APPENDIX D

TECHNICAL REPORT ON THE WELCH RANCH COAL FIRE

Technical Report on the Welch Ranch Coal Fire
Sheridan County, Wyoming

April 28, 2003

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Description of Site Visits

On May 22, 2002, Richard Zander, Willy Frank, and Mike McKinley of the Buffalo FO, Ed Heffern and Ken Henke of the Wyoming SO, and Randy McKinley of the USGS EROS remote sensing data center in Sioux Falls, SD, visited the Welch Ranch along the Tongue River about nine miles north of Sheridan, Wyoming. This private ranch is owned by the Pittsburg and Midway Coal Mining Company (P&M), under their parent company ChevronTexaco, and is part of a proposed exchange for Federal coal in the Ash Creek area several miles northwest of the Welch Ranch.

We visited the area to evaluate concerns about a coal fire on the Welch Ranch property raised by Mr. Frank Mommsen, a local landowner, in a congressional inquiry from Senator Enzi of Wyoming. Mr. Mommsen has stated on several occasions that a coal fire was burning on the Welch Ranch north of the abandoned Acme mine. Some BLM staff had been aware of the fire since early in the exchange negotiations, when Western Water Consultants discussed and photographed the fire in an environmental site study prepared for the exchange (WWC 2001). The mineral report prepared for the exchange by Jerry Queen, the Buffalo Field Office geologist, also mentioned and photographed the fire (Queen 2000). However, this fire was only briefly mentioned in the draft EIS for the exchange proposal. On page 3-9 of the draft, after discussing reclamation of underground coal fires in the abandoned Acme Mine just south of the Welch Ranch, one sentence states: “Spontaneous coal fires still occur along outcrops adjacent to the Tongue River within the Welch lands, specifically in the southwest portion of T.58N., R.84W., Section 2 (WWC 2001)”. The actual location is in T.57N., rather than T.58N.

We saw evidence that the coal underlying a hillside between and north of two draws along the west bank of the Tongue River is actively burning, in the area of the proposed exchange. The day was cold, with drizzle and sleet, so we left after taking some pictures and videotape of the fire. The next day, BLM geologists Jerry Queen of the Buffalo FO and Ed Heffern of the Wyoming SO returned and used a Trimble Pathfinder Pro XR GPS unit to map the fissures and the extent of the fire, and an Industrial Scientific ATX 620 unit to collect oxygen, methane, and carbon monoxide spot readings at several fissures and vents (Photo 1). These data were downloaded into ArcView GIS to produce Figure 1 of this report.

Figure 1 shows that the treeless area associated with the coal fire covers about 13 acres. The lack of trees may be a result of the ground being too hot for plants with deep roots, or have something to do with fumes coming from the fissures. The coal underlying the upper part of the hillside appears to be actively burning, as evidenced by fissures several feet deep. Figure 2 is a black and white enlargement of a small part of a NAPP color infrared aerial photo of the Acme area, taken on September 20, 2001. The active coal fire is visible in the north central part of the picture as a treeless area along the west bank of the Tongue River. Fissures are especially visible along the north edge of the fire and the land surface appears to be slumping south and east towards the river. The northern limit of the fissures (and underground coal fire) is near the top of the hill (see Photo 2). In places, these fissures emit heat and vapor. At vent #6, the plastic funnel attached to the ATX 620 gas monitor partially melted as we were taking gas readings in the fissure about a foot below the surface (Photo 3). Gas readings in the fissures showed elevated levels of methane and carbon monoxide, and depleted levels of oxygen (Table 1). Methane concentrations varied from 100 to 5,000 ppm, and averaged 1,600 ppm. Carbon monoxide levels varied from 1 to 1,000 ppm and averaged 300 ppm; the two highest readings (1,000 ppm) were at the instrument's maximum detection limit and caused the over range alarm to go off. Oxygen levels varied from 18.0 to 20.8 percent and averaged 19.5 percent.

In the area where the coal is actively burning, only grass grows (Photos 4 and 5). Some burned logs are present. In the hottest areas, not even grass grows on the ground. Partly burned ponderosa pine and juniper trees are present along the perimeter of the fire; some of these have dead or discolored branches, probably due to the vapor and/or heat coming off the coal (Photos 6 and 7). The junipers grow in an unusual columnar fashion.

Table 1. Gas Readings at Welch Ranch Coal Fire.

Data Point	Carbon Monoxide (ppm)	Methane (ppm)	Oxygen (percent)
Vent 1	1	100	20.5
Vent 2	1,000	5,000	19.3
Vent 3	239	2,500	20.1
Vent 4	67	800	18.0
Vent 5	1,000	2,300	18.8
Vent 6	163	1,000	19.0
Vent 7	132	1,000	20.4
Vent 8	210	1,500	18.4
Vent 9	30	300	20.8
Hot Spot	158	1,500	19.9

In September of 2002, contractors for the Wyoming State Abandoned Mine Land Division, Department of Environmental Quality (AMLD), worked onsite to stabilize the north end of the fire. On September 17, 2002, Dennis Stenger and Richard Zander of the Buffalo Field Office toured the reclamation site with

Rodney Gaines of P&M. They discussed the reclamation efforts with David Murja of Spectrum Engineering (the AMLD consultant) and possible safety fencing and educational interpretation needs if BLM decides to acquire the site.

On September 26, 2002, Ed Heffern of the Wyoming State Office and Mike McKinley of the Buffalo Field Office returned to check the progress of the reclamation effort. The northern edge of the fire was in the final stages of being regraded (Photos 12–14). The foreman for the AMLD contractor, Everett Seaton of S&T Excavating in Thermopolis, Wyoming, said that they had worked on the site for the past three weeks with Spectrum Engineering to fill the fissures. The smaller cracks were excavated to the base of the crack (six to eight feet deep on average), filled with two feet of reject fines from crushed clinker (scoria), and backfilled the rest of the way with country rock. The larger cracks were filled with a slurry of clinker fines and water. A D-8 bulldozer was busy regrading the surface. The fissures on the steep hill to the south had not been reclaimed due to concerns about stability of the excavation equipment on the slope.

On the morning of February 25, 2003, Jerry Queen, Bob Hartman and Barney Whiteman of the Buffalo Field Office visited the Welch fire site. The air temperature was 15 to 20 degrees F., which was the warmest since a snowstorm had blanketed the area two days before. However, vapor was rising from areas of melting snow and bare spots and fissures were exposed in the regraded area near the top of the hill at the north end of the fire and along the ridge to the east. Snow covered the rest of the landscape, indicating that coal is still smoldering at depth despite the reclamation efforts. They took photographs and GPS measurements (Photos 15-16).

Geology

Figures 3 and 5 of this report provide a picture of the geology at the site. They are based on the structure and isopach maps for the Monarch, Dietz 2, and Dietz 3 coal beds (Figures 2.5-5, 6, and 7) and cross-sections A through D (Figures 2.5-8 through 12) in the geology section of the Welch No. 1 North mine permit application (Sheridan Enterprises 1983). Three coal beds are present below the surface of the hillside. They dip to the east at a slope of about 200 feet per mile. The uppermost Dietz 2 bed is about eight feet thick; its top drops from an elevation of about 3,730 feet in the west side of the active burn area to 3,700 feet on the east side. It has partially burned in prehistoric times to form clinker near the top of the hill. The Dietz 2 is separated by 80 to 90 feet of shale, siltstone, sandstone, and thin coal stringers from the underlying Dietz 3 bed, which is about 26 feet thick and whose top dips from an elevation of about 3,630 feet on the west side to 3,600 feet on the east side. The main burning at the site appears to be occurring in the Dietz 3 coal bed, which is between zero and 140 feet deep. A prehistoric burn of the Dietz 3 occurs in the draw a hundred yards north of the north end of the active fire. About 15 to 40 feet of

shale, siltstone, and sandstone separate the Dietz 3 from the underlying Monarch bed, which is about 16 feet thick and whose top dips from an elevation of about 3,580 feet on the west side to 3,540 feet on the east side at the edge of the Tongue River by the diversion dam. The Monarch bed is from zero to 180 feet deep. Data are lacking as to whether any of the Monarch bed has burned at the site; however, the Monarch has burned or is burning over a large area south of the Welch Ranch.

Aqua Terra Associates, Inc. of Sheridan, Wyoming, currently provides access to and manages activities on the Welch No. 1 North mine permit area for the Pittsburg-Midway Coal Company, along with Rodney Gaines of P&M. Julie Gerlach of Aqua Terra Associates is the mine manager.

The Welch fire is a few hundred yards north and east of the abandoned Acme No. 42 underground coal mine (Figure 4). According to Dunrud and Osterwald (1980), this mine was active from 1911 through 1940 and produced from the Monarch coal bed. Other records (WWC 2001) indicate that mining continued until about 1942 and produced from the underlying Carney bed as well as the Monarch coal bed. The Monarch bed has been burning sporadically due to air inflow from collapse of the rooms between the pillars in the old workings at the Acme mine. The Wyoming AMLD has done a number of reclamation and emergency rehabilitation projects over the past 20 years to extinguish these fires. As the fire advances in the Monarch bed, and the overburden collapses, the overlying Dietz 3 and Dietz 2 beds also collapse and the resulting set of fractures may be allowing oxygen in and causing these overlying beds to catch on fire as well (Figure 3 and Photos 8 and 9).

Mine maps obtained from the U.S. Office of Surface Mining's Mine Map Repository show that as of August 1940, the year that the Acme mine lost its lease, mining had advanced northward up to the boundary between Sections 2 and 11, and eastward to the boundary between Sections 2 and 3 (Figure 4). The mine maps show that most of the Monarch coal seam in the S2 SE of Section 3 was mined out, and that a prehistoric burn line kept the mine from advancing any further north. An entry had been driven diagonally into the SW SW corner of Section 2 but no mining was shown. However, it is possible that unauthorized mining could have advanced into the southwest part of Section 2 after that date. Earlier mining in Section 2 also occurred. Taff (1909, p. 141), in his U.S. Geological Survey Bulletin 341-B report on the Sheridan Coal Field, states that a Mr. Evans mined a coal bed (probably the Monarch) for domestic use in the south half of Section 2. Over 14 feet of this coal was exposed along the bank of the Tongue River, and the base was concealed below the water line. Plate VIII of his report shows an entry along the west bank of the Tongue River in the SW of Section 2. This mine could have underlain the area of the active fire. A fissure near the 3,560-foot elevation contour (see Figure 1) may mark collapse of the Monarch coal bed just above the level of the Tongue River in the active fire area. WWC (2001) reports that mine maps show that the Carney bed, as well as the overlying Monarch, was mined in the SE of Section 3.

Figure 5 shows the limits of the Acme mine in relation to the coal beds as mapped in the Welch No. 1 North mine permit application, on file with the Land Quality Division of the State Of Wyoming's Department of Environmental Quality. This application was filed in January 1983 by Sheridan Enterprises, Inc. Figure 5 was compiled by Spectrum Engineering, Inc., of Billings, Montana (Murja 2002, Attachment 3).

Current Activity and Research

A coal fire is eligible for full reclamation funding through AMLD's SMCRA program if:

1) the fire is the result of historic coal mining activity that occurred prior to the eligibility dates established in SMCRA;
2) the fire constitutes an extreme danger or potential adverse effect to public health, safety and property;
3) there is no responsible party with outstanding reclamation obligations for the site; and
4) if the site is located within the boundaries of an active coal mine permit area, the permittee must not have re-disturbed the site after the eligibility date. Currently, the area of the Welch fire is within the active permit area of the proposed Welch No. 1 North mine.

In addition to these considerations, AMLD prioritizes all potential reclamation sites based on the level of hazard, accessibility to the public, and budgetary constraints. In the case of mine fires, AMLD involvement may depend on the degree to which success is expected in controlling or extinguishing the fire.

The AMLD contracted with Spectrum Engineering to evaluate the Welch fire and perform emergency stabilization work. From September 9 through 27, 2002, David Murja of Spectrum Engineering, and the AMLD subcontractors, stabilized fissures at the north end of the Welch Ranch fire (Photos 12-14). Ernie Robb of the AMLD's Casper office and Kent Simon of the AMLD's Lander office served as project officers. The contractors graded the road to the top of the hill with a dozer and constructed a pad there, then excavated fissures, filled them with inert material, and regraded the slope. The control effort was limited to repairing and sealing cracks on top of the ridge at the north end of the site. The work was intended to reduce site hazards and to impede air circulation along the advancing edge of the underground fire by sealing cracks that were functioning as chimneys. The fissures on the hill at the south end of the fire (including vents 4, 7, 8, and 9 on Figure 1) were not reclaimed and are still open and warm. The AMLD hoped that this action would help to control surface evidence of the fire and retard its advance to the north, at least in the short term (Gillette News-Record 9/16/2002). On October 7, 2002, Spectrum submitted its final report to AMLD (Murja 2002).

The Spectrum report describes the state of the fire during the summer of 2002 and details the methods used to seal the cracks. Several sets of fissures, several feet wide and as much as seven feet deep, were on the ridge at the north end of the site; most of these fissures trended east-west. Toward the east end of the ridge, steam vents were developing. Further south and east, wide cracks had opened up in the siltstone layers at the top of the ridge. These were producing elevated temperature, methane, and carbon monoxide readings and depleted oxygen readings. Older cracks, which had nearly filled in, extended down the nose of the ridge. The fissure repair started with the cracks furthest to the north and worked south from the ridge top down the slope. The contractors dug down with a track hoe excavator to create trenches about eight feet deep, then used a wheel loader to fill the base of each trench with two to three feet of dry, finely ground clinker waste which had been trucked in from a crushing operation north of Ranchester. The excavator compacted the fines, then backfilled the trench to the surface with excavated material. For the deeper cracks extending down the nose of the ridge, and for those cracks furthest downhill where it was difficult to get equipment in, a slurry of clinker fines and water was pumped in to seal the fissures. In total, the contractors repaired 23 cracks and vents totaling 2,410 linear feet. Temperatures at the base of the trenches ranged from ambient air temperature to 359 degrees F.

Several remote sensing projects have been conducted, or are pending, in the area. In August 2002, Airborne Data Systems completed a thermal imaging project of the entire Acme area. Results were inconclusive. Attachment 1 of the Murja (2002) report is a thermal scan of the fire area by Airborne Data Systems; the report recommends periodic thermal scans early in the morning and during winter months so problems with solar heating can be negated.

Randy McKinley of the USGS EROS remote sensing data center in Sioux Falls, South Dakota, who visited the fire on May 22 with the BLM staff, obtained a thermal LANDSAT satellite image dated June 24, 2002, of the area extending from Decker, Montana south to the Acme mine area north of Sheridan, Wyoming. The image resolution is coarse, and the area is partially cloud-covered. The sky over the area of the Welch Ranch is clear, however, and there appears to be a slight thermal anomaly in that area. The resolution is not good enough to provide details of the fire. Randy also is analyzing the Airborne Data Systems images to better define thermal anomalies, and is collecting Synthetic Aperture Radar (SAR) interferometry images of the area, to determine if it is possible to detect minute changes in elevation of the fire area over time, due to slumps or landslides as coal is consumed.

Nancy Russell of the BLM National Science and Technology Center in Denver was trying to arrange to have the U.S. Forest Service fly and photograph the Welch Ranch and Acme Mine area, as well as two other sites in Colorado, with their Phoenix thermal infrared sensor during the winter. However, to date the sensor has not been available.

Origin of the Coalbed Fire

The authors think that the Welch Ranch coalbed fire is probably related to an abandoned coal mine fire at the Acme No. 42 mine, immediately south of the Welch Ranch. The mine fire appears to have migrated further north into the area of the current fire since the Acme fire was mapped in 1978 as part of US Geological Survey Professional Paper 1164 (Dunrud and Osterwald 1980). According to this publication, coal fires have been burning in the abandoned Acme mine for many years, as rooms in the underground mine collapsed and allowed air from the surface to enter. Figure 4 of Professional Paper 1164 shows the north edge of the Acme mine fire to extend into the S2 SW of Section 2 as well as the SE SE of Section 3, both within the proposed exchange area of the Welch Ranch. The extent of the fire was based on aerial photos taken in February of 1978 that showed bare ground at a time when deep snow covered the landscape. Notes on an Acme mine map dated August 1940 and received in September 1952 (by whom is undetermined), from the U.S. Office of Surface Mining's Mine Map Repository, tend to support the migration hypothesis. The notes show a fire in a mined area in the E2 NW NW of Section 11, just south of the Welch Ranch and just west of the Tongue River, suggesting that mine collapse near the coal outcrop caused the fire to spread north along the outcrop. Less likely alternatives are that the Welch Ranch fire originated naturally from a coal fire on the outcrop in the SW of Section 2 or resulted from collapse of the old Evans mine in that area. In 1987, the AMLD extinguished and reclaimed coal fires which were advancing upstream in a drainage located in the NE of Sec. 10, T.57N., R.84W., several hundred yards southwest of the current fire (WWC 2001). The Fire Hole Draw project (OSM/AML Project 8-13) covered the area with a mantle of fill in an effort to smother the fire. According to Murja (2002), that fire had broken through to the surface from the underground mine workings during the 1970s.

Figure 4 of our report compares the 1978 fire extent with the mined-out area, the 1940-era fire area, the 1987 fire control project, and the area of current burning in Section 2. The maps indicate that the fire has moved north about 300 feet within the past 24 years. Murja (2002) states that the fire burned as much as 700 feet north during that period. Figure 4 also shows the extent of the Thunder Child forest fire (ArcView shapefiles of forest fire perimeter and limits of Acme Mine courtesy of Julie Gerlach, Aqua Terra Associates, Sheridan, Wyoming).

The Spectrum report (Murja 2002, p. 3) concurs with our view that the Welch fire may be related to the Acme fire. It states, "Available information suggests that this underground coal seam fire is an extension of the Acme Mine Fire. Prior to 1978, the fire in the mine apparently broke out of the mine and began burning northward following the outcrops of the Monarch and Dietz 3 coal seams along bluffs on the west side of the Tongue River. The underground fire has now moved approximately a quarter of a mile north from the mine. If the

fire continues to the north, it will reach the Dietz 3 outcrop on the opposite side of the ridge within 800 feet."

The fire shown on the 1978 map in the SE SE of Section 3 does not appear to have advanced to the north or east. Although there are subsidence cracks on the surface resulting from collapse of the overburden above mined cavities in the underlying Monarch bed (see Photo 17), heat is not escaping from the cracks. The areas in Sections 3 and 10 just west and south of the fence line marking the limits of the quarter quarter section within the Welch Ranch have been reclaimed in previous AMLD projects over the past 20 years (see Photo 18); this appears to have extinguished any fires in the SE SE of Section 3 as well.

Origin of the Forest Fire

Richard Zander and Ed Heffern visited with neighboring landowner Mr. Frank Mommsen at his carburetor shop in Sheridan on the afternoon of May 22, 2002. Mr. Mommsen contends the Thunder Child forest fire of July 2001 started from the coal fire in a draw in the SE SW SW of Section 2 that had been spouting blue smoke all the previous winter. He showed us photos he had taken of this area, including aerial views of the fracture pattern on the bare hillside. He said that a strong wind from the southeast the day of the forest fire caused the coal fire to spread out of control towards the northwest. He said there was no lightning in the area the day the forest fire started, and showed us his results from an Internet lightning detection service, which also did not detect lightning. Mr. Mommsen said he was concerned about BLM acquiring a safety hazard. Jerry Queen and Ed Heffern found the same site as in his photo in the field the following day (Vent #9 on Figure 1, Photos 10 and 11).

Other local residents contend that lightning did occur in the area the day the Thunder Child fire started. One nearby landowner said that lightning struck cottonwood trees in the Tongue River floodplain, and that the fire started on top of a ridge within a few hundred yards of the coal fire. However, apart from the question of whether the coal fire is likely to start additional forest fires, the cause of the forest fire is not a BLM issue, as the fire originated on surface estate that was private at the time.

The Spectrum report states that the cause of the forest fire is not certain. Many of the trees around the site of the underground coal fire were charred. Few trees were present in the central area and eastern edge of the active coal fire, before the forest fire; however, there are many burned trees around the west, south, and north edges of the coal fire.

Hazards

The coal seam fire will probably continue to burn northward and westward until: 1) it runs out of coal, either by hitting an outcrop or prehistoric burn line; 2) the supply of oxygen is cut off because fissures fail to reach the surface; 3) the coal drops below the water table; or 4) the area is fully reclaimed by DEQ (which may be very difficult due to the depth of the fire). Burning could continue for tens to hundreds of years. Potential hazards to the public, if the exchange is consummated and access is allowed, include:

1. Noxious or explosive gases (methane, carbon monoxide, and most likely others that were not evaluated);
2. Depleted levels of oxygen near the fissures;
3. Hot spots on the ground which may mask a fissure or cause burns if someone stepped on them;
4. Unstable ground near fissures which could collapse under weight;
5. Danger of burns or suffocation if someone fell in a fissure; and
6. Risk of the coal fire igniting additional forest and range vegetation.

Toxic and explosive limits for the gases measured are found in a number of publications. Kim and Chaiken (1993, p. 9) stress that carbon monoxide is the most serious hazard in coal fires and cite a threshold limit value of 50 ppm, at which point formation of carboxyhemoglobin will start to produce carbon monoxide poisoning. The NIOSH Pocket Guide to Chemical Hazards (1990, p. 170) gives a 10-hour time-weighted average permissible exposure limit (PEL) of 35 ppm for carbon monoxide in a confined space. EPA has an ambient air standard of 9 ppm for carbon monoxide. Methane of itself is not a toxic gas; however, it is explosive at a concentration in air of between 5% and 15% (50,000 to 150,000 ppm). The main respiratory danger of high levels of methane is that oxygen may be displaced to a level below 19.5%, at which point breathing and pulse rates start to increase (29 CFR 1910, Occupational Safety and Health Standards). Below 10% oxygen, nausea, vomiting, and loss of consciousness occur; below 6% oxygen, convulsions and respiratory failure occur (Kim and Chaiken 1993, p. 10). The data in Table 1 show that carbon monoxide levels are a definite concern and that low oxygen levels may also exist in some areas, especially inside partially confined spaces such as fissures.

Possible methods to control the fire include excavating and removing the coal, digging a trench and filling it with inert material to isolate the coal fire area from unburned coal further back in the hill, injecting liquid nitrogen, fine particles, or foaming grouts into fissures to cut off the oxygen supply, sealing the surface, and/or injecting water (Kim and Chaiken 1993). Water injection may not be effective due to the danger of steam explosions, the fact that the coal beds dip towards the river (which could cause injected water to flow back toward the outcrop instead of toward unburned coal), and the fact that adsorption of water on a dry coal surface (the “heat of wetting” reaction) actually increases the likelihood of combustion. As mentioned earlier, AMLD

did emergency stabilization at the site, using inert material to fill fissures. This may reduce surface expressions of the fire in the short term. The fire is still smoldering underneath the regraded area, as of February 2003. In the long term, it may be difficult and expensive to completely isolate and extinguish the fire, as the fire appears to be fairly extensive and at a depth that would require major excavation to isolate the fire area from unburned coal.

Management Alternatives

We have identified several options for management consideration. They are divided into two sets. One set addresses the land exchange decision process, and the other set addresses possible future BLM management actions if the land exchange is completed in the area of the coal fire. It is important to remember that additional land use planning would need to be completed to address the management of the Welch Ranch if it is acquired. It may be that pieces of several options can be combined to reach a preferred solution. The solution will depend on the level of liability risk that BLM management is willing to assume in exchange for the resources to be acquired, and whether part of the Welch Ranch can or should be deleted from the exchange proposal. The main concern is safety and potential liability for accidents; a recent U.S. District Court decision in Wyoming refused to dismiss a lawsuit filed by a person who was severely burned when he fell into a thermal pool in Yellowstone National Park. The BLM is limited from acquiring private land contaminated with hazardous waste, but coal fires are not defined as hazardous waste. The appraisal staff would need to review and document how potential hazards presented by acquiring lands containing an active coal fire and tonnages of coal involved in the fire would affect the estimated value of the Welch Tract, which could affect the estimate of minable coal reserves that the BLM would offer for exchange. According to the regulations governing exchanges (43 CFR 2200.0-6(c)), the value of the interests being acquired must be equal to the value of the lands or interests being conveyed into private ownership.

The following options deal with the issue of whether or not BLM should acquire the area impacted by the existing coal seam fire:

1. Proceed with the exchange “as is”. Under this option, BLM would acquire the entire Welch Ranch property, including that portion of the Welch Ranch impacted by the existing coal seam fire, and future management would consider the presence of the fire. BLM would assume responsibility as a landowner for any future liability claims related to the fire under this option.

2. Delete the 40-acre parcel that contains the fire from the exchange area. This involves the E2 SW SW and W2 SE SW of Section 2. Figure 6 shows the area covered by Options 2, 3, and 4. Option 2 would eliminate the possibility of BLM incurring liability from the existing coal seam fire on

the hill above the Tongue River. It would not eliminate BLM's future liability for claims from the public if the coal seam fire continues to burn and expand after the remaining Welch Ranch lands are acquired. Additionally, this would not remove liability from BLM if and/or when the fire moves onto Federal surface/coal. This option might also be crafted to delete the mineral estate on this parcel from the exchange and acquire the surface estate only, with the idea of limiting potential liability. Such an option might also eliminate the possibility of BLM incurring liability from the existing coal seam fire, but it has the same limitations as the previous option. If the fire continues to burn, any surface acquired by the BLM could be impacted in the future.

3. Delete the W2 SW SW of Section 2, and the SE SE of Section 3, which has been mined out by the Acme mine, from the exchange area, as well as the 40-acre parcel in Option 2 (a total of 100 acres). The 1980 USGS report showed that the southwest corner of the SE SE of Section 3 was on fire as well. However, a BLM field inspection of this area on September 26, 2002, showed no evidence of active burning. Further collapse in the mined area might allow more air to enter and a fire to ignite or spread. This option also might have the effect of limiting BLM's liability from the existing coal seam fire.

4. Delete a larger area, including a buffer zone, around the mined area and fire. This would prevent the fire from encroaching into a public area for a longer period of time. The option listed here would remove a total of 210 acres, including the 100 acres in Option 3 as well as a buffer zone of 110 acres comprising the following lands: SE NE SW, S2 NW SE, and S2 NE SE of Section 3; and S2 NW SW, S2 NE SW, and E2 SE SW of Section 2. This buffer zone includes small mined out areas as well as outcrops of the Dietz 3 coal seam, past which it will be more difficult for the fire to advance. Management may wish to consider other configurations of the buffer zone, which would eliminate different acreages.

The following options deal with future management of the coal seam fire area if BLM proceeds with the exchange proposal on the entire Welch Ranch without the modifications discussed above:

1. After the Welch Ranch is acquired, exclude the coal seam fire area from any designated recreation area. Fence off the fire area, post warning signs, and monitor advance of the fire with soil gas probes (perhaps setting a north-south row of three-foot long PVC/plastic tubing probes on the hilltop in the direction of fire advance, with a parallel row of gas sorbers, to compare different methods of soil gas analysis).

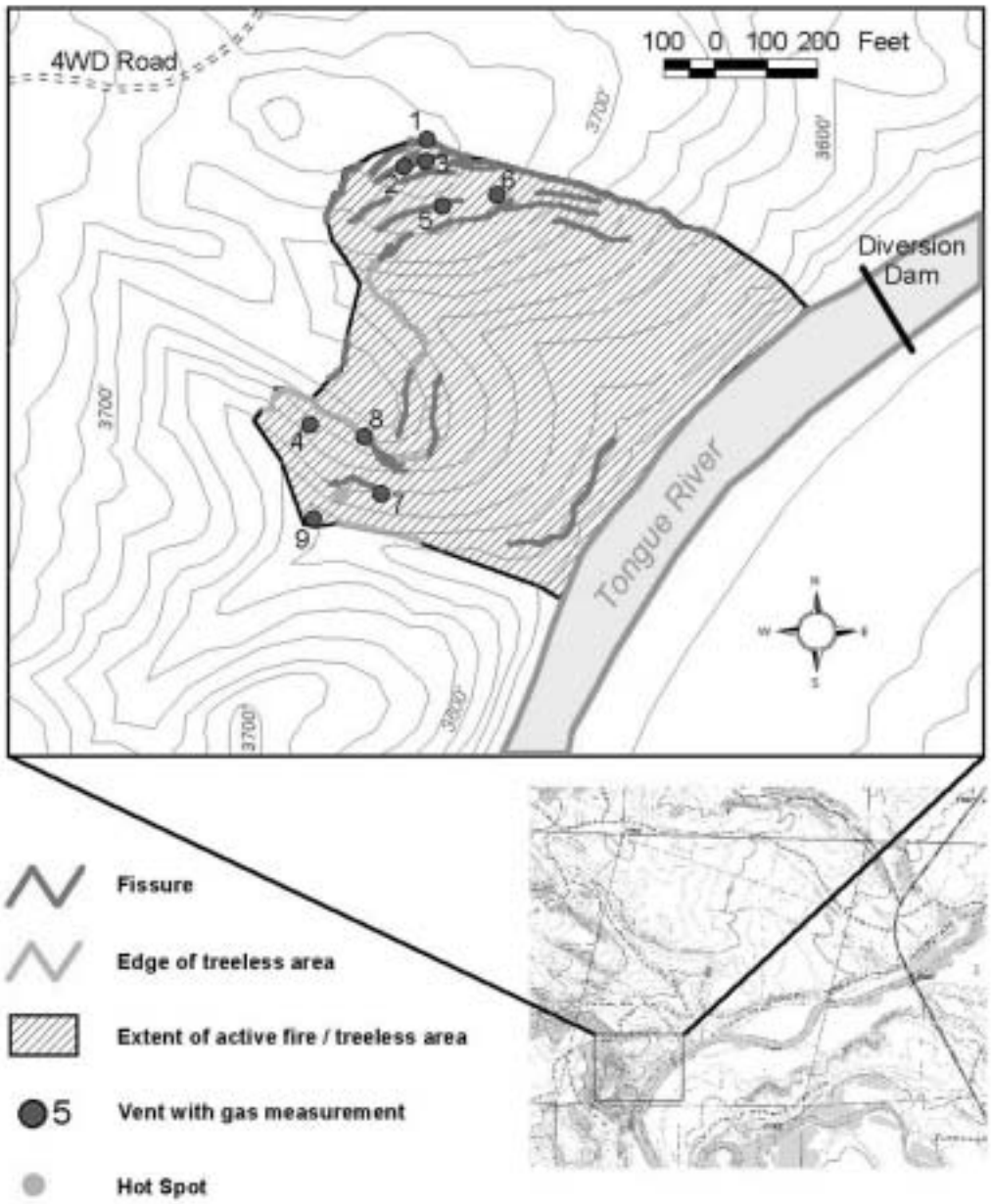
2. Designate the coal fire as a research natural area. Conduct research on burning processes, types and rates of gases produced, and solicit outside research proposals. Allow educational geological tours of the area with

authorized staff. Use remote sensing on a periodic basis to scan for thermal anomalies and escape of gases.

3. There are, or have been, burning coal seams in Theodore Roosevelt National Park and the Little Missouri National Grassland in North Dakota. If the decision is to include the area of the Welch fire in the exchange, it might be useful to visit these sites to see how they are managed and interpreted. We contacted Mr. Noel Poe, superintendent at Theodore Roosevelt National Park, who related that the park had a burning coal vein nature trail; the coal fire there started as a result of a lightning strike in the 1950s and burned until 1972. All coal fires in the park have been extinguished. We also contacted Mr. Curt Glasoe, an engineer with the Little Missouri National Grassland, who has extinguished a number of burning coal veins, especially near oil and gas production sites and pipelines. They have a program to dig out and isolate the burning veins, which ignite due to range fires and lightning. He mentioned a Burning Coal Vein campground on their lands (which the main author of this report has also visited). The Forest Service posted warning signs and fenced off the fire from the campground; they moved the fence every year as the fire advanced. That fire is now extinguished as well. He said there are about 30 active fire areas today in their district.

4. Reclaim the fire in cooperation with the State AMLD. They have already done emergency stabilization of the north part of the active fire. Full reclamation would likely be much more involved, and would have to address the hot areas in the draw along the southwest edge of the fire as well as any resurgence of the north end of the fire. The AMLD may use SMCRA funds to reclaim only fires associated with mining which occurred prior to the SMCRA eligibility date, that present a hazard to public safety and property, and for which there is no responsible party with reclamation obligations for the site. Budgetary constraints may also limit AMLD involvement. The active mine permit may also complicate matters. The fire may be difficult and expensive to extinguish because of the rough topography and the fact that fires are burning in more than one coal bed and as deep as 100 to 200 feet underground. Under this option, additional detailed drilling would be needed to acquire a better understanding of the fire and what coal seams are involved in different areas of the fire.

5. Showcase the coal fire and subsidence areas to the public as an example of natural burning processes and/or coal fire reclamation methods. Develop environmental education signs and exhibits; design pathways to avoid unstable or dangerous areas; and post warning signs where needed. Consider whether P&M could contribute funds or equipment to help monitor future advance of the coal fire, extinguish any future flare-ups of the fire, and/or develop interpretive services.



Coal Seam Fire on Welch Ranch
Sheridan County, Wyoming
SW Sec. 2, T57N, R84W

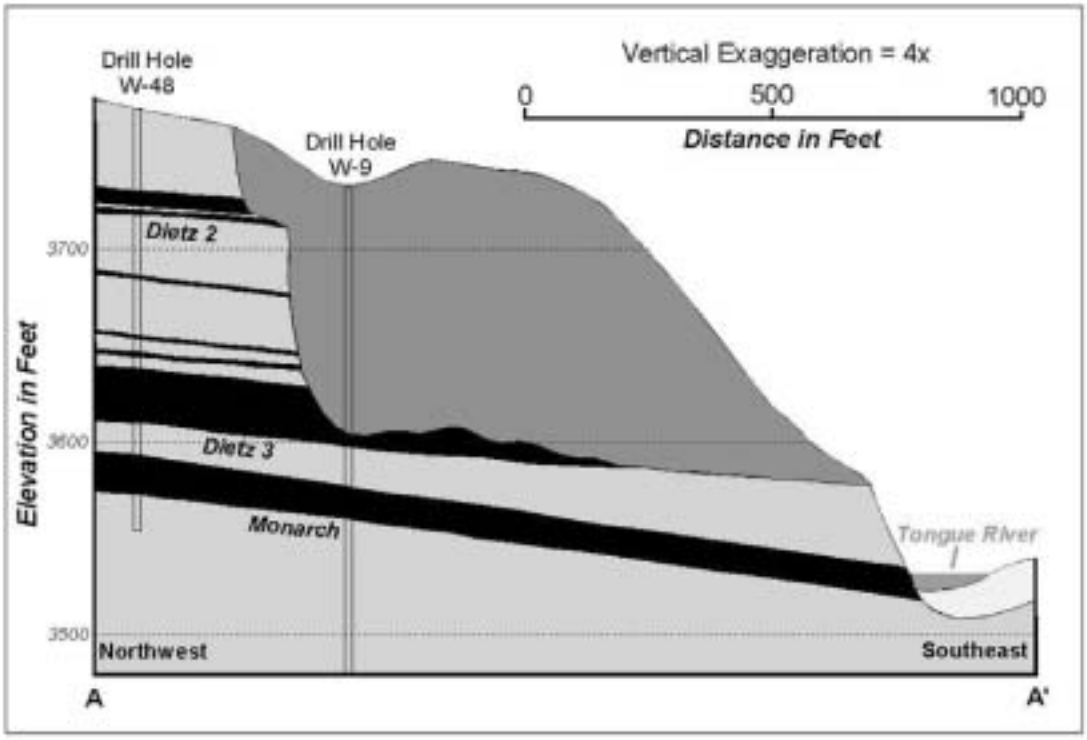
Figure 1

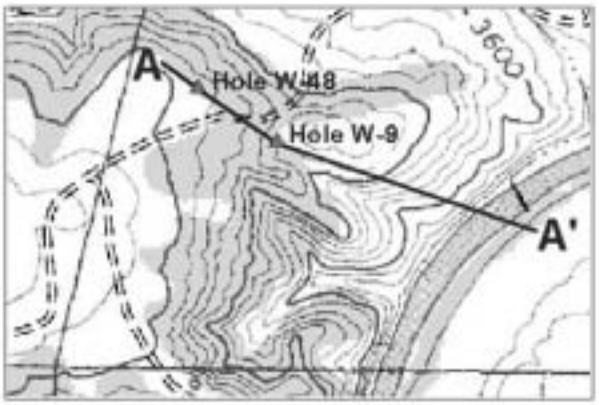
Color Infrared Aerial Photo of Welch Ranch Coal Fire

Enlargement of NAPP image 12641-136, dated September 20, 2001

This enlargement shows features in the vicinity of the Welch Ranch coal fire, two months after the date of the Thunder Child forest fire. The Tongue River flows north across picture; main floodplain is on right (east) side of river. The active Welch Ranch coal fire shows up as the treeless area in the upper center of the picture directly west of the Tongue River. Note the subsidence cracks and fissures, especially along the north rim of the fire area. The diversion dam on the river is at the right edge of the photo. The east-west boundary between Sections 2 and 11 is near lower edge of photo, just north of the island in the river. North is at the top; the picture covers an area of about 0.35 mile by 0.35 mile.

Figure 2

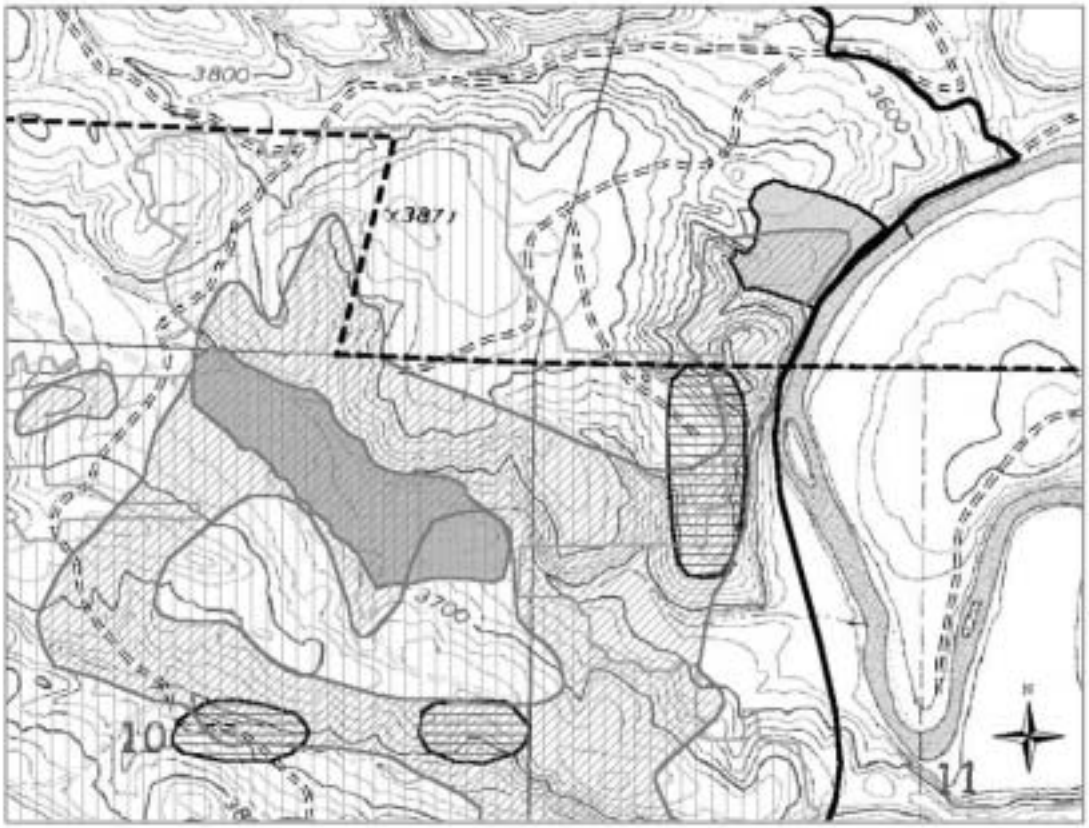




Cross Section Diagram of Coal Beds in Welch Ranch Fire Area

SW Section 2, T57N, R84W, Sheridan County, Wyoming

Figure 3



Current Welch Ranch coal fire / treeless area

Area of 1987 Acme mine fire reclamation project 8-13

Area of Acme mine fire in 1978 (from Dunrud and Osterwald, 1980)

Area of Acme mine fires in 1940's (from OSMRE Mine Map Repository)

Southern edge of Welch Ranch exchange tract (approximate)

East edge of Thunder Child range fire (courtesy of Julie Gerlach, Aqua Terra Associates)

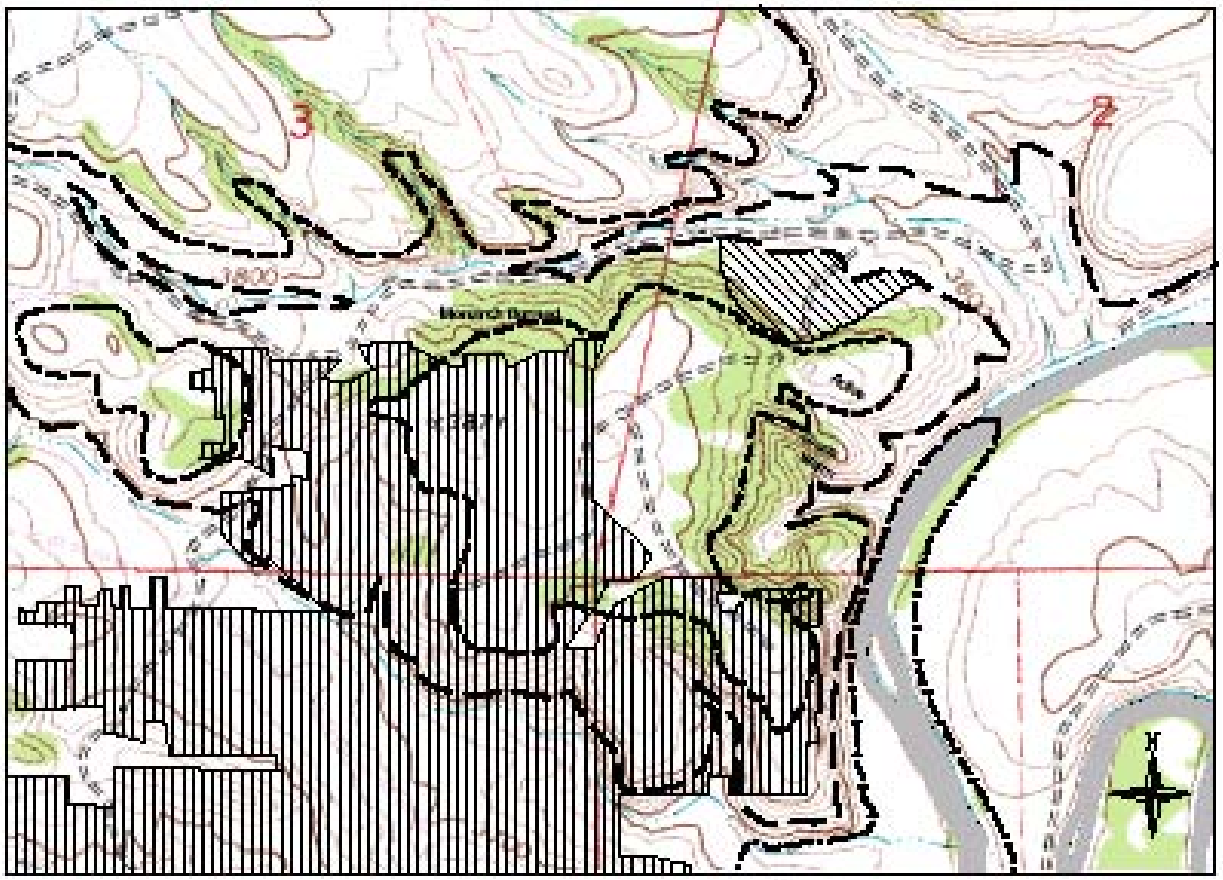
Mined out areas of Acme mine (from OSMRE Mine Map Repository, ArcView shapefile by Julie Gerlach, Aqua Terra Associates)

0.1 0 0.1 0.2 Miles

Mined Areas and Coal Fires - Welch Ranch and Vicinity

Sections 2, 3, 10, and 11, T57N, R84W, Sheridan County, Wyoming

Figure 4



Mined Out Areas of Acme Mine
(from OSMRE Mine Map Repository)

Ancient Burn

0.1 0 0.1 0.2 Miles

Dietz 2 Coal Outcrop

Dietz 3 Coal Outcrop

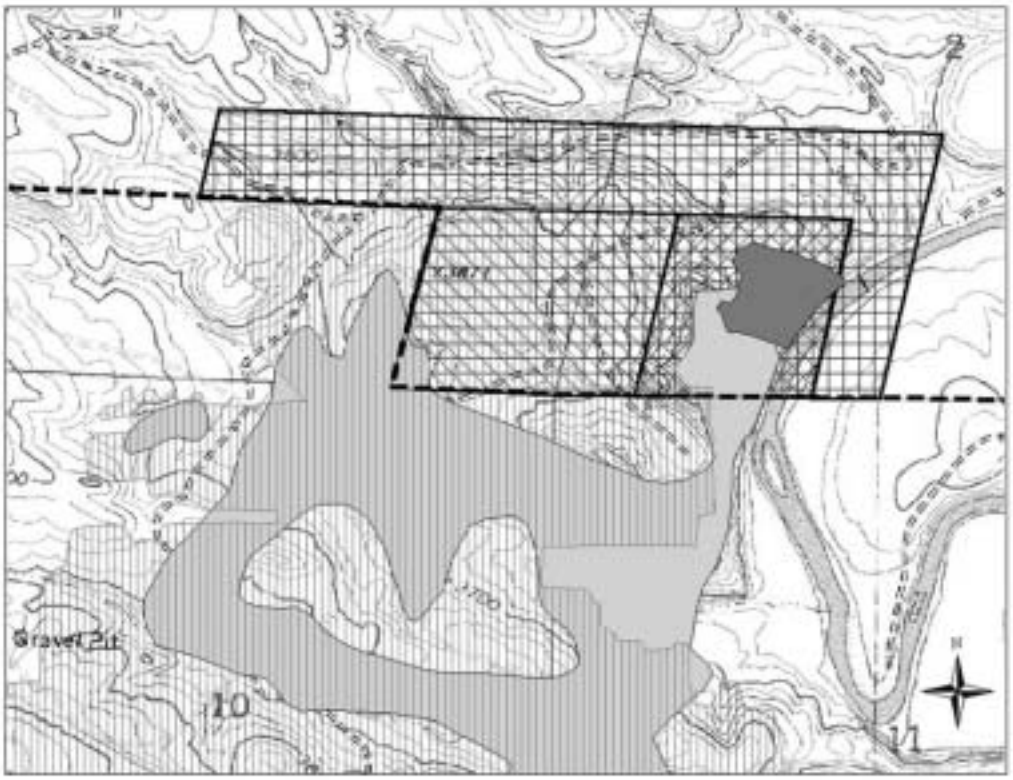
Monarch Coal Outcrop

Notes: Limits of the coal beds from the Welch No. 1 North mine permit application (Sheridan Enterprises 1983), on file with WDEQ/LQD. Entire figure was compiled by Murja (2002).

Limits of Acme Mine and Coal Beds - Welch Ranch and Vicinity

Sections 2, 3, 10, and 11, T57N, R84W, Sheridan County, Wyoming

Figure 5



Option 2 - Delete 40 acres in current fire area

Option 3 - Delete 60 acres in mined area to west of current fire plus 40 areas in Option 2

Option 4 - Delete 110 acres in buffer zone plus 60 acres in Option 3 and 40 acres in Option 2

Current fire/treeless area

Area of Acme coal mine fire in 1978 (from Dunrud and Osterwald, 1980)

Mined-out area of Acme mine

Southern boundary of Welch Ranch exchange tract

Secs. 2, 3, 10, and 11, T57N, R84W

0.1 0 0.1 0.2 Miles

Options for Deleting Acreage from Welch Ranch Tract

Figure 6

Photo 1 - *Jerry Queen of Buffalo FO takes gas readings with ATX 620 monitor from Vent #3.*

Photo 2 -- *Richard Zander of Buffalo FO examines fissure near top of hill.*

Photo 3 - White plastic funnel attached to end of rubber tubing has partially melted after taking gas readings about a foot inside Vent #6. Jerry Queen of Buffalo FO is holding the Industrial Scientific ATX 620 gas meter.

Photo 4 - Treeless, grass-covered hillside marks the area of the active coal fire. Fissures rim the upper edges of the fire. View is to NW from near level of Tongue River.

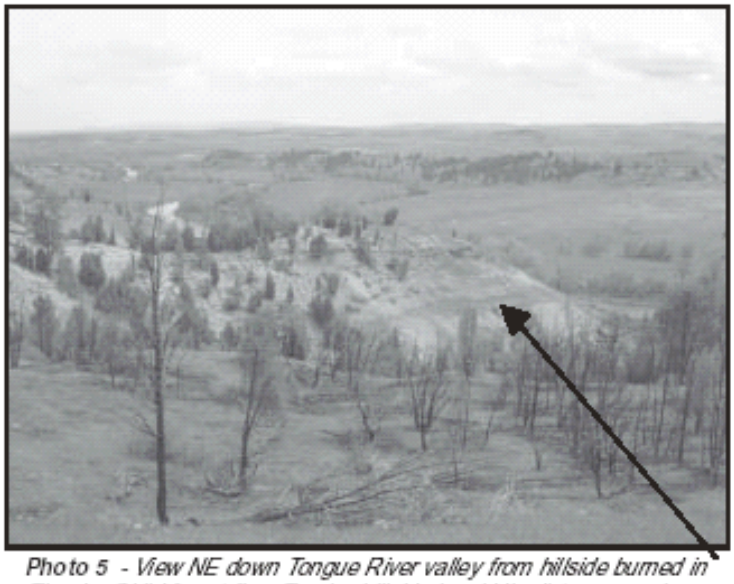


Photo 5 - View NE down Tongue River valley from hillside burned in Thunder Child forest fire. Treeless hillside in middle distance marks area of active coal fire.

Photo 6 - Columnar juniper with discolored branches. Note vapor rising from fissure in ground below tree.

Photo 7 - View to SW from top of hill marking edge of coal fire. Note discolored junipers in foreground as well as columnar junipers along edge of active fire on hill in middle distance. Tongue River valley and area of Acme coal mine are in far distance.

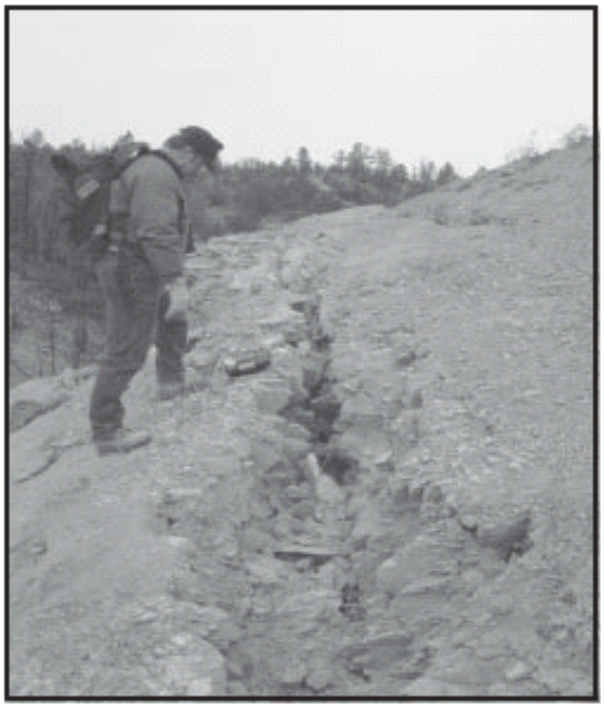


Photo 8 - Fissure on bare hillside. View to NW. Jerry Queen of Buffalo FO takes gas reading from three feet inside Vent #7. Reading showed 132 ppm carbon monoxide, 1000 ppm methane, and 20.4 % oxygen.

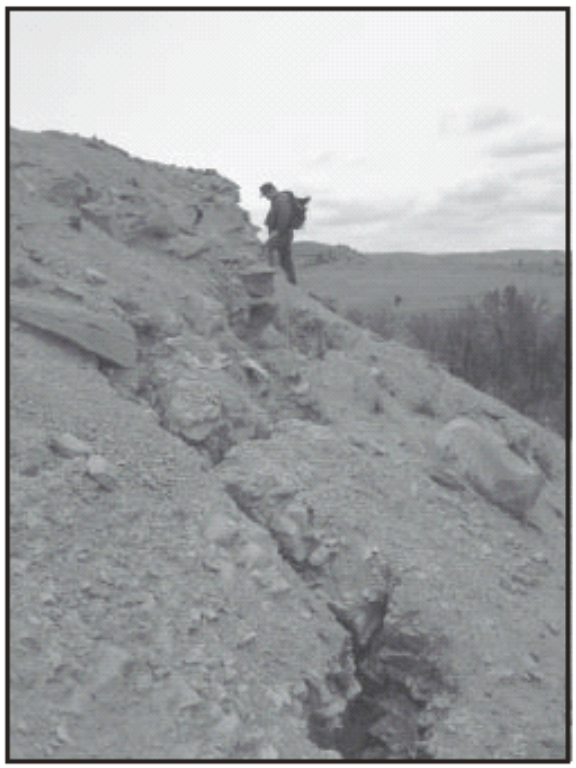


Photo 9 - Another view of fissure at Vent #7. View to NE. Fractures are caused by burning and collapse of underlying Dietz 3 coal bed, leaving a scarp along upper face of slump block.

Photo 10 - Taking gas readings at Vent #9 in draw at edge of active fire. This is where Mr. Mommsen contends the Thunder Child fire originated.

Photo 11 - *View SW from area of whitish bleached hot spot (see Figure 1) to Vent #9 at base of draw. Note burned trees on hillside. Vent is at end of arrow.*

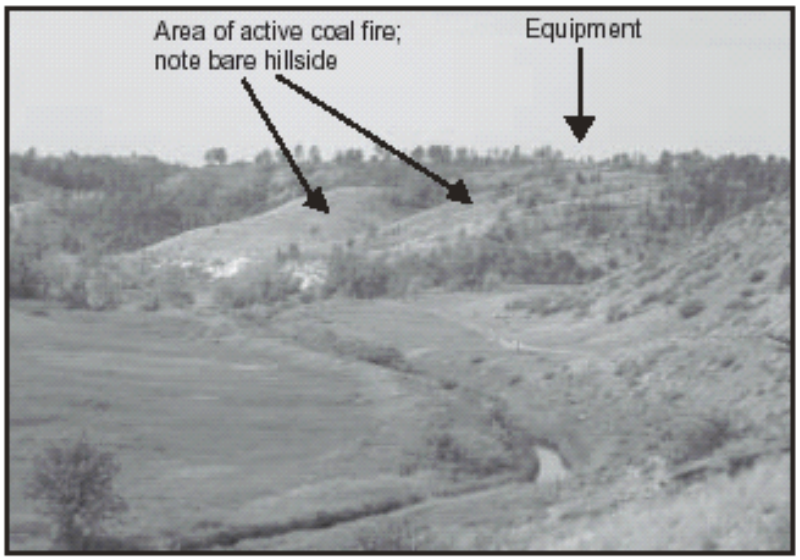


Photo 12 - *View to west of coal fire area along slope and hilltop northwest of Tongue River. Irrigation ditch and access road in foreground. Note reclamation equipment on hilltop.*

Photo 13 - D-8 bulldozer and John Deere 490Z backhoe completing regrading and filling fissures at north end ofcoal fire. Photo taken September 26, 2002.

Photo 14 - Regraded area at north end of coal fire; bare hillside in middle distance is in coal fire area. Tongue River in distance. View southwest toward Acme.

Photo 15 - Fissure with vapor emissions at north end of Welch Ranch coal fire, February 25, 2003.

Photo 16 - Vapor rising from regraded area, February 25, 2003.

Photo 17 - Ed Heffern of BLM Wyoming State Office examines subsidence cracks above old Acme Mine in SE SE of Section 3, T57N, R84W.

Photo 18 - View to west from SE SE Section 3, T57N, R84W. Area in foreground is part of Welch Ranch. Field behind fence is part of reclaimed Acme mine area.

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