate <0.01 PPM

pH (Lab) 8.20
SAR 3.3
Specific Conductance 705 µmhos
Total Dissolved Solids PPM
Total Suspended Solids 4.0 PPM
Turbidity (NTU) 5.4

****

CATIONS	meq/l	mg/l
Calcium	2.59	51.9
Magnesium	2.44	29.7
Potassium	0.14	5.73
Sodium	5.20	120
Total	10.37	

ANIONS	meq/l	mg/l
Bicarbonate	5.84	356
Carbonate	0.0	0.0
Chloride	0.17	6.00
Flouride	0.01	0.24
Nitrate	0.02	0.93
Sulfate	4.47	215
Total	10.51	

****

mg/l	Total	Dissolved
Aluminum	0.5	0.2
Arsenic		
Barium		
Cadmium	<0.002	<0.002
Chromium	<0.02	<0.02
Copper	0.03	<0.01
Iron	0.96	0.63
Lead	0.05	<0.05

mg/l	Total	Dissolved
Manganese	0.03	<0.02
Mercury	<0.001	<0.001
Molybdenum		
Nickel		
Selenium	0.003	<0.002
Vanadium	<0.1	<0.1
Zinc	0.03	<0.02

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 11/3/82

Sample Identification Site #9
Sampling Time
Location Virtue Gulch
Sampling Date 10/20/82
Analysis Date 10/21/82

Acidity	0.0 PPM	pH (Lab)	8.00
Alkalinity (as $CaCO_3$)	332 PPM	SAR	1.7
Ammonium (as N)	PPM	Specific Conductance	620 µmhos
Boron	PPM	Total Dissolved Solids	PPM
Oil and Grease	<1.0 PPM	Total Suspended Solids	4.8 PPM
Ortho-Phosphate	0.01 PPM	Turbidity (NTU)	24.0

CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	3.36	67.4	Bicarbonate	6.64	405
Magnesium	2.65	32.2	Carbonate	0.0	0.0
Potassium	0.15	5.92	Chloride	0.14	5.00
Sodium	3.06	69.6	Flouride	0.03	0.53
Total	9.16		Nitrate	0.02	1.47
			Sulfate	2.36	113
			Total	9.19	

---

mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum	0.6	<0.1	Manganese	<0.02	<0.02
Arsenic			Mercury	<0.001	<0.001
Barium			Molybdenum		
Cadmium	<0.002	<0.002	Nickel		
Chromium	<0.02	<0.02	Selenium	0.003	0.003
Copper	0.02	<0.01	Vanadium	<0.1	<0.1
Iron	4.37	0.13	Zinc	0.03	<0.02
Lead	<0.05	<0.05			

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis

To Jim Rowlby

Date 11/3/82

Sample Identification Site #10
Sampling Time
Location Victus Gulch
Sampling Date 10/19/82
Analysis Date 10/21/82

***

Acidity	0.0 PPM	pH (Lab)	8.07
Alkalinity (as $CaCO_3$)	338 PPM	SAR	1.7
Ammonium (as N)	PPM	Specific Conductance	1,070 µmhos
Boron	PPM	Total Dissolved Solids	PPM
Oil and Grease	<1.0 PPM	Total Suspended Solids	6.0 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	5.5

***

CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	5.55	111	Bicarbonate	6.76	412
Magnesium	5.74	69.8	Carbonate	0.0	0.0
Potassium	0.21	8.26	Chloride	0.14	5.00
Sodium	4.10	94.3	Flouride	0.03	0.49
Total	15.60		Nitrate	0.02	1.26
			Sulfate	8.70	417
			Total	15.65	

***

mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum	0.4	0.2	Manganese	0.02	<0.02
Arsenic			Mercury	0.004	0.003
Barium			Molybdenum		
Cadmium	<0.002	<0.002	Nickel		
Chromium	0.05	<0.02	Selenium	<0.002	<0.002
Copper	0.03	0.01	Vanadium	<0.1	<0.1
Iron	0.72	0.39	Zinc	0.06	<0.02
Lead	<0.05	<0.05			

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 12/13/82

Sample Identification Site #1
Sampling Time
Location Rock Creek
Sampling Date 11/9/82
Analysis Date 11/12/82

****

Acidity 0.0 PPM
Alkalinity (as $CaCO_3$) 38.0 PPM
Ammonium (as N) PPM
Boron PPM
Oil and Grease 1.0 PPM
Ortho-Phosphate <0.01 PPM

pH (Lab) 7.15
SAR 0.1
Specific Conductance 58.1 µmhos
Total Dissolved Solids 70.0 PPM
Total Suspended Solids 4.0 PPM
Turbidity (NTU) 0.65

****

CATIONS	meq/1	mg/1
Calcium	0.67	13.4
Magnesium	0.22	2.68
Potassium	0.03	1.10
Sodium	0.08	1.84
Total	1.00	

ANIONS	meq/1	mg/1
Bicarbonate	0.76	46.4
Carbonate	0.0	0.6
Chloride	0.04	1.50
Flouride	0.01	0.18
Nitrate	0.04	2.36
Sulfate	0.14	6.72
Total	0.99	

****

mg/1	Total	Dissolved
Aluminum	0.9	0.1
Arsenic		
Barium		
Cadmium	<0.002	<0.002
Chromium	<0.02	<0.02
Copper	<0.01	<0.01
Iron	0.57	0.07
Lead	<0.05	<0.05

mg/1	Total	Dissolved
Manganese	0.03	<0.02
Mercury	<0.001	<0.001
Molybdenum		
Nickel		
Selenium	0.002	<0.002
Vanadium	<0.1	<0.1
Zinc	0.09	<0.02
Silver	0.08	0.01

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 12/13/82

Sample Identification Site #2
Sampling Time
Location Rock Creek
Sampling Date 11/9/82
Analysis Date 11/12/82

****

Acidity 0.0 PPM
Alkalinity (as $CaCO_3$) 36.0 PPM
Ammonium (as N) PPM
Boron PPM
Oil and Grease 4.0 PPM
Ortho-Phosphate <0.01 PPM

pH (Lab) 7.27
SAR 0.2
Specific Conductance 54.1 µmhos
Total Dissolved Solids 66.0 PPM
Total Suspended Solids 2.8 PPM
Turbidity (NTU) 0.43

****

CATIONS	meq/l	mg/l
Calcium	0.54	10.8
Magnesium	0.21	2.55
Potassium	0.01	0.30
Sodium	0.10	2.30
Total	0.86	

ANIONS	meq/l	mg/l
Bicarbonate	0.72	43.9
Carbonate	0.0	0.0
Chloride	<0.01	<0.50
Flouride	0.01	0.11
Nitrate	0.04	2.59
Sulfate	0.12	5.59
Total	0.89	

****

mg/l	Total	Dissolved
Aluminum	1.0	<0.1
Arsenic		
Barium		
Cadmium	<0.002	<0.002
Chromium	<0.02	<0.02
Copper	<0.01	<0.01
Iron	0.52	0.10
Lead	0.10	0.06

mg/l	Total	Dissolved
Manganese	<0.02	<0.02
Mercury	<0.001	<0.001
Molybdenum		
Nickel		
Selenium	<0.002	<0.002
Vanadium	<0.1	<0.1
Zinc	0.07	<0.02
Silver	0.03	<0.01

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 12/13/82

Sample Identification Site #3
Sampling Time
Location Rock Creek
Sampling Date 11/9/82
Analysis Date 11/12/82

***

Acidity	0.0 PPM	pH (Lab)	7.42
Alkalinity (as $CaCO_3$)	40.0 PPM	SAR	0.2
Ammonium (as N)	PPM	Specific Conductance	63.4 µmhos
Boron	PPM	Total Dissolved Solids	82.0 PPM
Oil and Grease	<1.0 PPM	Total Suspended Solids	2.0 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	0.54

***

CATIONS	meq/1	mg/1	ANIONS	meq/1	mg/1
Calcium	0.77	15.4	Bicarbonate	0.80	48.8
Magnesium	0.24	2.92	Carbonate	0.0	0.0
Potassium	0.01	0.30	Chloride	0.06	2.00
Sodium	0.12	2.76	Flouride	0.01	0.15
Total	1.14		Nitrate	0.02	0.98
			Sulfate	0.26	12.3
			Total	1.15	

***

mg/1	Total	Dissolved	mg/1	Total	Dissolved
Aluminum	0.7	0.3	Manganese	<0.02	<0.02
Arsenic			Mercury	0.002	<0.001
Barium			Molybdenum		
Cadmium	<0.002	<0.002	Nickel		
Chromium	<0.02	<0.02	Selenium	<0.002	<0.002
Copper	<0.01	<0.01	Vanadium	<0.1	<0.1
Iron	0.70	0.07	Zinc	0.06	0.04
Lead	<0.05	<0.05	Silver	0.02	0.01

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 12/13/82

Sample Identification Site #4
Sampling Time
Location Scotch Coulee
Sampling Date 11/10/82
Analysis Date 11/12/82

****

Acidity	0.0	PPM	pH (Lab)	7.88
Alkalinity (as $CaCO_3$)	360	PPM	SAR	2.5
Ammonium (as N)		PPM	Specific Conductance	601 µmhos
Boron		PPM	Total Dissolved Solids	544 PPM
Oil and Grease	<1.0	PPM	Total Suspended Solids	3.6 PPM
Ortho-Phosphate	<0.01	PPM	Turbidity (NTU)	1.0

****

CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	2.72	54.5	Bicarbonate	7.20	439
Magnesium	2.57	31.3	Carbonate	0.0	0.0
Potassium	0.11	4.20	Chloride	0.17	6.00
Sodium	4.00	92.0	Flouride	0.03	0.57
Total	9.40		Nitrate	<0.01	<0.50
			Sulfate	2.28	109
			Total	9.68	

****

mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum	1.5	0.4	Manganese	<0.02	<0.02
Arsenic			Mercury	<0.001	<0.001
Barium			Molybdenum		
Cadmium	<0.002	<0.002	Nickel		
Chromium	<0.02	<0.02	Selenium	<0.002	<0.002
Copper	<0.01	<0.01	Vanadium	<0.1	<0.1
Iron	1.60	0.13	Zinc	0.02	<0.02
Lead	<0.05	<0.05			

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis

To: Jim Bowlby

Date: 12/13/82

Sample Identification: Site #5
Sampling Time:
Location: Bear Creek
Sampling Date: 11/10/82
Analysis Date: 11/12/82

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Acidity	0.0	PPM
Alkalinity (as $CaCO_3$)	164	PPM
Ammonium (as N)		PPM
Boron		PPM
Oil and Grease	<1.0	PPM
Ortho-Phosphate	<0.01	PPM
pH (Lab)	7.40	
SAR	1.0	
Specific Conductance	234	µmhos
Total Dissolved Solids	224	PPM
Total Suspended Solids	20.8	PPM
Turbidity (NTU)	3.4	

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CATIONS	meq/l	mg/l
Calcium	1.61	32.3
Magnesium	0.88	10.7
Potassium	0.08	3.20
Sodium	1.16	26.7
Total	3.73	

ANIONS	meq/l	mg/l
Bicarbonate	3.28	200
Carbonate	0.0	0.0
Chloride	0.07	2.50
Flouride	0.02	0.32
Nitrate	0.04	2.70
Sulfate	0.57	27.2
Total	3.98	

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mg/l	Total	Dissolved
Aluminum	0.7	<0.1
Arsenic		
Barium		
Cadmium	<0.002	<0.002
Chromium	<0.02	<0.02
Copper	0.03	0.01
Iron	0.74	0.10
Lead	<0.05	<0.05

mg/l	Total	Dissolved
Manganese	<0.02	<0.02
Mercury	0.002	<0.001
Molybdenum		
Nickel		
Selenium	<0.002	<0.002
Vanadium	<0.1	<0.1
Zinc	0.05	<0.02

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Sample Identification Site #6
Sampling Time
Location Bear Creek
Sampling Date 11/10/82
Analysis Date 11/12/82

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Acidity	0.0 PPM	pH (Lab)	8.14
Alkalinity (as $CaCO_3$)	298 PPM	SAR	3.4
Ammonium (as N)	PPM	Specific Conductance	611 µmhos
Boron	PPM	Total Dissolved Solids	544 PPM
Oil and Grease	1.6 PPM	Total Suspended Solids	3.6 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	2.4

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CATIONS	meq/1	mg/1	ANIONS	meq/1	mg/1
Calcium	2.29	45.9	Bicarbonate	5.96	364
Magnesium	2.19	26.6	Carbonate	0.0	0.0
Potassium	0.12	4.80	Chloride	0.10	3.50
Sodium	5.10	117	Flouride	0.02	0.41
Total	9.70		Nitrate	0.02	1.42
			Sulfate	3.78	181
			Total	9.88	

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mg/1	Total	Dissolved	mg/1	Total	Dissolved
Aluminum	2.5	0.8	Manganese	0.04	<0.02
Arsenic			Mercury	<0.001	0.001
Barium			Molybdenum		
Cadmium	<0.002	<0.002	Nickel		
Chromium	<0.02	<0.02	Selenium	<0.002	<0.002
Copper	<0.01	<0.01	Vanadium	<0.1	<0.1
Iron	1.40	0.18	Zinc	0.06	<0.02
Lead	<0.05	<0.05			

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Sample Identification Foster Gulch Upstr
Sampling Time
Location
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Acidity	0.0 PPM	pH (Lab)	8.06
Alkalinity (as $CaCO_3$)	1,740 PPM	SAR	31.2
Ammonium (as N)	PPM	Specific Conductance	2,960 µmhos
Boron	PPM	Total Dissolved Solids	3,360 PPM
Oil and Grease	<1.0 PPM	Total Suspended Solids	238 PPM
Ortho-Phosphate	0.04 PPM	Turbidity (NTU)	12

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CATIONS	meq/1	mg/1	ANIONS	meq/1	mg/1
Calcium	2.08	41.7	Bicarbonate	34.8	2,130
Magnesium	2.45	29.8	Carbonate	0.0	0.0
Potassium	0.34	13.4	Chloride	0.37	13.0
Sodium	47.0	1,080	Flouride	0.08	1.58
Total	51.87		Nitrate	0.03	2.03
			Sulfate	16.8	808
			Total	52.08	

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mg/1	Total	Dissolved	mg/1	Total	Dissolved
Aluminum	1.9	0.6	Manganese	0.05	0.07
Arsenic			Mercury	0.004	0.002
Barium			Molybdenum		
Cadmium	<0.002	0.002	Nickel		
Chromium	0.02	<0.02	Selenium	<0.002	<0.002
Copper	0.01	<0.01	Vanadium	<0.1	<0.1
Iron	1.80	0.65	Zinc	0.07	0.02
Lead	<0.05	<0.05			

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Sample Identification Foster Gulch Downst
Sampling Time
Location
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Acidity	0.0 PPM	pH (Lab)	7.95
Alkalinity (as $CaCO_3$)	1,620 PPM	SAR	15.0
Ammonium (as N)	PPM	Specific Conductance	4,980 µmhos
Boron	PPM	Total Dissolved Solids	5,960 PPM
Oil and Grease	<1.0 PPM	Total Suspended Solids	301 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	19

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CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	7.20	144	Bicarbonate	32.4	1,980
Magnesium	24.7	300	Carbonate	0.0	0.0
Potassium	0.47	18.9	Chloride	0.56	20.0
Sodium	60.0	1,380	Flouride	0.06	1.06
Total	92.37		Nitrate	0.10	6.07
			Sulfate	60.3	2,890
			Total	93.42	

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mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum	4.3	0.5	Manganese	<0.02	0.12
Arsenic			Mercury	0.001	<0.001
Barium			Molybdenum		
Cadmium	<0.002	<0.002	Nickel		
Chromium	0.07	<0.02	Selenium	<0.002	<0.002
Copper	0.02	<0.01	Vanadium	0.4	0.3
Iron	1.18	0.51	Zinc	0.06	<0.02
Lead	<0.05	<0.05			

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Sample Identification Site #9
Sampling Time
Location Virtue Gulch
Sampling Date 11/8/82
Analysis Date 11/12/82

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Acidity	0.0 PPM	pH (Lab)	7.96
Alkalinity (as $CaCO_3$)	330 PPM	SAR	2.0
Ammonium (as N)	PPM	Specific Conductance	517 µmhos
Boron	PPM	Total Dissolved Solids	430 PPM
Oil and Grease	<1.0 PPM	Total Suspended Solids	6.4 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	2.1

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CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	2.65	53.1	Bicarbonate	6.60	403
Magnesium	2.37	28.8	Carbonate	0.0	0.0
Potassium	0.11	4.50	Chloride	0.08	3.00
Sodium	3.20	73.6	Flouride	0.05	0.91
Total	8.33		Nitrate	0.04	2.59
			Sulfate	1.70	81.6
			Total	8.47	

****

mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum	0.6	<0.1	Manganese	<0.02	<0.02
Arsenic			Mercury	<0.001	<0.001
Barium			Molybdenum		
Cadmium	<0.002	<0.002	Nickel		
Chromium	<0.02	<0.02	Selenium	0.003	<0.002
Copper	0.04	<0.01	Vanadium	<0.1	<0.1
Iron	2.10	<0.05	Zinc	0.04	<0.02
Lead	<0.05	<0.05			

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Sample Identification Site #10
Sampling Time
Location Virtue Gulch
Sampling Date 11/8/82
Analysis Date 11/12/82

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Acidity	0.0 PPM	pH (Lab)	7.98
Alkalinity (as $CaCO_3$)	350 PPM	SAR	1.9
Ammonium (as N)	PPM	Specific Conductance	903 µmhos
Boron	PPM	Total Dissolved Solids	952 PPM
Oil and Grease	<1.0 PPM	Total Suspended Solids	9.6 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	0.82

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CATIONS	meq/1	mg/1	ANIONS	meq/1	mg/1
Calcium	4.75	95.2	Bicarbonate	7.00	427
Magnesium	5.89	71.6	Carbonate	0.0	0.0
Potassium	0.19	7.40	Chloride	0.10	3.50
Sodium	4.40	101	Flouride	0.04	0.85
Total	15.23		Nitrate	<0.01	<0.50
			Sulfate	7.85	377
			Total	14.99	

****

mg/1	Total	Dissolved	mg/1	Total	Dissolved
Aluminum	1.3	0.5	Manganese	<0.02	<0.02
Arsenic			Mercury	0.003	0.002
Barium			Molybdenum		
Cadmium	0.002	<0.002	Nickel		
Chromium	<0.02	<0.02	Selenium	<0.002	<0.002
Copper	<0.01	<0.01	Vanadium	<0.1	<0.1
Iron	1.16	0.10	Zinc	0.67	<0.02
Lead	<0.05	<0.05			

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Sample Identification Bear Creek Ba.
Sampling Time
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Acidity 0.0 PPM
Alkalinity (as $CaCO_3$) 80.0 PPM
Ammonium (as N) PPM
Boron <0.10 PPM
Oil and Grease PPM
Ortho-Phosphate <0.01 PPM

pH (Lab) 7.11
SAR 0.1
Specific Conductance 114 µmhos
Total Dissolved Solids 118 PPM
Total Suspended Solids 2.0 PPM
Turbidity (NTU)

****

CATIONS	meq/l	mg/l
Calcium	1.30	26.1
Magnesium	0.42	5.11
Potassium	0.05	1.80
Sodium	0.10	2.30
Total	1.87	

ANIONS	meq/l	mg/l
Bicarbonate	1.60	97.6
Carbonate	0.0	0.0
Chloride	<0.01	<0.50
Flouride	0.01	0.18
Nitrate	0.02	1.26
Sulfate	0.16	7.52
Total	1.79	

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mg/l	Total	Dissolved
Aluminum		0.1
Arsenic		
Barium		
Cadmium		<0.002
Chromium		
Copper		
Iron		0.21
Lead		<0.05

mg/l	Total	Dissolved
Manganese		<0.02
Mercury		<0.001
Molybdenum		
Nickel		
Selenium		<0.002
Vanadium		<0.1
Zinc		0.14

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Sample Identification BW
Sampling Time
Location
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Acidity	0.0 PPM	pH (Lab)	8.59
Alkalinity (as $CaCO_3$)	1,640 PPM	SAR	30.5
Ammonium (as N)	PPM	Specific Conductance	2,760 µmhos
Boron	PPM	Total Dissolved Solids	3,230 PPM
Oil and Grease	<1.0 PPM	Total Suspended Solids	12.8 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	3.7

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CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	1.75	35.1	Bicarbonate	29.5	1,800
Magnesium	2.40	29.2	Carbonate	3.32	99.6
Potassium	0.34	13.4	Chloride	0.14	5.00
Sodium	44.0	1,010	Flouride	0.06	1.08
Total	48.49		Nitrate	0.03	1.64
			Sulfate	13.7	655
			Total	46.75	

****

mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum	5.2	4.5	Manganese	0.14	0.03
Arsenic			Mercury	0.005	0.003
Barium			Molybdenum		
Cadmium	<0.002	<0.002	Nickel		
Chromium	0.02	<0.02	Selenium	<0.002	<0.002
Copper	0.04	<0.01	Vanadium	<0.1	<0.1
Iron	8.30	4.80	Zinc	0.08	<0.02
Lead	<0.05	<0.05			

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Sample Identification Smith Seep
Sampling Time
Location
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Acidity	0.0 PPM	pH (Lab)	7.50
Alkalinity (as $CaCO_3$)	534 PPM	SAR	11.0
Ammonium (as N)	PPM	Specific Conductance	3,070 µmhos
Boron	0.14 PPM	Total Dissolved Solids	2,960 PPM
Oil and Grease	PPM	Total Suspended Solids	61.6 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	

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CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	6.70	134	Bicarbonate	10.7	651
Magnesium	10.2	124	Carbonate	0.0	0.0
Potassium	0.35	13.9	Chloride	0.32	11.5
Sodium	32.0	736	Flouride	0.06	1.06
Total	49.25		Nitrate	<0.01	<0.50
			Sulfate	38.2	1,830
			Total	49.28	

****

mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum		0.1	Manganese		0.06
Arsenic			Mercury		<0.001
Barium			Molybdenum		
Cadmium		<0.002	Nickel		
Chromium			Selenium		<0.002
Copper			Vanadium		<0.1
Iron		0.14	Zinc		<0.02
Lead		<0.05			

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Sample Identification Washoe Dump Sp
Sampling Time
Location
Sampling Date 11/10/82
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Acidity	0.0 PPM	pH (Lab)	8.14
Alkalinity (as $CaCO_3$)	490 PPM	SAR	6.2
Ammonium (as N)	PPM	Specific Conductance	1,070 µmhos
Boron	<0.10 PPM	Total Dissolved Solids	790 PPM
Oil and Grease	PPM	Total Suspended Solids	46.8 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	

****

CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	1.81	36.3	Bicarbonate	9.80	598
Magnesium	3.03	36.8	Carbonate	0.0	0.0
Potassium	0.16	6.50	Chloride	0.20	7.00
Sodium	9.70	223	Flouride	0.03	0.58
Total	14.76		Nitrate	0.01	0.44
			Sulfate	4.87	234
			Total	14.91	

****

mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum		<0.1	Manganese		<0.02
Arsenic			Mercury		<0.001
Barium			Molybdenum		
Cadmium		<0.002	Nickel		
Chromium			Selenium		<0.002
Copper			Vanadium		<0.1
Iron		0.07	Zinc		<0.02
Lead		<0.05			

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Sample Identification Bear Crk Downstr
Sampling Time
Location
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Acidity 0.0 PPM
Alkalinity (as $CaCO_3$) 326 PPM
Ammonium (as N) PPM
Boron PPM
Oil and Grease <1.0 PPM
Ortho-Phosphate <0.01 PPM

pH (Lab) 8.15
SAR 3.5
Specific Conductance 761 µmhos
Total Dissolved Solids 766 PPM
Total Suspended Solids 11.6 PPM
Turbidity (NTU) 1.7

****

CATIONS	meq/l	mg/l
Calcium	2.93	58.8
Magnesium	3.27	39.8
Potassium	0.14	5.50
Sodium	6.20	143
Total	12.54	

ANIONS	meq/l	mg/l
Bicarbonate	6.52	398
Carbonate	0.0	0.0
Chloride	0.11	4.00
Flouride	0.03	0.48
Nitrate	0.03	1.81
Sulfate	6.50	312
Total	13.19	

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mg/l	Total	Dissolved
Aluminum	0.8	0.3
Arsenic		
Barium		
Cadmium	0.003	<0.002
Chromium	<0.02	<0.02
Copper	0.01	<0.01
Iron	0.64	0.16
Lead	<0.05	<0.05

mg/l	Total	Dissolved
Manganese	0.03	0.03
Mercury	0.001	<0.001
Molybdenum		
Nickel		
Selenium	0.002	<0.002
Vanadium	<0.1	<0.1
Zinc	1.46	<0.02

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Sample Identification REA Seep
Sampling Time
Location
Sampling Date 11/11/82
Analysis Date 11/12/82

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Acidity	0.0 PPM	pH (Lab)	7.64
Alkalinity (as $CaCO_3$)	304 PPM	SAR	1.2
Ammonium (as N)	PPM	Specific Conductance	472 µmhos
Boron	<0.10 PPM	Total Dissolved Solids	416 PPM
Oil and Grease	PPM	Total Suspended Solids	27.6 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	

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CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	3.56	71.4	Bicarbonate	6.08	371
Magnesium	2.38	28.9	Carbonate	0.0	0.0
Potassium	0.11	4.20	Chloride	0.06	2.0
Sodium	2.00	46.0	Flouride	0.03	0.51
Total	8.05		Nitrate	0.01	0.87
			Sulfate	1.98	94.8
			Total	8.16	

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mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum		<0.1	Manganese		<0.02
Arsenic			Mercury		<0.001
Barium			Molybdenum		
Cadmium		<0.002	Nickel		
Chromium			Selenium		<0.002
Copper			Vanadium		<0.1
Iron		0.05	Zinc		<0.02
Lead		<0.05			

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Sample Identification Mt Power Portal
Sampling Time
Location
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Acidity	0.0 PPM	pH (Lab)	6.50
Alkalinity (as $CaCO_3$)	206 PPM	SAR	1.8
Ammonium (as N)	PPM	Specific Conductance	500 µmhos
Boron	<0.10 PPM	Total Dissolved Solids	444 PPM
Oil and Grease	PPM	Total Suspended Solids	20.0 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	

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CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	1.75	35.1	Bicarbonate	4.12	251
Magnesium	1.41	17.2	Carbonate	0.0	0.0
Potassium	0.10	3.80	Chloride	0.03	1.00
Sodium	2.20	50.6	Flouride	0.02	0.41
Total	5.46		Nitrate	<0.01	<0.50
			Sulfate	1.37	65.8
			Total	5.54	

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mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum		<0.1	Manganese		0.28
Arsenic			Mercury		<0.001
Barium			Molybdenum		
Cadmium		<0.002	Nickel		
Chromium			Selenium		<0.002
Copper			Vanadium		<0.1
Iron		0.90	Zinc		<0.02
Lead		<0.05			

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Sample Identification Farmhouse Portal Sec
Sampling Time
Location
Sampling Date 11/11/82
Analysis Date 11/12/82

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Acidity	0.0 PPM	pH (Lab)	7.04
Alkalinity (as $CaCO_3$)	434 PPM	SAR	6.3
Ammonium (as N)	PPM	Specific Conductance	611 µmhos
Boron	<0.10 PPM	Total Dissolved Solids	546 PPM
Oil and Grease	PPM	Total Suspended Solids	1.2 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	

****

CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	1.55	31.1	Bicarbonate	8.68	529
Magnesium	0.83	10.1	Carbonate	0.0	0.0
Potassium	0.12	4.60	Chloride	<0.01	<0.50
Sodium	6.90	159	Fluuride	0.06	1.23
Total	9.40		Nitrate	<0.01	<0.50
			Sulfate	1.03	49.5
			Total	9.77	

****

mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum		0.1	Manganese		0.12
Arsenic			Mercury		<0.001
Barium			Molybdenum		
Cadmium		<0.002	Nickel		
Chromium			Selenium		<0.002
Copper			Vanadium		<0.1
Iron		0.12	Zinc		<0.02
Lead		<0.05			

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Sample Identification RL Top Seep B
Sampling Time
Location
Sampling Date 11/10/82
Analysis Date 11/12/82

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Acidity	0.0 PPM	pH (Lab)	6.78
Alkalinity (as $CaCO_3$)	65.0 PPM	SAR	0.2
Ammonium (as N)	PPM	Specific Conductance	122 μmhos
Boron	<0.10 PPM	Total Dissolved Solids	124 PPM
Oil and Grease	PPM	Total Suspended Solids	18.4 PPM
Ortho-Phosphate	<0.01 PPM	Turbidity (NTU)	

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CATIONS	meq/l	mg/l	ANIONS	meq/l	mg/l
Calcium	1.04	20.9	Bicarbonate	1.30	79.3
Magnesium	0.54	6.57	Carbonate	0.0	0.0
Potassium	0.02	0.90	Chloride	<0.01	<0.50
Sodium	0.20	4.60	Flouride	0.02	0.38
Total	1.80		Nitrate	0.01	0.66
			Sulfate	0.39	18.5
			Total	1.72	

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mg/l	Total	Dissolved	mg/l	Total	Dissolved
Aluminum		<0.1	Manganese		<0.02
Arsenic			Mercury		<0.001
Barium			Molybdenum		
Cadmium		<0.002	Nickel		
Chromium			Selenium		0.002
Copper			Vanadium		<0.1
Iron		0.06	Zinc		<0.02
Lead		<0.05			

PKS Mining District
Sheridan, Wyoming
Laboratory Report
Water Analysis
To Jim Bowlby

Date 12/13/82

Sample Identification Victure Gulch Porta Seep
Sampling Time
Location
Sampling Date 11/10/82
Analysis Date 11/12/82

****

Acidity 0.0 PPM
Alkalinity (as $CaCO_3$) 334 PPM
Ammonium (as N) PPM
Boron <0.10 PPM
Oil and Grease PPM
Ortho-Phosphate 0.03 PPM

pH (Lab) 7.66
SAR 1.3
Specific Conductance 1,520 µmhos
Total Dissolved Solids 1,980 PPM
Total Suspended Solids 117 PPM
Turbidity (NTU)

****

CATIONS	meq/1	mg/1
Calcium	9.74	195
Magnesium	14.5	176
Potassium	0.36	14.2
Sodium	4.50	103
Total	29.10	

ANIONS	meq/1	mg/1
Bicarbonate	6.68	407
Carbonate	0.0	0.0
Chloride	0.17	6.00
Flouride	0.02	0.41
Nitrate	<0.01	<0.50
Sulfate	23.1	1,110
Total	29.97	

****

mg/1	Total	Dissolved
Aluminum		<0.1
Arsenic		
Barium		
Cadmium		<0.002
Chromium		
Copper		
Iron		0.11
Lead		<0.05

mg/1	Total	Dissolved
Manganese		0.03
Mercury		<0.001
Molybdenum		
Nickel		
Selenium		<0.002
Vanadium		<0.1
Zinc		0.02

10 References

Zucker, Dr. Alexander, Executive Director. 1972. Water Quality Criteria, 1972. Environmental Protection Agency.

6.3 Soil and Overburden Study

In October of 1982 soils and overburden materials were sampled at 60 sites in the Red Lodge, Montana abandoned mines area. (Exhibits No. 3 and 4). All samples were analyzed by KM&E's soils laboratory located in Sheridan, Wyoming. Analytical methods, as outlined by Montana Strip and Underground Mine Reclamation Rules and Regulations, and pursuant guidelines, were used. Laboratory procedures are contained on Table 6.3.1.

6.3.1 Soils

Soils at 29 sites were sampled. Sample sites were chosen according to their proximity to dump areas, drainage areas, subsidence areas and pan spots. Generally, samples were taken at 6 to 12 inch intervals to a depth of 60 inches, bedrock or gravel. Additionally, a 6 to 12 inch sample was taken from any underlying soft weathered bedrock material that was encountered. A summary of soil quality and availability at each sample site is presented on Table 6.3.2, and laboratory data are contained in Section 6.3.3.

Except for sample 11-OB-1 (taken on the floor of the Washoe strip mine cut), and the top 6 inches of sample 15-TS-1, most of the soils sampled have proven to be chemically suitable for reclamation purposes. However, some clayey textures, excessively steep slopes and a general lack of sufficient soil quantities in many areas will present a problem to reclamation efforts.

6.3.2 Overburden

Overburden materials at 31 sites were sampled in the abandoned mines area. For the purpose of this report the term "gob pile" is used to describe the coal tailings and carbonaceous refuse piles that occur throughout the area. "Spoil piles" refer to the mixed overburden materials that have been removed to expose the shallow coal seams of the Washoe, Bear Creek and Foster Gulch strip mines. A summary of the samples taken from the gob piles and spoil piles is contained in Table 6.3.3, and laboratory data are contained in Section 6.3.4.

Gob Piles. A total of 22 sites were sampled on the gob piles. Sample sites were chosen at random and include samples taken from vegetated and barren areas, and the top, sides, base and interior of various piles. Samples were taken to a depth of at least 12 inches at each site. Where textural or other physical variations occurred, additional samples were taken (8-OB-1 and 14-OB-1). Additionally, an eight foot composite sample was taken from the exposed interior of the Airport gob pile (14-OB-2), and a six foot "broken" sample was taken from a cut face of the gob pile adjacent to the Red Lodge municipal solid waste landfill (8-OB-4).

pH readings suggest acid conditions occur in the surface materials of most gob piles, and it appears that salts, some heavy metals and boron may become concentrated with depth. These conditions make the materials contained in most of the gob piles undesirable for use as surface material for reclamation purposes. However, in many areas gob pile materials may be suitable for use as a subsoiling material.

Spoil Piles. A total of nine sites were sampled on the three surface mine areas. All samples were taken to a depth of 12 inches. Sample sites were chosen at random and include east, west, north and south aspects, and slopes ranging from 0 percent to nearly vertical.

Samples were taken from the inside slopes (slopes facing the high wall), outside slopes, and the top of the outcast piles. Additionally, samples were taken at both vegetated and barren sites.

Sample sites 2-OB-2 and 5-OB-4 have elevated NO_3 (Nitrate) levels and site 11-OB-2 has a pH 4.0 making them undesirable for use in reclamation. However, it is believed that these occurrences are only local phenomena, and that most of the spoil material is chemically and physically suitable for use as either surface or subsoiling material in any reclamation effort.

6.3.3 The following tables present the laboratory data for the soil analysis. The sample site is shown on the tables as the series and may be located on Exhibits No. 3 and 4.

6.3.4 The following tables illustrate the laboratory results for the gob and spoil pile samples. The series is the sample number and may be located on Exhibits 3 and 4.

6.4 Geotechnical Study

From December 10, 1982, to December 15, 1982, Kiewit Mining & Engineering Co. drilled 15 holes in the Red Lodge Coal Field. The drilling was completed to determine the accuracy of the underground mine plans and the characteristics of the mine voids and overlying strata. Drill logs are contained in Section 6.4.2 and drill hole diagrams in Section 6.4.3. The hole locations are shown on Exhibits No. 3 and 4.

6.4.1 Drilling Results

The primary area of concern was the bluff east of Red Lodge where substantial subsidence has occurred. Available mine maps indicate that five coal seams were mined in this area and the subsidence evidence verifies this. A line of drill holes was designed to intercept these seams. Alluvial gravels and sands from 25-30 feet thick hampered initial drilling attempts but this was eventually solved by using a larger drill rig.

From the drilling it appears that the coal seams outcropped on this bluff long ago but they have since been eroded somewhat and overlain with an alluvial cap from 20-30 feet thick.

The first drill locations were selected to define the No. 6 coal seam situation. A total of five drill holes (No. 1 thru No. 5) were punched in two separate locations. From the logs of these holes the following conjectures can be made. The No. 6 coal seam has, in fact, been mined up dip to within at least 70 feet of the surface and still remains open to some extent. There has been some caving occurring but it appears to have advanced only thru the overlying soft sandstone and probably no more than 10 feet above the original mine roof. This verifies the suspicion that the subsidence observed is a localized incident caused by the collapse of workings at a point where the roof material and coal seam have been eroded and replaced by alluvium. The No. 5 coal seam, which is 13 feet thick, has not been extensively mined in this area. This is also borne out in historical documents.

Two holes (No. 6 and No. 7) were drilled to define the No. 4 coal seam situation. The pillar location was not determined with this drilling but the seam was mined leaving a void of 4-8 feet and some caving is or has occurred due to the soft fill found below the void. A massive sandstone or shale (depending on which log you look at) strata is found above the void. Since the coal was not found, it is hard to define the advance of the caving. From the amount of subsidence observed and associated with the No. 4 seam, it again appears that the coal seam was mined up dip until the overlying alluvium was intercepted and subsidence occurred at these points.

Two holes (No. 8 and No. 9) were drilled to define the No. 1½ and 2 coal seam situations. The No. 1½ seam was intercepted on the first hole, therefore, drilling continued to the No. 2 seam. The workings of the No. 2 seam were found near 150 feet in depth. A void exists at this level and six feet of soft fill indicates that a minor amount of caving has occurred. The second hole intercepted the No. 1½ seam mine workings with very little void remaining and 11 feet of soft fill was detected. Comparing the logs of both holes indicates that the caving has advanced approximately seven feet. A massive shale zone overlays the workings. The No. 2 seam appears to have caused no surface subsidence. Only one subsidence hole was observed that could be associated with the No. 1½ seam. Since this area is presently a hay meadow, old subsidences may have been filled in.

The next major area to be drilled occurred approximately .6 mile east of this site in an area of extensive subsidence. The first hole (No. 10) drilled was located south of the hardpan spots believed to be old subsidence holes filled in long ago with clays. Coal seam No. 2 was intercepted and appeared to be too thin to mine in this area. The mined-out void of the No. 3 seam was intercepted at 87 feet with only two feet of void detected and seven feet of soft fill found below this. It appears that caving has occurred, the void is almost filled by fluff and a hard sandstone roof overlies the void.

The next drill hole (No. 11) was located to define the No. 4 seam. The void was found at a depth of 100 feet, was overlain by sandstone and no soft fill was detected at the bottom of the void.

An attempt was then made to drill a hole (No. 12) at the end of the access route on Bear Creek. The hole was abandoned in 40 foot of sand when caving and lost circulation occurred. As no subsidence was indicated in the vicinity, no further drilling was attempted in this area.

The next area of interest was on the ridge above the Washoe No. 1 mine (Bear Creek Dump). Drill hole No. 13 intercepted a minor coal seam at 17 feet, another minor coal seam at 62 feet and what we surmise to be the No. 2 coal seam from 72-80 feet. Moving 40 feet to the south, drill hole No. 14 intercepted the same two minor coal seams as before. The mined out void of the No. 2 seam was detected immediately below the lower minor seam by loss of circulation and slight drop of the drill steel. The steel was then pushed through 14 feet of loose fill. It appears that the No. 2 seam workings have collapsed to the point where the loose fluff has expanded to fill the void.

The final hole (No. 15) was drilled on the ridge above the Smith Mine. Two minor coal seams were again encountered, but on reaching 100 feet of depth, no further coal seams were encountered.

It should also be stated that all drill holes were backfilled and a concrete plug constructed 18 inches below ground line. Any remaining drill cuttings were scattered, the area seeded and then raked.

6.4.2 Drill Logs

The following drill hole logs define results of the drilling program in the Red Lodge Coal Field.

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT
DEPARTMENT

	26		
X			

Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 1

Lessee or permittee Red Lodge Coal Field

Address

Driller Kiewit Mining & Engineering Co.

Commenced drilling 12-10-82 Finished 12-10-82

Sec. 26 T. 7S R. 20E M. State Montana

Method of drilling Air Logged by L. Reed

Surface Owner

(SIGNED) [signature]

DATE 12-10-82 Page 1 of 1

(TITLE) Field Engineer

FORMATION RECORD

DEPTH From— Feet Tenths	DEPTH To— Feet Tenths	Thickness of stratum Feet Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0	30	30	Gravel
30	40	10	Sand, brown clay
40	52	12	Gray shale
52	53	1	Sandstone
53	72	19	Gray shale
72	85	13	Coal Seam #5
85	101	16	Gray, sandy shale
101	109	8	Siltstone
109	117	8	Void Mined out seam #6

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT DEPARTMENT

	26		
X			

Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

Surface Owner

DATE 12-14-82 Page 1 of 1

LOG OF PROSPECT BORE HOLE No. 2

Lessee or permittee Red Lodge Coal Field

Address

Driller Kiewit Mining & Engineering Co.

Commenced drilling 12-14-82 Finished 12-14-82

Sec. 26 T. 7S R. 20E M. State Montana

Method of drilling Air Logged by L. Reed

(SIGNED) J L Webb

(TITLE) Field Engineer

FORMATION RECORD

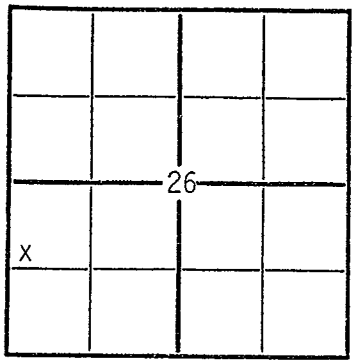
DEPTH From— Feet Tenths	DEPTH To— Feet Tenths	Thickness of stratum Feet Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0	19	19	Sand
19	20	1	Sandstone
20	30	10	Sand with ¼" gravel stringer
30	78	48	Gray shale
78	92	14	Coal Seam #5
92	110	18	Gray Shale
110	116	6	Sandstone, medium soft
116	120	4	Void. Mined out seam #6

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT DEPARTMENT



Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 3

Lessee or permittee: Red Lodge Coal Field

Address:

Driller: Kiewit Mining & Engineering Co.

Commenced drilling: 12-14-82 Finished: 12-14-82

Sec. 26 T. 7S R. 20E M. State: Montana

Method of drilling: Air Logged by: L. Reed

Surface Owner:

(SIGNED)

DATE: 12-14-82 Page 1 of 1

(TITLE): Field Engineer

FORMATION RECORD

DEPTH From— Feet	Tenths	DEPTH To— Feet	Tenths	Thickness of stratum Feet	Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0		23		23		Sand
23		24		1		Gravel
24		29		5		Sand
29		29.5		.5		Sandstone
29.5		63		33.5		Gray Shale
63		64		1		Sandstone
64		81		17		Gray Shale
81		93		12		Coal Seam #5
93		98		5		Gray Shale
98		99		1		Sandstone, medium hard
99		111		12		Gray Shale
111		126		15		Gray Sandstone, medium soft
126		132		6		Coal Seam #6 pillar
132		135		3		Gray Sandstone

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT DEPARTMENT

	26		
X			

Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 4

Lessee or permittee Red Lodge Coal Field

Address

Driller Kiewit Mining & Engineering Co.

Commenced drilling 12-14-82 Finished 12-14-82

Sec. 26 T. 7S R. 20E M. State Montana

Method of drilling Air Logged by L. Reed

Surface Owner

(SIGNED) [signature]

DATE 12-14-82 Page 1 of 1

(TITLE) Field Engineer

FORMATION RECORD

DEPTH From— Feet	Tenths	DEPTH To— Feet	Tenths	Thickness of stratum Feet	Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0		22		22		Sand
22		40		18		Sand with gravel
40		57		17		Gray shale
57		71		14		Sandstone, medium soft
71		77		6		Coal Seam #6
77		78		1		Sandstone
78		80		2		Gray shale

THE HILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT
DEPARTMENT

LOG OF PROSPECT BORE HOLE No. 5

		26		
X				

Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

Lessee or permittee Red Lodge Coal Field

Address

Driller Kiewit Mining & Engineering Co.

Commenced drilling 12-14-82 Finished 12-14-82

Sec. 26 T. 7S R. 20E M. State Montana

Method of drilling Air Logged by L. Reed

Surface Owner

(SIGNED) [signature]

DATE 12-14-82 Page 1 of 1

(TITLE) Field Engineer

FORMATION RECORD

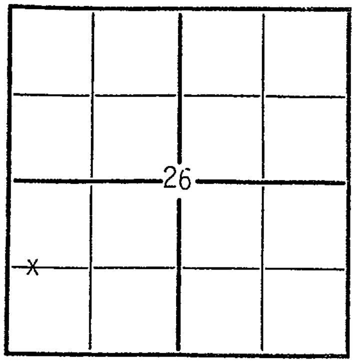
DEPTH From— Feet Tenths	DEPTH To— Feet Tenths	Thickness of stratum Feet Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0	34	34	Sand with brown clay
34	38	4	Coal stringer; washed out Seam #5
38	59	21	Gray shale
59	75.5	16.5	Sandstone, medium soft
75.5	78	2.5	Void. Mined out Seam #6
78	80	2	Soft fill

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT DEPARTMENT



Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 6

Lessee or permittee: Red Lodge Coal Field

Address:

Driller: Kiewit Mining & Engineering Co.

Commenced drilling: 12-14-82 Finished: 12-14-82

Sec. 26 T. 7S R. 20E M. State: Montana

Method of drilling: Air Logged by: L. Reed

Surface Owner:

(SIGNED)

DATE: 12-14-82 Page 1 of 1

(TITLE): Field Engineer

FORMATION RECORD

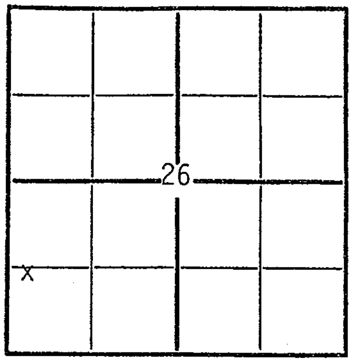
DEPTH From— (Feet / Tenths)	DEPTH To— (Feet / Tenths)	Thickness of stratum (Feet / Tenths)	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0	29	29	Brown clay
29	31	2	Sandstone, medium hard
31	51	20	Brown shale
51	52	1	Sandstone, soft
52	63	11	Gray shale
63	92	29	Sandstone, medium soft
92	96	4	Void Mined out Seam #4
96	100	4	Soft fill

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT
DEPARTMENT



Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 7

Lessee or permittee Red Lodge Coal Field

Address

Driller Kiewit Mining & Engineering Co.

Commenced drilling 12-14-82 Finished 12-14-82

Sec. 26 T. 7S R. 20E M. State Montana

Method of drilling Air Logged by L. Reed

Surface Owner

(SIGNED)

DATE 12-14-82 Page 1 of 1 (TITLE) Field Engineer

FORMATION RECORD

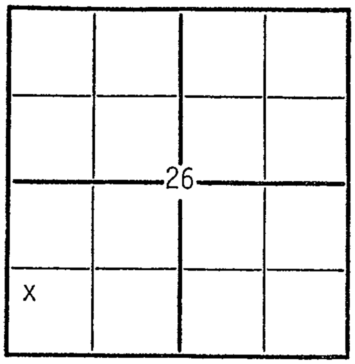
DEPTH From— (Feet, Tenths)	DEPTH To— (Feet, Tenths)	Thickness of stratum (Feet, Tenths)	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0	30	30	Brown clay
30	32	2	Sandstone, medium hard
32	35	3	Brown shale
35	36	1	Sandstone, medium hard
36	54	18	Brown shale
54	56	2	Sandstone, hard
56	91	35	Gray shale
91	99	8	Void. Mined out Seam #4
99	100	1	Soft fill

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT
DEPARTMENT



Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 8

Lessee or permittee: Red Lodge Coal Field

Address:

Driller: Kiewit Mining & Engineering Co.

Commenced drilling: 12-14-82 Finished: 12-14-82

Sec. 26 T. 7S R. 20E M. State Montana

Method of drilling: Air Logged by: L. Reed

Surface Owner:

(SIGNED)

DATE 12-14-82 Page 1 of 1

(TITLE) Field Engineer

FORMATION RECORD

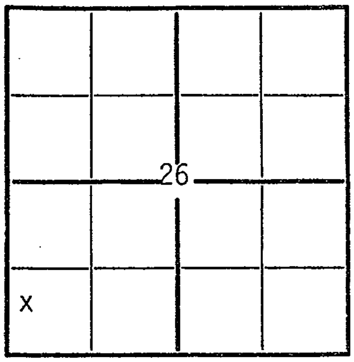
Depth From— (Feet / Tenths)	Depth To— (Feet / Tenths)	Thickness of stratum (Feet / Tenths)	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0	25	25	Brown sandy shale
25	62	37	Gray shale
62	63	1	Sandstone, medium soft
63	68	5	Gray sandstone, soft
68	87	19	Gray shale
87	92	5	Coal Seam #1½
92	125	33	Gray shale with thin sandstone stringers
125	126	1	Gray sandstone, medium hard
126	148	22	Gray shale
148	151	3	Void. Mined out #2 seam.
151	157	6	Soft fill

THE HILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT
DEPARTMENT



Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section: when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 9

Lessee or permittee: Red Lodge Coal Field

Address:

Driller: Kiewit Mining & Engineering Co.

Commenced drilling: 12-14-82 Finished: 12-14-82

Sec. 26 T. 7S R. 20E M. State Montana

Method of drilling: Air Logged by: L. Reed

Surface Owner:

(SIGNED) J L Welsh

DATE 12-14-82 Page 1 of 1

(TITLE) Field Engineer

FORMATION RECORD

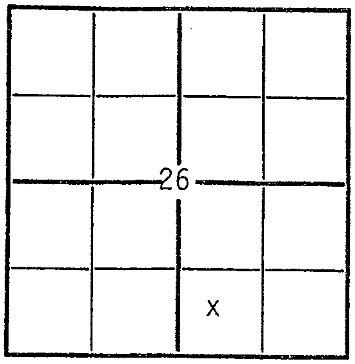
DEPTH From— Feet Tenths	DEPTH To— Feet Tenths	Thickness of stratum Feet Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0	25	25	Brown shale
25	78.5	53.5	Gray shale
78.5	79	0.5	Void Mined out Seam #1½
79	90	11	Soft fill

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT DEPARTMENT



Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section: when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 10

Lessee or permittee: Red Lodge Coal Field

Address:

Driller: Kiewit Mining & Engineering Co.

Commenced drilling: 12-14-82 Finished: 12-14-82

Sec. 26 T. 7S R. 20E M. State: Montana

Method of drilling: Air Logged by: L. Reed

Surface Owner:

(SIGNED) [illegible]

DATE: 12-14-82 Page 1 of 1

(TITLE) Field Engineer

FORMATION RECORD

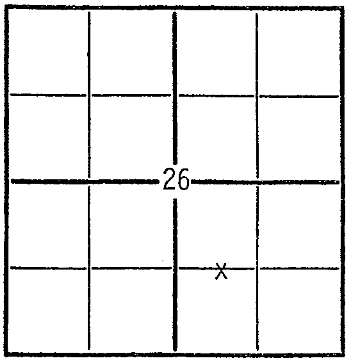
DEPTH From— Feet	Tenths	To— Feet	Tenths	Thickness of stratum Feet	Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0		22		22		Sand
22		69		47		Gray shale
69		71		2		Coal Seam #2
71		74		3		Gray shale
74		75		1		Sandstone
75		84		9		Gray shale
84		87		3		Sandstone, hard
87		89		2		Void. Mined out Seam #3
89		96		7		Soft fill

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT
DEPARTMENT



Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 11

Lessee or permittee: Red Lodge Coal Field

Address:

Driller: Kiewit Mining & Engineering Co.

Commenced drilling: 12-14-82 Finished: 12-14-82

Sec. 26 T. 7S R. 20E M. State Montana

Method of drilling: Air Logged by: L. Reed

Surface Owner:

(SIGNED)

DATE 12-14-82 Page 1 of 1

(TITLE) Field Engineer

FORMATION RECORD

DEPTH From— Feet	DEPTH From— Tenths	DEPTH To— Feet	DEPTH To— Tenths	Thickness of stratum Feet	Thickness of stratum Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0		32		32		Sand with some gravel
32		35		3		Brown shale
35		39		4		Sandstone, hard
39		55		16		Brown shale, sandy
55		57		2		Sandstone, medium soft
57		84		27		Brown sand, firm
84		86		2		Gray sand, firm
86		89		3		Brown sand, firm
89		101		12		Gray sandstone
101		107		6		Void - no fill. Seam #4

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT DEPARTMENT

LOG OF PROSPECT BORE HOLE No. 12

Lessee or permittee: Red Lodge Coal Field

Address:

Driller: Kiewit Mining & Engineering Co.

Commenced drilling: 12-15-82 Finished: 12-15-82

Sec. 1 T. 8S R. 20E M. State: Montana

Method of drilling: Air/water/foam Logged by: L.Reed

Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

Surface Owner:

(SIGNED):

DATE: 12-15-82 Page 1 of 1

(TITLE): Field Engineer

FORMATION RECORD

DEPTH From— Feet	DEPTH From— Tenths	DEPTH To— Feet	DEPTH To— Tenths	Thickness of stratum Feet	Thickness of stratum Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
	0	40		40		Soft sand
						Hole caving - abandoned.

THE HILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT DEPARTMENT

			X
	1		

Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

Surface Owner

DATE 12-15-82 Page 1 of 1

LOG OF PROSPECT BORE HOLE No. 13

Lessee or permittee Red Lodge Coal Field

Address

Driller Kiewit Mining & Engineering Co.

Commenced drilling 12-15-82 Finished 12-15-82

Sec. 1 T. 8S R. 20E M. State Montana

Method of drilling Air Logged by L. Reed

(SIGNED) [signature]

(TITLE) Field Engineer

FORMATION RECORD

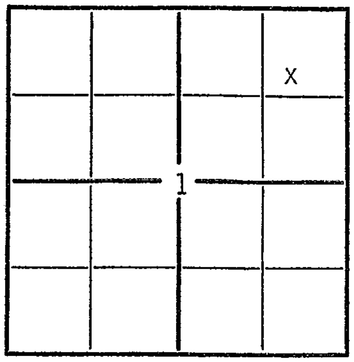
DEPTH From— Feet Tenths	DEPTH To— Feet Tenths	Thickness of stratum Feet Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0	13	13	Sand
13	17	4	Shale
17	17.5	.5	Coal stringer. Seam #1
17.5	27	9.5	Gray shale
27	28.5	1.5	Sandstone
28.5	30	1.5	Sand
30	42	12	Shale
42	44	2	Sandstone
44	62	18	Gray shale
62	62.5	0.5	Coal stringer Seam #1½
62.5	67	4.5	Shale
67	68	1	Sandstone
68	72	4	Shale
72	80	8	Coal Seam #2

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT
DEPARTMENT



Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 14

Lessee or permittee: Red Lodge Coal Field

Address:

Driller: Kiewit Mining & Engineering Co.

Commenced drilling: 12-15-82 Finished: 12-15-82

Sec. 1 T. 8S R. 20E M. State: Montana

Method of drilling: Air Logged by: D. Fudge

Surface Owner:

(SIGNED) [signature]

DATE: 12-15-82 Page 1 of 1

(TITLE) Field Engineer

FORMATION RECORD

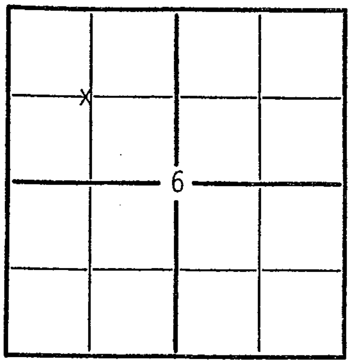
DEPTH From— (Feet, Tenths)	DEPTH To— (Feet, Tenths)	Thickness of stratum (Feet, Tenths)	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0	13	13	Sand
13	18	5	Brown shale
18	19	1	Coal stringer Seam #1
19	28	9	Gray shale
28	30	2	Coal stringer Seam #1
30	32	2	Shale
32	33	1	Sandstone
33	47	14	Shale
47	48.5	1.5	Sandstone
48.5	63	14.5	Shale
63	65	2	Coal Seam #1½
65	66.5	1.5	Void Seam #2
66.5	80	13.5	Soft fill

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

PETER KIEWIT SONS' CO.

EXPLORATION AND DEVELOPMENT
DEPARTMENT



Locate hole correctly, giving distance in feet from N. or S. and E. or W. line of section; when hole is not vertical, give direction and angle.

LOG OF PROSPECT BORE HOLE No. 15

Lessee or permittee: Red Lodge Coal Field

Address:

Driller: Kiewit Mining & Engineering Co.

Commenced drilling: 12-15-82 Finished: 12-15-82

Sec. 6 T. 8S R. 21 E M. State: Montana

Method of drilling: Air Logged by: D. Fudge

Surface Owner:

(SIGNED)

DATE: 12-15-82 Page 1 of 1

(TITLE): Field Engineer

FORMATION RECORD

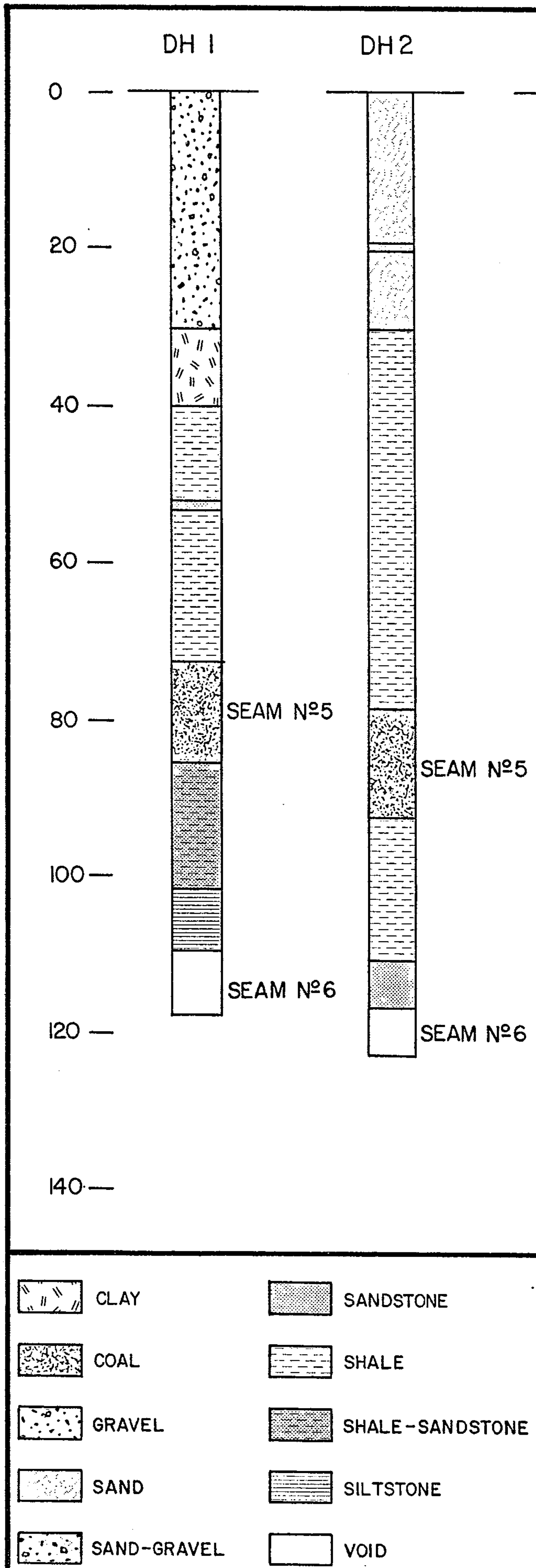
Depth From— Feet / Tenths	Depth To— Feet / Tenths	Thickness of stratum Feet / Tenths	Geologic formations; character of rock; oil, gas and water horizons; coal and other mineral occurrences
0	4	4	Sand
4	4.5	0.5	Coal stringer
4.5	10	5.5	Sand
10	12	2	Shale
12	13	1	Sandstone
13	29	16	Shale
29	30	1	Coal, oxidized
30	47	17	Shale
47	49.5	2.5	Sandstone
49.5	70	20.5	Gray shale
70	84	14	Brown shale
84	85	1	Gray shale
85	87	2	Coal
87	94	7	Sand, moist
94	100	6	Gray shale
			Quit drilling @. 100'. Mining must be
			below this and no subsidence effects foreseen.

THE MILLS COMPANY, SHERIDAN

(Attach continuation sheets if necessary)

6.4.3 Drill Hole Diagrams

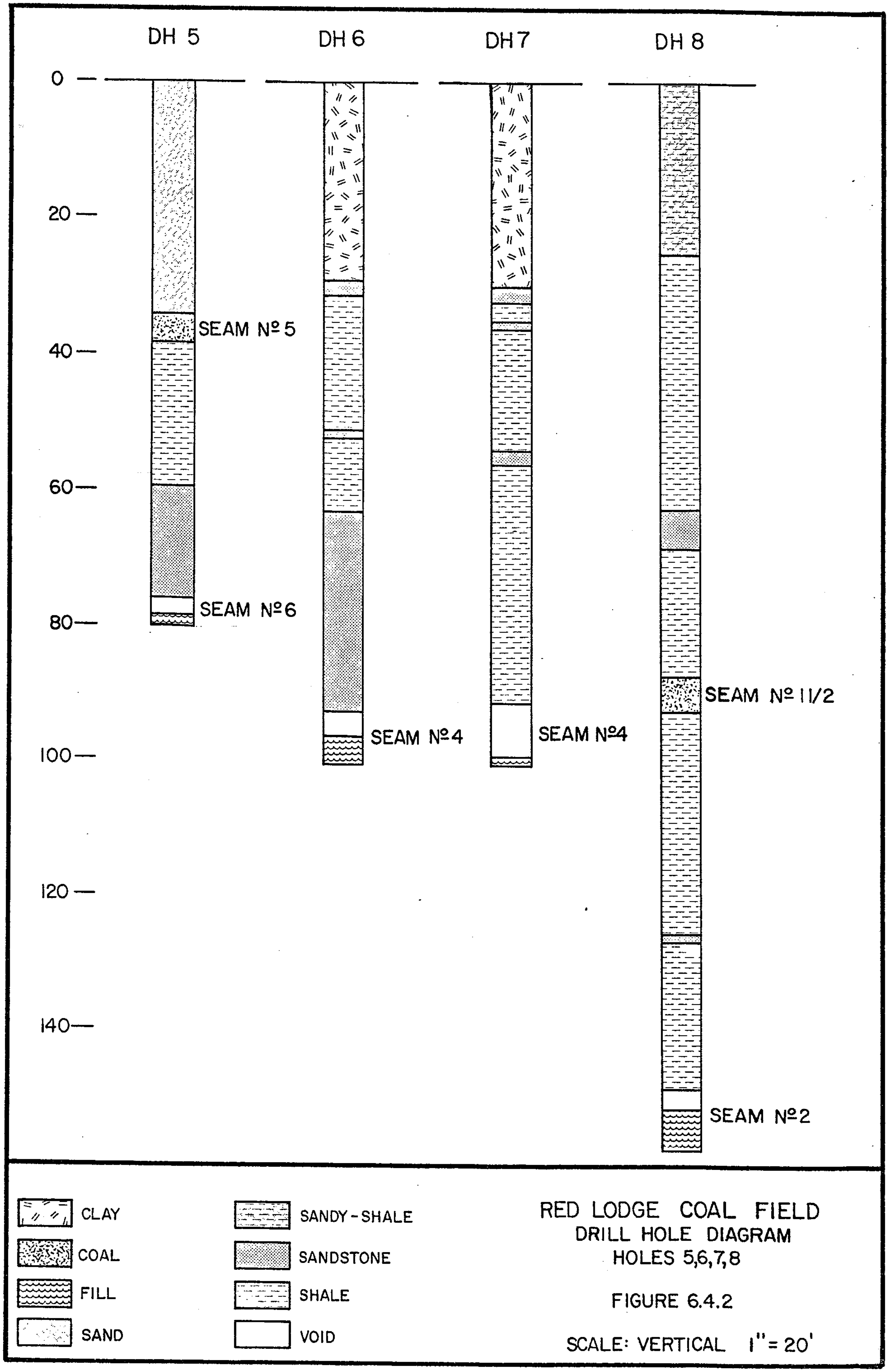
The results of the Red Lodge Coal Field drilling program are displayed graphically on the following figures 6.4.1 thru 6.4.4.



RED LODGE COAL FIELD
DRILL HOLE DIAGRAM
HOLES 1,2,3,4

FIGURE 6.4.1

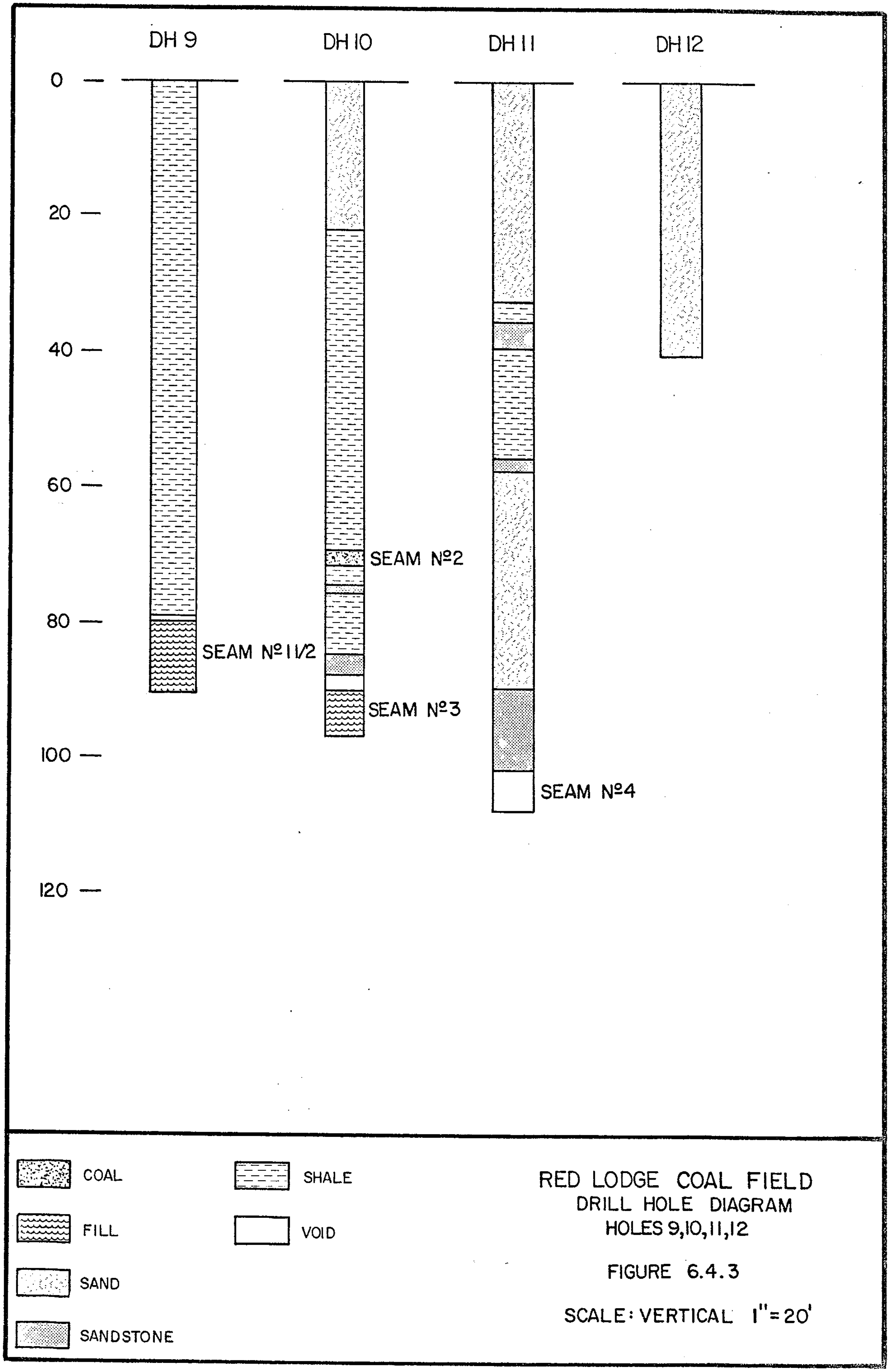
SCALE: VERTICAL 1" = 20'



RED LODGE COAL FIELD
DRILL HOLE DIAGRAM
HOLES 5,6,7,8

FIGURE 6.4.2

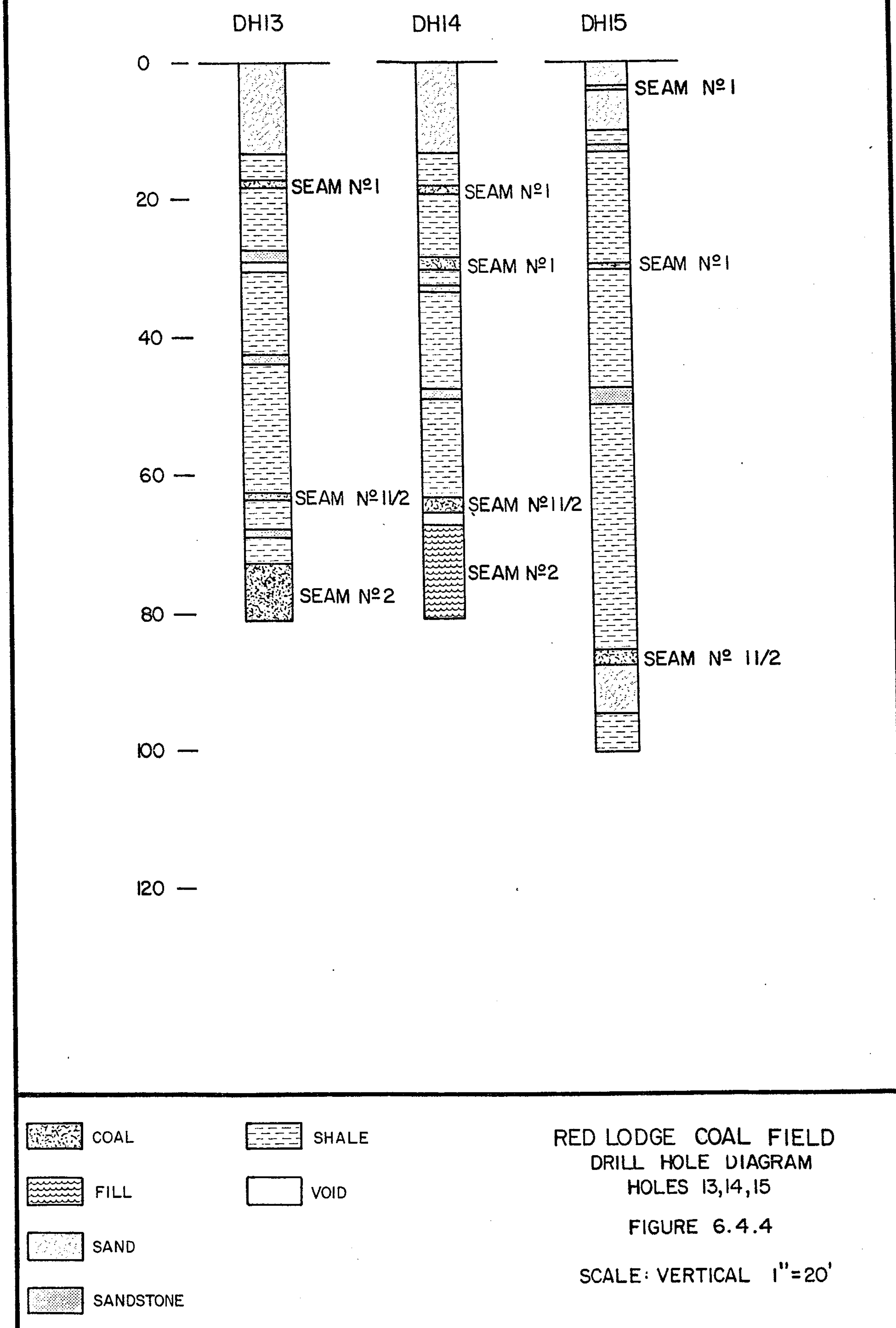
SCALE: VERTICAL 1" = 20'



RED LODGE COAL FIELD
DRILL HOLE DIAGRAM
HOLES 9,10,11,12

FIGURE 6.4.3

SCALE: VERTICAL 1" = 20'



RED LODGE COAL FIELD
DRILL HOLE DIAGRAM
HOLES 13,14,15

FIGURE 6.4.4

SCALE: VERTICAL 1"=20'

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-15-11-82 to TS-17-11-82 Date 11/82 Sample ID Red Lodge Series 1-TS-1

Comments Area BC

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
15	0- 6"			6.4	0.65	1.30	4.29	1.81	0.7							1.02
16	6-12"			7.5	0.40	0.81	2.95	0.92	0.7							2.46
17	12-24"			7.7	0.37	1.08	2.34	0.98	0.8							1.29
	Salvage 24"															

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-18-11-82 to TS-19-11-82 Date 11/82 Sample ID Red Lodge Series 2-TS-1
Comments Area BC

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
18	0- 6"	A		7.7	0.54	0.75	5.07	0.90	0.4							1.29
19	6-12"	Cr		7.8	0.32	0.73	3.10	0.51	0.5							0.99
	Salvage 12"															

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-38-11-82 Date 11/82 Sample ID Red Lodge Series 2-TS-2
Comments Area BC

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
38	0-12"			6.0	0.70	0.94	4.21	1.34	0.6							0.69

Sample taken in bottom of strip cut.

Salvage 12"

Kiewit Mining & Engineering Co. Env. Lab

Report of Laboratory Soil Analysis

Series: 2-TS-2

Lab No. 0B-38-11-82 Date 11/82 Sample ID Red Lodge Comments Area BC

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
38	0-12"	17.3	0.15	0.6	0.08	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. 0B-39-11-82 Date 11/82 Sample ID Red Lodge Series 3-TS-1
Comments Area BM

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
39	0-12"			7.1	1.30	1.30	9.19	4.77	0.5							0.27

Sample taken in drainage.

Kiewit Mining & Engineering Co. Env. Lab

Report of Laboratory Soil Analysis

Lab No. 0B-39-11-82 Date 11/82 Sample ID Red Lodge Series: 3-TS-1 Comments Area BM

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
39	0-12"	9.0	0.09	1.2	0.05	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

)-11-82 to TS-22-11-82 Date 11/82 Sample ID Red Lodge Series 3-TS-2

Comments Area BM

al Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
A		7.5	0.47	0.67	4.06	0.90	0.4							1.71
C		7.7	0.40	0.51	2.81	1.29	0.4							0.87
Cr		7.9	0.49	0.79	2.81	2.58	0.5							1.20

je 24"

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

lo. TS-23-11-82 Date 11/82 Sample ID Red Lodge Series 4-TS-1

Comments Area CM

Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
0- 6"	C		7.5	0.63	0.91	5.56	1.13	0.5							
Salvage 6"															1.80

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-24-11-82 to TS-26-11-82 Date 11/82 Sample ID Red Lodge Series 5-TS-1

Comments Area FG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
24	0- 6"	A		7.3	0.70	0.80	6.45	1.29	0.4							2.22
25	6-12"	C		7.6	0.44	0.52	3.95	0.91	0.3							1.08
26	12-24"	Cr		7.3	0.33	0.85	1.91	1.25	0.7							<0.10

Salvage 24"

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-27-11-82 to TS-29-11-82 Date 11/82 Sample ID Red Lodge Series 5-TS-4

Comments Area FG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
27	0- 6"	A		6.6	0.35	1.40	1.93	0.85	1.2							1.71
28	6-12"	C		7.1	0.43	0.99	3.23	0.99	0.7							1.23
29	12-17"	Cr		7.3	0.42	0.93	3.43	0.90	0.6							1.02

Salvage 17"

Kiewit Mining & Engineering Co.

Report of Laboratory Soil Analysis

Lab No. 08-40-11-82 Date 11/82 Sample ID Red Lodge

Series 5-TS-2

Comments Area FG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
40	0- 6"			6.4	0.60	1.30	3.31	2.08	0.8							0.21

Sample taken in drainage.

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. 0B-40-11-82 Date 11/82 Sample ID Red Lodge Series: 5-TS-2 Comments Area FG

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
40	0- 6"	9.6	0.24	1.1	0.05	0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. 0B-41-11-82 Date 11/82 Sample ID Red Lodge Series 5-TS-3
Comments Area FG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
41	0- 6"			7.0	3.30	13.9	23.3	11.0	3.3							0.42

Sample taken in drainage.

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-41-11-82 Date 11/82 Sample ID Red Lodge Series: 5-TS-3 Comments Area FG

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
41	0- 6"	11.9	0.18	0.6	0.03	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Series 6-TS-1

Lab No. OB-42-11-82 Date 11/82 Sample ID Red Lodge Comments Area FG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
42	0-12"			6.1	1.16	2.47	6.77	4.07	1.1							0.39

Sample taken in drainage.

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Series: 6-TS-1

Lab No. 0B-42-11-82 Date 11/82 Sample ID Red Lodge Comments Area FG

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
42	0-12"	12.5	0.15	0.4	0.05	0.3	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-30-11-82 Date 11/82 Sample ID Red Lodge Series 6-TS-2

Comments Area FG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
30	0-12"	A-Cr		7.2	0.63	0.78	5.45	1.66	0.4							0.81
	Salvage 12"															

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-31-11-82 to TS-33-11-82 Date 11/82 Sample ID Red Lodge Series 6-TS-3

Comments Area FG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
31	0- 6"	A		7.5	1.80	0.76	24.5	2.37	0.2							1.56
32	6-12"	C		7.6	0.59	0.94	4.55	1.35	0.5							0.87
33	12-24"	Cr		7.8	0.49	0.95	3.03	1.75	0.6							0.48
	Salvage 24"															

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-34-11-82 and TS-35-11-82 Date 11/82 Sample ID Red Lodge

Series 6-TS-4
Comments Area FG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
34	0- 6"	A		7.6	0.44	0.75	3.75	0.85	0.5							1.32
35	6-12"	Cr		7.6	0.65	0.82	5.96	1.02	0.4							0.87
	Salvage 12"															

Kiewit Mining & Engineering Co.

Report of Laboratory Soil Analysis

Lab No. TS-36-11-82 to TS-38-11-82 Date 11/82 Sample ID Red Lodge Series 9-TS-1

Comments Area RL

Lab #	Sample Interval	Horizon	Satura-tion %	pH	Conduc-tivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
36	0- 6"			7.3	0.68	1.10	3.77	1.62	0.7							4.23
37	6-12"			7.4	0.92	0.61	7.14	3.21	0.3							3.12
38	12-24"			7.4	0.59	0.76	4.13	1.35	0.5							2.40
	Salvage 24"															

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-39-11-82 and TS-40-11-82 Date 11/82 Sample ID Red Lodge Series 9-TS-2

Comments Area RL

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
39	0- 6"			4.0	0.30	0.42	2.06	0.41	0.4							0.60
40	6-12"			3.6	0.46	0.54	3.11	0.64	0.4							<0.10
	Salvage 12"															

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-41-11-82 to TS-46-11-82 Date 11/82 Sample ID Red Lodge Series 9-TS-4

Comments Area RL

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
41	0- 6"	Ap		5.2	0.37	1.02	2.84	0.55	0.8							1.08
42	6-12"	B_2t		5.3	0.23	0.96	1.70	0.29	1.0							<0.10
43	12-24"	B_3ca		5.4	0.21	1.20	1.24	0.25	1.4							<0.10
44	24-36"	Cca		5.1	0.20	1.30	1.09	0.18	1.6							<0.10
45	36-48"	Cca		5.4	0.19	1.20	1.15	0.30	1.4							<0.10
46	48-60"	Cca		5.4	<0.15	0.87	0.87	0.17	1.2							0.12

Salvage 60"

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-47-11-82 to TS-50-11-82 Date 11/82 Sample ID Red Lodge Series 9-TS-5

Comments Area RL

Lab #	Sample Interval	Horizon	Satura-tion %	pH	Conduc-tivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
47	0- 6"	Ap		5.6	0.30	0.81	2.52	0.73	0.6							1.50
48	6-12"	B		5.4	0.38	1.30	2.86	0.67	1.0							1.17
49	12-24"	C		5.7	0.25	1.20	1.79	0.33	1.2							0.54
50	24-32"	C		5.9	0.20	0.95	1.50	0.23	1.0							1.83

Salvage 32"

UNDISTURBED
SOIL SAMPLE SOUTH
OF NORTH DUMP

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-43-11-82 and OB-44-11-82 Date 11/82 Sample ID Red Lodge Series PS-9-TS-1

Comments Area PS

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
43	0- 6"			7.0	3.60	3.50	33.2	17.0	0.7							<0.10
44	6-12"			7.3	0.57	0.85	3.04	1.36	0.6							<0.10

Pan spot sample.

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-43-11-82 and OB-44-11-82 Date 11/82 Sample ID Red Lodge Series: PS-9-TS-1 Comments Area PS

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
43	0- 6"	10.9	0.12	1.5	<0.01	<0.2	<0.02
44	6-12"	9.0	0.13	1.5	<0.01	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-45-11-82 Date 11/82 Sample ID Red Lodge Series 9-TS-3

Comments Area PS

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
45	0-12"			6.6	0.37	0.81	2.46	1.21	0.6							
	Salvage to 12"															2.13

Kiewit Mining & Engineering Co. Env. Lab

Report of Laboratory Soil Analysis

Series: 9-TS-3

Lab No. OB-45-11-82 Date 11/82 Sample ID Red Lodge Comments Area PS

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
45	0-12"	14.4	0.22	0.9	<0.01	<0.2	<0.02

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-12-11-82 to OB-14-11-82 Date 11/82 Sample ID Red Lodge

Series: 6-OB-1, 6-OB-2, 6-OB-3

Comments Area FG

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
12	6-OB-1/ 0-12"	22.8	0.31	1.3	0.07	<0.2	<0.02
13	6-OB-2/ 0-12"	14.2	0.19	0.9	0.05	<0.2	<0.02
14	6-OB-3/ 0-12"	33.5	0.07	0.3	0.02	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-51-11-82 to TS-53-11-82 Date 11/82 Sample ID Red Lodge Series 10-TS-1
Comments Area SM

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
51	0- 6"	A		6.7	0.50	1.10	3.51	0.81	0.7							3.57
52	6-12"	C		7.0	0.40	0.90	2.81	0.62	0.7							2.82
53	12-24"	Cr		7.4	0.32	0.89	2.43	0.58	0.7							1.50

Salvage 24"

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-54-11-82 Date 11/82 Sample ID Red Lodge Series 10-TS-2

Comments Area SM

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
54	0-6"	C		7.4	0.38	0.68	4.02	0.68	0.4							0.90
	Salvage 6"															

Kiewit Mining & Engineering Co.

Report of Laboratory Soil Analysis

Lab No. 0B-27-11-82 Date 11/82 Sample ID Red Lodge Series 11-0B-1

Comments Area WS

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
27	0-12"			4.7	1.37	0.89	9.34	4.54	0.3							1.77

No salvage.

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Series: 11-OB-1

Lab No. OB-27-11-82 Date 11/82 Sample ID Red Lodge Comments Area WS

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
27	0-12"	23.5	0.07	0.5	<0.01	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-55-11-82 and TS-56-11-82 Date 11/82 Sample ID Red Lodge Series 11-TS-1

Comments Area WS

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
55	0- 6"	AC		7.2	0.55	0.71	5.02	1.14	0.4							1.26
56	6-18"	Cr		7.4	0.35	0.47	2.53	1.20	0.3							0.69
	Salvage 18"															

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-57-11-82 to TS-59-11-82 Date 11/82 Sample ID Red Lodge Series 12-TS-1

Comments Area WD

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
57	0- 6"			6.7	0.57	1.50	3.58	1.61	0.9							1.68
58	6-12"			7.3	0.64	4.40	1.80	1.42	3.5							1.26
59	12-24"			7.5	0.55	4.90	0.94	0.74	5.3							3.00
	Salvage 24"															

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-60-11-82 to TS-62-11-82 Date 11/82 Sample ID Red Lodge Series 14-TS-1

Comments Area RL

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
60	0- 6"	A		7.8	0.70	0.94	5.13	1.54	0.5							2.04
61	6-12"	B_2t		5.8	0.29	1.30	1.81	0.45	1.2							0.72
62	12-23"	B_3		5.5	0.24	1.00	1.07	0.25	1.2							0.48
	Salvage 23"															

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-63-11-82 to TS-67-11-82 Date 11/82 Sample ID Red Lodge Series 15-TS-1

Comments Area VG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
63	0- 6"			5.8	1.01	1.20	9.06	3.12	0.5							7.44
64	6-12"			7.4	0.53	0.81	3.79	1.24	0.5							2.34
65	12-24"			7.5	0.50	0.58	4.00	1.15	0.4							1.53
66	24-48"			7.7	0.39	1.08	2.78	1.04	0.8							1.29
67	48-62"			7.1	0.90	0.57	7.92	2.10	0.3							1.17
	Salvage 62"															

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. TS-68-11-82 to TS-71-11-82 Date 11/82 Sample ID Red Lodge

Series 16-TS-1

Comments Area VG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
68	0- 6"			7.6	0.67	2.40	3.15	2.10	1.5							2.01
69	6-12"			7.4	0.65	0.88	6.78	1.37	0.4							<0.10
70	12-24"			7.6	0.36	0.52	3.22	0.68	0.4							<0.10
71	24-42"			8.0	0.37	0.64	2.25	1.75	0.5							<0.10

Kiewit Mining & Engineering Co.

Report of Laboratory Soil Analysis

Lab No. TS-72-11-82 to TS-75-11-82 Date 11/82 Sample ID Red Lodge Series 17-TS-1

Comments Area VG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
72	0- 6"	A		7.3	0.87	0.54	7.07	2.28	0.2							1.35
73	6-12"	C		7.8	0.57	0.54	5.01	1.16	0.3							0.51
74	12-24"	C		7.5	0.45	0.55	4.07	1.06	0.3							0.93
75	24-32"	C		7.6	0.44	0.72	2.93	1.43	0.5							0.42

Salvage to 32"

6.3.4 The following tables illustrate the laboratory results for the gob and spoil pile samples. The series is the sample number and may be located on Exhibits 3 and 4.

Kiewit Mining & Engineering Co.

Report of Laboratory Soil Analysis

Lab No. 0B-1-11-82 Date 11/82 Sample ID Red Lodge

Series 1-0B-1

Comments Area BC

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
	0-12"			3.5	4.01	1.90	27.7	20.2	0.4							0.48

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-1-11-82 Date 11/82 Sample ID Red Lodge Series: 1-OB-1
Comments Area BC

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
1	0-12"	39.2	0.19	3.0	0.05	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-2-11-82 to OB-3-11-82 Date 11/82 Sample ID Red Lodge Series 2-OB-1 2-OB-2

Comments Area BC

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
2	2-OB-1/ 0-12"			6.6	0.65	0.61	4.02	2.22	0.3							0.63
3	2-OB-2/ 0-12"			5.1	4.40	1.20	28.9	40.6	0.2							0.87

Kiewit Mining & Engineering Co. Env. Lab

Report of Laboratory Soil Analysis

Lab No. OB-2-11-82 to OB-3-11-82 Date 11/82 Sample ID Red Lodge Series: 2-OB-1, 2-OB-2

Comments Area BC

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
2	2-OB-1/ 0-12"	18.9	0.07	1.5	0.05	<0.2	<0.02
3	2-OB-2/ 0-12"	107	0.20	0.6	0.02	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-4-11-82 Date 11/82 Sample ID Red Lodge Series 3-OB-1
Comments Area BN

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
4	0-12"			5.3	2.70	0.55	32.1	6.83	0.1							1.11

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

b No. 0B-4-11-82 Date 11/82 Sample ID Red Lodge Series: 3-0B-1
Comments Area BN

b #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
4	0-12"	17.0	0.3	0.4	0.03	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

[illegible]b No. OB-5-11-82 to OB-6-11-82 Date 11/82 Sample ID Red Lodge Series 4-OB-1 4-OB-2

Comments Area CM

[illegible]b #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
5	4-OB-1/ 0-12"			6.4	4.30	2.00	28.6	37.9	0.3							<0.10
6	4-OB-2/ 0-12"			5.0	3.10	0.71	27.1	15.7	0.2							0.96

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-5-11-82 to OB-6-11-82 Date 11/82 Sample ID Red Lodge Series: 4-OB-1, 4-OB-2
Comments Area CM

#	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
	4-OB-1/ 0-12"	12.7	0.11	1.2	0.02	<0.2	<0.02
	4-OB-2/ 0-12"	17.2	0.04	0.2	0.03	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Series: 5-OB-1, 5-OB-2, 5-OB-3, 5-OB-4, 5-OB-5

No. OB-7-11-82 to OB-11-11-82 Date 11/82 Sample ID Red Lodge Comments Area FG

#	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
	5-OB-1/ 0-12"			6.8	1.79	0.79	15.9	5.08	0.2							0.21
	5-OB-2/ 0-12"			5.6	3.00	1.40	27.4	17.3	0.3							0.72
	5-OB-3/ 0-12"			5.9	4.30	4.50	27.6	37.9	0.8							0.90
	5-OB-4/ 0-12"			6.0	13.0	80.0	22.6	138.0	8.9							0.66
	5-OB-5/ 0-12"			6.6	1.68	3.20	6.07	6.38	1.3							0.54

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-7-11-82 to OB-11-11-82 Date 11/82 Sample ID Red Lodge

Series: 5-OB-1, 5-OB-2, 5-OB-3, 5-OB-4, 5-OB-5
Comments Area FG

# Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
5-OB-1/ 0-12"	13.3	0.6	0.5	0.05	<0.2	<0.02
5-OB-2/ 0-12"	17.1	0.17	0.6	0.01	<0.2	<0.02
5-OB-3/ 0-12"	21.6	0.12	0.6	<0.01	<0.2	<0.02
5-OB-4/ 0-12"	111	0.15	1.2	0.03	<0.2	<0.02
5-OB-5/ 0-12"	23.3	0.02	4.5	0.07	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-12-11-82 to OB-14-11-82 Date 11/82 Sample ID Red Lodge Series 6-OB-1, 6-OB-2, 6-OB-3

Comments Area FG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
12	6-OB-1/ 0-12"			2.9	3.30	1.60	27.2	7.72	0.4							1.95
13	6-OB-2/ 0-12"			3.0	3.10	1.30	28.1	3.19	0.3							<0.10
14	6-OB-3/ 0-12"			3.8	3.70	4.10	28.1	10.8	0.9							<0.10

NORTH DUMP
OVERBURDEN
4 DIFF SAMPLE SITES

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-15-11-82 to OB-22-11-82 Date 11/82 Sample ID Red Lodge

Series: 8-OB-1, 8-OB-2, 8-OB-3, 8-OB-4
Comments Area RL

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
15	8-OB-1/ 0- 3"	25.0	0.09	0.5	0.13	<0.2	<0.02
16	3-12"	20.6	0.07	0.2	0.08	<0.2	<0.02
17	8-OB-2/ 0-12"	7.5	0.08	0.7	0.74	<0.2	<0.02
18	8-OB-3/ 0-12"	7.9	0.11	0.4	0.15	<0.2	<0.02
19	8-OB-4/ 0-12"	6.4	0.07	0.8	0.10	<0.2	<0.02
20	12-24"	5.9	0.07	0.2	0.19	<0.2	<0.02
21	24-48"	5.6	0.05	1.0	0.23	<0.2	<0.02
22	48-72"	11.6	0.17	5.6	0.19	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-15-11-82 to OB-22-11-82 Date 11/82 Sample ID Red Lodge

Series 8-OB-1 8-OB-2 8-OB-3 8-OB-4

Comments Area RL

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
15	8-OB-1/ 0- 3"			3.8	2.32	0.76	14.7	9.90	0.2							0.93
16	3-12"			3.6	0.87	0.85	5.58	3.07	0.4							0.90
17	8-OB-2/ 0-12"			3.9	0.88	0.98	5.01	2.57	0.5							2.01
18	8-OB-3/ 0-12"			3.7	2.80	1.01	26.6	11.3	0.2							1.44
19	8-OB-4/ 0-12"			3.9	0.57	0.84	3.02	1.18	0.6							3.60
20	12-24"			3.7	1.05	0.78	7.32	3.17	2.4							2.25
21	24-48"			3.8	2.38	1.30	24.9	5.12	0.3							5.73
22	48-72"			5.3	2.98	1.40	28.3	16.9	0.3							3.93

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-23-11-82 Date 11/82 Sample ID Red Lodge Series 9-OB-1

Comments Area RL

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
23	0-12"			3.7	1.50	1.20	10.6	3.71	0.4							1.41

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. 0B-23-11-82 Date 11/82 Sample ID Red Lodge Series: 9-0B-1
Comments Area RL

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
23	0-12"	9.0	0.06	0.3	0.07	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-24-11-82 to OB-26-11-82 Date 11/82 Sample ID Red Lodge Series 10-OB-1, 10-OB-2, 10-OB-3

Comments Area SM

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
24	10-OB-1/ 0-12"			3.4	2.60	1.10	28.5	4.11	0.3							2.55
25	10-OB-2/ 0-12"			7.4	3.20	1.70	24.6	14.5	0.4							3.54
26	10-OB-3/ 0-12"			3.2	3.18	1.60	25.3	6.65	0.4							9.48

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-24-11-82 to OB-26-11-82 Date 11/82 Sample ID Red Lodge

Series: 10-OB-1, 10-OB-2, 10-OB-3
Comments Area SM

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
24	10-OB-1/ 0-12"	11.3	0.04	0.5	0.13	<0.2	<0.02
25	10-OB-2/ 0-12"	21.2	0.07	<0.1	0.08	0.3	<0.02
26	10-OB-3/ 0-12"	18.4	0.09	0.3	0.04	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-27-11-82 to OB-29-11-82 Date 11/82 Sample ID Red Lodge Series 11-OB-1, 11-OB-2, 11-OB-3 Comments Area WS

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
27	11-OB-1/ 0-12"			4.7	1.37	0.89	9.34	4.54	0.3							1.77
28	11-OB-2/ 0-12"			4.0	4.90	4.00	29.8	35.9	0.7							1.14
29	11-OB-3/ 0-12"			5.4	1.23	1.20	6.79	5.33	0.5							1.47

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-27-11-82 to OB-29-11-82 Date 11/82 Sample ID Red Lodge

Series: 11-OB-1, 11-OB-2, 11-OB-3
Comments Area WS

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
27	11-OB-1/ 0-12"	23.5	0.07	0.5	<0.01	<0.2	<0.02
28	11-OB-2/ 0-12"	42.5	0.12	<0.1	0.04	0.2	<0.02
29	11-OB-3/ 0-12"	8.8	0.16	0.5	0.02	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-30-11-82 to OB-31-11-82 Date 11/82 Sample ID Red Lodge Series 12-OB-1 12-OB-2

Comments Area WD

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
30	12-OB-1/ 0-12"			6.5	0.80	1.60	4.92	1.95	0.9							0.12
31	12-OB-2/ 0-12"			5.7	1.13	1.00	6.30	4.07	0.4							0.81

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-30-11-82 to OB-31-11-82 Date 11/82 Sample ID Red Lodge

Series: 12-OB-1, 12-OB-2
Comments Area WD

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
30	12-OB-1/ 0-12"	7.8	0.11	2.1	0.06	0.7	<0.02
31	12-OB-2/ 0-12"	9.4	0.07	1.1	0.02	0.3	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-32-11-82 to OB-34-11-82 Date 11/82 Sample ID Red Lodge

Series 14-OB-1 14-OB-2

Comments Area RL

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
32	14-OB-1/ 0- 4"			5.7	0.90	0.97	6.16	4.10	0.4							0.87
33	4-12"			5.2	0.91	1.30	4.79	2.84	0.7							0.96
34	14-OB-2/ Composite			6.7	10.1	114.0	22.2	18.5	25.3							4.44

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Lab No. OB-32-11-82 to OB-34-11-82 Date 11/82 Sample ID Red Lodge Series: 14-OB-1, 14-OB-2
Comments Area RL

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
32	14-OB-1/ 0- 4"	9.4	0.12	1.3	0.05	0.2	<0.02
33	4-12"	10.4	<0.01	1.5	0.03	0.3	<0.02
34	14-OB-2/ Composite	8.3	0.08	1.0	0.05	<0.2	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. 0B-35-11-82 Date 11/82 Sample ID Red Lodge Series 15-0B-1

Comments Area UG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
35	0-12"			2.8	3.00	1.60	25.9	14.6	0.4							1.11

Kiewit Mining & Engineering Co.

Report of Laboratory Soil Analysis

Lab No. 0B-36-11-82 Date 11/82 Sample ID Red Lodge Series 16-0B-1

Comments Area VG

Lab #	Sample Interval	Horizon	Satura-tion %	pH	Conduc-tivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
36	0-12"			2.8	3.10	1.30	25.3	6.75	0.3							<0.10

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Series: 16-OB-1

Lab No. OB-36-11-82 Date 11/82 Sample ID Red Lodge Comments Area VG

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
36	0-12"	10.0	0.11	0.3	0.05	0.4	<0.02

Kiewit Mining & Engineering Co.
Report of Laboratory Soil Analysis

Lab No. OB-37-11-82 Date 11/82 Sample ID Red Lodge Series 17-OB-1
Comments Area UG

Lab #	Sample Interval	Horizon	Saturation %	pH	Conductivity mmhos/cm	Sodium meq/L	Calcium meq/L	Magnesium meq/L	SAR	V Fine Sand	% Sand	% Silt	% Clay	Texture Class*	% Organic Matter	Boron (B) PPM
37	0-12"			4.5	3.00	0.73	32.4	6.73	0.2							1.35

Kiewit Mining & Engineering Co. Env. Lab
Report of Laboratory Soil Analysis

Series: 17-OB-1

Lab No. OB-37-11-82 Date 11/82 Sample ID Red Lodge Comments Area UG

Lab #	Sample Interval	Nitrate (as N) PPM	Cadmium (Cd) PPM	Lead (Pb) PPM	Mercury (Hg) PPM	Molybdenum (Mo) PPM	Selenium (Se) PPM
37	0-12"	13.2	0.07	0.2	<0.01	0.4	<0.02

RED LODGE COAL FIELD
PHASE I REPORT
Table 6.3.1
Analytical Methods and Procedures

Analysis	Procedure
1. Preparation of soils for analysis and subsampling	U.S.D.A. Handbook 60, 1954 - Diagnosis and Improvement of Saline and Alkali Soils, pp. 83-84; all analyses conducted on samples that have been passed through at least a 20-mesh sieve.
2. pH (determination on paste)	U.S.D.A. Handbook 60, p. 102.
3. Conductivity mmohs/cm on saturation extract	U.S.D.A. Handbook 60, pp. 88-89.
4. Calcium - Report in meq/l on the extract	Preparation of extract U.S.D.A. Handbook 60, p. 84, Method 2 and 3a. Analysis by atomic absorption spectrophotometry.
5. Magnesium - Report in meg/l	Same as for Calcium.
6. Sodium - Report in meq/l	Same as for Calcium.
7. SAR (Sodium Adsorption Ratio)	U.S.D.A. Handbook 60, p. 26, $SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$ Where Na^{+}, Ca^{2+} and Mg^{2+} are the concentrations of those ions found in 5, 6 and 7 above.
8. Boron - Hot water extract reported as ppm	A.S.A. Agronomy Monograph #9, 1965. Methods of Soil Analysis, Part 2, Method 62-3.6, pp. 949-951.
9. Nitrate (as N) (ppm)	Analysis by phenoldisufonic acid method, A.S.A. Monograph #9, part 2, p. 1212-1214.
10. Cadmium (ppm)	DTPA extractable. Analysis by atomic absorption spectrophotometry.
11. Lead (ppm)	Same as Cadmium.

RED LODGE COAL FIELD
PHASE I REPORT
Table 6.3.1 (cont.)
Analytical Methods and Procedures

Analysis	Procedure
12. Mercury (ppm)	Acid soluble soil Hg and analysis by cold vapor technique. Manual of Methods for Chemical Analysis of Water and Wastes, E.P.A., 1979. Method 245.5.
13. Selenium (ppm)	Hot water extract. Extraction procedure A.S.A. Monograph #9, part 2, 80-3.2.2, p. 1122. Analysis of extract by sodium borohydride method.
14. Molybdenum (ppm)	Acid Ammonium oxalate extraction A.S.A. Monograph #9, part 2, pp. 1054-1057. Analysis by atomic absorption spectrophotometry.

RED LODGE COAL FIELD
PHASE I REPORT
Table 6.3.2
Soil Sample Summary

Site #	Sample Depths (")	Chemical[1]	Physical[2]	Quantity[3]	Comments
1-TS-1	0- 6	G[4]	P	F	Heavy clay; weathered shale bedrock
	6-12	G	P	-	
	12-24	G	P	-	
2-TS-1	0- 6	G	G	P	Weathered shale and siltstone bed-rock at about 6 inches.
	6-12	G	F	-	
2-TS-2	0-12	G	G	P	Site located in bottom of mine cut.
3-TS-2	0- 6	G	G	P	Steep slopes; large amounts of exposed bedrock and outcropings.
	6-12	G	G	-	
	12-24	G	G	-	
3-TS-1	0-12	G	-	-	Drainage-way sample.
4-TS-1	0- 6	G	G	P	Steep slopes; shallow soils; exposed hard bedrock.
5-TS-1	0- 6	G	G	F	Soft weathered shale and siltstone occurs at about 12 inches.
	6-12	G	G	-	
	12-24	G	F	-	
5-TS-4	0- 6	G	G	P	Clayey textures; hard bedrock at about 17 inches.
	6-12	G	F	-	
	12-17	G	F	-	
5-TS-2	0-12	G	-	-	Drainage-way sample.
5-TS-3	0-12	G	-	-	Drainage-way sample.

RED LODGE COAL FIELD
PHASE I REPORT
Table 6.3.2 (cont.)
Soil Sample Summary

SOIL SAMPLE DESCRIPTION

Site #	Sample Depths (")	Chemical[1]	Physical[2]	Quantity[3]	Comments
6-TS-2	0-12	G	G	P	Steep slopes; shallow to bedrock; much rock outcropping.
6-TS-3	0- 6	G	G	P	Steep slopes; much rock outcropping; weathered bedrock at 6 to 12 inches.
	6-12	G	F	-	
	12-24	G	F	-	
6-TS-4	0- 6	G	G	P	Steep broken slopes; much rock outcropping; weathered bedrock at about 6 inches or less.
	6-12	G	F	-	
6-TS-1	0-12	G	-	-	Drainage-way sample; coal slack on surface.
9-TS-1	0- 6	F	G	P	Reworked soil, outcast material and coal fines from road cut on side of terrace; slightly elevated boron readings at 0 to 6 inches; some barren patches.
	6-12	G	G	-	
	12-24	G	G	-	
9-TS-2	0- 6	G	G	P	Reworked soil, outcast material, and coal fines along terrace road cut.
	6-12	G	G	-	
9-TS-4	0- 6	G	G	G	Good deep clay loam soil; slightly low Ph readings.
	6-12	G	G	-	
	12-24	G	G	-	
	24-36	G	G	-	
	36-48	G	G	-	
	48-60	G	G	-	

RED LODGE COAL FIELD
PHASE I REPORT
Table 6.3.2 (cont.)
Soil Sample Summary

Site #	Sample Depths (")	Chemical[1]	Physical[2]	Quantity[3]	Comments
9-TS-5	0- 6	G	G	G	Slightly low pH readings; soil underlain with gravels in place; generally deep soil.
	6-12	G	G	-	
	12-24	G	G	-	
	24-32	G	G	-	
PS-9-TS-1	0- 6	G	P	-	Pan spot area; appears to be overburden fill material placed in old subsidence hole.
	6-12	G	P	-	
9-TS-3	0-12	G	F	P	Sample taken in field near pan spot; cobbles and boulders occur throughout soil profile to the surface.
10-TS-1	0- 6	G	G	P	Steep, broken slopes; weathered bedrock and hard bedrock occurs at about 18 inches.
	6-12	G	F	-	
	12-24	G	F	-	
10-TS-2	0- 6	G	F	P	Sample taken on bedrock plain; hard bedrock is exposed on about ½ of the area.
11-TS-1	0- 6	G	G	P	Hard bedrock occurs to the surface over much of the area.
	6-18	G	F		
11-OB-1	0-12	P	F	P	Sample taken in bottom of mine cut; pH 4.7.
12-TS-1	0- 6	G	P	G	Very heavy clayey soils.
	6-12	G	P		
	12-24	G	P		

RED LODGE COAL FIELD
PHASE I REPORT
Table 6.3.2 (cont.)
Soil Sample Summary

Site #	Sample Depths (")	Chemical[1]	Physical[2]	Quantity[3]	Comments
14-TS-1	0- 6	G	G	F	Gravels occur at about 2 feet or shallower.
	6-12	G	G	-	
	12-23	G	G	-	
15-TS-1	0- 6	P	G	G	Elevated boron level at 0 to 6 inches; good vegetative cover; good texture; some gravel stringers occur below 60 inches.
	6-12	G	G	-	
	12-24	G	G	-	
	24-48	G	G	-	
	48-62	G	G	-	
16-TS-1	0- 6	G	G	F	Hit hard bedrock at 42 inches; steep slopes; scattered rock outcroppings.
	6-12	G	G	-	
	12-24	G	G	-	
	24-42	G	G	-	
17-TS-1	0- 6	G	G	G	Good, deep, clay loam soil.
	6-12	G	G	-	
	12-24	G	G	-	
	24-32	G	G	-	

[1]Chemical = Determination made from laboratory analyses, based on Montana Land Quality Division guidelines.

[2]Physical = Field conditions and textures.

[3]Quality = Based on field determinations and analytical data for the general sample area (0-20 inches = Poor; 20-40 inches = Fair; 40-60+ inches = Good).

[4]G = Good; F = Fair; P = Poor.

RED LODGE COAL FIELD
PHASE I REPORT
Table 6.3.3 (cont.)
Spoil and Gob Pile Sample Summary

Site #	Sample Depth (in.)	Suitability*	Sample Location Comments
16-OB-1	0-12	U	Small gob pile near abandoned load-out; acid pH; barren.
17-OB-1	0-12	U	Gob pile at portal mouth; acid pH; barren.

*S = Suitable
U = Unsuitable

Determinations made from field observations and laboratory analyses, based on Montana Land Quality division guidelines.

RED LODGE COAL FIELD
PHASE I REPORT
Table 6.3.3
Spoil and Gob Pile Sample Summary

Site #	Sample Depth (in.)	Suitability*	Sample Location Comments
1-OB-1	0-12	U	Face of gob pile; acid pH; no vegetation.
2-OB-1	0-12	S	Inside slope of spoil outcast material; north facing slope; vegetated.
2-OB-2	0-12	U	Crest of spoil outcast pile; high NO_3; barren.
3-OB-1	0-12	S	Crest of gob pile; barren.
4-OB-1	0-12	S	Small dump area (gob pile) on west side of drainage; barren.
4-OB-2	0-12	S	Small gob pile near portal mouth; barren.
5-OB-1	0-12	S	Inside slope of spoil outcast material; mixed sandstone and shale; WNW facing slope; vegetated.
5-OB-2	0-12	S	Outside slope of spoil outcast material; 45-60% north facing slope; vegetated.
5-OB-3	0-12	S	Inside slope of spoil outcast material; 45-60% south facing slope; very sparse vegetation.
5-OB-4	0-12	U	Crest of spoil outcast pile; high NO_3; barren.
5-OB-5	0-12	S	Inside slope of spoil outcast pile; 20-25% south facing slope; vegetated.
6-OB-1	0-12	U	Small dump area (gob pile) on ESE facing slope; acid pH; barren.
6-OB-2	0-12	U	Top of gob pile located in drainage; acid pH; barren.
6-OB-3	0-12	U	Mixed shale, scoria and coal slack at base of small gob pile; acid pH; barren.
8-OB-1	0- 3 3-12	U U	Flat top of gob pile west of Rock Creek; granular surface materials; acid pH; vegetated.

OVERBURDEN DESCRIPTION

RED LODGE COAL FIELD
PHASE I REPORT
Table 6.3.3 (cont.)
Spoil and Gob Pile Sample Summary

Site #	Sample Depth (in.)	Suitability*	Sample Location Comments
8-OB-2	0-12	U	Base of gob pile near river; loose granular materials; extremely steep slope; barren.
8-OB-3	0-12	U	Top of gob pile; acid pH; barren area approximately 10 feet in diameter (numerous barren patches in this area appears to have been caused by camp fires).
8-OB-4	0-12 12-24 24-48 48-72	U U U U	Cut in east face of gob pile for municipal solid waste disposal; granular materials near surface; acid pH and high boron readings; vegetated.
9-OB-1	0-12	U	West side at base of gob pile; acid pH; barren.
10-OB-1	0-12	U	Top of west gob pile; acid pH; barren.
10-OB-2	0-12	S	Top of large central gob pile; barren.
10-OB-3	0-12	U	South base of east gob pile; acid pH and high boron; barren.
11-OB-2	0-12	U	Crest of spoil outcast pile; acid pH; barren.
11-OB-3	0-12	S	Outside east facing slope of spoil outcast pile; vegetated.
12-OB-1	0-12	S	North facing slope of gob pile; barren.
12-OB-2	0-12	S	North facing slope of gob pile; vegetated.
14-OB-1	0- 4 4-12	S S	Northeast face of gob pile; loose granular surface material; vegetated.
14-OB-2	96	U	Composite sample taken from cut face on southeast side of gob pile; high sodium; barren.
15-OB-1	0-12	U	Top of large gob pile in Virtue Gulch drainage; acid pH; barren.

Associated Surveys Inc.
land & aerial
P.O. BOX 20953 • 1127 ALDERSON
BILLINGS, MONTANA 59102
(406) 252-6685

LETTER OF TRANSMITTAL

RECEIVED
JUN 28 1983
STATE LANDS

DATE: June 27, 1983
JOB NO.: 50-80-1
ATTENTION: Dick Juntunen
RE:

TO: Department of State Lands
Capitol Station
Helena, Montana 59601

GENTLEMEN:

WE ARE SENDING YOU ☐ Attached ☐ Under separate cover via ______ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications

☐ Copy of letter ☐ Change order ☐ ______

COPIES	DATE	NO.	DESCRIPTION
			Contact Sheets and Copies of Flight Logs For 6-10-83 and 6-15-16-83
			2nd Transmittal of Data For Kiewit, Requested Mapping North of
			Virtue Gulch.

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit ______ copies for approval

☐ For your use ☐ Approved as noted ☐ Submit ______ copies for distribution

☐ As requested ☐ Returned for corrections ☐ Return ______ corrected prints

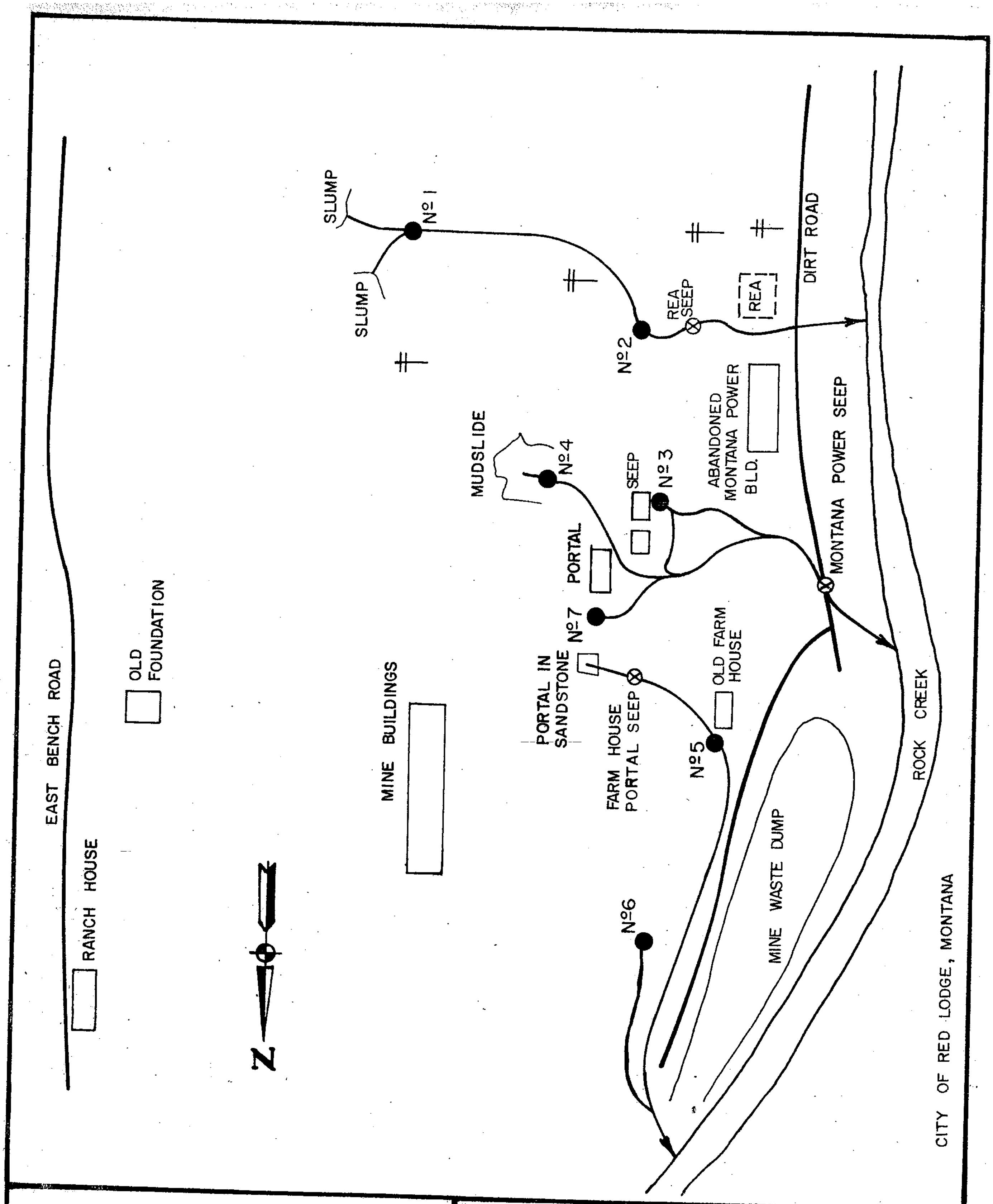
☐ For review and comment ☐ ______

☐ FOR BIDS DUE ______ 19 ______ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS ______

COPY TO ______

SIGNED: Jim Osman
Jim Osman



⊗ KME SAMPLING SITE

● FISH AND GAME SAMPLING SITE

EXHIBIT Nº 8

RED LODGE AML PROJECT
CARBON COUNTY, MONT.

APPROXIMATE LOCATION OF WASTE WATER SEEPS FROM UNDERGROUND MINE OPENINGS NEAR RED LODGE

DRAWN BY:	DATE	SHEET
JCC	1-17-82	

DRAWING NO.

PKS PETER KIEWIT SONS' COMPANY – MINING DISTRICT