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SEEP AND SPRING INVENTORY OF THE CRANDALL CANYON MINE PERMIT AND ADJACENT AREAS

Prepared for

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June 12, 1985

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1.0 INTRODUCTION

The Crandall Canyon Mine is an underground coal mine operated by Genwal Coal Company in Emery County, Utah, Sections 5 and 6, T. 16 S., R. 7 E., SLBM. The mine operates under an existing permit from the Utah Division of Oil, Gas, and Mining covering an area of 80 acres (referred to as Tract 1). Genwal has applied for a permit to extend their mining operation to the north into an area referred to as Tract 2 covering an area of approximately 75 acres.

On June 6 and 7, 1985 a field investigation was conducted to identify the location and characteristics of all seeps and springs within the permit and adjacent areas. This report presents the results of this inventory as well as an interpretation of the data collected therefrom.

Six formations outcrop within the Crandall Canyon Mine permit and adjacent areas (Figure 1). According to Doelling (1972), the Masuk Shale Member of the Mancos Shale (Km on Figure 1) is a light gray to blue-gray marine sandy shale. This unit is exposed at the mouth of Crandall Canyon and in adjacent areas along Huntington Creek.

The Star Point Sandstone (Ksp) is predominantly a light gray massive sandstone with minor interbedded layers of shale and siltstone. In the vicinity of the mine, the Star Point Sandstone is 700 to 900 feet thick.

The Blackhawk Formation (Kb) is the principal coal-bearing unit in the region. This formation consists of interbedded layers of sandstone, shale, and coal. The Blackhawk is about 1000 feet thick in the mine area, with the principal coal seam (the Hiawatha seam) occurring near the bottom of the formation.

The Castlegate Sandstone (Kc) overlies the Blackhawk Formation and consists of cliff-forming sandstones of fluvial origin. The sandstones are massive and medium to coarse grained. In the area of the mine, the Castlegate Sandstone is approximately 300 feet thick.

The Price River Formation (Kpr) consists predominantly of friable limy sandstone interbedded with pebbly conglomerates and shales. It forms steep receeding slopes and is about 500 feet thick in the mine area.

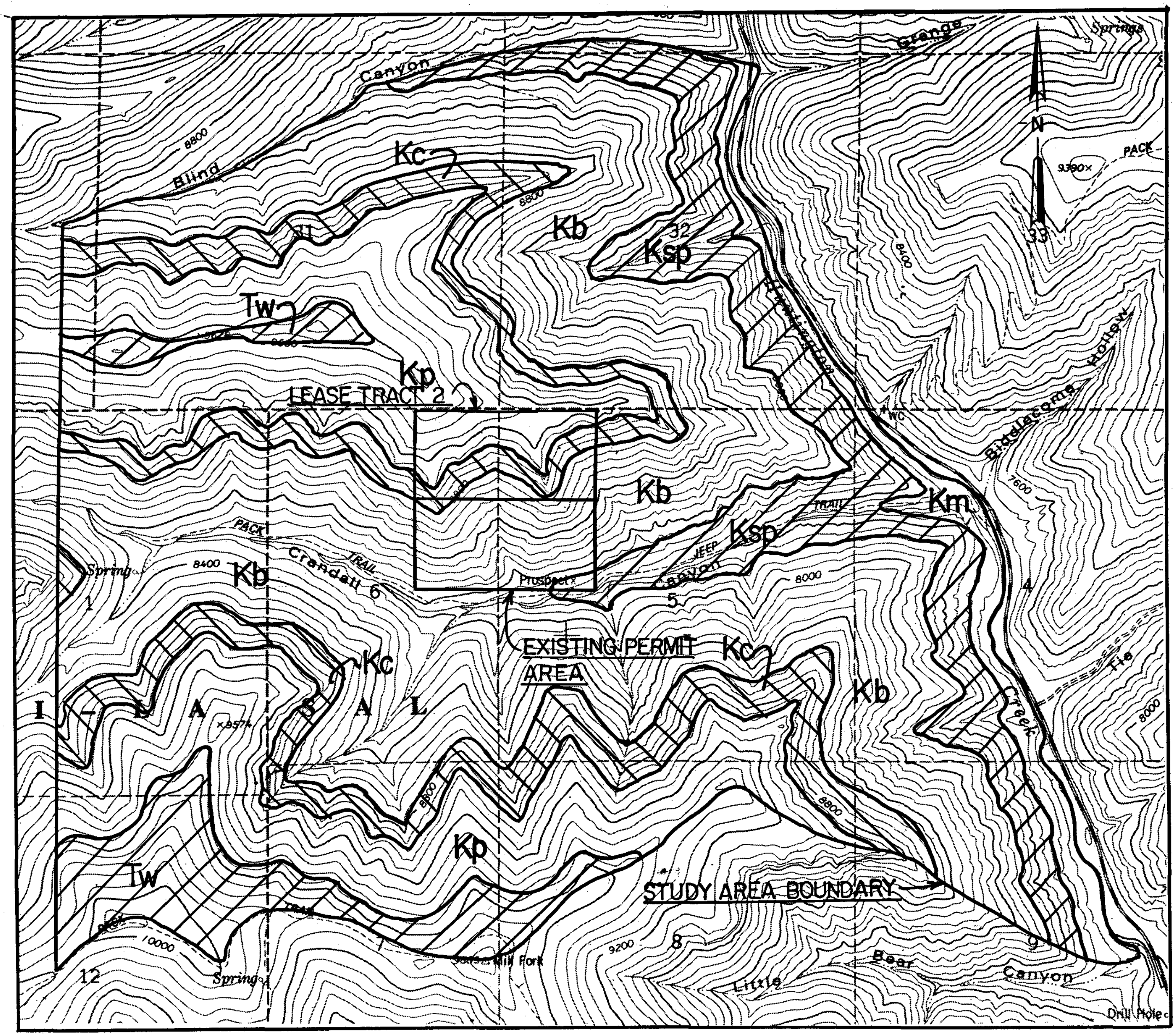

Figure 1. Geology of the Crandall Canyon area.

The uppermost formation that outcrops within the study area is the North Horn Formation (Tw). This formation consists of interbedded limestones, sandstones, and shales. Due to high topographic presence but limited areal extent, the North Horn Formation serves primarily as a recharge unit to underlying formations rather than as an important source of water itself.

The remainder of this report is divided into four sections. Section 2.0 discusses the methods used during the inventory, followed by a presentation and discussion of the results in Section 3.0. The potential impacts of mining on the seeps and springs are presented in Section 4.0. Section 5.0 provides a list of references cited in the report.

2.0 METHODS

The boundary of the study area is generally one mile from the edge of the permit areas (existing and proposed) for Tracts 1 and 2, as constrained by the presence of Huntington Creek on the east, Blind Canyon on the north, and the ridge between Crandall Canyon and Little Bear Canyon on the south. The boundary of this study area and the field methodology were approved in a discussion between Wayne Hedberg and Tom Suchoski of the Division and Richard White of EarthFax Engineering, Inc. on May 8, 1985.

An aerial reconnaissance of the study area was conducted at the beginning of the field investigation to provide a gross indication of spring locations and site accessibility. The study area was then traversed on foot to allow springs and seepage points to be precisely located, examined, and sampled.

Geologic conditions at all seeps and springs were noted in the field, including lithologic and structural controls and the geologic formation from which the seepage issued. Signs of usage were also noted. The flow rate was visually estimated and (if sufficient water was present) a sample of the water was collected. The temperature of the water issuing from the spring was measured at the site.

All samples were analyzed in the field for pH and specific conductance. Due to time constraints, no samples were submitted for additional laboratory analyses. Although this is a departure from a previous commitment by Genwal to perform laboratory analyses on the water samples (see letter to the Division dated August 23, 1984), verbal approval was obtained during the May 8, 1985 meeting to preclude laboratory analyses.

Due to the steep, often inaccessible, and sometimes heavily vegetated nature of the study area, it is possible that a limited number of seeps and springs at the site were not found during the inventory. However, the seeps and springs that were found are considered representative of local conditions.

3.0 RESULTS AND DISCUSSION

Results of the seep and spring inventory are contained in Table 1. Locations of these sources are shown in Figure 2.

Over 50 percent of the seeps and springs inventoried issued from the Blackhawk Formation. Flow rates at these points tend to be minimal (less than 1 gallon per minute), with seepage issuing predominantly at the interface between sandstone lenses above and less-permeable shale layers below. Usage at these points is also minimal, due to the low flow rate and often inaccessibility of the seeps.

Notable exceptions to the above generality concerning the Blackhawk Formation occur in a few springs that issue from fractured sandstone within the formation. Examples of this phenomenon were found in the western portion of the study are (SP-53 through SP-58), where flow rates of up to 15 gallons per minute were encountered. Travertine deposits are common at these springs, suggesting that the recharge area for these springs is dominated by limestone (probably the North Horn Formation on the ridges to the north and west).

Several seeps were discovered issuing from colluvium overlying sandstone of the Blackhawk Formation and the Castlegate Sandstone. These seeps normally occur in drainage bottoms where shallow subsurface water collects at topographic lows following infiltration of snowmelt. Nearly all flows from seeps of this type were insignificant, suggesting (together with the topographic position) that these seeps are intermittent in nature.

Most seeps and springs found in the Castlegate and Star Point Sandstones issue from bedding planes within these formations. Flows issuing in this manner were generally low (1 gallon per minute or less), with only occasional usage being evident (due primarily to inaccessibility and low flow rate).

Usage of seeps and springs in the study area is confined entirely to deer, elk, and other wildlife. No signs were noted of use of the springs for stockwatering or human consumption. As would be expected, wildlife usage of the springs is most abundant where flows are greatest.

Data contained in Table 1 indicate that the specific conductance of water issuing from springs in the study area generally increases with increasing stratigraphic depth. Springs issuing from the Price River Formation typically had a specific conductance varying from 150 to 450 umhos/cm at 25^{o}C while those issuing from the Blackhawk Formation and Star Point Sandstone had a specific

Table 1. Results of seep and spring inventory in the permit and adjacent areas.

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[(a)]	Temp (°C)	Geology	Use
SP-1	0	(b)	(b)	(b)	From base of Starpoint SS over Masuk Sh. Member of Mancos Sh.	None
SP-2	0	(b)	(b)	(b)	From base of Starpoint SS over Masuk Sh. Member of Mancos Sh.	None
SP-3	4	8.12	730	17.0	From sandstone bedding plane in Starpoint SS	None
SP-4	6	7.86	660	10.0	From colluvium at head of landslide in Blackhawk Fm.	Deer and elk
SP-5	0	(b)	(b)	(b)	From colluvium over sandstone in Starpoint SS	None
SP-6	5	7.67	590	4.5	From sandstone bedding plane in Blackhawk Fm.	Deer and elk
SP-7	10	8.36	440	10.0	From snow patch at top of Castlegate SS	Deer and elk
SP-8	20	7.95	280	3.5	From snow patch at top of Castlegate SS	Deer and elk
SP-9	0	(b)	(b)	(b)	From sandstone/shale interface Castlegate SS/Blackhawk Fm.	None
SP-10	40	7.90	220	10.0	From snow patch at base of Castlegate SS	Deer and elk

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[(a)]	Temp (^oC)	Geology	Use
SP-11	0	(b)	(b)	(b)	From colluvium over sandstone of Castlegate SS	None
SP-12	15	7.66	250	3.0	From base of sandstone (Price River Fm.) in channel bottom	Deer and elk
SP-13	3	8.57	100	7.0	From sandstone at head of slide in Price River Fm.	Deer and elk
SP-14	25	8.10	150	5.5	From fractured sandstone and soil in Price River Fm.	Deer and elk
SP-15	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-16	1	8.34	560	14.5	From sandstone at head of slide in Blackhawk Fm.	Deer
SP-17	2	7.71	460	10.0	From sandstone/shale interface in Blackhawk Fm.	Deer and elk
SP-18	10	7.42	500	7.0	From sandstone bedding plane in Star Point SS	Deer and elk
SP-19	5	7.60	620	6.5	From sandstone at head of slide in Blackhawk Fm.	None
SP-20	0	(b)	(b)	(b)	From sandstone bedding plane in Star Point SS	None

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-21	2	8.53	820	13.5	From sandstone bedding plane in Star Point SS	Deer
SP-22	4	8.05	230	3.5	From fractured sandstone over shale in Blackhawk Fm.	None
SP-23	5	8.02	550	6.0	From sandstone/shale interface in Blackhawk Fm.	None
SP-24	2	7.35	790	6.0	From sandstone/shale interface in Blackhawk Fm.	Deer and elk
SP-25	<1	6.80	820	10.0	From sandstone bedding plane in Star Point SS	None
SP-26	0	(b)	(b)	(b)	From road cut, sandstone bedding plane in Star Point SS	None
SP-27	0	(b)	(b)	(b)	From colluvium over sandstone in Star Point SS	None
SP-28	<<1	(b)	(b)	(b)	From road cut, sandstone bedding plane in Star Point SS	None
SP-29	0	(b)	(b)	(b)	From road cut, sandstone bedding plane in Star Point SS	None
SP-30	1	8.10	1060	16.5	From sandstone/shale interface in Blackhawk Fm.	None

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-31	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-32	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-33	<<1	(b)	(b)	(b)	From alluvium over sandstone in Blackhawk Fm.	None
SP-34	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-35	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-36	2	8.39	890	16.0	From sandstone/shale interface in Blackhawk Fm.	Deer and elk
SP-37	0	(b)	(b)	(b)	From sandstone bedding plane in Blackhawk Fm.	None
SP-38	<1	8.22	1180	9.0	From sandstone/shale interface in Blackhawk Fm.	Deer and elk
SP-39	0	(b)	(b)	(b)	From sandstone bedding plane in Blackhawk Fm.	None
SP-40	0	(b)	(b)	(b)	From sandstone bedding plane in Blackhawk Fm.	None

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-41	<<1	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-42	<<1	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	Deer and elk
SP-43	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-44	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-45	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-46	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-47	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-48	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-49	0	(b)	(b)	(b)	From sandstone bedding plane in road cut in Blackhawk Fm.	None
SP-50	0	(b)	(b)	(b)	From sandstone/shale interface in slump in Blackhawk Fm.	None

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[(a)]	Temp (°C)	Geology	Use
SP-51	0	(b)	(b)	(b)	From sandstone/shale interface in slump in Blackhawk Fm.	None
SP-52	1	7.99	600	12.0	From colluvium over sandstone in Blackhawk Fm., w/ travertine	Deer
SP-53	8	7.31	490	5.5	From fractured sandstone with travertine in Blackhawk Fm.	Deer
SP-54	15	7.35	500	5.5	From fractured sandstone with travertine in Blackhawk Fm.	Deer
SP-55	10	7.36	480	5.5	From fractured sandstone with travertine in Blackhawk Fm.	Deer
SP-56	15	7.61	490	5.5	From fractured sandstone with travertine in Blackhawk Fm.	Deer
SP-57	6	7.35	480	5.5	From fractured sandstone with travertine in Blackhawk Fm.	Deer
SP-58	10	7.40	500	5.0	From fractured sandstone in Blackhawk Fm.	Deer
SP-59	1	7.43	690	7.0	From colluvium over sandstone in Blackhawk Fm.	Deer
SP-60	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-61	15	7.36	450	2.0	From fractured sandstone in Price River Fm.	Deer and elk
SP-62	0	(b)	(b)	(b)	From sandstone/shale interface in Price River Fm.	None
SP-63	0	(b)	(b)	(b)	From sandstone/shale interface in Price River Fm.	None
SP-64	10	7.33	440	3.0	From fractured sandstone in Price River Fm.	Deer
SP-65	15	7.43	430	5.0	From colluvium over sandstone in Price River Fm.	Deer and elk
SP-66	0	(b)	(b)	(b)	From sandstone/shale interface in Blackhawk Fm.	None
SP-67	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-68	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-69	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-70	15	7.17	550	3.5	From fractured sandstone in in Price River Fm.	Deer

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp ($^{\circ}$C)	Geology	Use
SP-71	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-72	<<1	(b)	(b)	(b)	From sandstone/shale interface in Price River Fm.	None
SP-73	0	(b)	(b)	(b)	From sandstone/shale interface in Blackhawk Fm.	None
SP-74	0	(b)	(b)	(b)	From sandstone/shale interface in Blackhawk Fm.	None
SP-75	0	(b)	(b)	(b)	From sandstone/shale interface in Blackhawk Fm.	None
SP-76	1	7.48	960	10.0	From sandstone/shale interface in Blackhawk Fm.	Deer
SP-77	0	(b)	(b)	(b)	From sandstone/shale interface in Blackhawk Fm.	None
SP-78	0	(b)	(b)	(b)	From sandstone bedding plane in Star Point SS	None
SP-79	0	(b)	(b)	(b)	From sandstone bedding plane in Star Point SS	None
SP-80	0	(b)	(b)	(b)	From sandstone bedding plane in Star Point SS	None

(a) In μmhos/cm at 25°C
(b) Insufficient water to sample

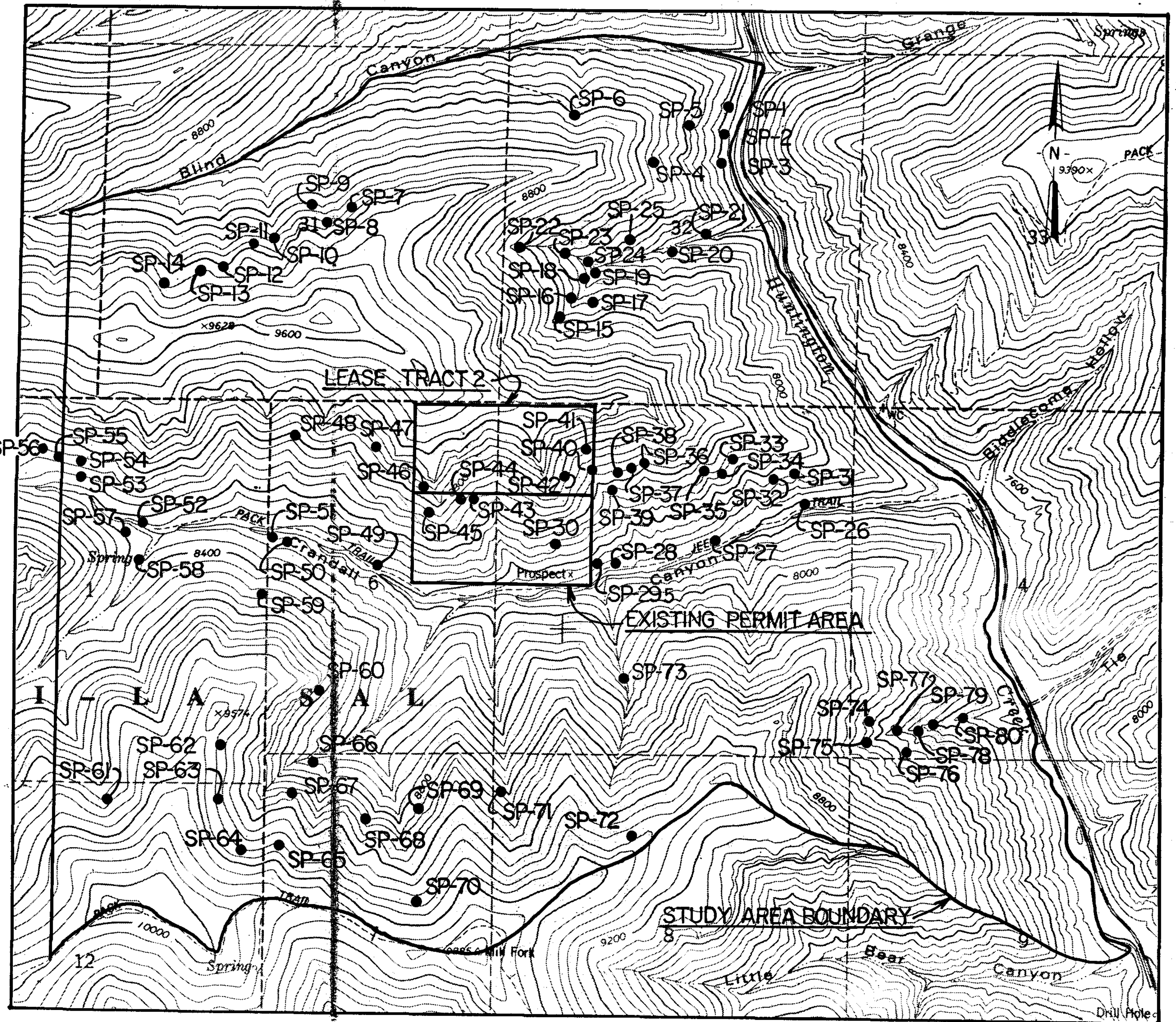

Figure 2. Location of seeps and springs found in the inventory.

conductance varying from 500 to 1000 umhos/cm at 25°C. This increase in specific conductance is indicative of leaching of minerals by the groundwater as it flows through increasing lengths of bedrock to the lower stratigraphic positions.

The hydrogen ion activity (pH) of water issuing from springs in the study area showed no trends within or between formations. Values varied from 6.80 to 8.57, averaging 7.74. Hence, spring water in the study area is slightly alkaline.

Water temperature varied widely at the site. In general, temperatures were lowest in springs issuing from fractures and highest in springs issuing from shallow colluvium over bedrock.

Based on the seep and spring inventory, two general conclusions can be drawn concerning the occurrence of groundwater in the vicinity of the Crandall Canyon Mine. Most of the seeps and some of the lower-flowing springs in the area issue along sandstone bedding planes or at the interface between overlying sandstones and underlying less-permeable shales. In simple terms, groundwater under these conditions flows vertically from the recharge area to the underlying confining bed (shale) or more permeable zone (bedding plane), whereupon the flow becomes horizontal and flows to the surface. Flow under these conditions is low, since most of the flow occurs in unfractured bedrock.

The other general condition occurs where springs issue from fractured bedrock. The temperature and specific conductance of water discharged from these springs tends to be lower and flows tend to be higher than that of other seeps and springs in the area, suggesting a topographically higher source of recharge and a shorter flow time. This is consistent with the higher hydraulic conductivity of the fractures relative to the unfractured bedrock.

4.0 SUBSIDENCE IMPACTS

A positive limit angle of 60° from horizontal was assumed to estimate the effects of subsidence on the seeps and springs found during the field inventory. This limit angle was selected to conform with previous work completed by Coal Systems (1981) for Genwal Coal Company. This positive limit angle is considered conservative for estimating subsidence impacts since Dunrud (1976) found positive limit angles that varies from 69° in weak overburden to 75° or more in moderately strong overburden in geologically similar areas in the Book Cliffs mining district, Utah and the Sommerset mining district, Colorado. The lower positive limit angle assumed for this assessment indicates a greater area of disturbance from subsidence.

Mine plans for the Crandall Canyon Mine indicate that 80 percent extraction will occur throughout the mine, with the exception of barrier pillars at the lease boundaries. The barrier pillar at the southern lease boundary will be sufficiently wide to preclude subsidence along Crandall Creek, thus limiting subsidence in areas north of the creek.

Using a positive limit angle of 60°, the maximum area of potential subsidence was determined as shown in Figure 3. As noted by this figure, 11 seeps and springs were found during the field inventory in the area of potential subsidence. A comparison with Table 1 indicates that, with the exception of SP-46 and SP-47, all of these 11 issue from the Blackhawk Formation. The two exceptions issue as seeps from bedding planes in the Castlegate Sandstone.

The maximum flow encountered within the area of potential subsidence was 1 gallon per minute (SP-30). This flow occurs as diffuse seepage above the mine portals and is collected in a pipe and routed around the portals to prevent problems at the portal face. There were no signs of usage of this spring. The only remaining spring discovered in the area of potential subsidence with a flow sufficient to sample (SP-38) showed some signs of deer and elk usage, but had a flow of less than 1 gallon per minute. All other sources issued as seeps with flows too small to permit sampling.

Deer and elk tracts and droppings were noted in the vicinity of SP-38 and SP-42. Other than these two seeps, no other signs of usage were seen within the area of potential subsidence.

Based on this information, subsidence from mining in Tracts 1 and 2 will have minimal impacts on water supplies from seeps and springs in the vicinity of the mine. Wildlife usage of the area to be impacted is essentially nonexistent, indicating

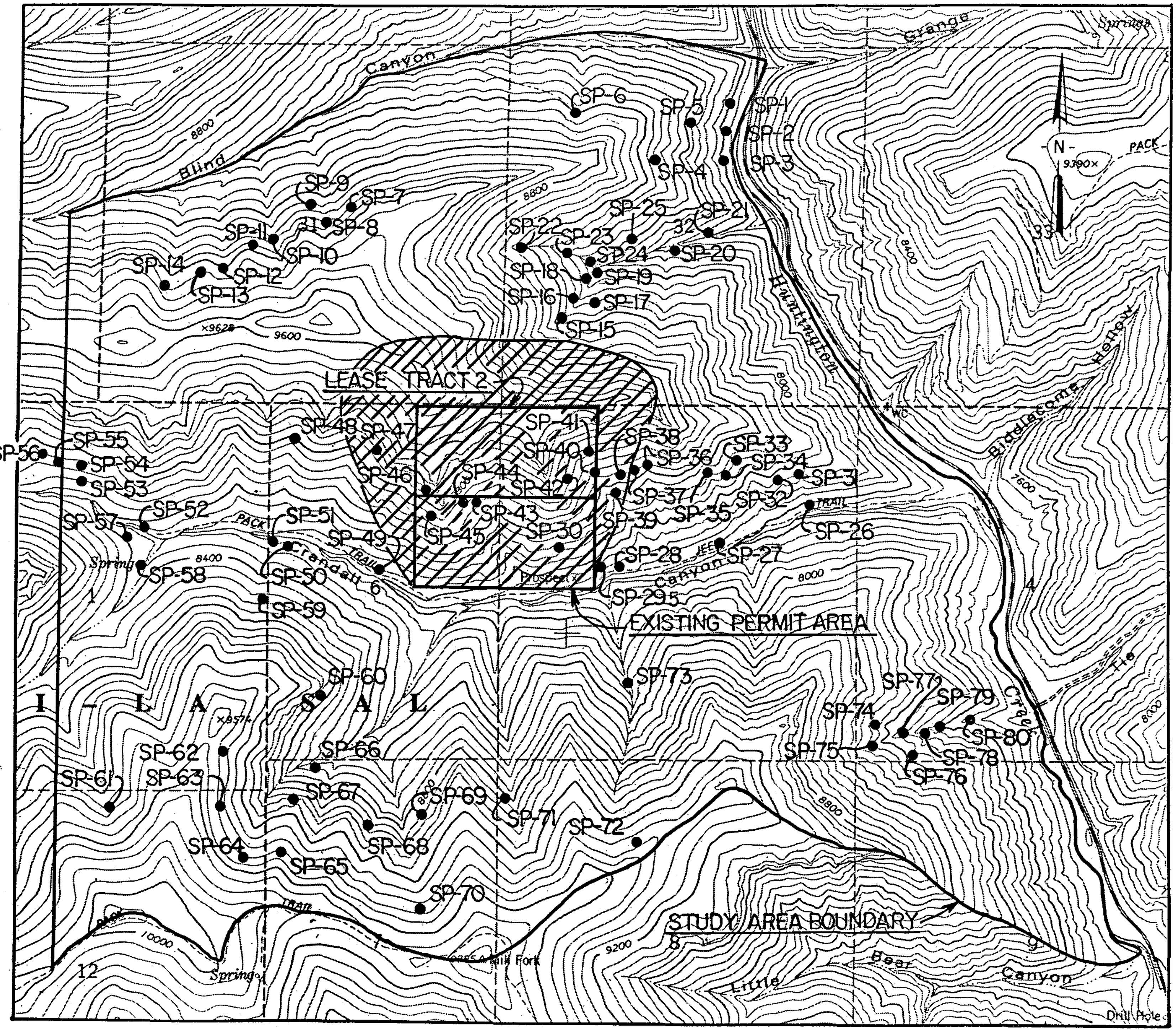

Figure 3. Maximum area of potential subsidence

that displacement of wildlife due to subsidence will be minimal. Flow rates encountered within the area of potential subsidence during the inventory were minimal, even though the field investigation was conducted shortly after the snow-melt period. Hence, the springs within the area of potential subsidence represent an insignificant resource to the local wildlife.

5.0 REFERENCES

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