CHAPTER VII

Hydrology

PART 7.1 Groundwater Hydrology

7.1.2 Existing Groundwater Resources

7.1.2.1 Regional Groundwater Hydrology

The water table elevation has been established in the general area by the U.S.G.S., Water Investigations Branch, at an elevation of 7,856 feet. This determination was made in T16S, R7E, Section 29, in the NW¼ of the NW¼, by means of a drill hole. We feel it would be near this same elevation in the permit area.

The following information is presented from a study done by Vaughn Hansen and Associates for Swisher Coal Company which was published in 1977. A copy of this study is included with this Chapter as Item Number VII-1. The area of study included Crandall Canyon and we feel that this information should be acceptable.

Water in the upper portion of each of the canyons studied (one of which was Crandall Canyon) flows intermittently and originates as interflow which surfaces above or near the Castlegate Sandstone - Blackhawk Formation interface and/or overland flow. The former process presumable dominates during the spring runoff season while the latter is most common during the summer thundershower period.

Springs throughout the general area of the Crandall Canyon appear to be watershield surfacing primarily above and below the Blackhawk Formation, with little groundwater activity showing in the Blackhawk. Field obervations in mines located in the San Rafael and Price River Basins have shown that typically, only a limited amount of subsurface water is found in the Blackhawk Formation. Apparently, even though fracturing in the area has presumably also penetrated the Blackhawk, the nature of the material (i.e., fine texture) is such that these fractures have sealed and thus remained relatively impermeable. It would

7.1.2.1 Continued-

appear, therefore, that water which does enter the ground in either the Castlegate or Star Point Sandstone surfaces in the same formation in which it entered, with very little passing through the Blackhawk. Groundwater flowing in thses formations has surfaced at fractures in these formations in the areas surrounding the permit area. Fractures in the more permeable sandstones above and below the Blackhawk Formation are presumably the means whereby groundwater would surface in the permit area, however, groundwater does not surface in the permit area. All this information indicates that very little or no groundwater would be encountered if coal mining in the lower Blackhawak Formationwere to be done in the permit area.

7.1.2.2 Mine Plan Area Aquifer
See 7.1.2.1 above.

7.1.3 Groundwater Development and Mine Dewatering

7.1.3.1 Water Supply
See 7.1.2.1 above.

7.1.3.2 Mine Dewatering
No mine dewatering anticipated, see 7.1.2.1 above.

7.1.4 Effects of Mining Operation on Groundwater
Applicant determines there will be no effect of mining operation on groundwater (see 7.1.2.1 above)

7.1.4.1 Hydrologic Balance
See 7.1.4 above.

7.1.4.2 Quantity
See 7.1.4 above.

7.1.5 Mitigation and Control Plans
Applicant determines these unnecessary, unless indicated by determinations and data which evolve from applicants Groundwater Monitoring Plan refered to in 7.1.6 of this Chapter.

7.1.6 Groundwater Monitoring Plan
Contained in this Chapter as Item Number VII-2, also for water monitoring points see [redacted]. map item VII-3

PART 7.2 Surface Water Hydrology

7.2.2 Existing Surface Water Resources ? Crandall Creek Springs & seeps?
(None) within permit area.

7.2.2.1 Regional Surface Water Hydrology
The permit area is located in the Crandall Creek watershed area which discharges water into Huntington Creek. We do not anticipate discharging any

7.2.2.1 Continued-

water into this watershed area or Crandall Creek. There are no surface water bodies within the permit area, however, there is a stream, Crandall Creek, adjacent to the permit area and four known springs farther up the canyon.

The only discharge conditions for streams that would be pertinent to this application would be for Crandall Creek. We can supply information obtained from U.S.G.S., Water Investigations Section and this information is shown in this Chapter as Item VII-4. Discharge data for two of the springs was available from U.S.G.S. and is included in this Chapter as Item VII-4.

Water quality data can be shown for surface waters in the adjacent areas as data extracted from a water quality and hydrologic study done by Vaughn Hansen and Associates for Swisher Coal Company and published in 1977. (As Part of VII-2, "Water Monitoring Plan").

Based on the data presented on ground and surface water in 7.1.2.1 and 7.2.2.1, we believe the proposed underground mining activities will probably not contaminate, diminish or interrupt and underground or surface source of area for domestic, agricultural, industrial or other legitimate use.

7.2.2.2 Mine Plan Area Watersheds and Streams, Springs and Seeps Characteristics, Streams Characteristics, Watershed Characteristics

See 7.2.2.1 above.

7.2.3 Surface Water Development, Control and Diversions

7.2.3.1 Water Supply

No surface water supply to be developed for this mining operation.

what about [illegible]

7.2.3.2 Sedimentation Control Structures and Diversions

A sedimentation pond for our surface disturbed area has been sized and location and is shown on map included with Chapter III as Item One.

7.2.4 Effects of Mining on Surface Water

Applicant determines that mining will have no effect on surface water due to fact, there is no surface water in propose mine plan area.

PART 7.2 Continued-

7.2.4.1 Hydrologic Balance
See 7.2.4 above.

7.2.4.2 Quality
See 7.2.4 above.

7.2.5 Mitigation and Control Plan
Applicant determines these unnecessary, unless indicated by determinations and data which evolve from applicant's Surface Water Monitoring Plan referred to in 7.2.6 of this Chapter

7.2.6 Surface Water Monitoring Plans
Contained in this Chapter as Item VII-2.

PART 7.3 Alluvial Valley Floor Determination
Determination made - none.

PART 7.4 Bibliography
None included

ITEM VII-1

WATER QUALITY AND HYDROLOGIC STUDY IN VICINITY OF HUNTINGTON CREEK MINE NO. 4 AND LITTLE BEAR SPRING

Prepared for

SWISHER COAL COMPANY

August 1977

CONSULTANTS/ENGINEERS
VAUGHN HANSEN ASSOCIATES
SALT LAKE CITY, UTAH

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CONTRACT RESPONSIBILITY

The study described in the following report was conducted for the purpose of determining the potential impact on ground water resulting from mining operations of Swisher Coal Company with recommendations for mitigating any potentially serious ground water impacts.

PROBLEM

Swisher Coal Company plans to expand their mining activity at Huntington Creek Mine No. 4 and Mill Fork Canyon, which is approximately twelve miles northwest of Huntington, Utah up Huntington Canyon. The expansion would be to the northwest in the vicinity of Little Bear Spring in Little Bear Canyon. Water from the spring is being used near Huntington for a domestic water supply. Concern has been expressed that extension of coal mining activity toward Little Bear Spring might intercept part or all of the flow that is now appearing at the spring and also that the quality of the spring water might be deteriorated.

OBJECTIVE OF THE STUDY

Vaughn Hansen Associates was requested to study the water quality and the hydrology in the vicinity of the intended activity. Two objectives were to guide the endeavor: (1) to determine the probable impact on Little Bear Spring of expanded mining and (2) to obtain background information pertaining to water quality for a reference to assess the cause of any changes in future quantity and quality of water at Little Bear Spring.

COORDINATION WITH FOREST SERVICE

Leases essential to the intended expansion of the mine are being requested from the U. S. Forest Service. This Federal Agency is concerned, therefore, about the probable adverse impact from the mining.

Several meetings have been held with staff from the Price office of the Forest Service to discuss the problem, to outline data acquisition procedures, and to discuss observations.

Forest Service personnel were to make geological observations in the area. Vaughn Hansen Associates was to gather and have analyzed water quality samples and to study the hydrology and fracturing patterns that may be related to water movement and water yield.

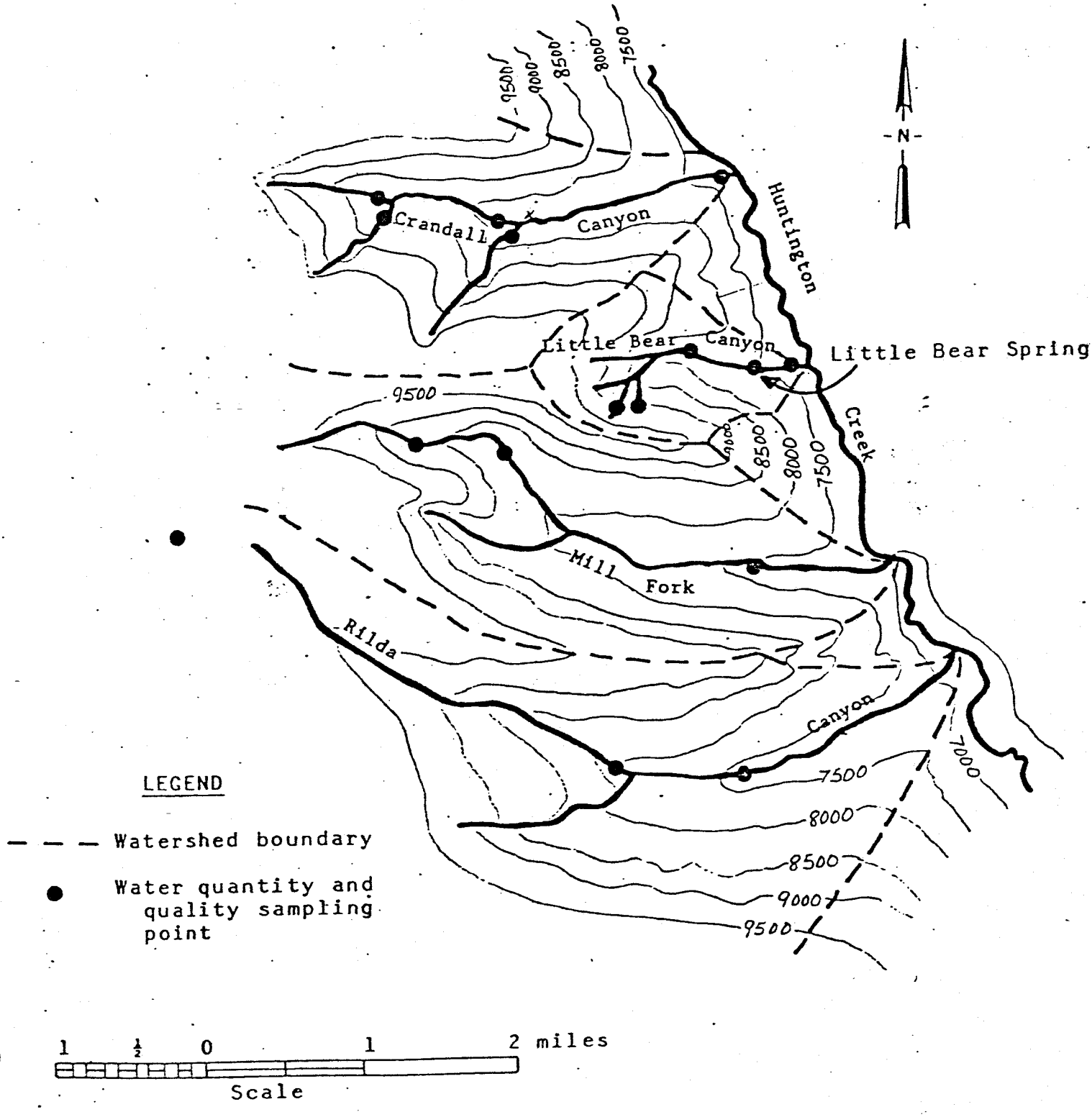
PERIOD OF FIELD STUDY

Field studies were conducted from November 8th through the 12th, 1976. These observations were after a dry fall and before the winter storms commenced. Data from water samples would, in general, reflect a base flow condition. In addition, samples were taken and field observations made during the period of May 31st through June 4th, 1977. This period of observation and sampling was preceeded by an unusually wet May. Some ice was still melting in the deeper sections of Little Bear Creek. However, the snow cover had melted.

Little Bear Canyon, a tributary to Huntington Creek, is situated between Crandall Canyon and Mill Fork. (See Figure 1). It is located primarily in sections 8 and 9 of T.16S., R.7E. Because of the abrupt drainage divide created by the incision of Crandall Canyon and Mill Fork, Little Bear Canyon has been left quite isolated from surrounding canyons by past geologic events. Its average change in elevation of 1600 feet per mile compares with 660 feet per mile in Crandall Canyon and 590 feet per mile in Mill Fork. This rate of change difference and degree of isolation is especially striking when seen from aerial photos and from figure 1, which shows that lines of equal elevation occur in Little Bear Canyon at a point much further east than in the surrounding canyons. Ridges are sharp and the sides of the canyons surrounding Little Bear Canyon are steep. Drainage into Crandall Canyon and into Mill Fork Canyon has eroded to a common sharp ridge only one-half of a mile west of the head of Little Bear Canyon. This erosional pattern essentially intercepts any shallow ground water flow before it can reach Little Bear Canyon.

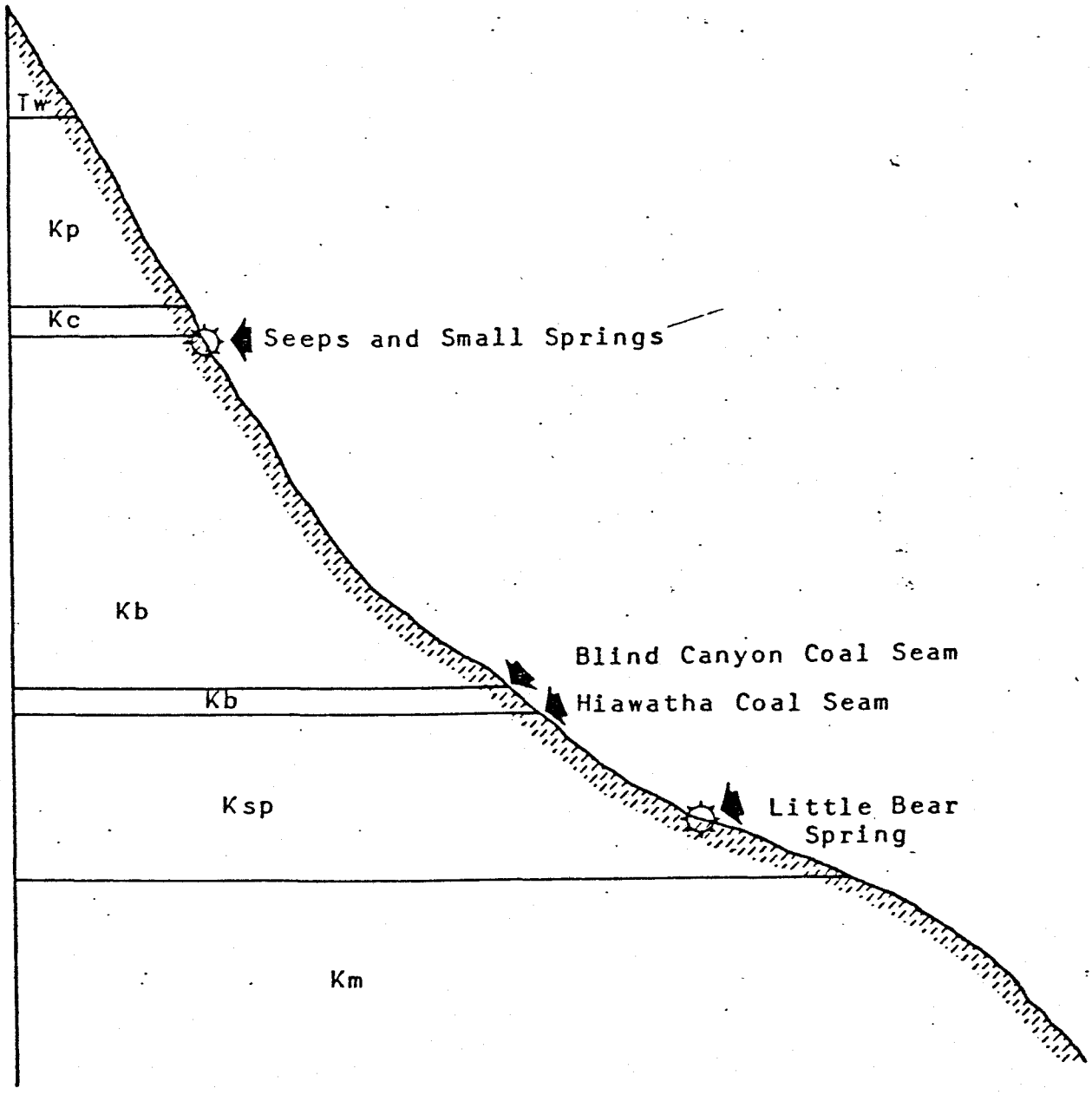
The drainage basin of Little Bear Canyon, covering approximately 755 acres, exposes six different geologic types, primarily cretaceous in age (See Figure 2): The North Horn Formation (a fluvial sandstone and mudstone), the Price River Formation (fluvial and marine sandstone and mudstone), the Castle Gate Sandstone (deltaic in origin), the Blackhawk Formation (sandstone, mudstone, shale, and coal), the Star Point Sandstone (deltaic and beach deposits), and the Masuk Shale member of the Mancos

FIGURE 1: ELEVATION CONTOUR MAP OF LITTLE BEAR AND NEIGHBORING CANYONS



Contour interval = 500 feet

FIGURE 2: CROSS-SECTION OF LITTLE BEAR CANYON FROM WESTERN MOST POINT TO MOUTH SHOWING GEOLOGICAL TYPES, SEEPS, AND SPRINGS.



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Tw = North Horn Formation
Kp = Price River Formation
Kc = Castle Gate Sandstone
Kb = Blackhawk Formation
Ksp= Star Point Sandstone
Km = Mancos Shale (Masuk Member)

shale (marine in origin). The Hiawatha and Blind Canyon Coal Seams, of interest in this study, appear at or near the bottom of the Blackhawk Formation. Springs surface in the upper reaches of the canyon near the Castle Gate Sandstone - Blackhawk Formation boundary while Little Bear Spring issues from the Star Point Sandstone. The predominate faulting pattern according to information supplied by the U.S. Forest Service, is from the northwest to the southeast accompanied by additional faults in a northeast southwest direction and a set of faults orthogonal to the former set extending in a southwest - northeast direction.

Jeppson et al. (1968) indicate a normal annual precipitation of approximately 20 inches and a potential evapotranspiration of 18 to 21 inches per year in and near Little Bear Canyon. A comparison of the area with the headwaters of the nearby Price River Basin (as reported by Mundorff, 1972) leads one to believe that most of this precipitation falls as snow during the winter months. The steepness of Little Bear Canyon suggests that only a small portion of the summer precipitation infiltrates and appears later as spring flow. The bulk presumably runs off as surface flow.

METHODS OF DATA COLLECTION

A total of sixteen water quantity and quality sampling stations were selected in Crandall, Little Bear, Mill Fork, and Rilda Canyons (see Figure 3). A more complete description of the

FIGURE 3: WATER QUANTITY AND QUALITY SAMPLING STATIONS NEAR HUNTINGTON CREEK MINE NO. 4

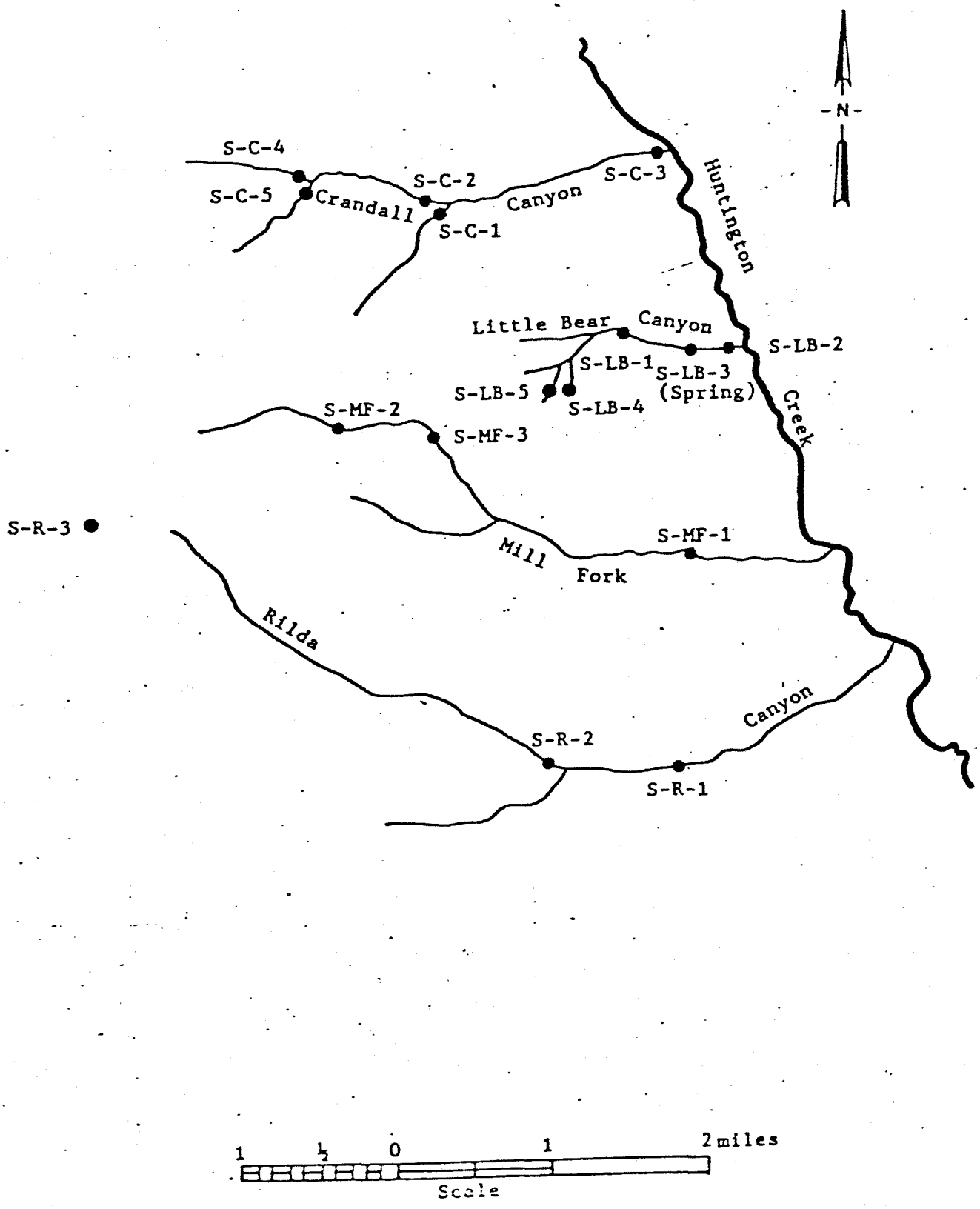


TABLE 1

DESCRIPTION OF WATER QUANTITY AND QUALITY SAMPLING STATIONS NEAR HUNTINGTON CREEK MINE NO. 4

Station Code	Location*	Description
S-C-1	(D-16-7) 6 dab	Crandall Canyon, 100 yards above confluence with West Branch.
S-C-2	(D-16-7) 6 dba	Crandall Canyon, 1.6 miles above highway, 200 yards above confluence with East Branch.
S-C-3	(D-16-7) 4 bbd	Crandall Canyon Creek above confluence with Huntington Creek.
S-C-4	(D-16-6) 1 acb	2.5 miles up Crandall Canyon on Right Fork of Each Branch, beyond fence.
S-C-5	(D-16-6) 1 acb	2.5 miles up Crandall Canyon on Left Fork of East Branch, beyond fence.
S-LB-1	(D-16-7) 8 daa	Little Bear Creek, 2400 feet north and 500 feet west of southeast corner of Section 8.
S-LB-2	(D-16-7) 9dac	Little Bear Creek, above confluence with Huntington Creek.
S-LB-3	(D-16-7) 9cad	Little Bear Spring, 0.3 mile up Little Bear Canyon.
S-LB-4	(D-16-7) 8dbd	Draw flowing north-west from hillside, below last fork, Little Bear Canyon.
S-LB-5	(D-16-7) 8 dbb	Middle Fork of south branch, Little Bear Canyon.
S-MF-1	(D-16-7) 21 baa	Mill Fork Canyon Spring near lower coal loading area, 1 mile up canyon.
S-MF-2	(D-16-6) 13 aab	Spring 3.9 miles up Mill Fork Canyon, on north branch.
S-MF-3	(D-16-7) 18 abd	Mill Fork Canyon, 100 yards below major split in canyon east side.
S-R-1	(D-16-7) 28 cab	Rilda Canyon Creek, 30 feet above bridge at old Helco Mine.

TABLE 1 con't

DESCRIPTION OF WATER QUANTITY AND QUALITY SAMPLING STATIONS NEAR HUNTINGTON CREEK MINE NO. 4

Station Code	Location*	Description
S-R-2	(D-16-7) 29 bdd	Rilda Canyon Springs water system, 2.6 miles up canyon on north fork.
S-R-3	(D-16-6) 14 cdb	Spring near the head of Rilda Canyon, near upper ridge.

* Based on the well and spring numbering system used in the State of Utah.

stations is found in Table 1. Stations four and five in Crandall and Little Bear Canyons as well as station three in Rilda Canyon were added for the June 1977 sampling period along with the other eleven stations sampled in November 1976.

During each of the sampling periods, data were collected to assess water quantity and quality. Flow measurements were estimated by the float method when applicable or by visual estimation in the case of low flows. The flow at Little Bear Spring was measured at a 90° V-notch weir located slightly downstream from the spring. Dip samples were also collected for chemical analyses. Those samples to be analyzed for trace metals were fixed with nitric acid. Chemical analyses were completed by Ford Chemical Laboratory in Salt Lake City.

For convenience in making comparisons, stations S-LB-3, S-MF-1, and S-R-1 have been grouped together and collectively called the lower springs. All other stations will be referred to as the upper stations. This was deemed justifiable due to the similarities found among the lower springs, as will be discussed.

RESULTS AND DISCUSSION

Water Quantity

Water in the upper portion of each of the canyons studied flows intermittently and originates as interflow which surfaces above or near the Castle Gate Sandstone - Blackhawk Formation interface

and/or overland flow. The former process presumably dominates during the spring runoff season while the latter is most common during the summer thundershower period, especially in Little Bear Canyon as previously discussed.

Springs throughout the area appear to be surfacing primarily above and below the Blackhawk Formation, with little groundwater activity showing in the Blackhawk, field observations in mines located in the San Rafael and Price River Basins have shown that typically, only a limited amount of subsurface water is found in the Blackhawk Formation. Apparently, even though fracturing in the area has presumably also penetrated the Blackhawk, the nature of the material (i.e. fine texture) is such that these fractures have sealed and thus remained relatively impermeable. It would appear, therefore, that water which does enter the ground in either the Castle Gate or Star Point Sandstone surfaces in the same formation in which it entered, with very little passing through the Blackhawk.

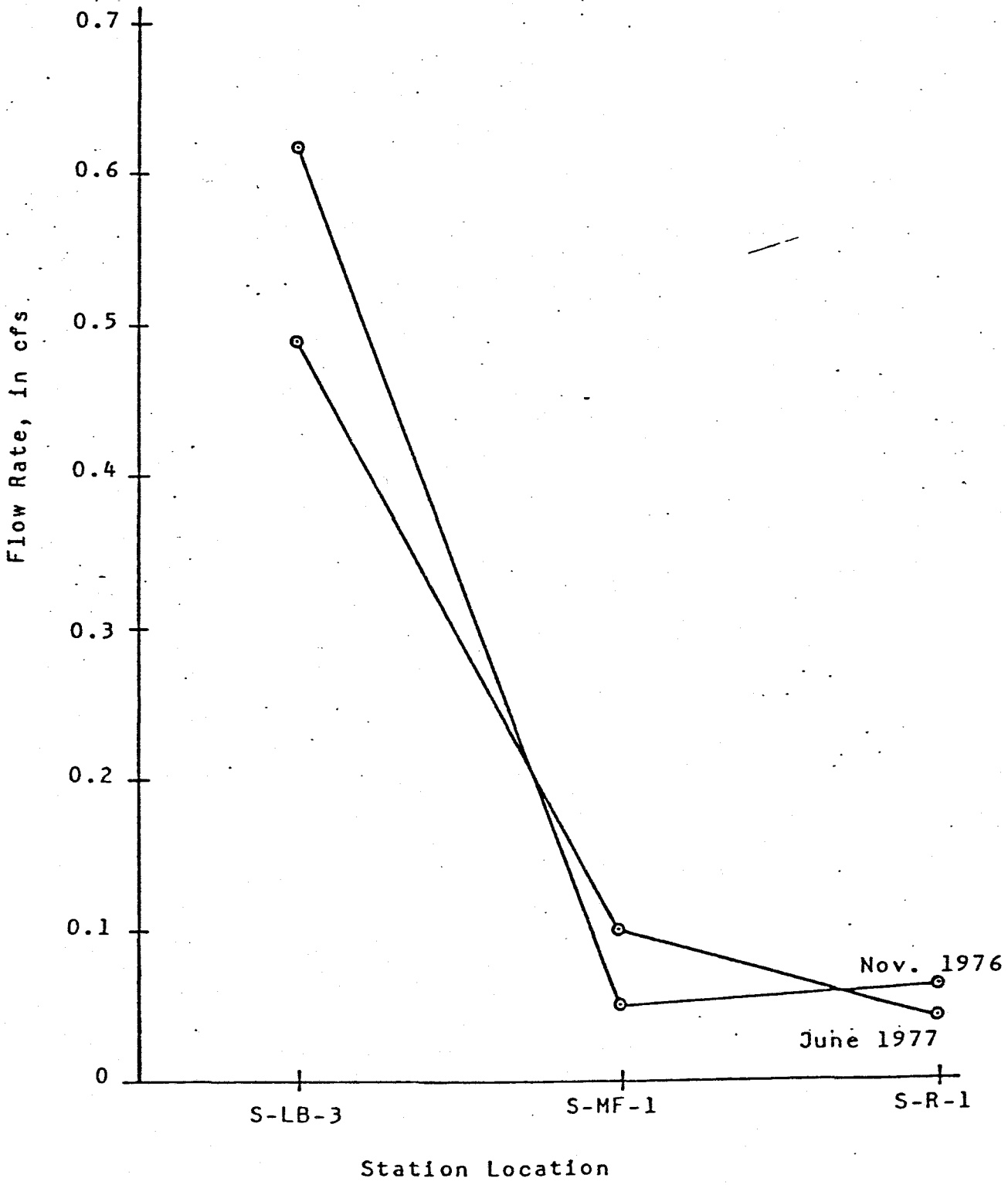
Substracting the previously indicated annual potential evapotranspiration from the normal annual precipitation, the expected yield from Little Bear Canyon should be on the order of one to two inches per year. A comparison with similar areas in the nearby Price River Basin indicates that an upper limit of four inches of runoff might be expected from the canyon annually (See Utah Division of Water Resources, 1975). Measurements of flow quantities at Little Bear Spring during each of the two

sampling periods, however indicate an average annual yield of approximately six inches from the spring alone during the course of a severe drought period. This suggests that at least a portion of the water in Little Bear Spring is originating at some point other than on the watershed to the west above. Hughes[1] has indicated that springs issuing from fractures in the Star Point Sandstone between Rilda Canyon and Bear Creek Canyon to the south produce flows at a fairly constant rate, almost independant of season. Such a faulting system is present in the Star Point at and near Little Bear Spring, as indicated by field observations by the U.S. Forest Service and Vaughn Hansen Associates.

It has been observed that spring and surface water flow rates decrease in a southerly direction from canyon to canyon in the study area. This phenomenon is especially marked in the lower springs as seen in Figure 4. In addition, information supplied by the U.S. Forest Service indicates that the number of springs in the Huntington Creek drainage decrease as one approaches Little Bear Spring from the northwest. This, plus the information already presented, leads to the conclusion that ground water is approaching the area from the north or northwest, with a progressive downstream depletion of the aquifer.

[1]Treavor C. Hughes, Associate Professor of Civil and Environmental Engineering, Utah Water Research Laboratory, Logan, Utah. Written communication received 18 July 1977.

FIGURE 4: FLOW RATES MEASURED AT THE LOWER SPRINGS NEAR HUNTINGTON CREEK MINE NO. 4



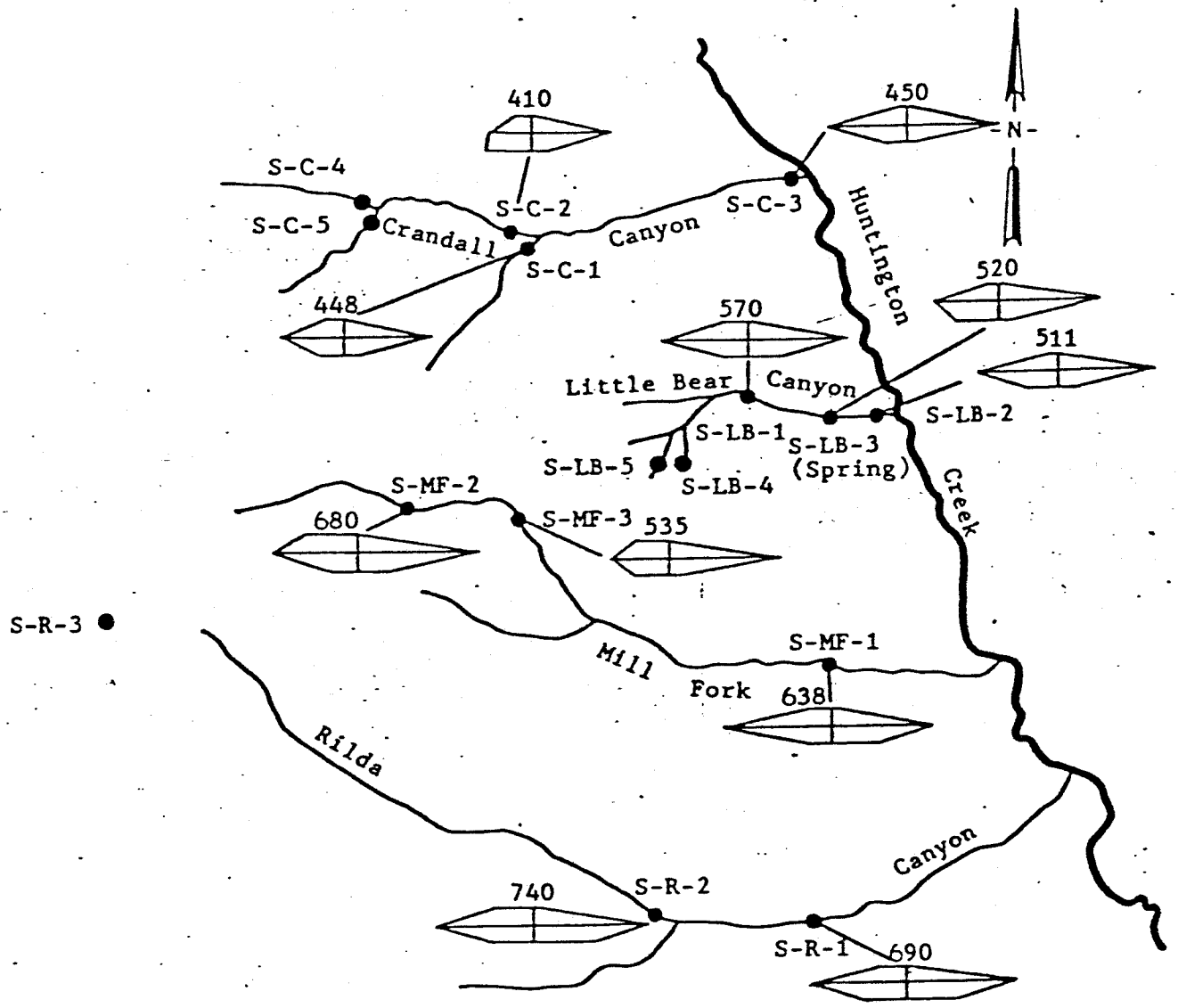
In summary, fractures in the more permeable sandstones above and below the Blackhawk Formation are presumably the means whereby ground water is surfacing in the area. The presence of the less permeable Blackhawk, the isolated nature and relatively small surface contributing area of Little Bear Canyon, the large flow measured at the spring, and the southward depletion in spring flow rates throughout the area indicate that water at Little Bear Spring originates primarily in the north, flowing through the Star Point Sandstone, rather than originating on the watershed to the west.

Water Quality

The waters of Crandall, Little Bear, Mill Fork, and Rilda Canyons are all chemically very closely related. The cation-anion configurations for all samples collected confirms this (see Figure 5 and 6). A progressive deterioration in water quality from north to south and west to east is also seen. It appears that if the water could be intercepted high in the system and discharged without passing through the lower portions of the various canyons, water of a higher quality would be available. Why ??

The major cation and anion concentrations remained fairly constant from November 1976 to June 1977. An increase in magnesium, noted at the lower stations, was observed in June with decreases in most other cases. The cation-anion ratios for all stations were similar during both sampling periods. The following is a synopsis of chemical quality results of the samples collected. See Appendix A

FIGURE 5: CATION-ANION DIAGRAMS OF SAMPLES COLLECTED NOVEMBER 8 THROUGH 12, 1976



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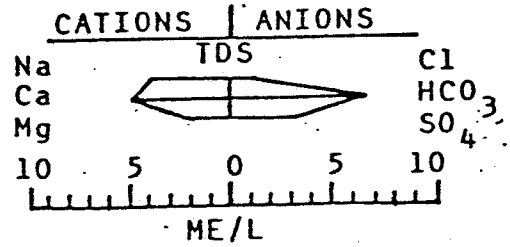
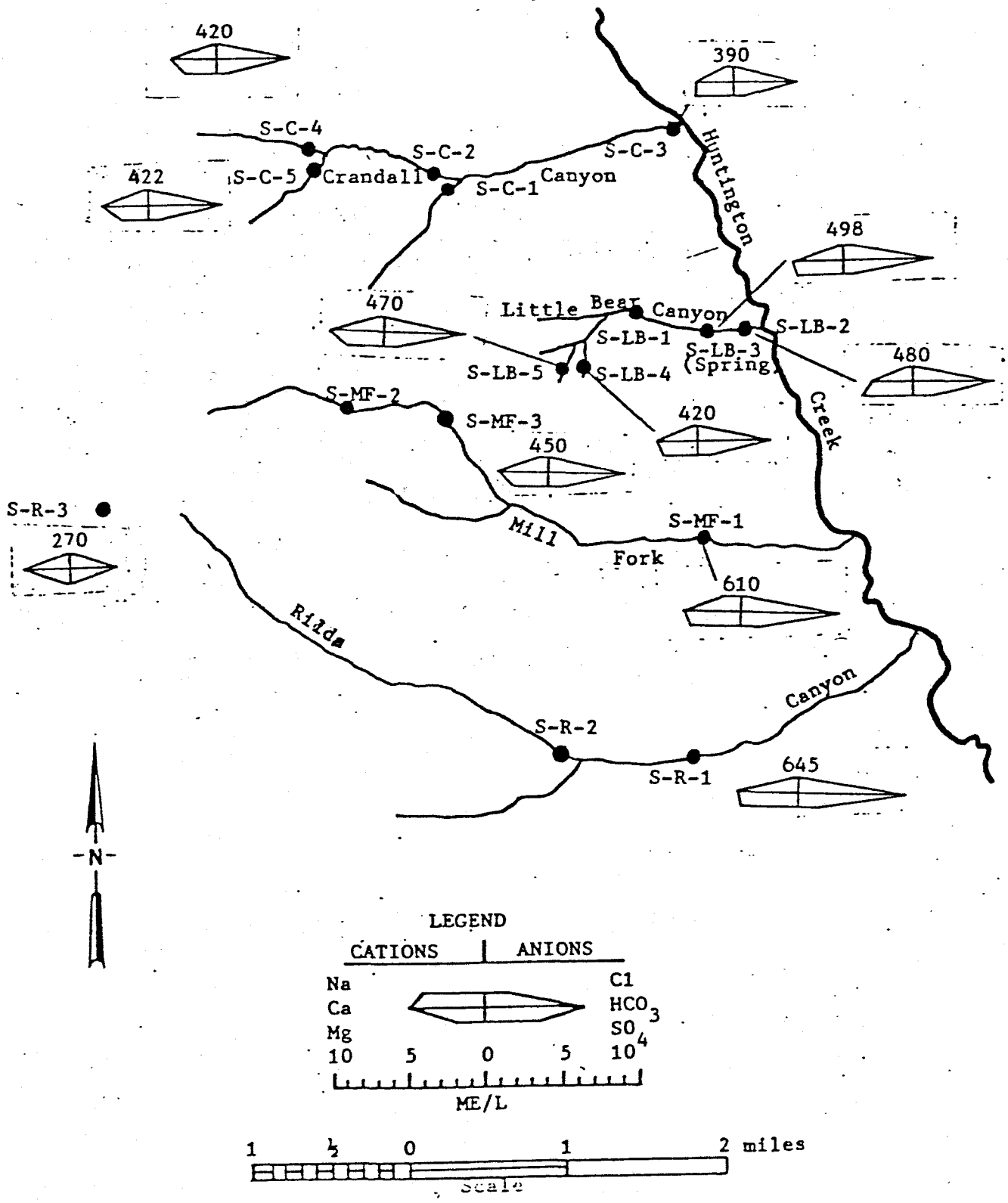


FIGURE 6: CATION-ANION DIAGRAMS OF SAMPLES COLLECTED

MAY 31 to JUNE 4, 1977



for a tabular presentation of all water quality data and Appendix B for maps showing the location of these data in the field.

Total Dissolved Solids

The recommended drinking water standard limit of 500 mg/l was exceeded at eight of the eleven stations sampled in the Fall. The average concentration was 563 mg/l. No samples in Crandall Canyon were in excess of 500 mg/l. During June 1977 two of the eleven stations sampled had TDS concentrations in excess of 500 mg/l. The average concentration was 461 mg/l. The two stations in excess of the recommended standard were the lower stations in both Mill Fork and Rilda Canyons. Concentrations typically increased from north to south in the study area.

Hardness

Hardness levels tended to increase as the water reached the deeper parts of the various canyons. (Explanation for this ?)

Alkalinity

Increases in alkalinity levels are seen as the water reaches the deeper canyon area.

Barium

None of the water samples exceeded the mandatory maximum limit of 1.0 mg/l. The concentrations ranged from 0.002 mg/l to 0.37 mg/l.

Bicarbonate

Bicarbonate showed the same increasing trends as alkalinity and hardness.

Boron

In November 1976, all analyses for boron were below the laboratory detection limit of 0.001 mg/l. In June 1977, the concentrations for boron ranged from less than 0.001 mg/l to 0.085 mg/l.

Calcium

Calcium concentrations increased as the water reached the deeper portions of Huntington Canyon. The highest concentrations were found in Rilda Canyon.

Chloride

Chloride is of little concern in this area. The recommended maximum concentration for drinking water supplies is 250 mg/l and the highest concentration found was 10 mg/l. The average concentration was 5 mg/l.

Copper

Copper concentrations were consistently low. The high concentration was 0.040 mg.l, found in Little Bear Spring, Mill Fork, and Rilda Canyons during the November sampling period. The high concentration in June was 0.035 mg/l in lower Crandall.

Fluoride

Fluoride concentrations averaged 0.18 mg/l. The concentrations increased deeper in the canyons.

Iron

Iron concentrations averaged 0.14 mg.l for both sampling periods. Upper LIttle Bear Canyon had the high concentration of 0.311 mg/l in November 1976.

Magnesium

Magnesium concentrations ranged from 2.88 mg/l on top of Rilda Canyon to 46.08 mg/l at the lower Rilda Canyon station. The average concentration for all samples was 25.09 mg/l. The June sampling averaged 10 mg/l higher in concentration than the November samples.

Manganese

No violations of the 0.05 mg/l recommended limit were observed. The average concentration was 0.008 mg/l.

Potassium

Potassium concentrations averaged 1.17 mg/l in November and 1.99 mg/l in June. The concentrations increased as the water reached the deeper parts of the canyons.

Sodium

Sodium concentrations increased in the deeper portions of Huntington Canyon. The November average was 31.1 mg/l. June's average concentration was 9.6 mg/l.

Sulfate

Sulfate concentrations increased from north to south with the highest concentrations being found in Rilda Canyon. The average concentrations were 74.9 mg/l and 41.8 mg/l in November and June, respectively. There was a greater range of sulfate concentrations in the Fall (27.7 to 167 mg/l) over the Summer (34 to 66 mg/l).

Zinc

Zinc concentrations increased in the lower waters. The average in November was 0.055 mg/l while only 0.010 mg/l in June.

The water quality data thus far collected indicate concentration gradients in both a north-south and west-east direction. This again leads to the conclusion that subsurface water supplies originate from one of two sources: (1) water which falls in the upper portions of the canyons tributary to Huntington Creek and subsequently infiltrates and flows east, surfacing normally above the Blackhawk Formation or (2) water which enters the area through aquifers in the Star Point Sandstone from the north, possibly being fed by Huntington Creek or its tributaries.

Data from this study and from the 208 water Quality Study show increases in concentration from increased contact with the mancos derived soils. The deeper the canyon, the more both the Blackhawk formation above the Star Point Sandstone and the underlying mancos formation are exposed. The longer the flow path, the greater the concentration.

CONCLUSIONS

Water quantity and quality data collected during November 1976 and June 1977 suggest that surface and subsurface water enters the study are both from the west and also from the north. Because of the apparant limited amount of ground water which flows through the less permeable Blackhawk Formation, water at Little Bear Spring is suspected to originate in the north, flowing through aquifers in the Star Point Sandstone, and surfacing usually at fractures ~~is~~ in the formation. The southward depletion in flow noted at the lower springs suggests that little ground water would be encountered if mining coal at the Blackhawk Formation-Star Point Sandstone interface were to expand in that direction.

The water table at Little Bear Spring is below the coal seams to be mined. Crandall Canyon serves as a major interceptor drain cutting into the Star Point Formation. These conditions indicate that increased mining proposed by Swisher Coal Company would have little or no affect on the Little Bear Spring.

Water quantity and quality should be monitored during the mining operation to document the impact on adjacent ground water.

LITERATURE CITED

Jeppson, R. W., G. L. Ashcroft, A. L. Huber, G. V. Skogerboe, and J. M. Bagley. 1968 Hydrologic Atlas of Utah, Utah Water Research Laboratory and Utah Department of Natural Resources. PRWG 35-1, Utah State University, Logan, Utah.

Mundorff, J. D. 1972. Reconnaissance of Chemical Quality of Surface Water and Fluvial Sediment in the Price River Basin, Utah. Utah Department of Natural Resources, Division of Water Rights. Technical Publication No. 39, Salt Lake City.

Utah Division of Water Resources, 1975. Hydrologic Inventory of the Price River Basin. Utah Department of Natural Resources, Salt Lake City.

APPENDIX A

RAW WATER QUALITY DATA

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

A-1
WATER QUALITY DATA

APPENDIX A

Station Huntington Creek Mine #4
Location

Station	Time	Flow (cfs)	Temperature Air (°C)	Temperature Water (°C)	pH	Dissolved Oxygen (mg/l)	Sulfate as SO_4 (mg/l)	[illegible] (mg/l)	T.D.S. (mg/l)	Specific Cond. (µmhos)	Turbidity (FTU)	Carbonate Alk. as CO_3 (mg/l)	Bicarbonate Alk. as HCO_3 (mg/l)	Total Alk. as $CaCO_3$ (mg/l)	Total Hardness as $CaCO_3$ (mg/l)
S-C-1	14:10	0.002		1.5	7.9	9.7	40.0	<0.01	448	680	1.10	<0.01	300.1	246	239
S-C-2	15:50	0.8		2.5	8.03	10.0	27.7	<0.01	410	630	1.60	<0.01	290.4	238	222
S-C-3	14:00	0.3	5	1.5	8.1	10.1	27.7	<0.01	450	690	2.20	<0.01	312.3	256	270
S-LB-1	8:50	0.05	1.0	1.5	7.97	9.95	92.0	<0.01	(570)	870	2.50	<0.01	329.4	270	292
S-LB-2	14:30	0.16	11	5	8.1	9.7	40.0	<0.01	(511)	780	1.50	<0.01	344	282	300
S-LB-3	15:45	0.62	7	9	7.8	8.95	33.8	<0.01	(520)	800	1.00	<0.01	356.2	292	298
S-MF-1	11:55	0.05	9	6	7.4	7.2	129	<0.01	(638)	980	3.50	<0.01	341.6	280	354
S-MF-2	12:00	0.01		4.5	7.98	9.8	92.0	<0.01	(480)	1040	1.20	<0.01	422.1	346	292
S-MF-3	16:20				7.88	9.9	33.0	<0.01	(535)	820	1.10	<0.01	373.3	306	244
S-R-1	14:55	1.16	3.5	7.0	7.93	8.6	142	<0.01	(690)	1060	1.00	<0.01	378.2	310	370
S-R-2	12:30				7.80	8.8	167	<0.01	(740)	1130	0.72	<0.01	384.3	315	382

Station	Aluminum Diss.	Antimony Diss.	Arsenic Diss.	Barium Diss.	Beryllium Diss.	Boron Diss.	Cadmium Diss.	Calcium Diss.	Chloride Diss.	Chromium Hexavalent	Cobalt Diss.	Copper Diss.	Fluoride Diss.	Germanium Diss.
S-C-1	<0.001	<0.001	<0.001	0.015	<0.001	<0.001	<0.001	68.8	1.5	<0.001	<0.001	0.007	0.17	<0.001
S-C-2	0.007	<0.001	<0.001	0.015	<0.001	<0.001	<0.001	48.0	2.0	<0.001	<0.001	0.002	0.15	<0.001
S-C-3	0.002	<0.001	<0.001	0.015	<0.001	<0.001	<0.001	86.4	4.0	<0.001	<0.001	0.024	0.17	<0.001
S-LB-1	0.005	<0.001	<0.001	0.028	<0.001	<0.001	<0.001	96.0	6.0	<0.001	<0.001	0.032	0.18	<0.001
S-LB-2	0.011	<0.001	<0.001	0.013	<0.001	<0.001	<0.001	88.0	6.0	<0.001	<0.001	0.031	0.17	<0.001
S-LB-3	0.006	<0.001	<0.001	0.037	<0.001	<0.001	<0.001	70.4	4.0	<0.001	<0.001	0.040	0.18	<0.001
S-MF-1	<0.001	<0.001	<0.001	0.37	<0.001	<0.001	<0.001	116.8	8.0	<0.001	<0.001	0.040	0.032	<0.001
S-MF-2	<0.001	<0.001	<0.001	0.005	<0.001	<0.001	<0.001	88.0	0.5	<0.001	<0.001	0.002	0.15	<0.001
S-MF-3	<0.001	<0.001	<0.001	0.018	<0.001	<0.001	<0.001	62.4	2.0	<0.001	<0.001	0.002	0.16	<0.001
S-R-1	<0.001	<0.001	<0.001	0.028	<0.001	<0.001	<0.001	100.8	4.0	<0.001	<0.001	0.030	0.20	<0.001
S-R-2	<0.001	<0.001	<0.001	0.012	<0.001	<0.001	<0.001	108.8	6.0	<0.001	<0.001	0.040	0.21	<0.001

Station	Iron Total	Lead Diss.	Magnesium Diss.	Manganese Diss.	Mercury Diss.	Molybdenum Diss.	Nickel Diss.	Potassium Diss.	Selenium Diss.	Silver Diss.	Sodium Diss.	Zinc Diss.	Vanadium Diss.	Date	Location
S-C-1	0.297	<0.001	14.88	0.012	<0.0002	<0.001	<0.001	0.91	<0.001	<0.001	22.0	0.044	<0.001	11-12-76	16S-7E-6-2
S-C-2	0.125	<0.001	24.48	0.006	<0.0002	<0.001	<0.001	0.71	<0.001	<0.001	20.0	0.083	<0.001	11-11-76	16S-7E-6-1
S-C-3	0.158	<0.001	12.96	0.006	<0.0002	<0.001	<0.001	0.90	<0.001	<0.001	9.0	0.049	<0.001	11-9-76	at confluence with Huntington Ck.
S-LB-1	(0.311)	<0.001	12.48	0.007	<0.0002	<0.001	<0.001	1.01	<0.001	<0.001	35.0	0.042	<0.001	11-8-76	700'N 500'W SE Cor Sec 8 16S 7E
S-LB-2	0.129	<0.001	19.20	0.008	<0.0002	<0.001	<0.001	1.24	<0.001	<0.001	12.0	0.065	<0.001	11-9-76	at confluence with Huntington Ck
S-LB-3	0.198	<0.001	29.28	0.002	<0.0002	<0.001	<0.001	1.06	<0.001	<0.001	15.0	0.052	<0.001	11-8-76	Little Bear Spring
S-MF-1	0.163	<0.001	14.88	0.004	<0.0002	<0.001	<0.001	1.51	<0.001	<0.001	78.0	0.055	<0.001	11-9-76	Near Lower Loading Area
S-MF-2	0.134	<0.001	17.28	0.008	<0.0002	<0.001	<0.001	0.84	<0.001	<0.001	65.0	0.043	<0.001	11-12-76	16S-6E-13-1
S-MF-3	0.066	<0.001	21.10	<0.001	<0.0002	<0.001	<0.001	0.79	<0.001	<0.001	45.0	0.047	<0.001	11-11-76	16S-7E-18-1
S-R-1	0.123	<0.001	28.32	0.007	<0.0002	<0.001	<0.001	2.14	<0.001	<0.001	41.0	0.071	<0.001	11-9-76	30' above bridge at old [illegible] mine
S-R-2	0.215	<0.001	26.4	0.009	<0.0002	<0.001	<0.001	1.77	<0.001	<0.001	50.0	0.092	<0.001	11-9-76	Springs in Rilda Canyon

WATER QUALITY DATA

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

Station HUNTINGTON CREEK MILL No. 4
Location _____

APPENDIX A

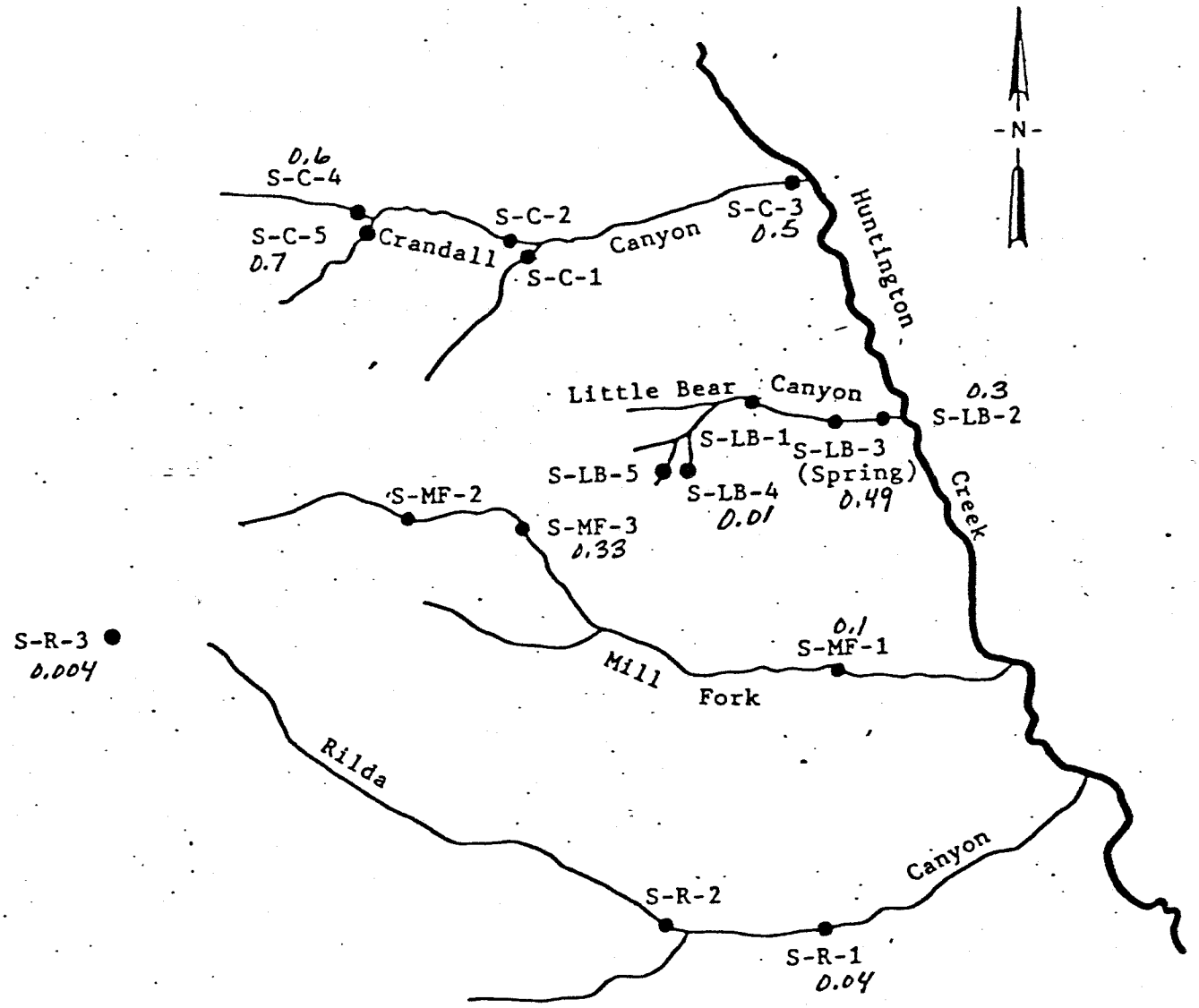
STATION	DATE	TIME	FLOW	TEMPERATURE AIR °C	TEMPERATURE WATER °C	pH	COLIFORM TOTAL MPN	COLIFORM FECAL MPN	FECAL STREP MPN	C.O.D. mg/l	B.O.D. mg/l	T.O.C. mg/l	DISSOLVED OXYGEN mg/l	OIL & GREASE mg/l	PHENOL mg/l	NITROGEN AMMONIA as NH_3-N mg/l	NITROGEN NITRATE as NO_3-N mg/l	NITROGEN NITRITE as NO_2-N mg/l	NITROGEN TOTAL KJELDAHL mg/l	NITROGEN ORGANIC mg/l	PHOSPHORUS TOTAL as PO4 mg/l	PHOSPHORUS ORTHO as PO4 mg/l	SULFATE as SO4 mg/l	HARDNESS as CaCO3 mg/l	ALKALINITY as CaCO3 mg/l	SOLIDS TDS mg/l	SOLIDS SUSPENDED mg/l	SOLIDS TDS mg/l	SOLIDS TOTAL mg/l	SOLIDS VOLATILE mg/l	SPECIFIC CONDUCTANCE micromhos	TURBIDITY FTU	CARBONATE as CO_3 mg/l	BICARBONATE as HCO_3 mg/l	ALKALINITY CARBONATE as $CaCO_3$ mg/l	ALKALINITY TOTAL as $CaCO_3$ mg/l	HARDNESS as $CaCO_3$ mg/l	GROSS ALPHA RADIOACTIVITY pCi/l
SC-3	4-3-77	15:15	0.5																				40.0					390					1.00		263.5		216	248	
SC-4	4-3-77	11:20	1.6																				36.0					420					630		291.4		238	262	
SC-5	4-3-77	11:30	0.7																				34.0					422					0.80		290.4		238	262	
S-LR-2	4-4-77	14:45	0.3																				57.0					480					1.50		317.2		260	308	
S-LR-4	4-4-77	12:40	0.007																				42.0					420					2.50		283		232	264	
S-LR-5	4-4-77	13:50																					58.0					470					1.60		314.9		258	300	
S-LR-3	5-31-77	19:10	0.49		8	7.6																	28.0		1.0			498					0.30		356.2		292	316	
SR-1	5-31-77	15:20	0.04		12	7.5																	66.0		6.0			(645)					0.70		331.9		354	390	
S-MF-1	5-31-77	16:05	0.1		10	7.6																	62.0		13.0			(610)					3.10		296.3		328	340	
S-MF-3	5-31-77	16:45	0.39		9	8.0																	37.0		5.0			450					0.50		307.4		252	264	
S-R-3	6-1-77	14:00	0.004		2	7.9																	8.0		188			270					15.00		192.8		158	170	

STATION	ALUMINUM DISS mg/l	ANTIMONY DISS mg/l	ARSENIC DISS mg/l	BARIUM DISS mg/l	BERYLLIUM DISS mg/l	BORON DISS mg/l	CADMIUM DISS mg/l	CALCIUM DISS mg/l	CHLORIDE DISS mg/l	CHROMIUM HEXAVALENT as Cr mg/l	COBALT DISS mg/l	COPPER DISS mg/l	CYANIDE as CN mg/l	FLUORIDE DISS mg/l	IRON DISS mg/l	IRON TOTAL mg/l	LEAD DISS mg/l	MAGNESIUM DISS mg/l	MANGANESE DISS mg/l	MERCURY DISS mg/l	MOLYBDENUM DISS mg/l	NICKEL DISS mg/l	POTASSIUM DISS mg/l	SELENIUM DISS mg/l	SILICA as SiO_2 mg/l	SILVER DISS mg/l	SODIUM DISS mg/l	ZINC DISS mg/l	VANADIUM DISS mg/l	COMMENTS
SC-3			<1.001	0.099		<0.001		98.0	9.0			0.035		0.20		0.147	0.002	38.72	1.009				1.495	<0.001			5.66	0.821		
SC-4			<1.001	0.096		0.014		61.6	4.0			0.020		1.19		0.140	<0.001	25.12	0.006				1.093	<0.001			8.26	0.012		
SC-5			<0.04	0.015		0.010		64.0	6.0			0.006		0.17		0.049	<0.001	24.98	1.010				1.135	<0.001			8.25	0.011		
S-LR-2			<0.001	0.115		0.012		53.6	4.0			0.014		0.21		0.269	<0.001	41.76	0.017				1.505	<0.001			8.38	0.014		
S-LR-4			<0.001	0.106		0.015		56.8	6.0			0.011		0.28		0.096	<1.001	29.18	0.007				1.710	<0.001			7.80	0.010		
S-LR-5			<0.001	0.110		0.012		72.8	6.0			0.006		0.21		0.053	<0.001	29.12	0.005				1.135	<0.001			7.95	0.009		
S-LR-3			<1.001	0.005		0.017		64.0	9.0			0.010		0.23		0.048	<0.001	37.14	0.004				1.42	<1.001			6.88	0.013		
SR-1			<0.01	0.012		0.085		79.2	6.0			0.006		0.23		0.116	<1.001	96.18	0.009				7.26	<1.001			15.13	0.005		
S-MF-1			<0.001	0.004		0.019		72.0	10.0			0.004		0.22		0.134	<0.001	58.90	0.017				3.16	<0.001			28.30	0.005		
S-MF-3			<0.001	0.002		0.016		63.2	9.0			0.003		0.18		0.072	<0.001	25.94	0.005				1.13	<0.001			14.20	0.003		
S-R-3			<0.001	0.003		0.019		63.2	8.0			0.004		0.14		0.052	<0.001	2.85	0.010				0.50	<0.001			3.35	0.004		

APPENDIX B

WATER QUALITY SAMPLING LOCATION MAPS

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Flow
Date May 31 to June 4, 1977

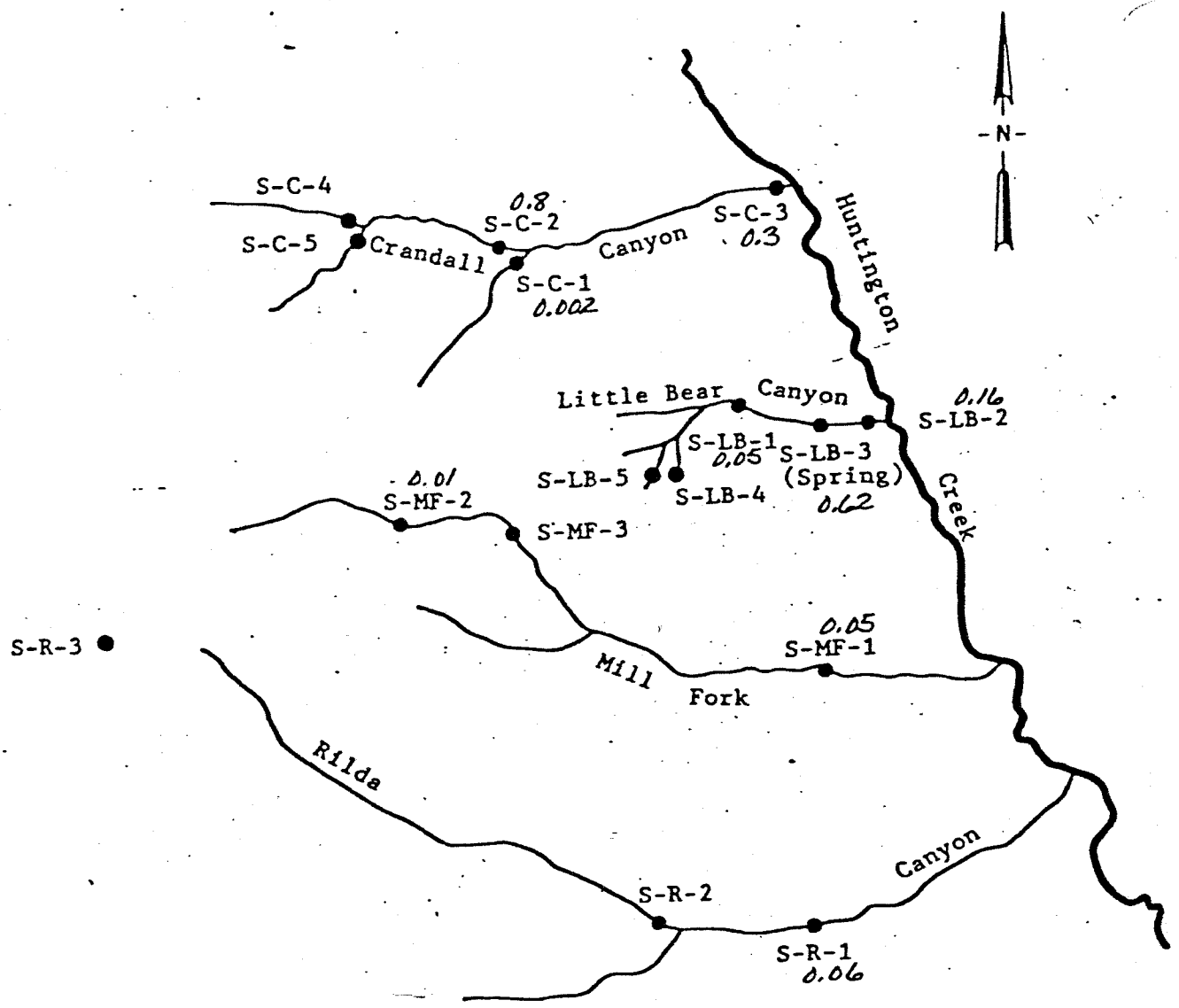
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

Vaughn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Flow, cfs.

Date November 8-12, 1976

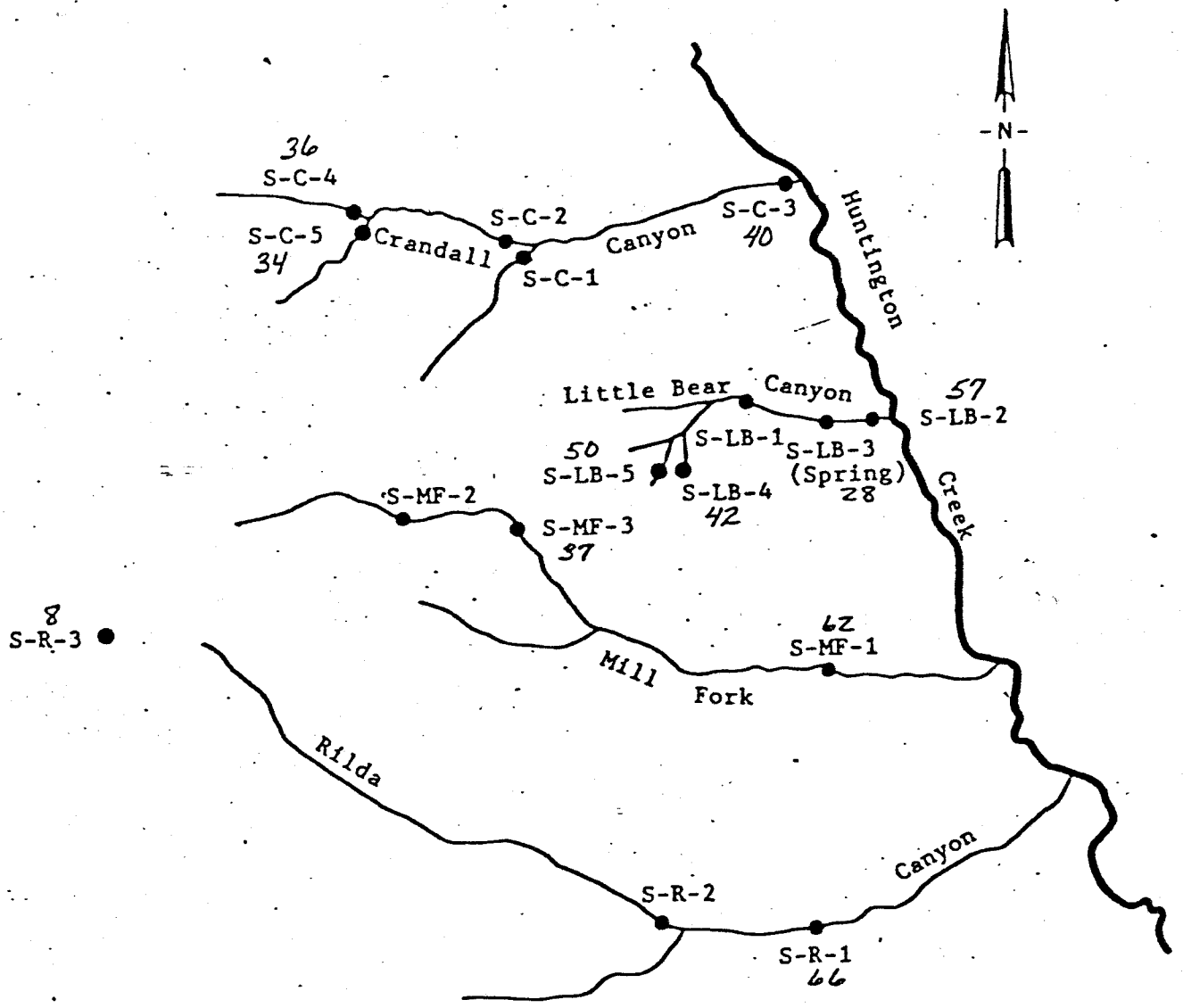
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

Vaughn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Sulfate
Date May 31 to June 4, 1977

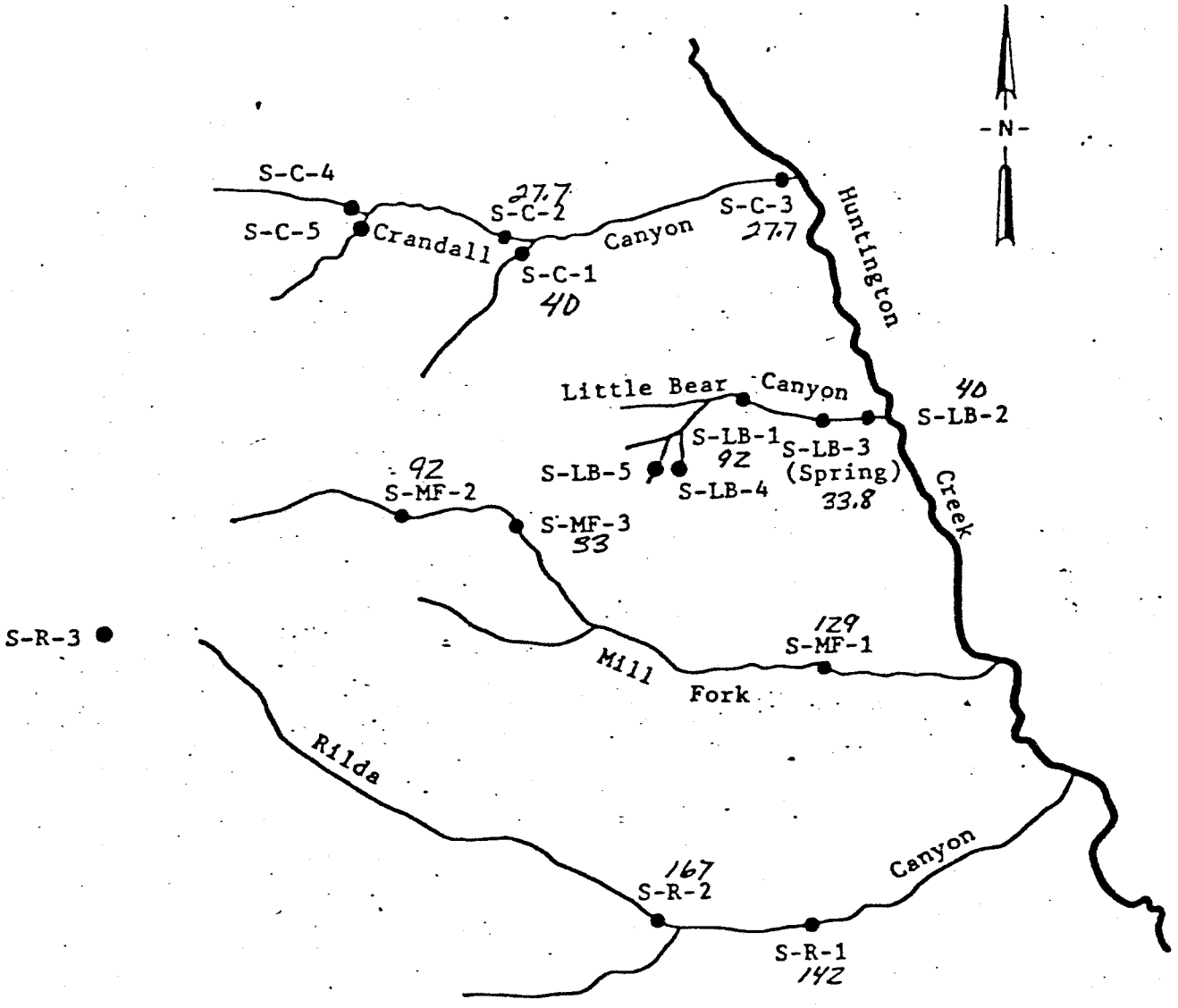
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 250 mg/l Recommended

Vaughn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Sulfate
Date November 8-12, 1976

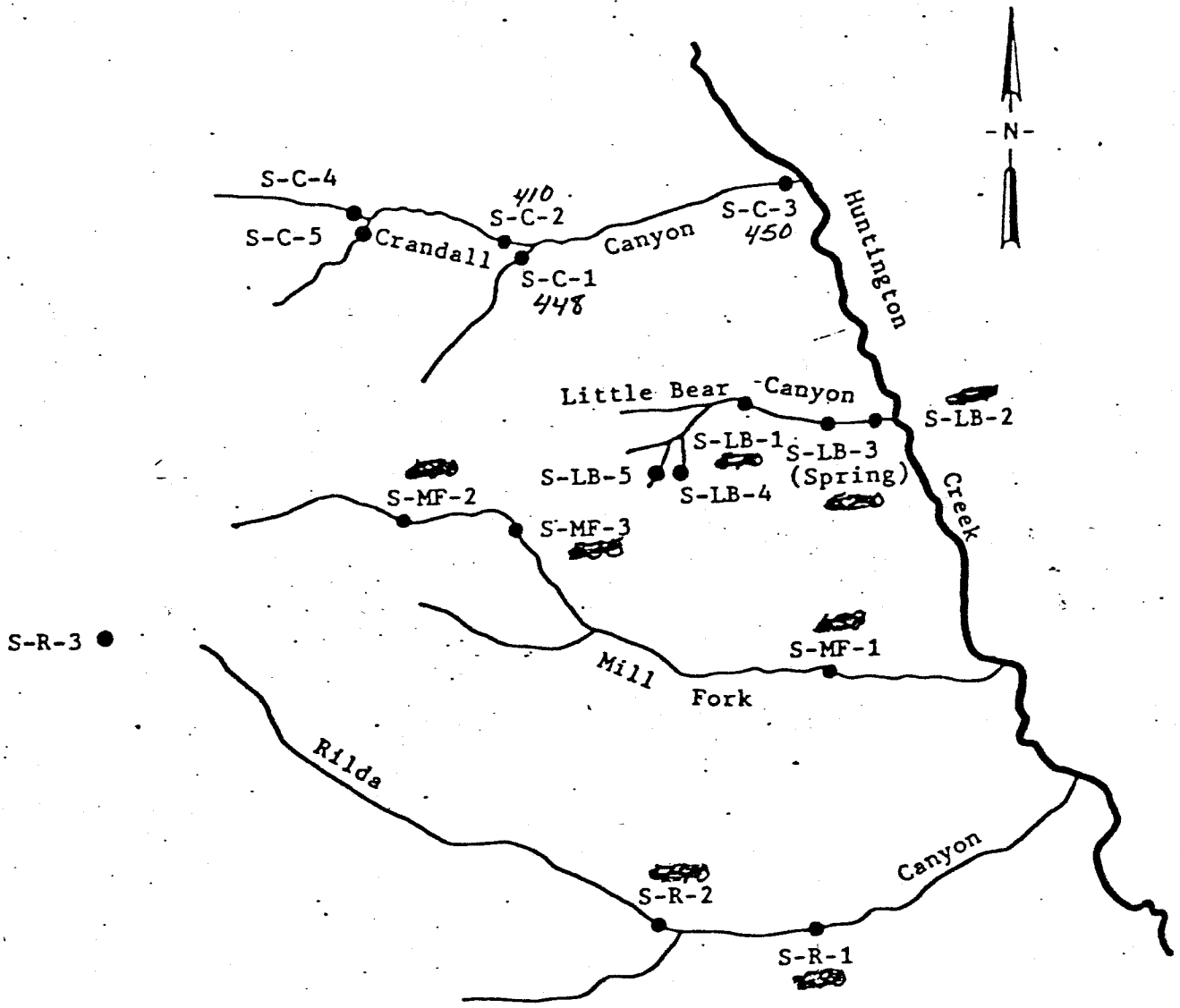
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 250 mg/l Recommended

Vaughn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Total Dissolved Solids
Date November 8-12, 1976

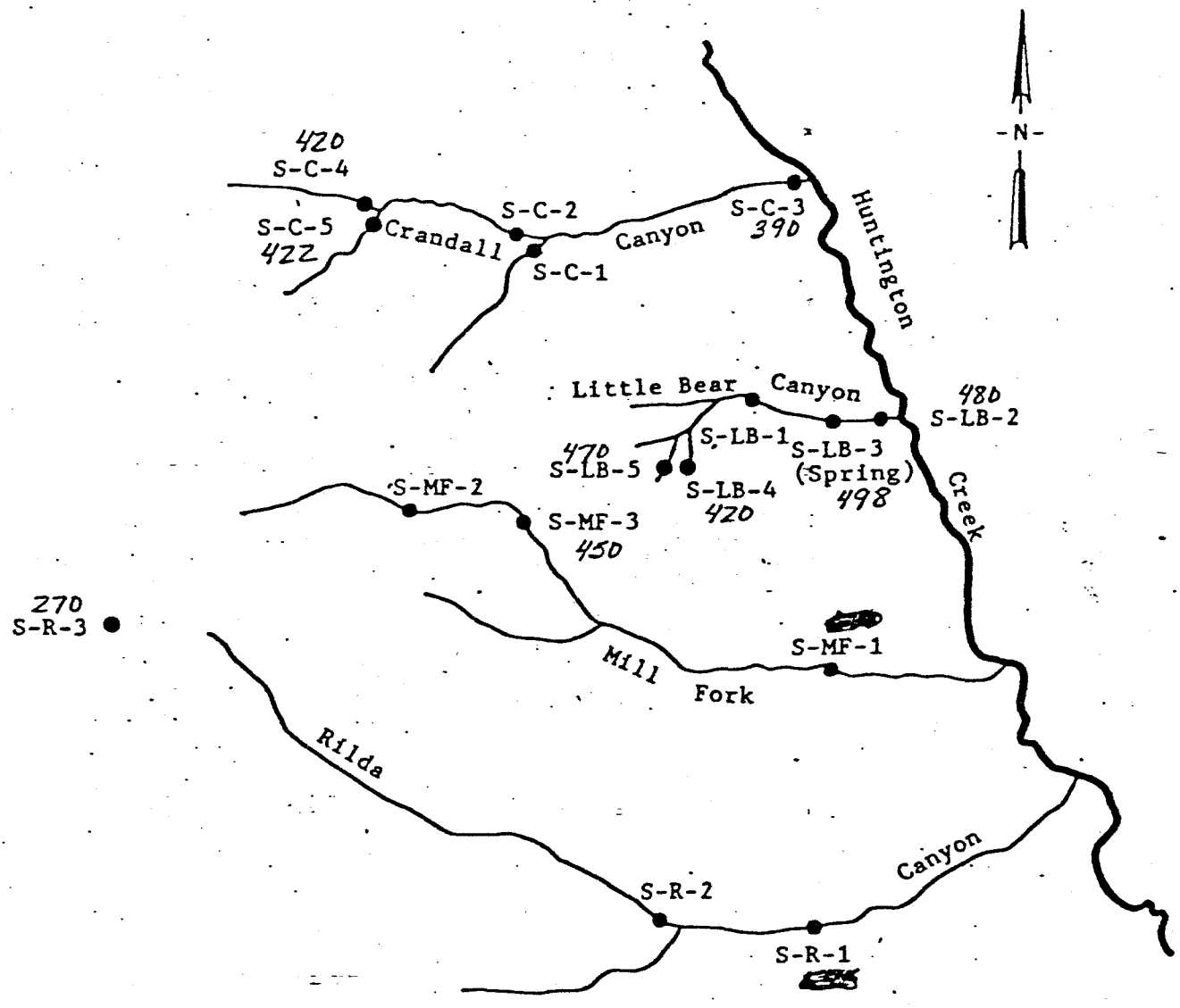
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 500 mg/l Recommended

Vaughn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Total Dissolved Solids
Date May 31 to June 4, 1977

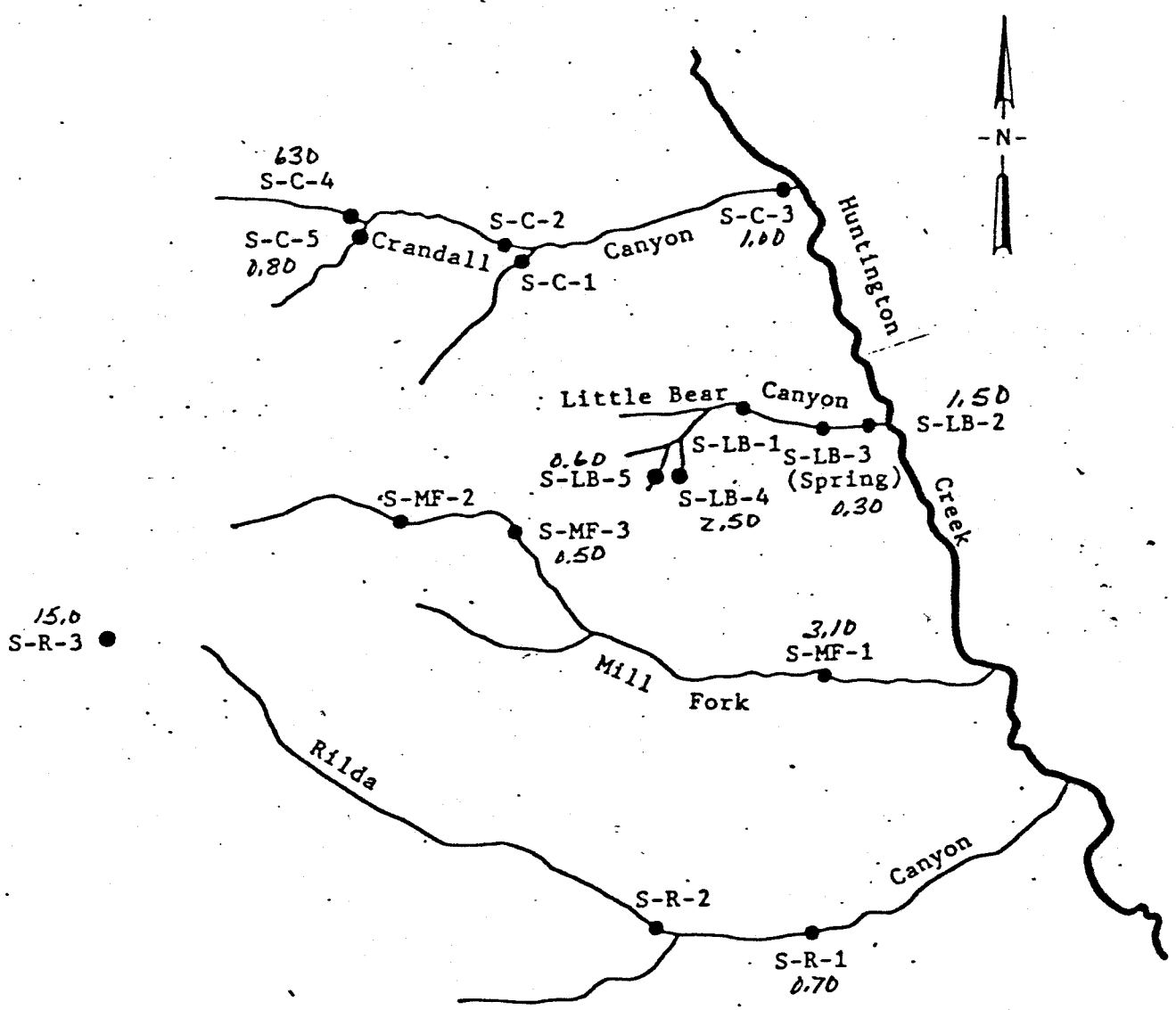
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 500 mg/l Recommended

aughn Hansen Associates
620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Turbidity

Date May 31 to June 4, 1977

NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:

lower _____

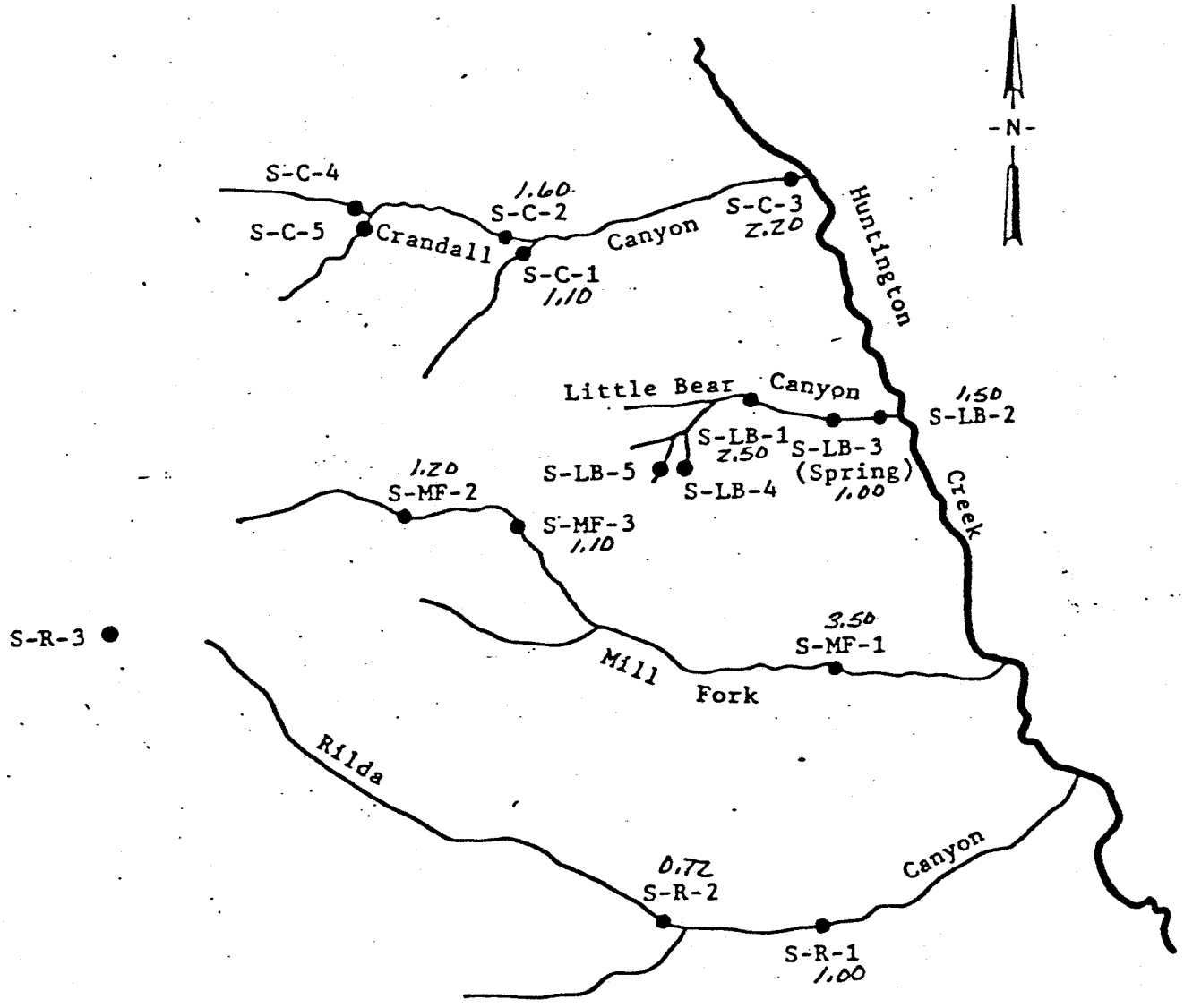
upper _____

ughn Hansen Associates
20 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles

Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Turbidity

Date November 8-12, 1976

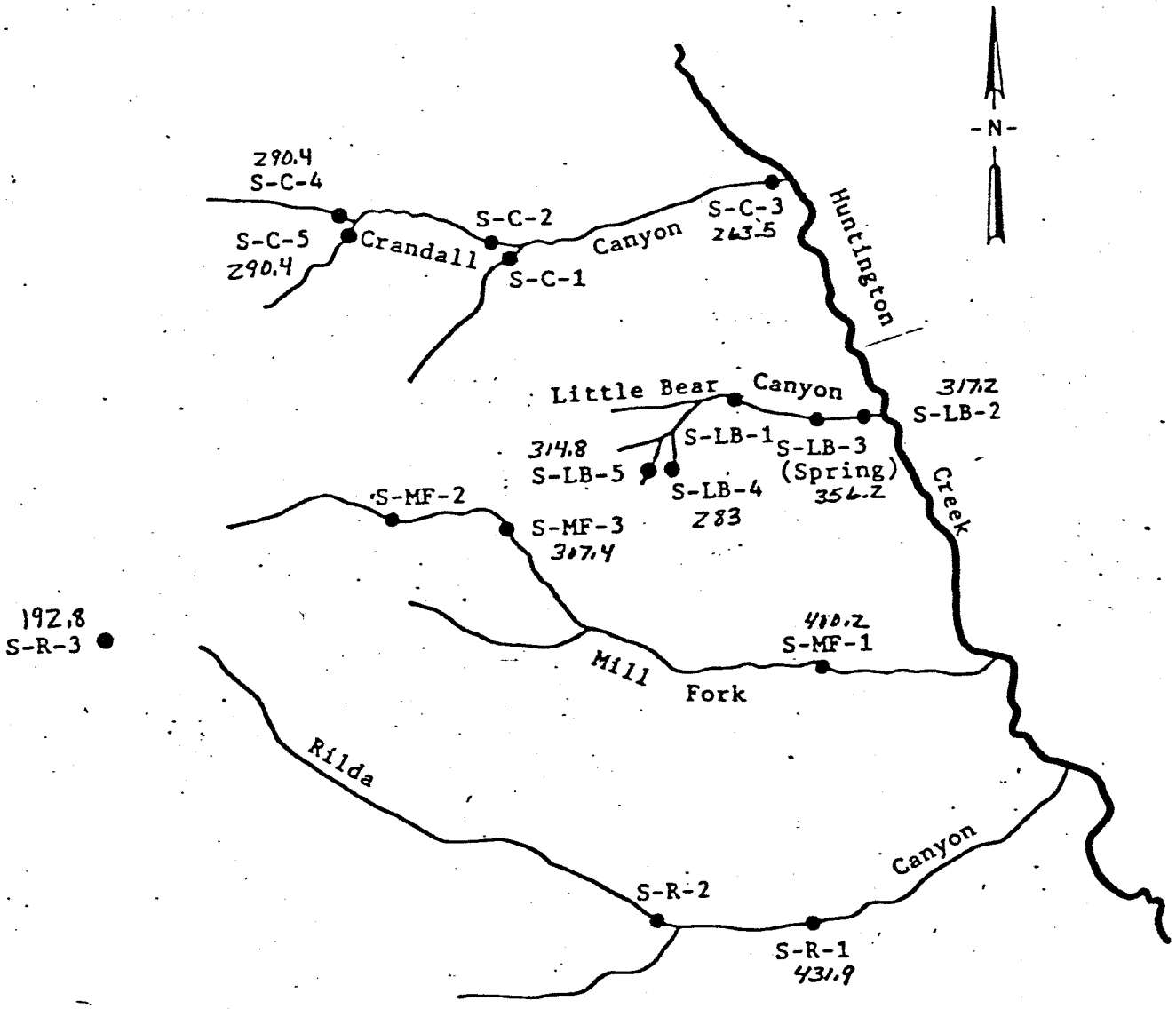
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

Vaughn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Bicarbonate
Date May 31 to June 4, 1977

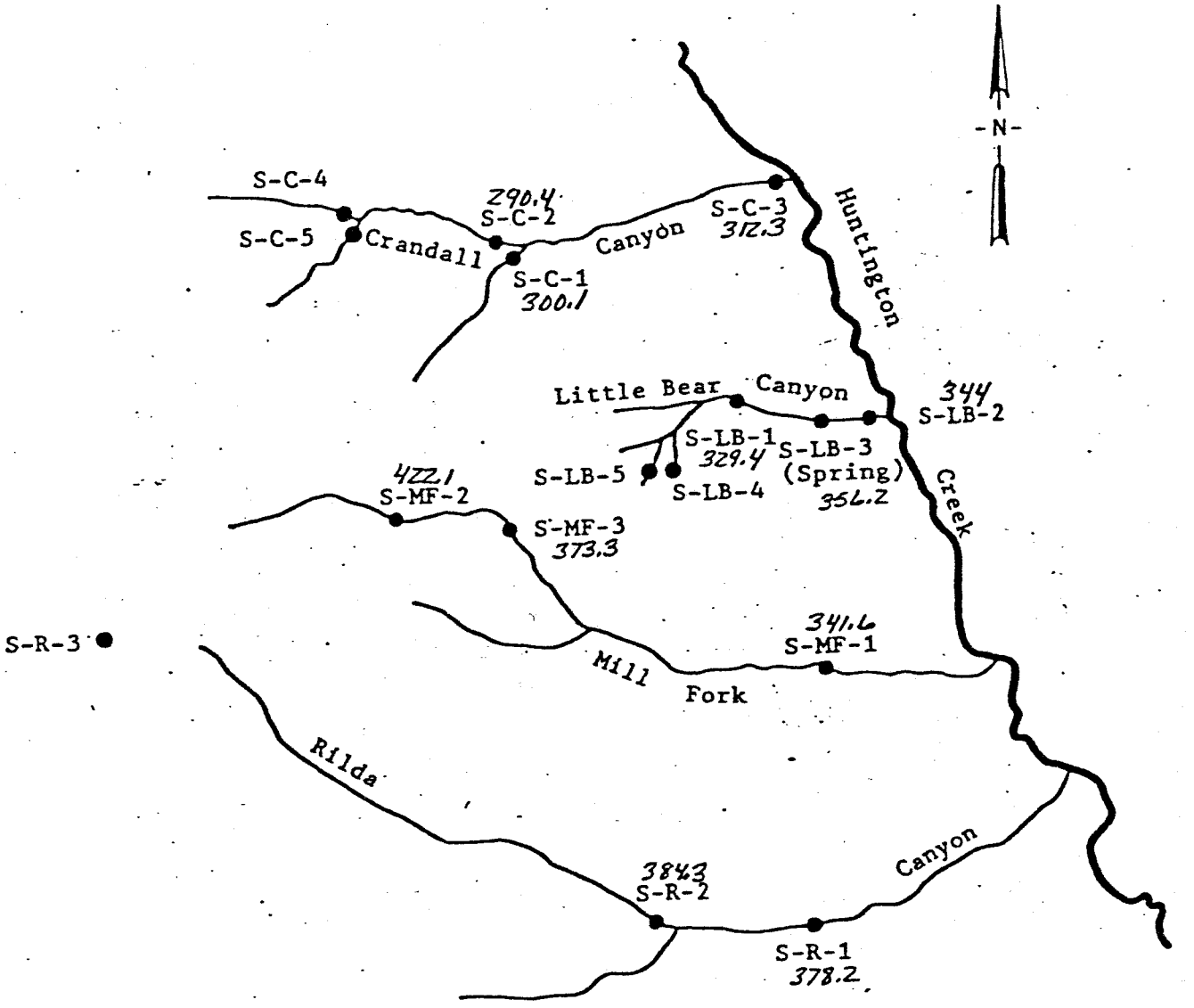
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

Vaughn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Bicarbonate

Date November 8-12, 1976

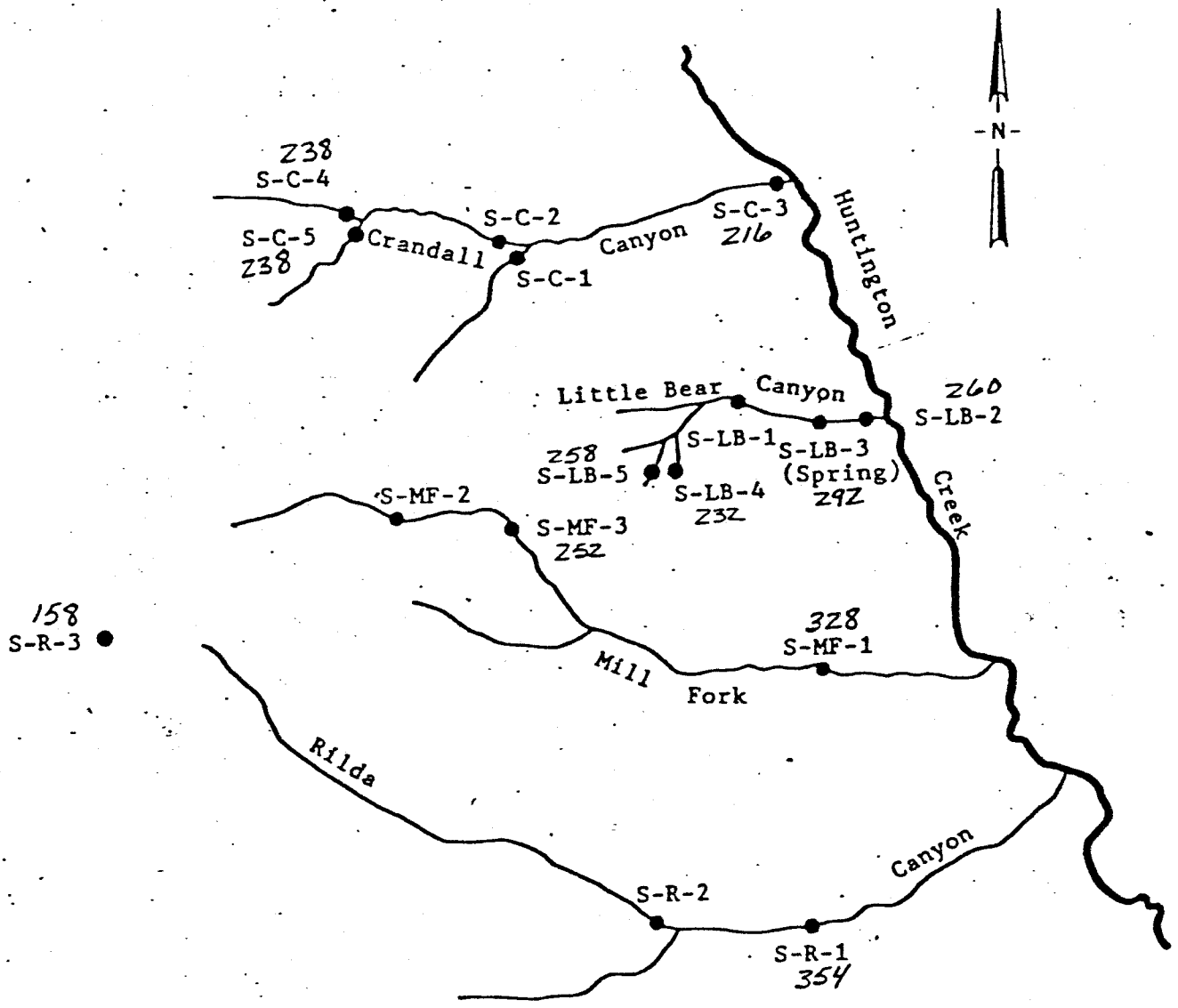
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

Vaughn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Total Alkalinity
Date May 31th June 4, 1977

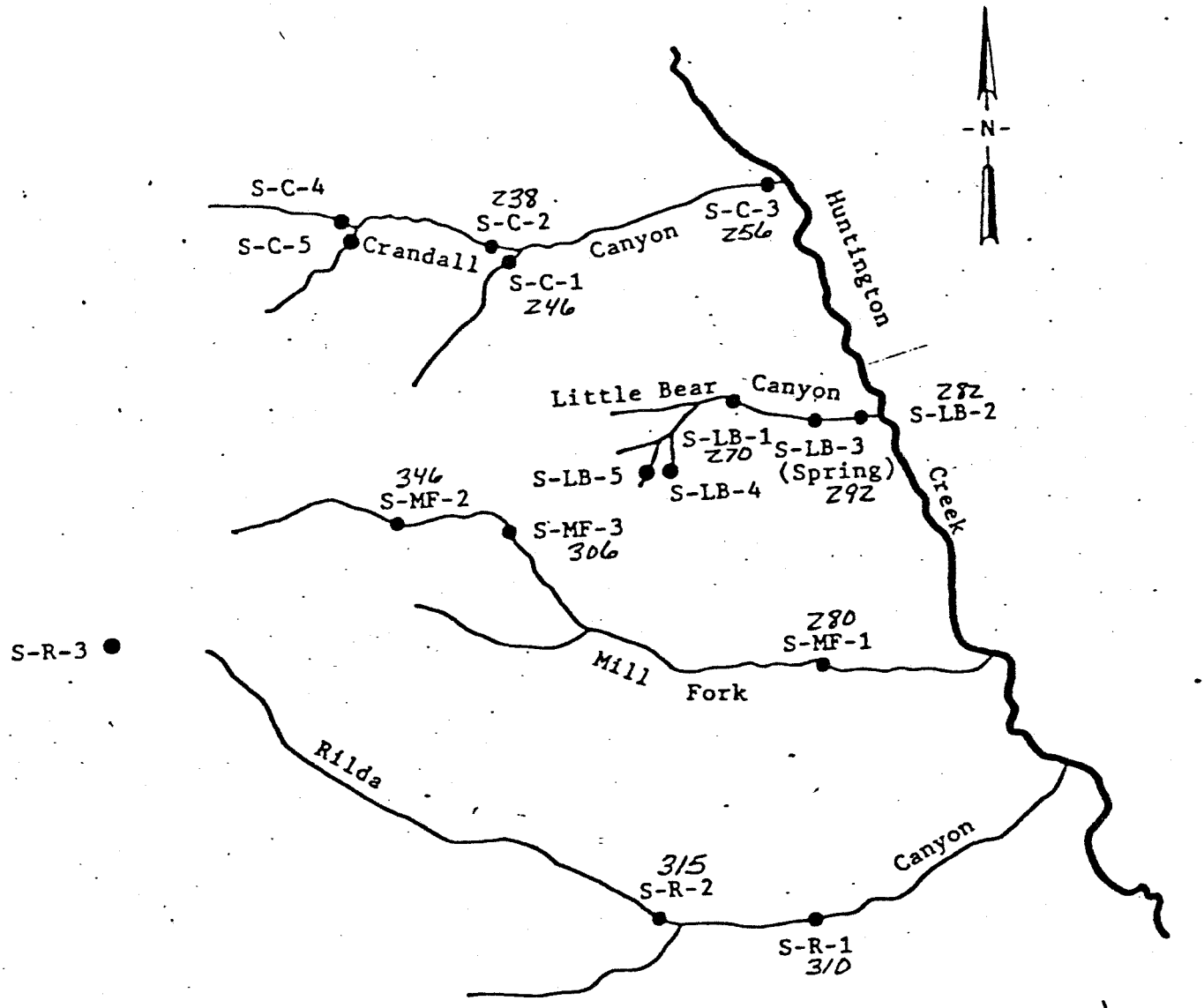
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

ghn Hansen Associates
5820 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Alkalinity (Total)
Date November 8-12, 1976

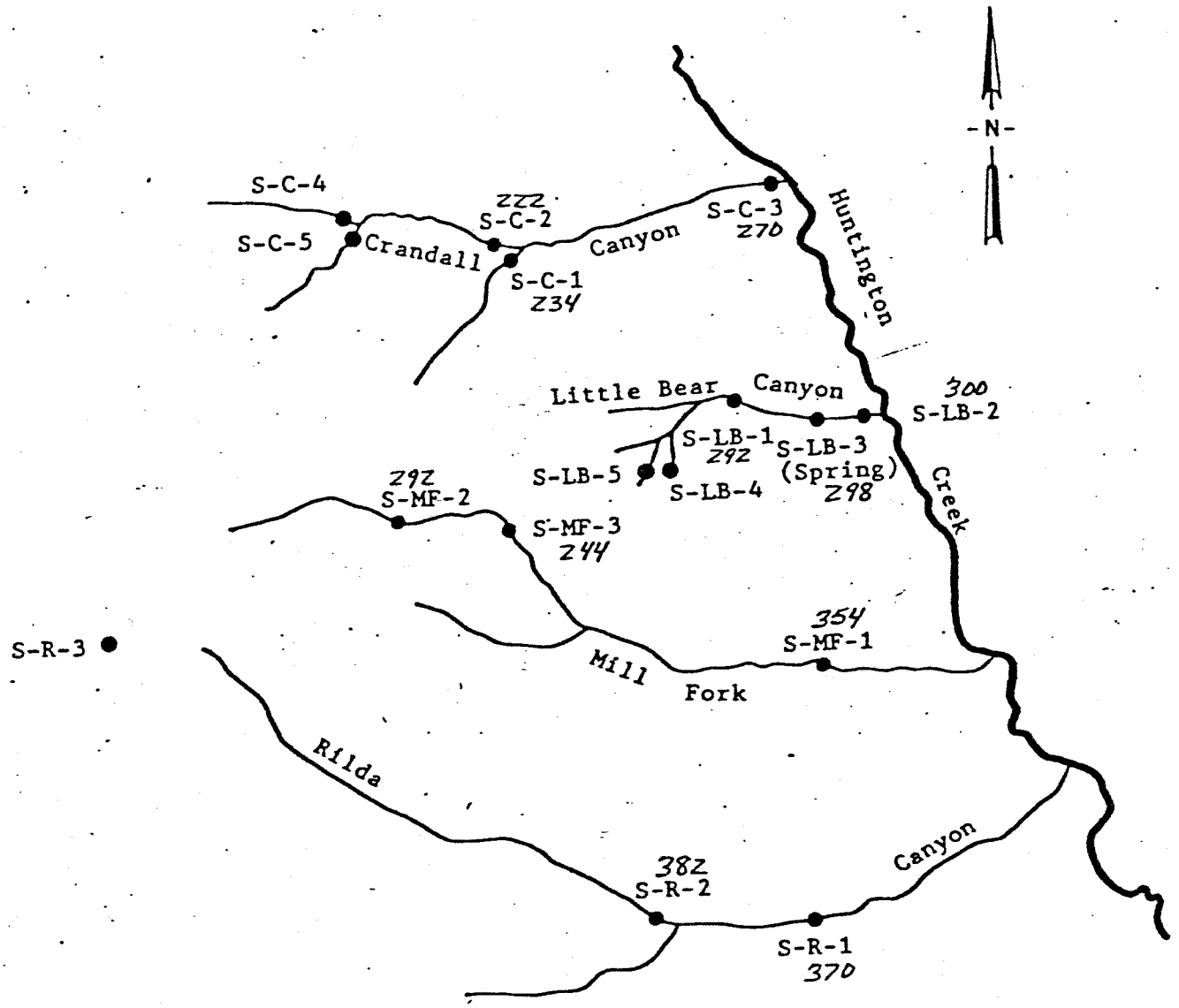
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

Waughn Hansen Associates
620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Hardness

Date November 8-12, 1976

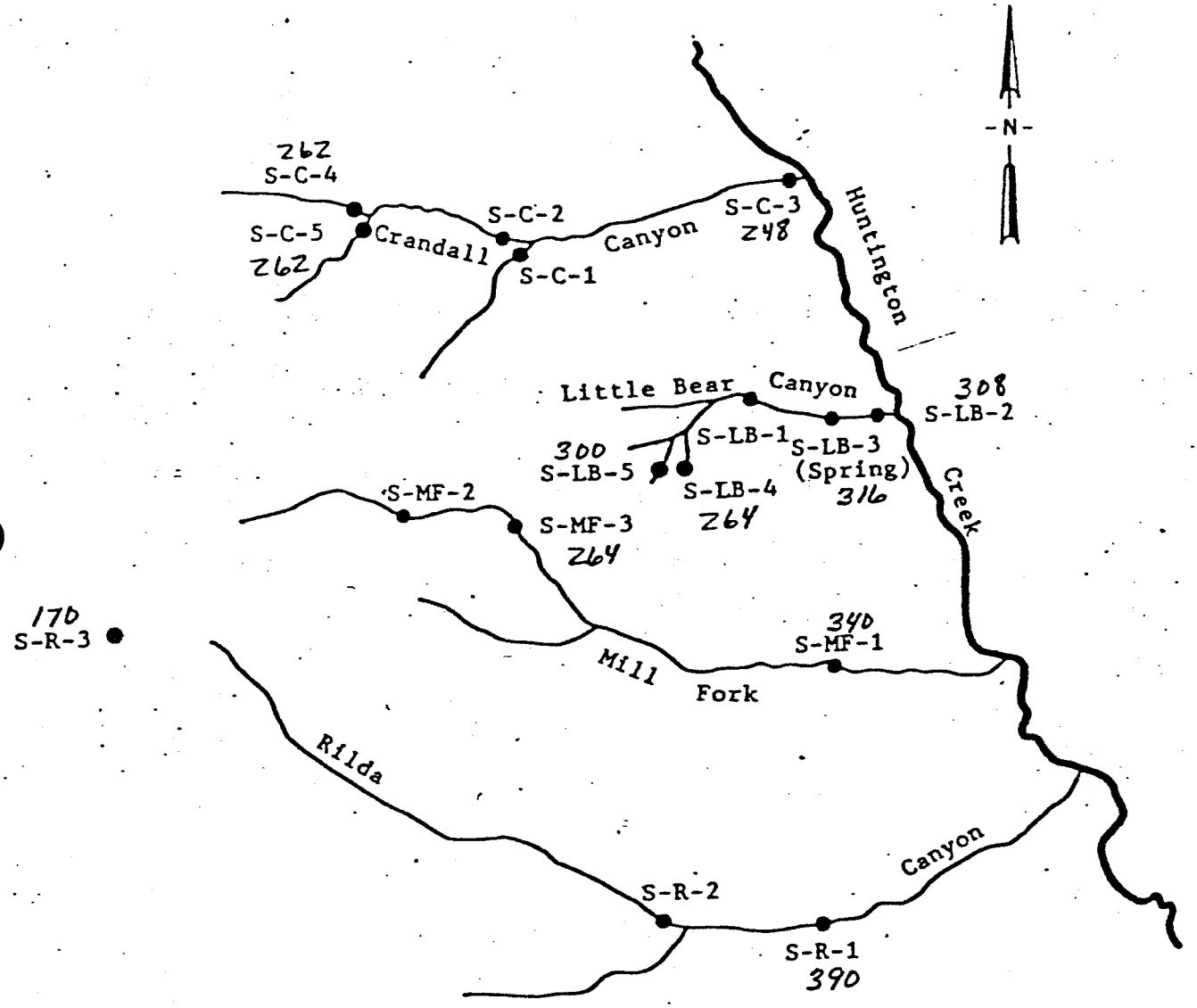
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

Loughn Hansen Associates
3620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Hardness
Date May 31 to June 4, 1977

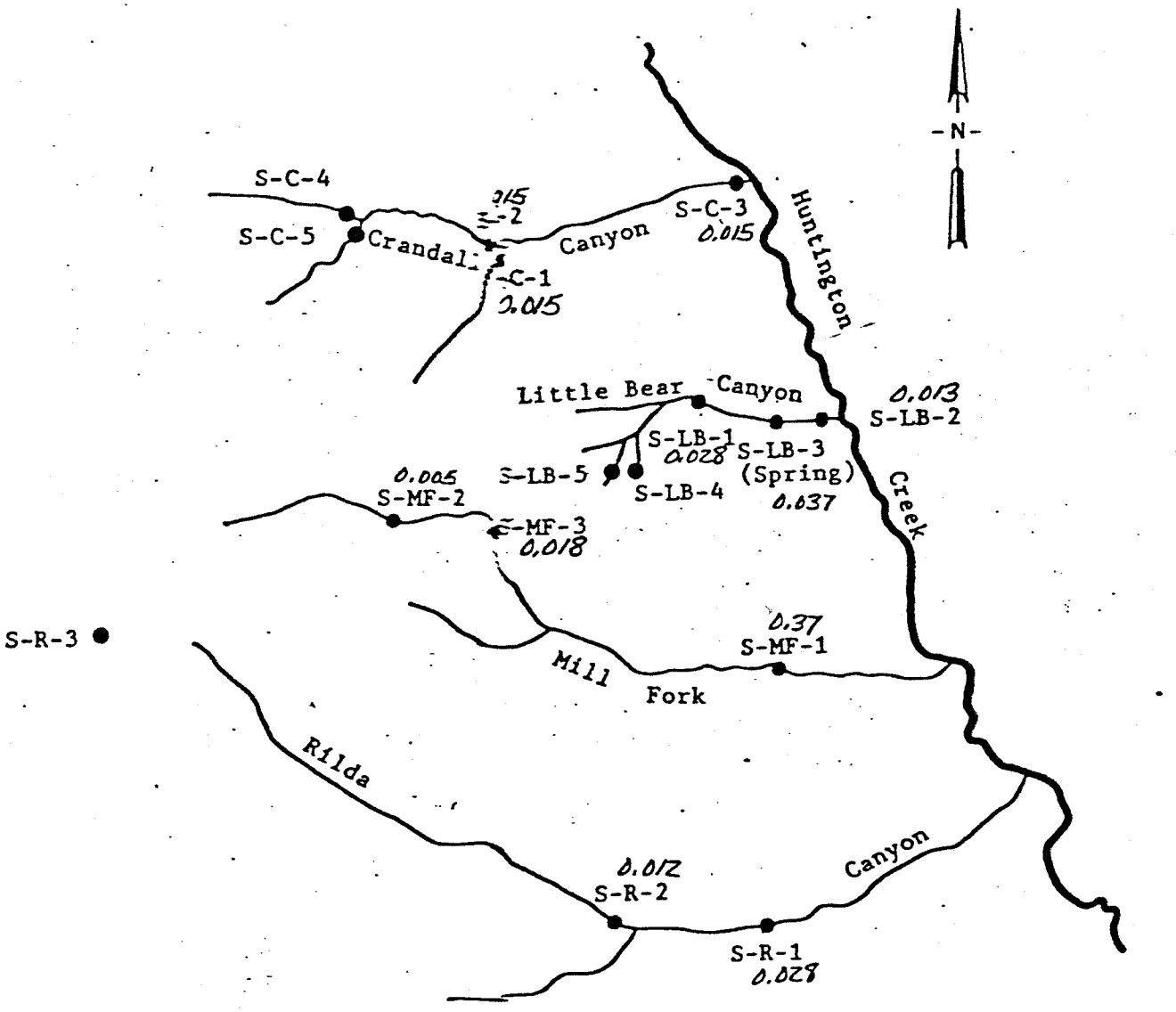
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

Vaughn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Barium

Date November 8-12, 1976

NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:

lower _____

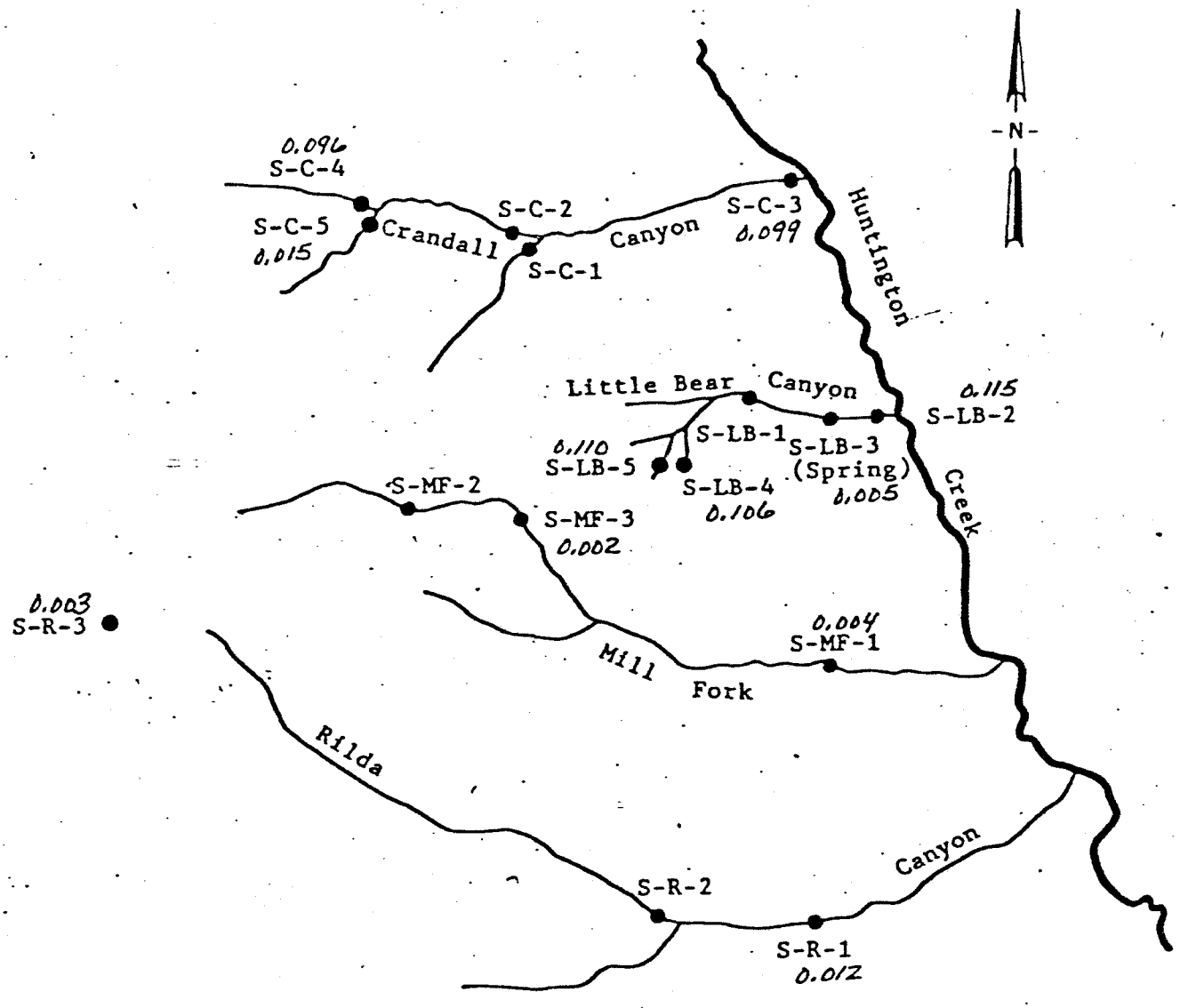
upper 1.0 mg/l Mandatory

Vaughn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles

[illegible]le

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Barium
Date May 31 to June 4, 1977

NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 1.0 mg/l Mandatory

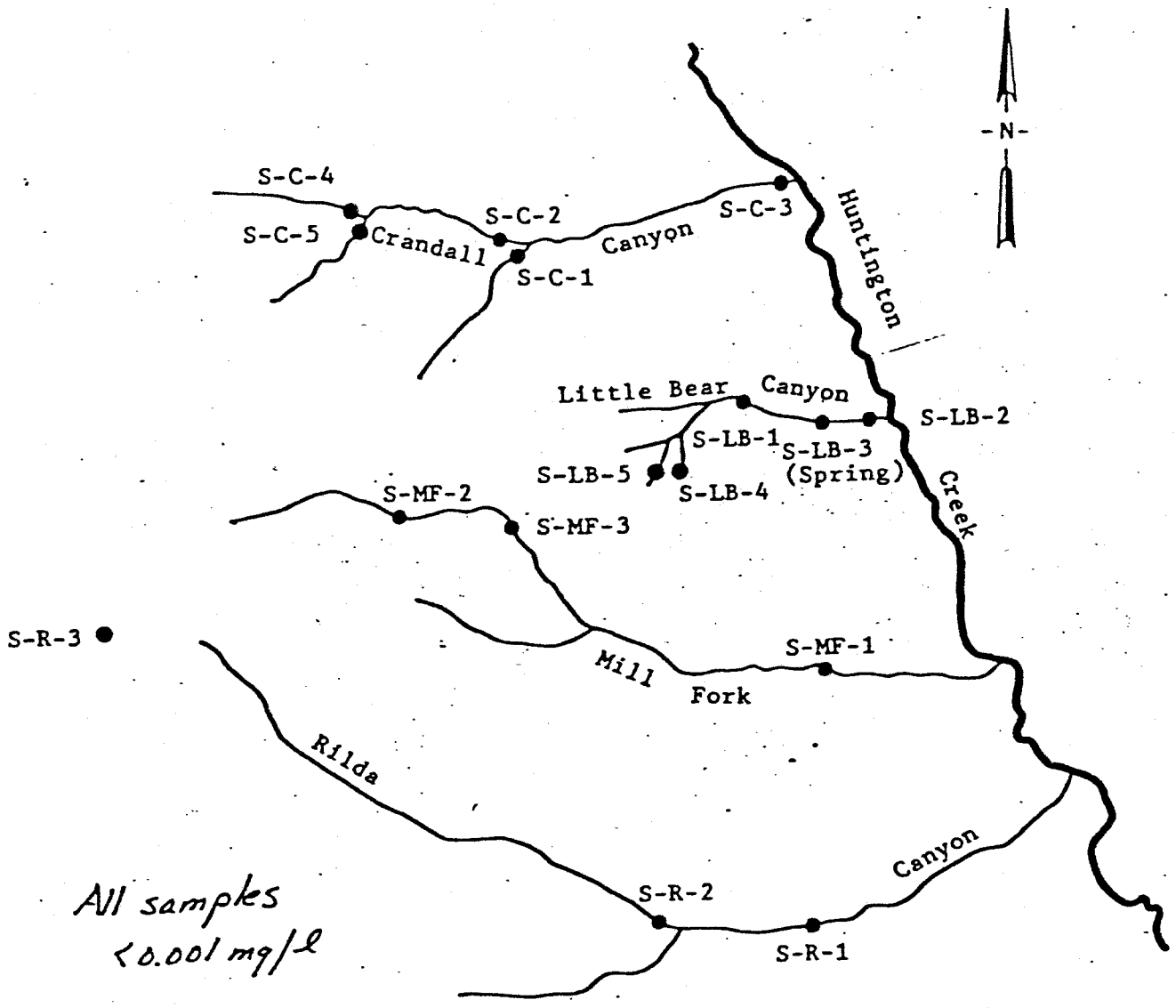
John Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS

HUNTINGTON CREEK MINE 4

SWISHER COAL COMPANY



All samples
< 0.001 mg/l

Parameter Boron

Date November 8-12, 1976

NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

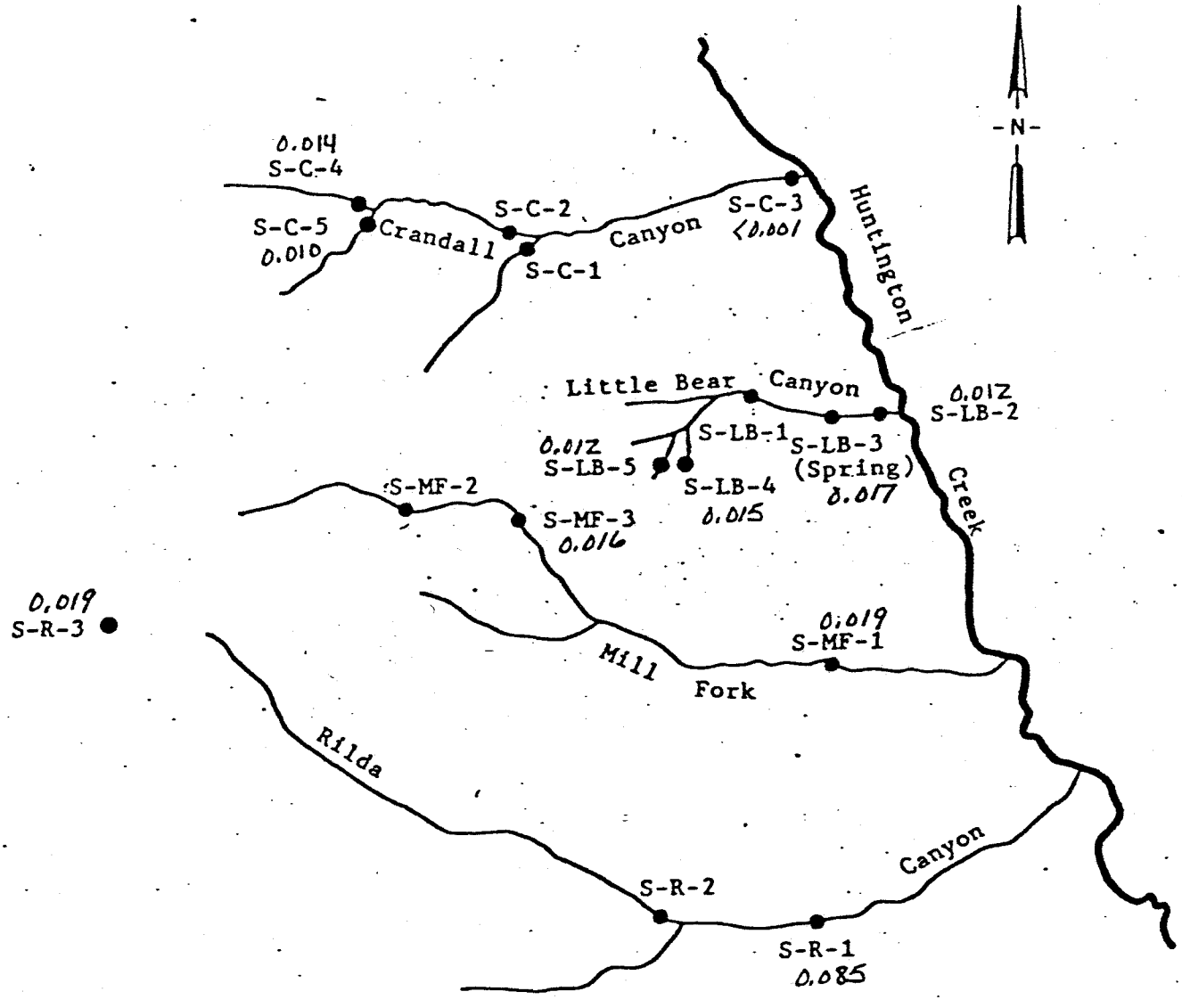
LIMITS:
lower _____
upper _____

Waughn Hansen Associates
[illegible]0 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles

Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Boron
Date May 31 to June 4, 1977

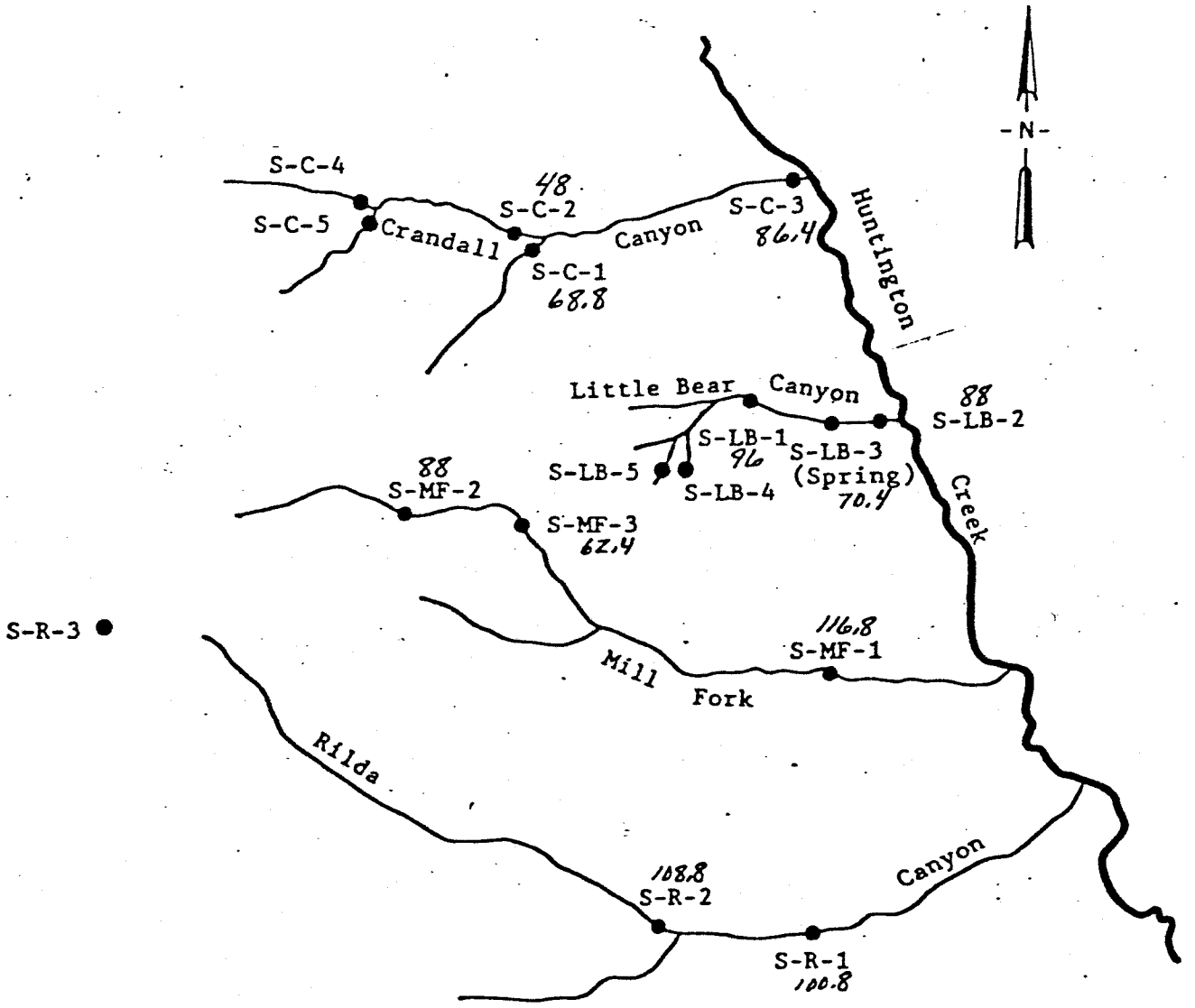
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

John Hansen Associates
5[illegible]0 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Calcium

Date November 8-12, 1976

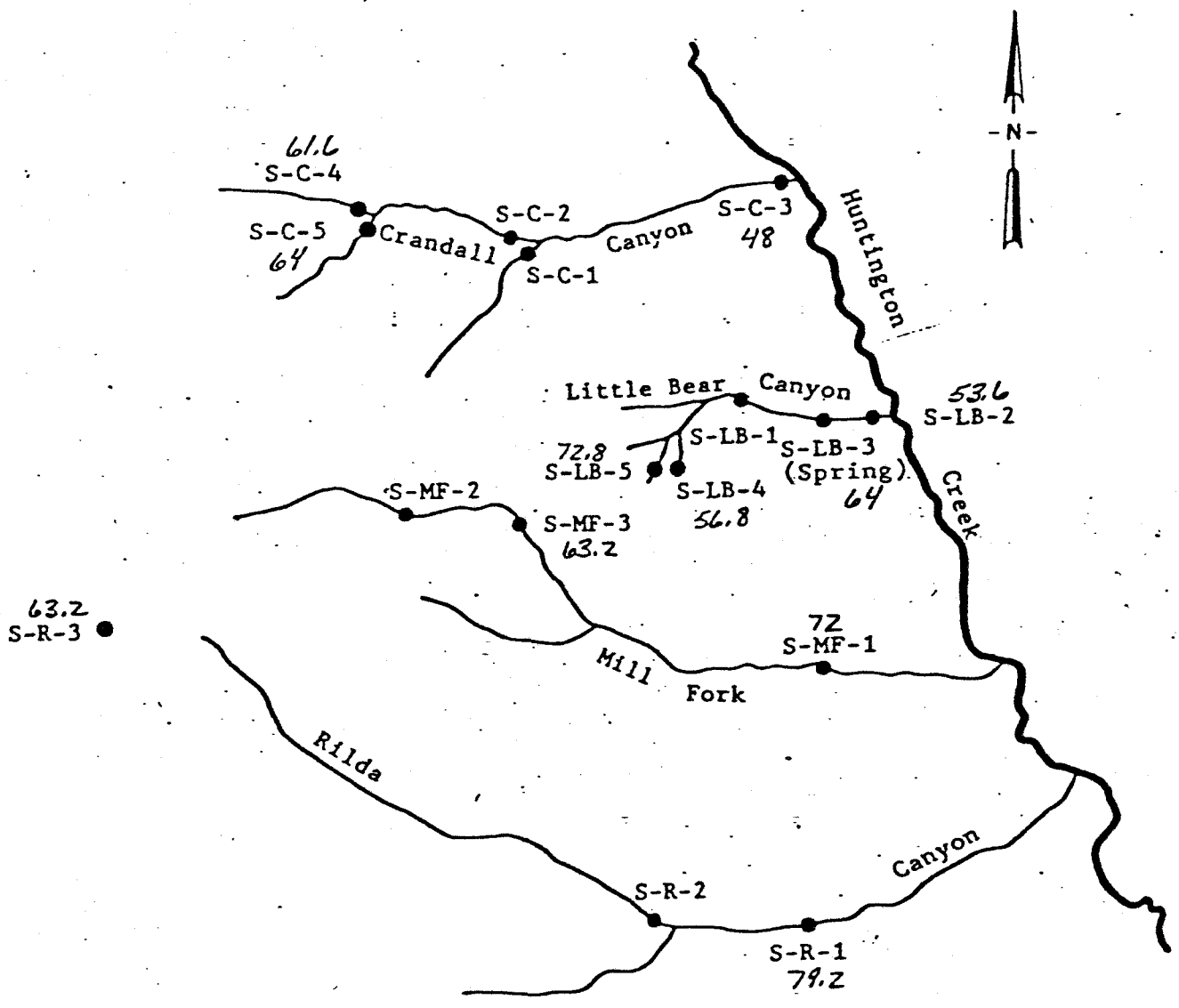
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

Vaughn Hansen Associates
5[illegible] South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Calcium

Date May 31 to June 4, 1977

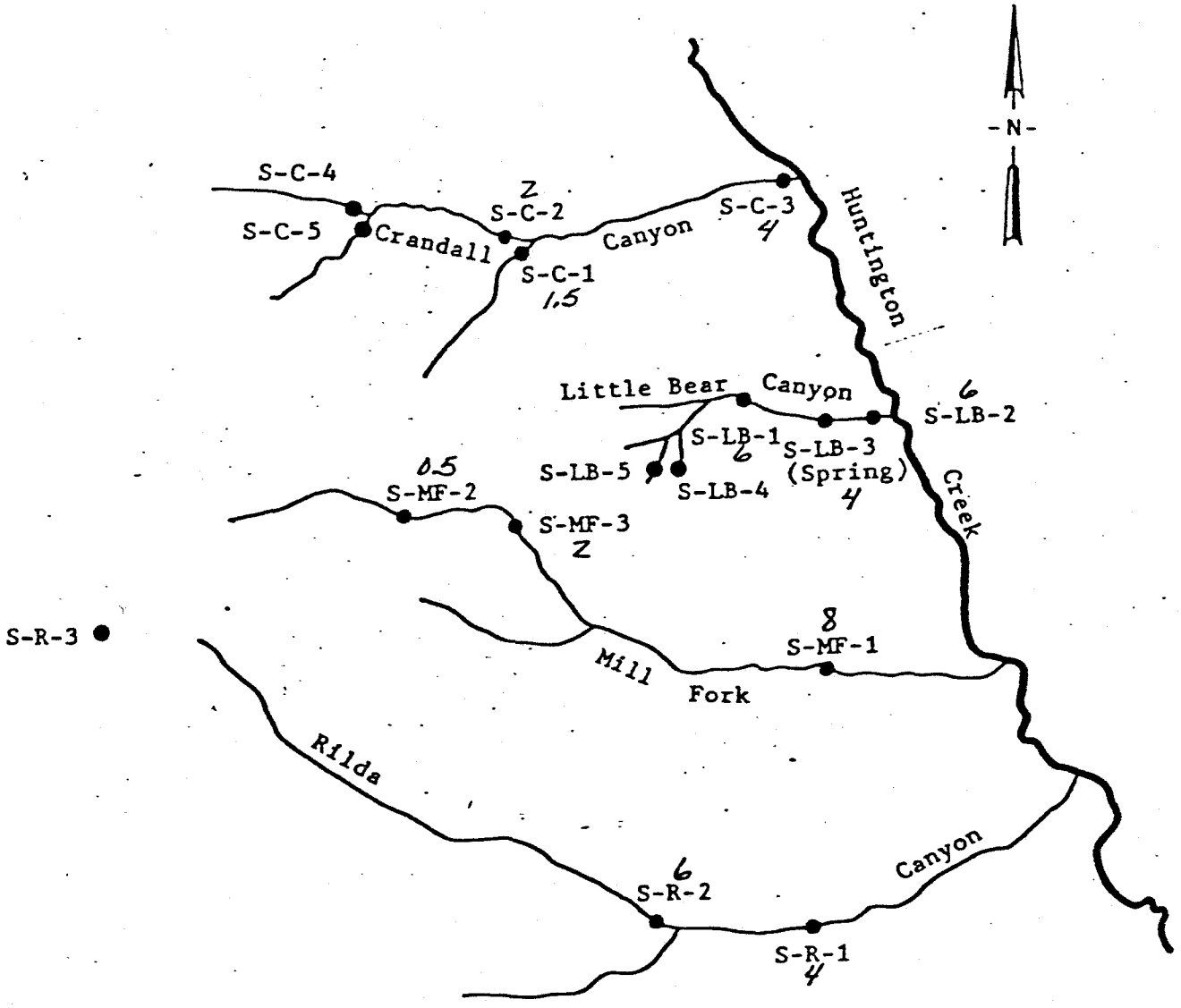
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

ughn Hansen Associates
0 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Chloride
Date November 8-12, 1976

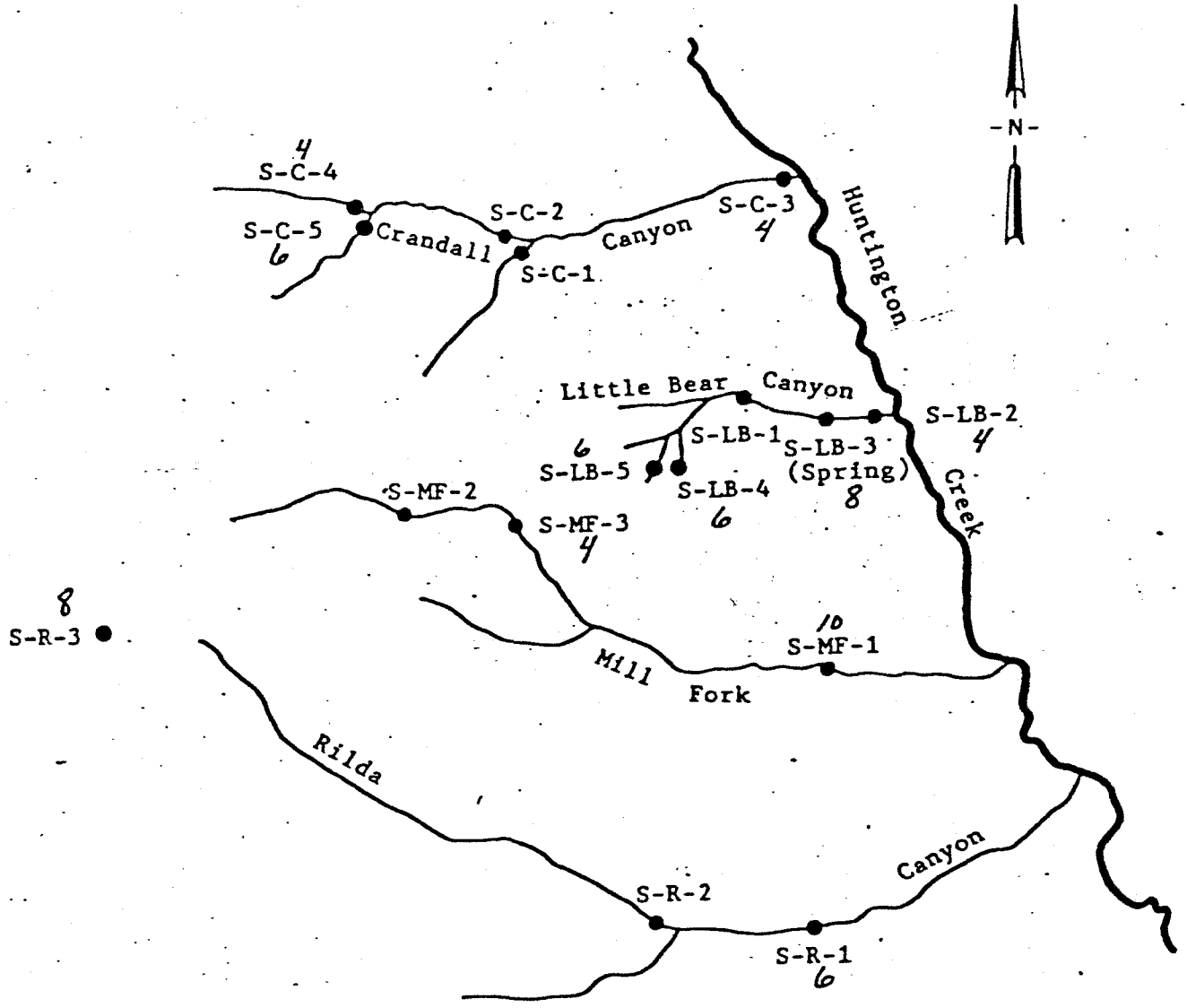
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 250 mg/l Recommended

Vaughn Hansen Associates
[illegible] South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Chloride
Date May 31 to June 4, 1977

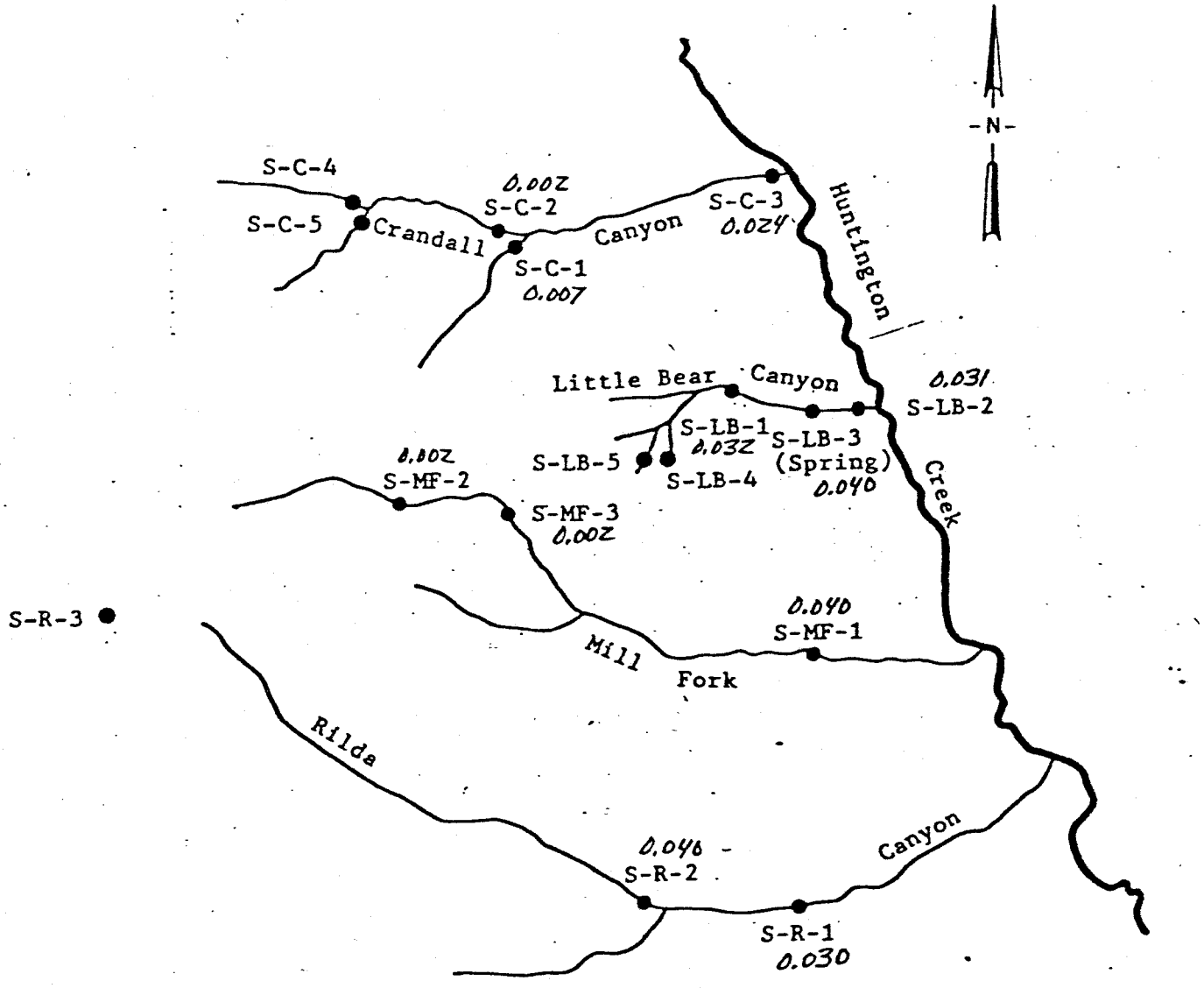
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 250 mg/l Recommended

ghn Hansen Associates
5020 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Copper

Date November 8-12, 1976

NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:

lower

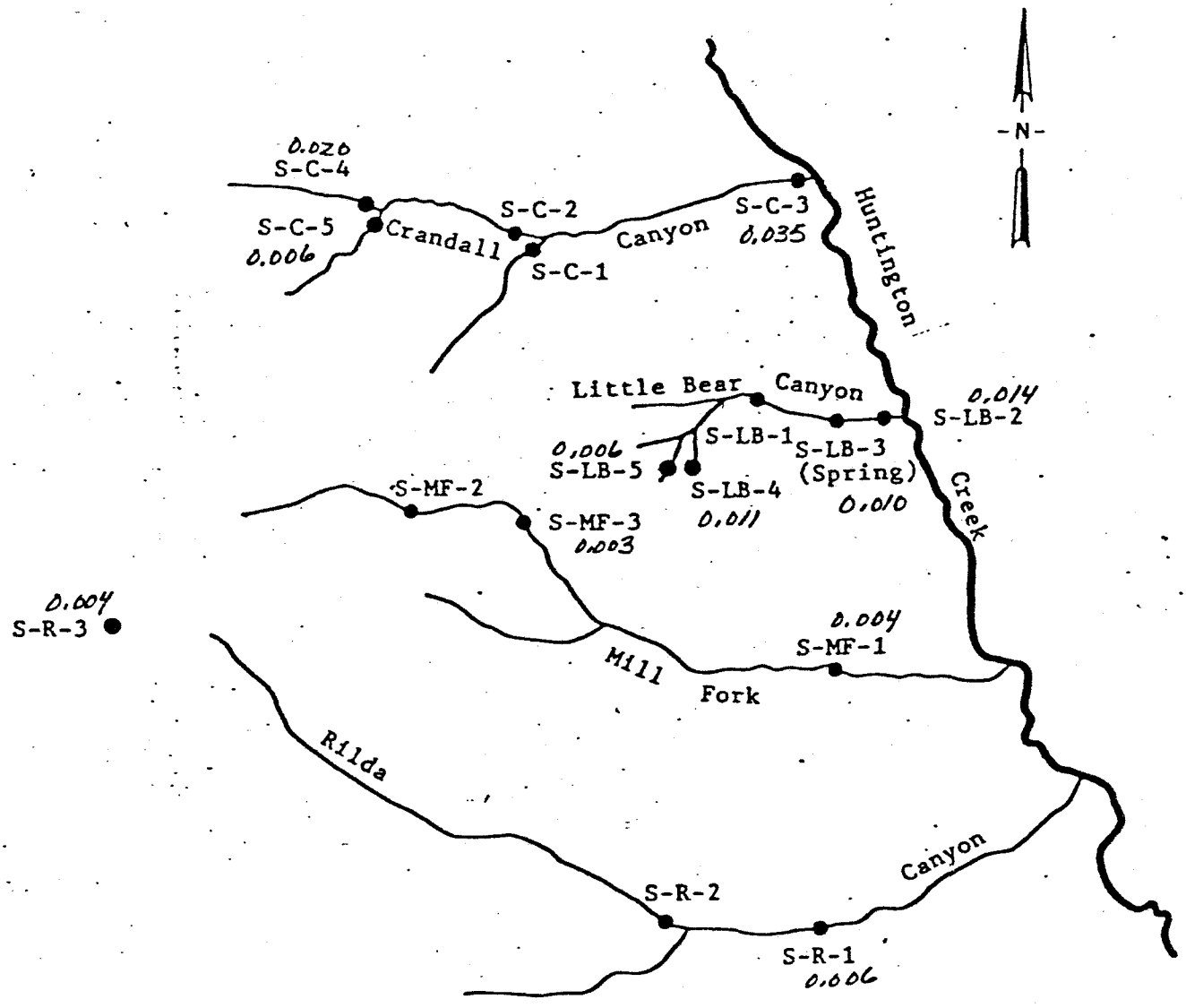
upper 1.0 mg/l Recommended

ughn Hansen Associates
20 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles

Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Copper
Date May 31 & June 4, 1977

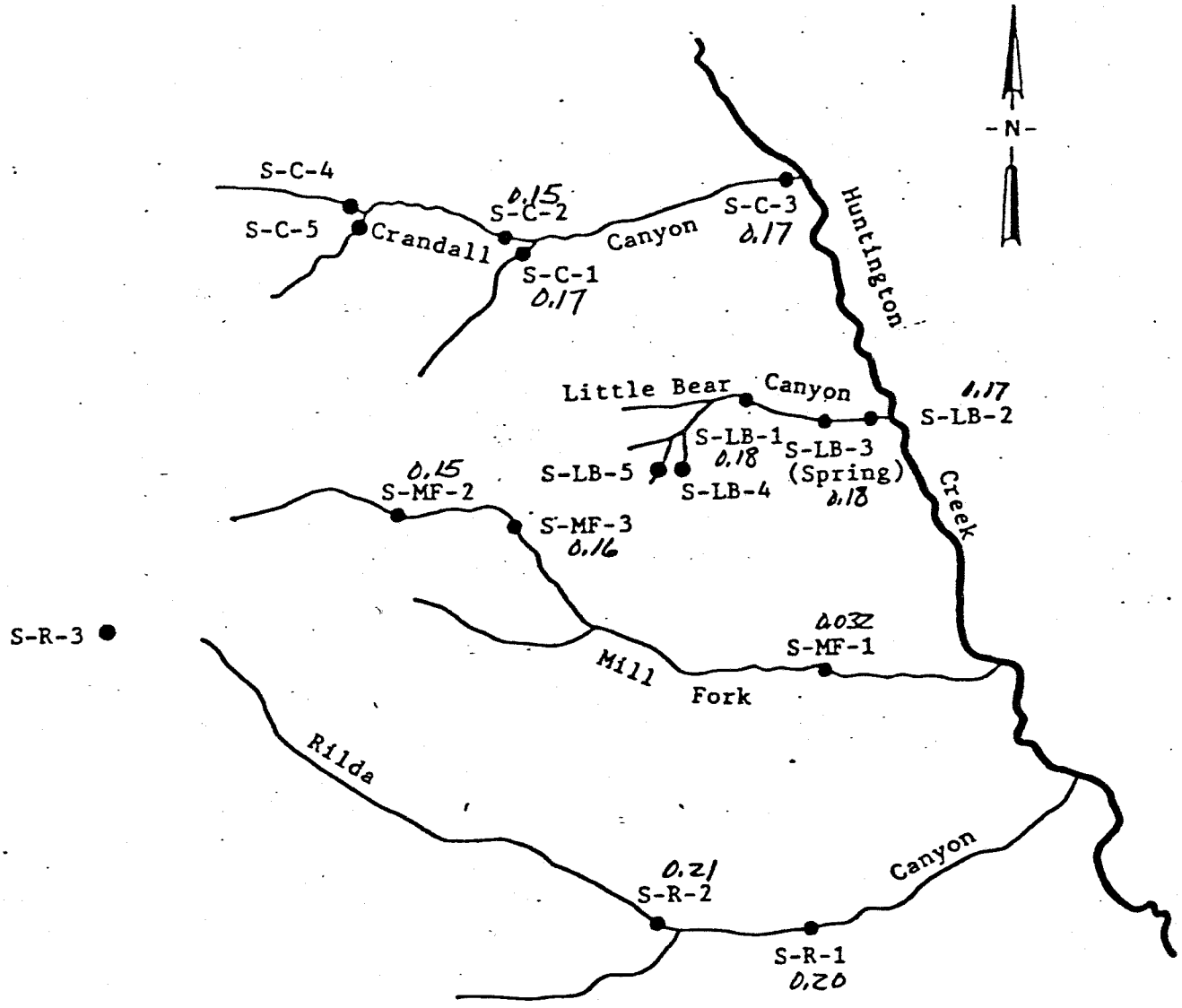
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower ____
upper 1.0 mg/l Recommended

Vaughn Hansen Associates
[illegible] South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Fluoride
Date November 8-12, 1976

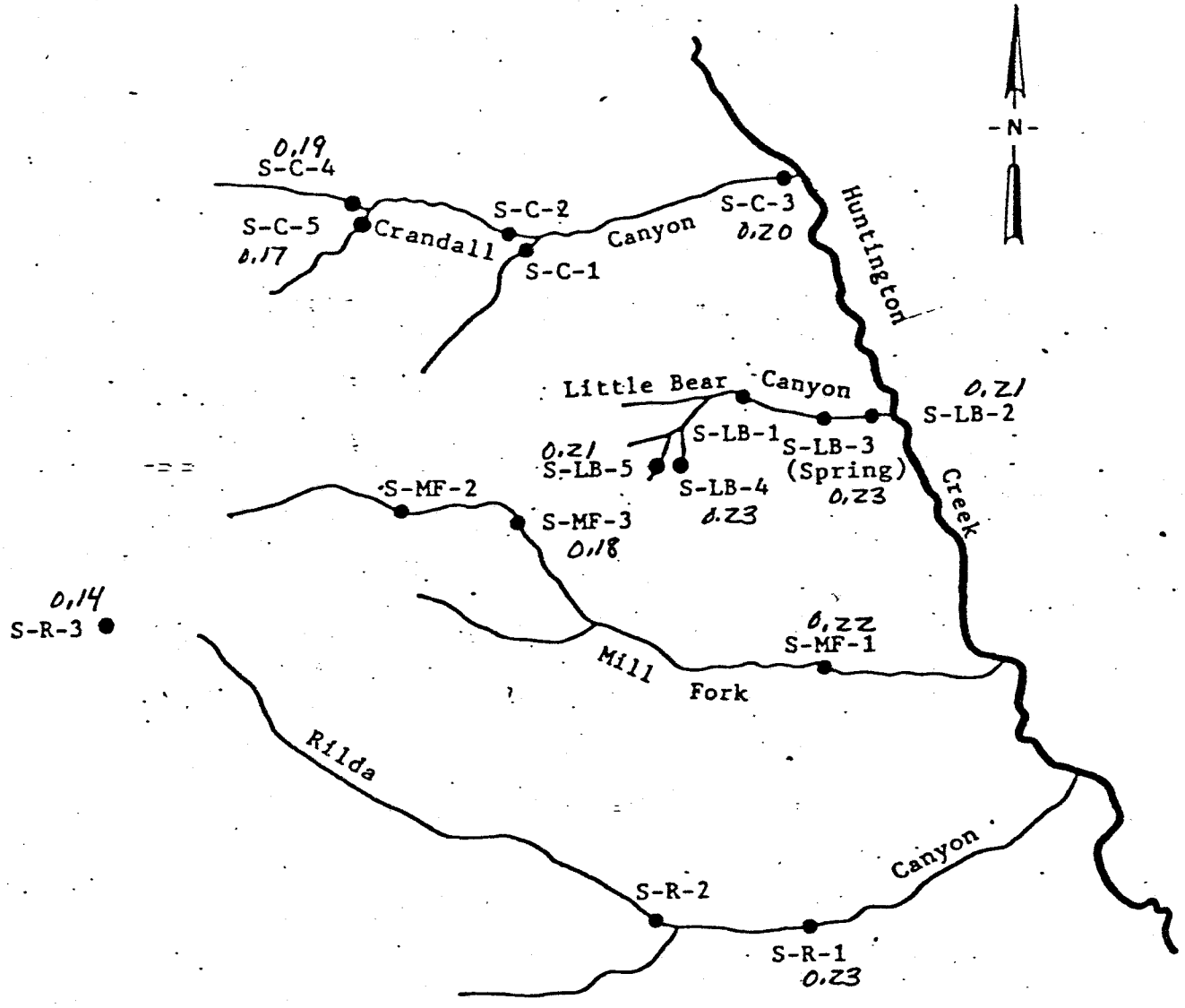
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
1.0 mg/l Recommended
upper 2.0 mg/l Mandatory

Laughn Hansen Associates
520 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Fluoride
Date May 31 to June 4, 1977

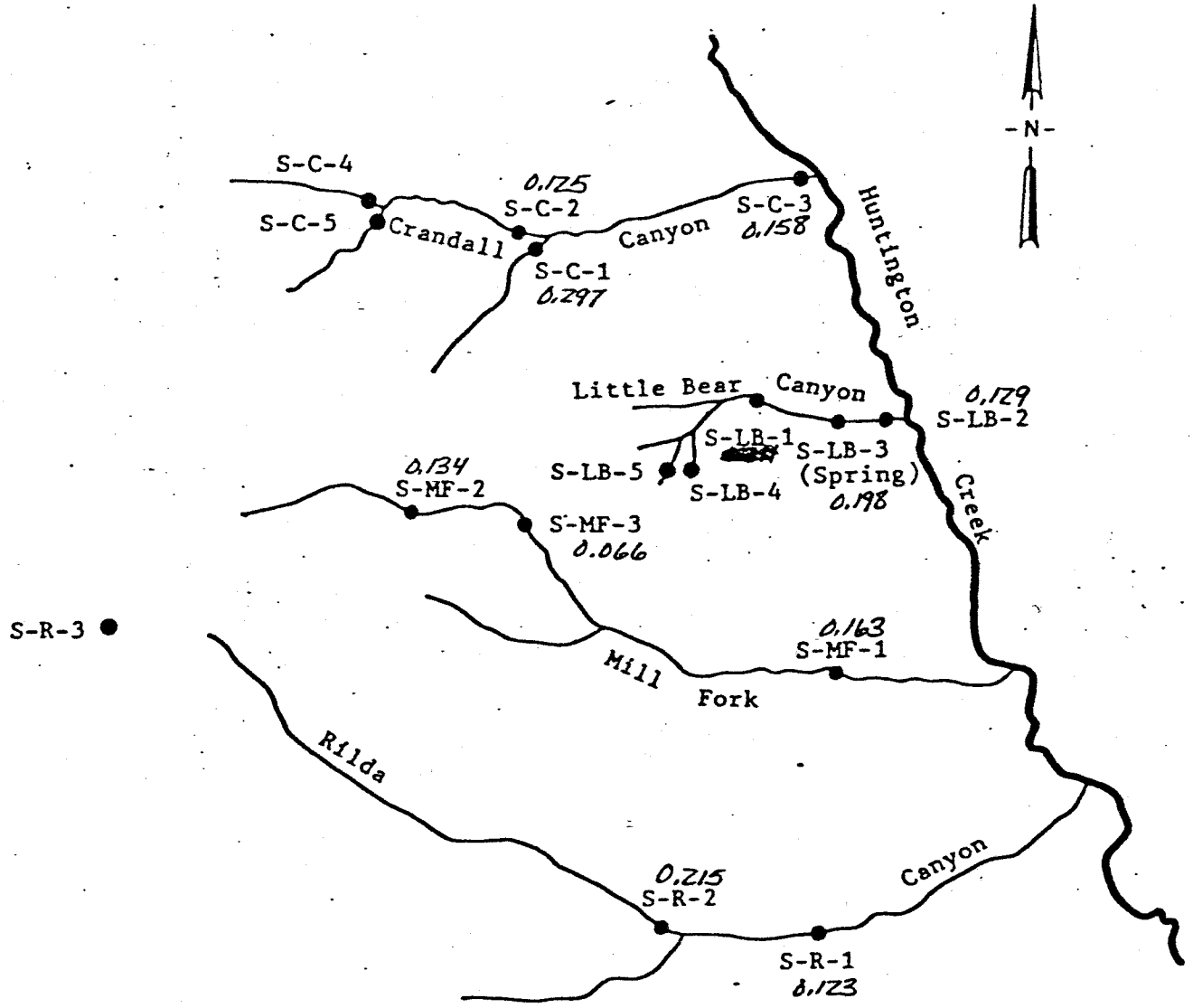
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
1.0 mg/l Recommended
upper 2.0 mg/l Mandatory

ghn Hansen Associates
5820 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Iron - (Total)

Date November 8-12, 1976

NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:

lower _____

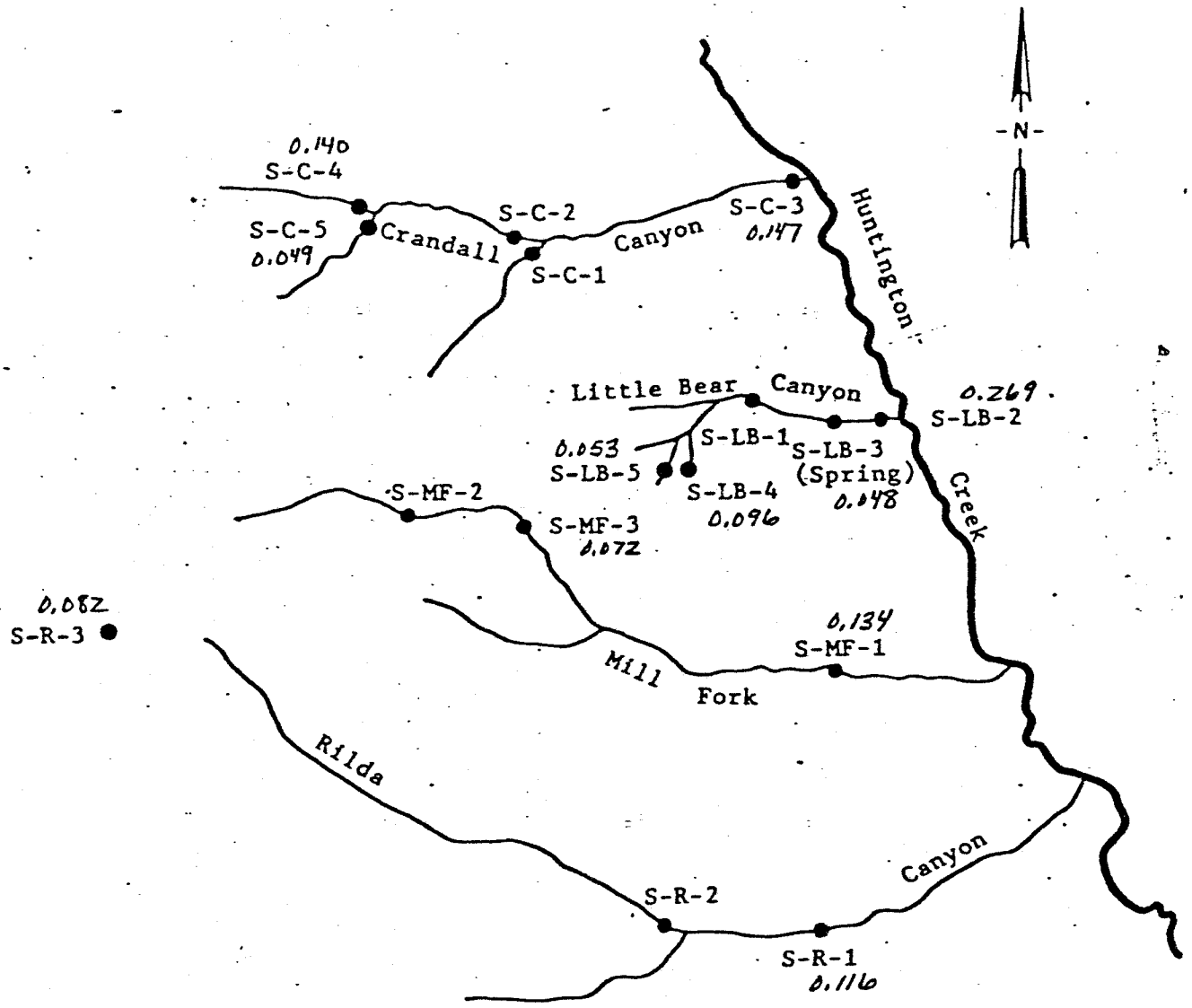
upper 0.3 mg/l Recommended

V ghn Hansen Associates
5 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles

Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Iron (Total)
Date May 31 to June 4, 1977

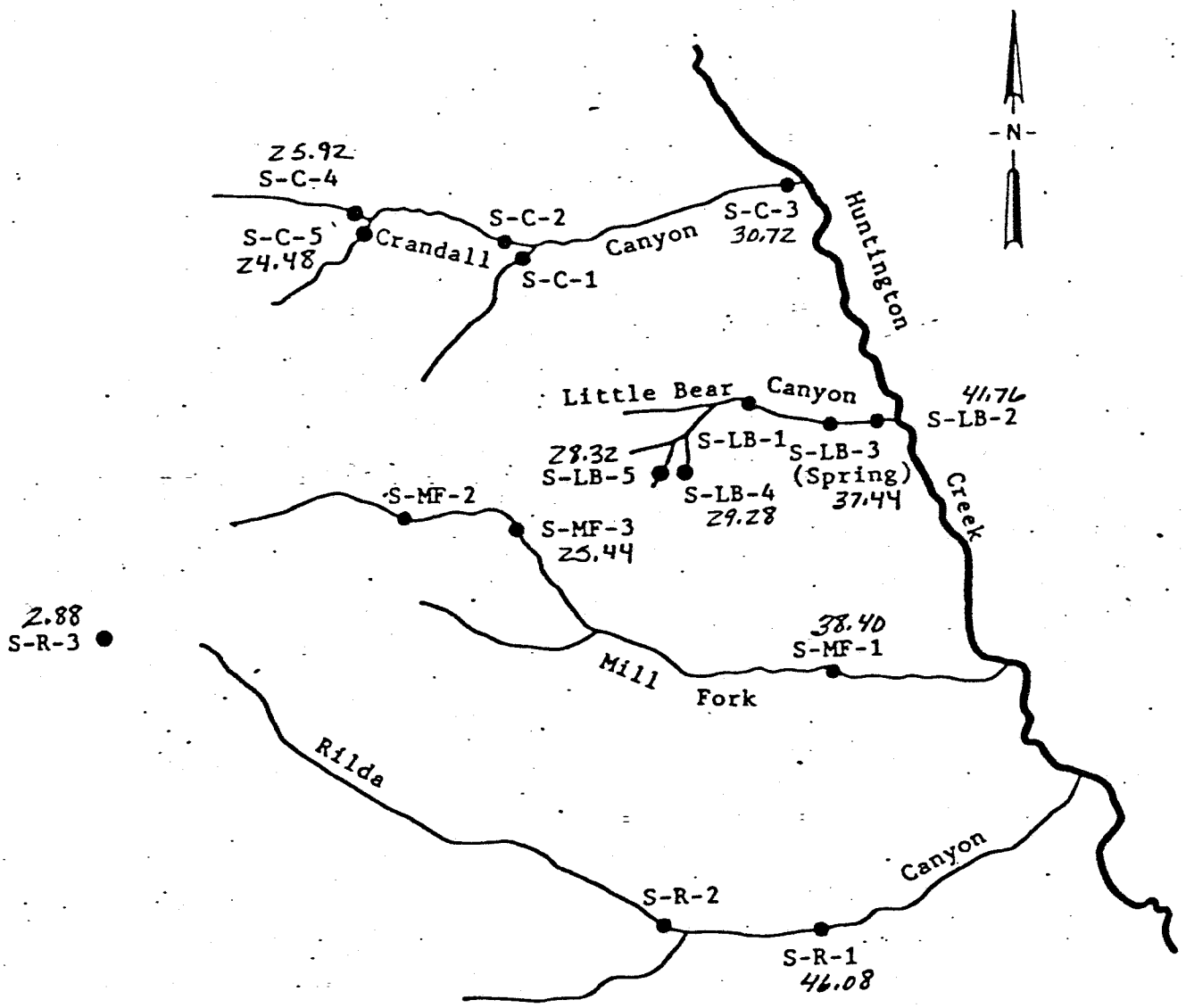
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower ____
upper 0.3 mg/l Recommended

ghn Hansen Associates
0 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Magnesium
Date May 31 to June 4, 1977

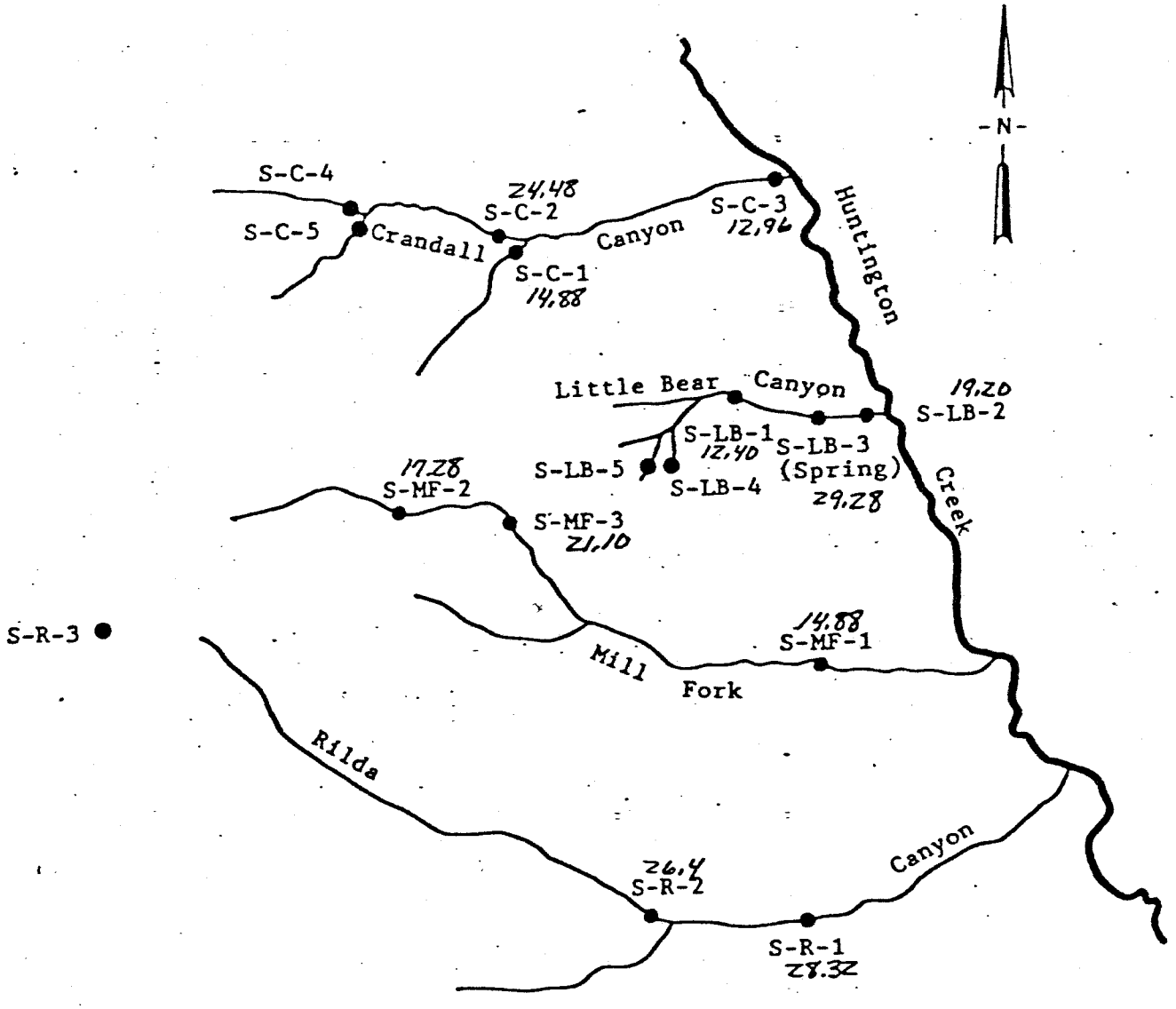
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

ughn Hansen Associates
3620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Magnesium

Date November 8-12, 1976

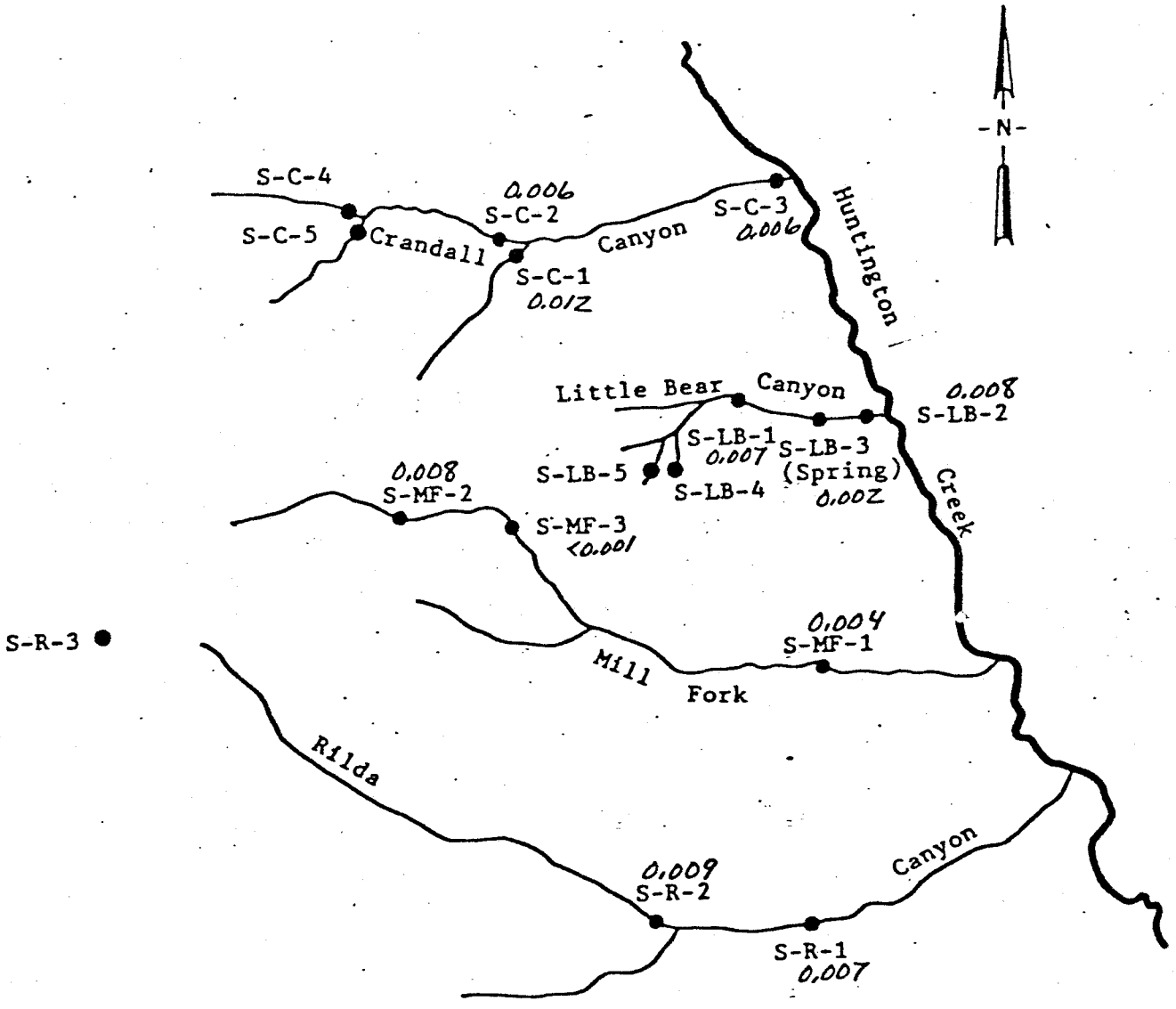
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

ughn Hansen Associates
20 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



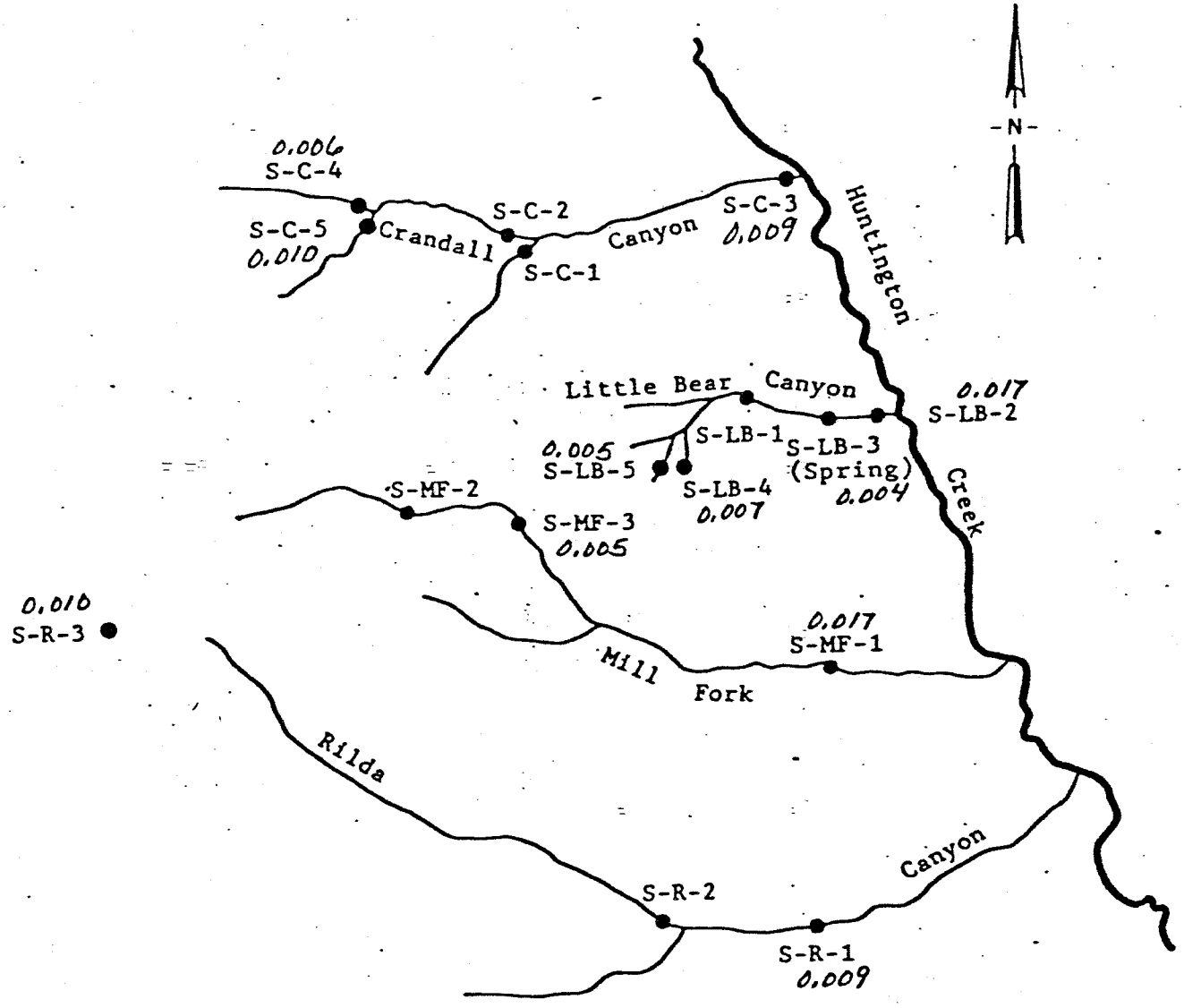
Parameter Manganese
Date November 8-12, 1976

NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 0.05 mg/l Recommended

ughn Hansen Associates
20 South 1475 East
Salt Lake City, Utah 84121

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Manganese
Date May 31 th - June 4, 1977

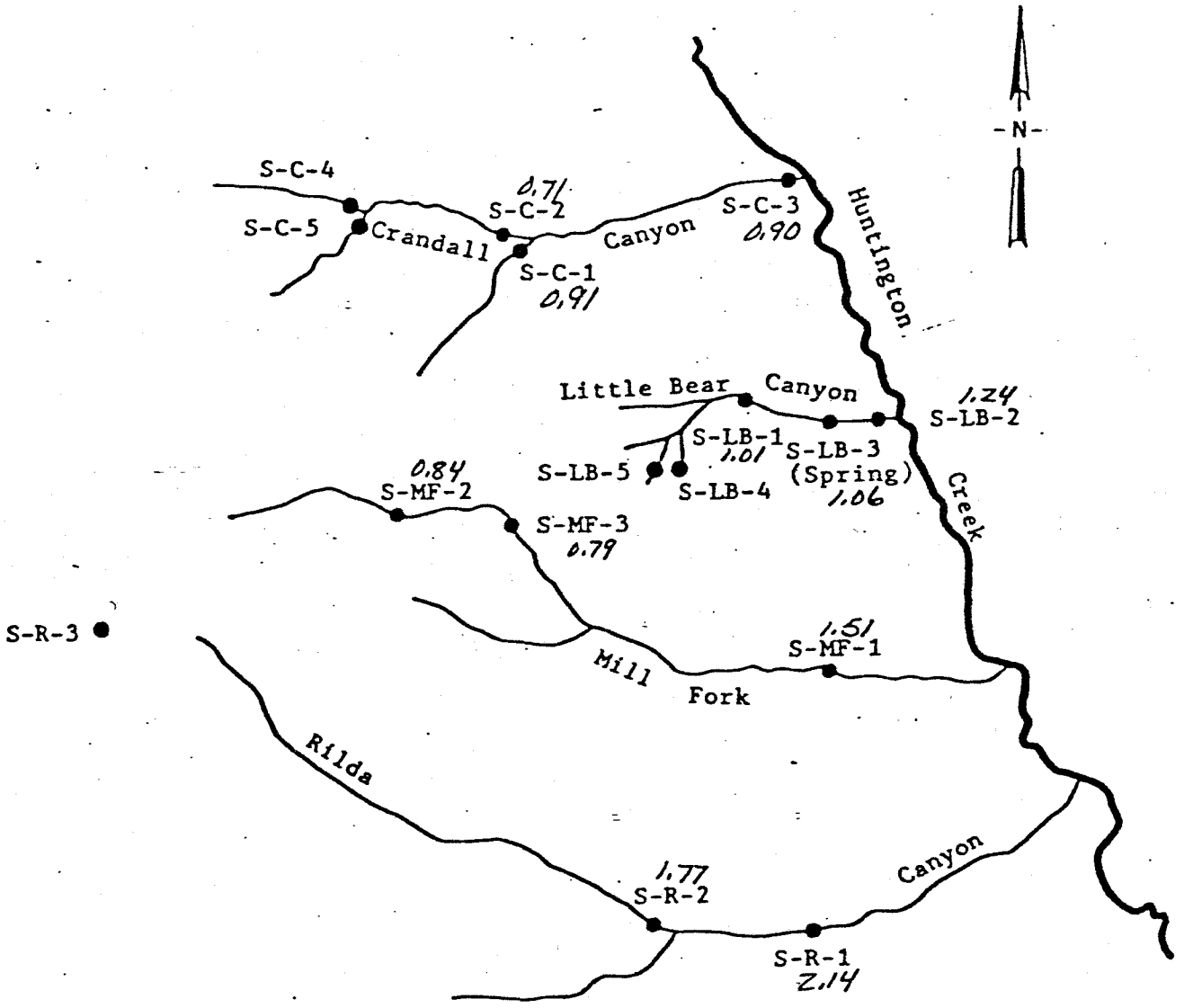
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 0.05 mg/l Recommended

ughn Hansen Associates
20 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Potassium

Date November 8-12, 1976

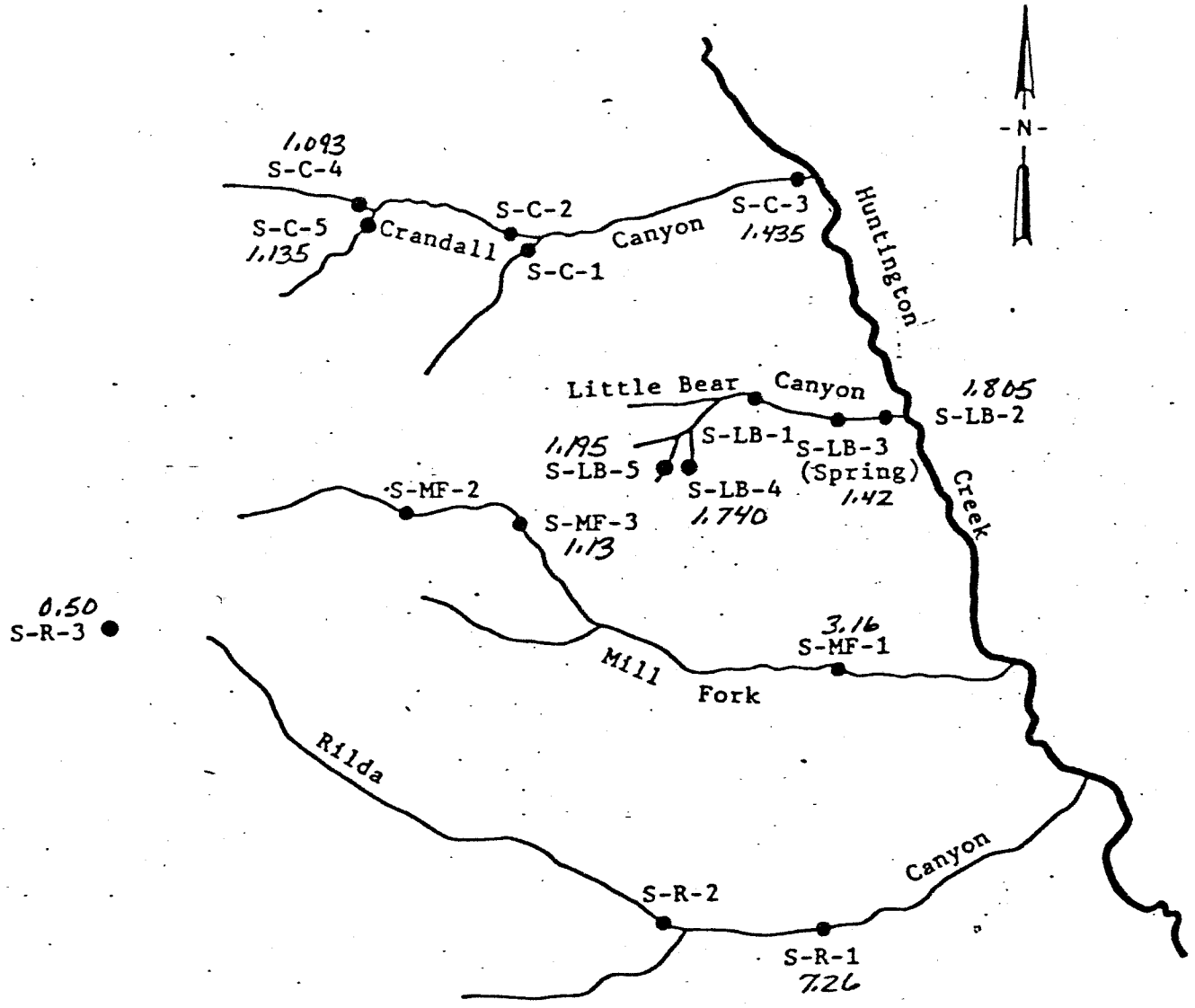
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

V[illegible]hn Hansen Associates
5[illegible] South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Potassium

Date May 31 to June 4, 1977

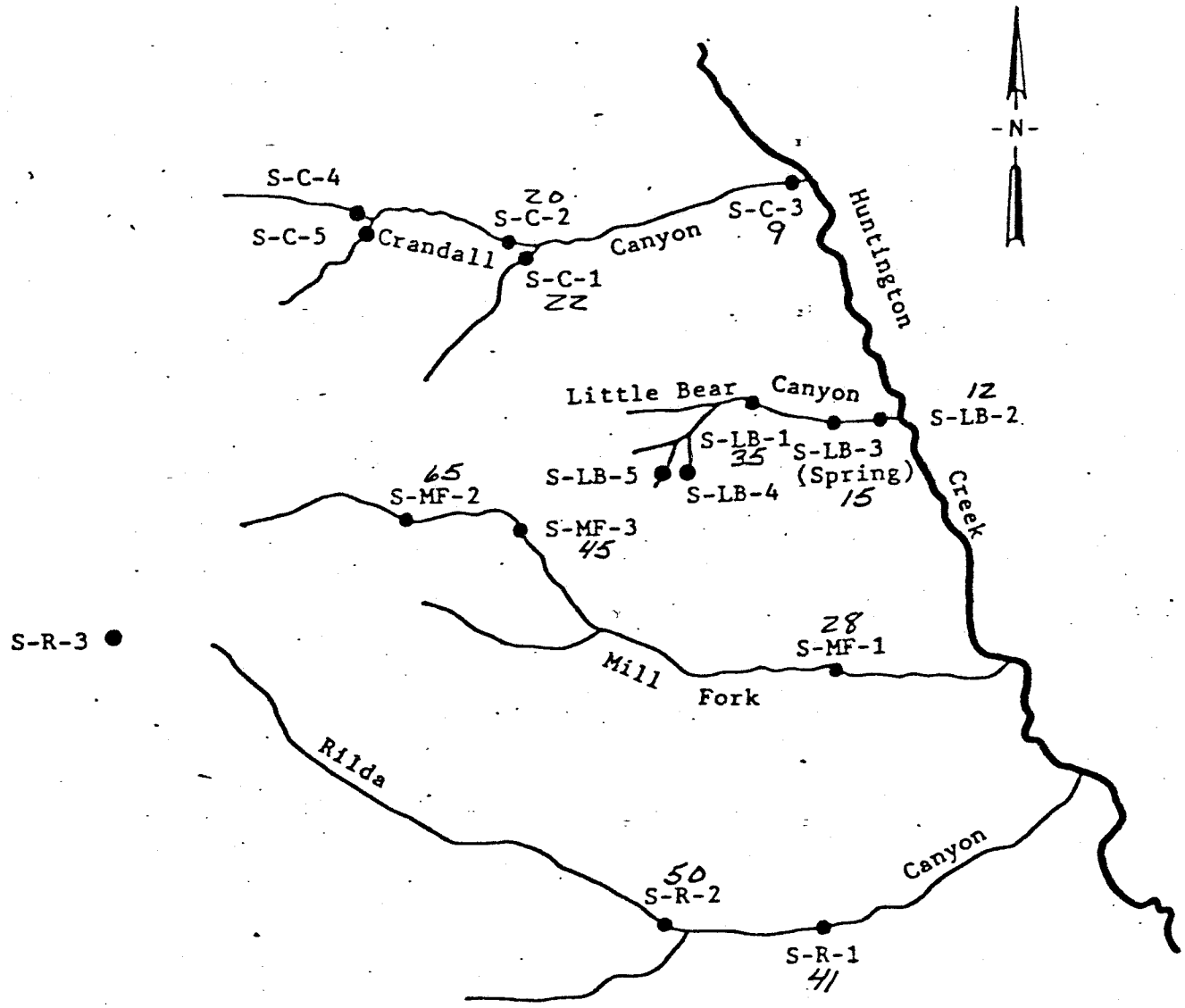
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

ghn Hansen Associates
0 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Sodium

Date November 8-12, 1976

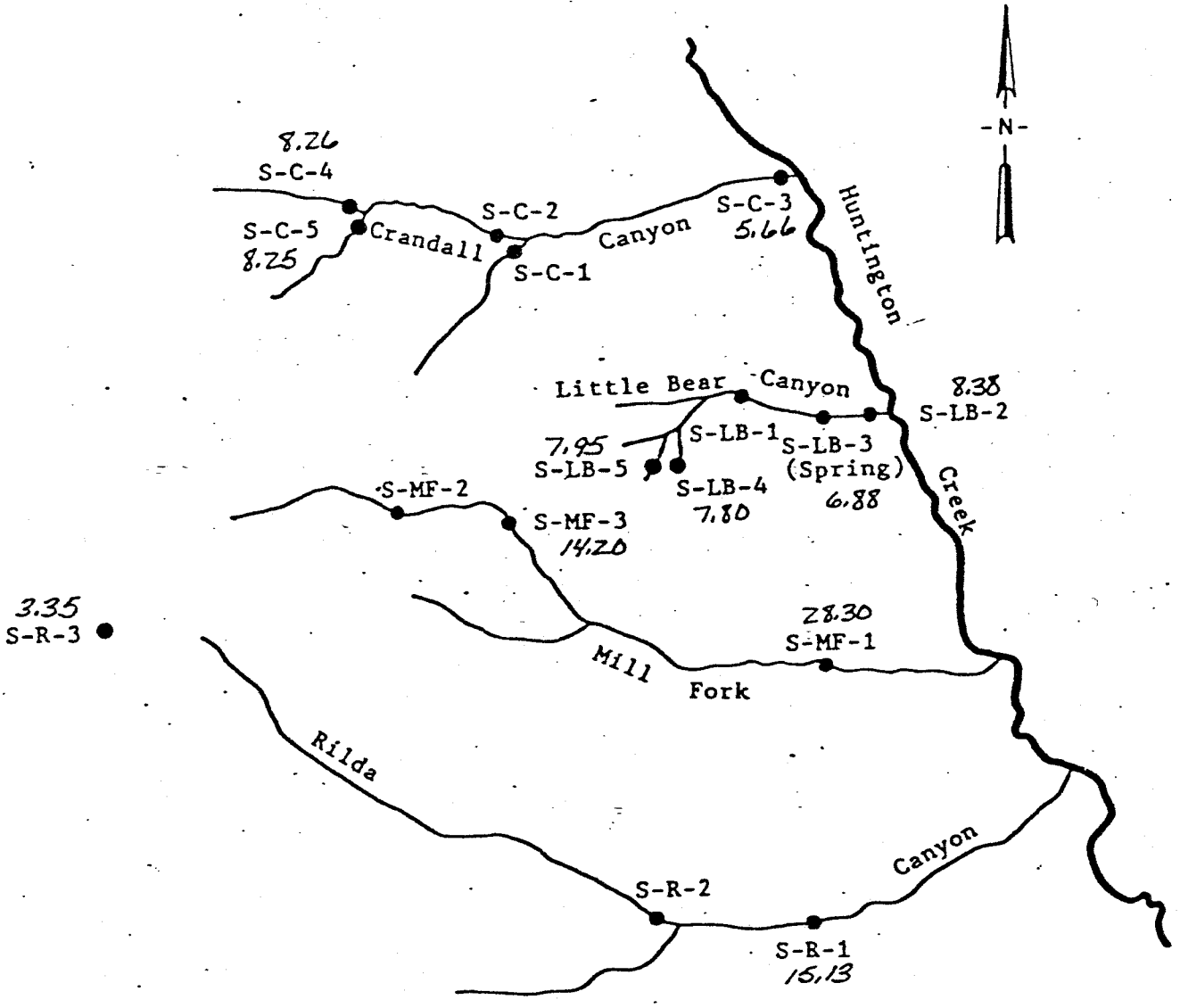
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

ughn Hansen Associates
0 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Sodium

Date May 31 to June 4, 1977

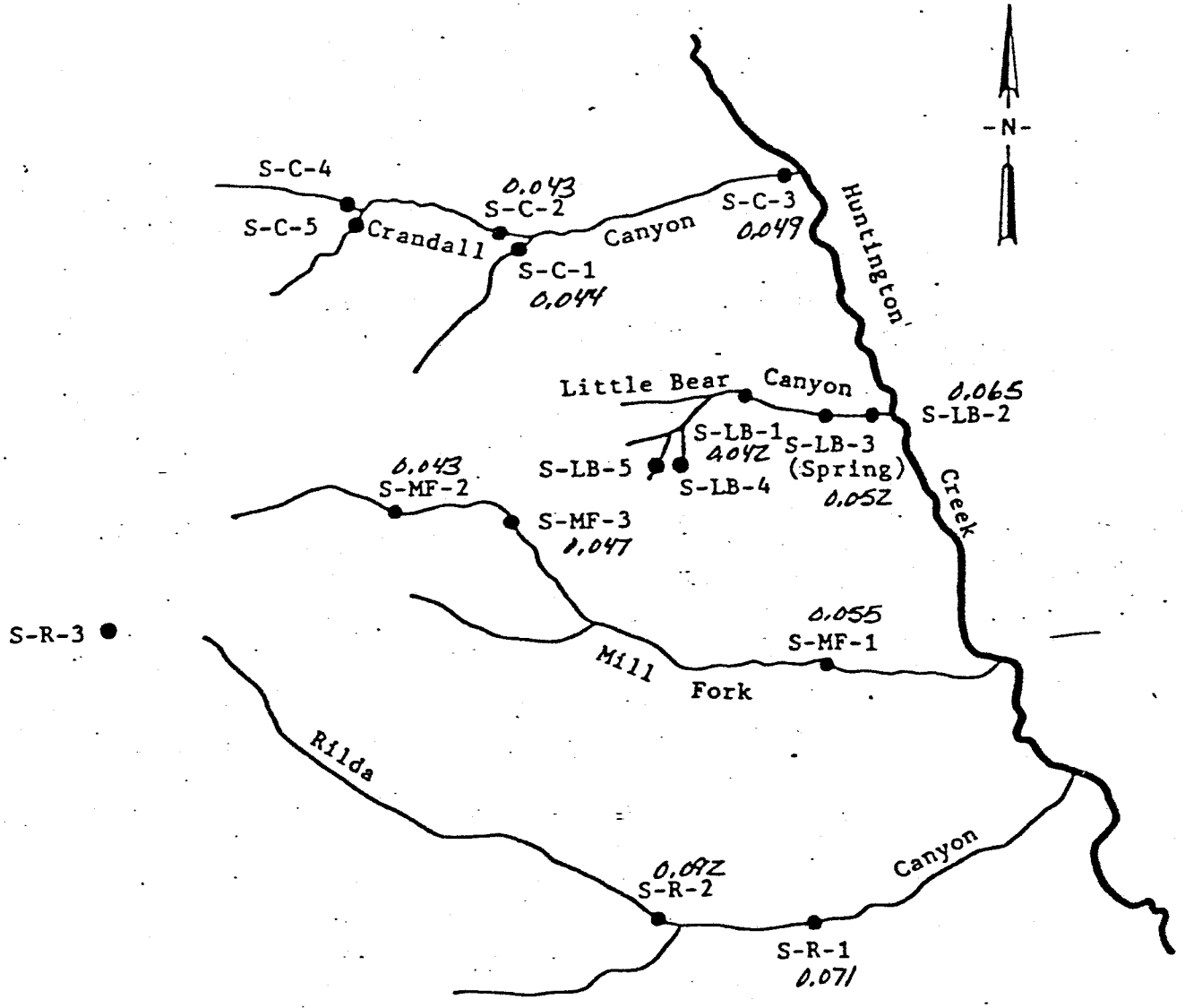
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower _____
upper _____

John Hansen Associates
[illegible]0 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Zinc
Date November 8-12, 1976

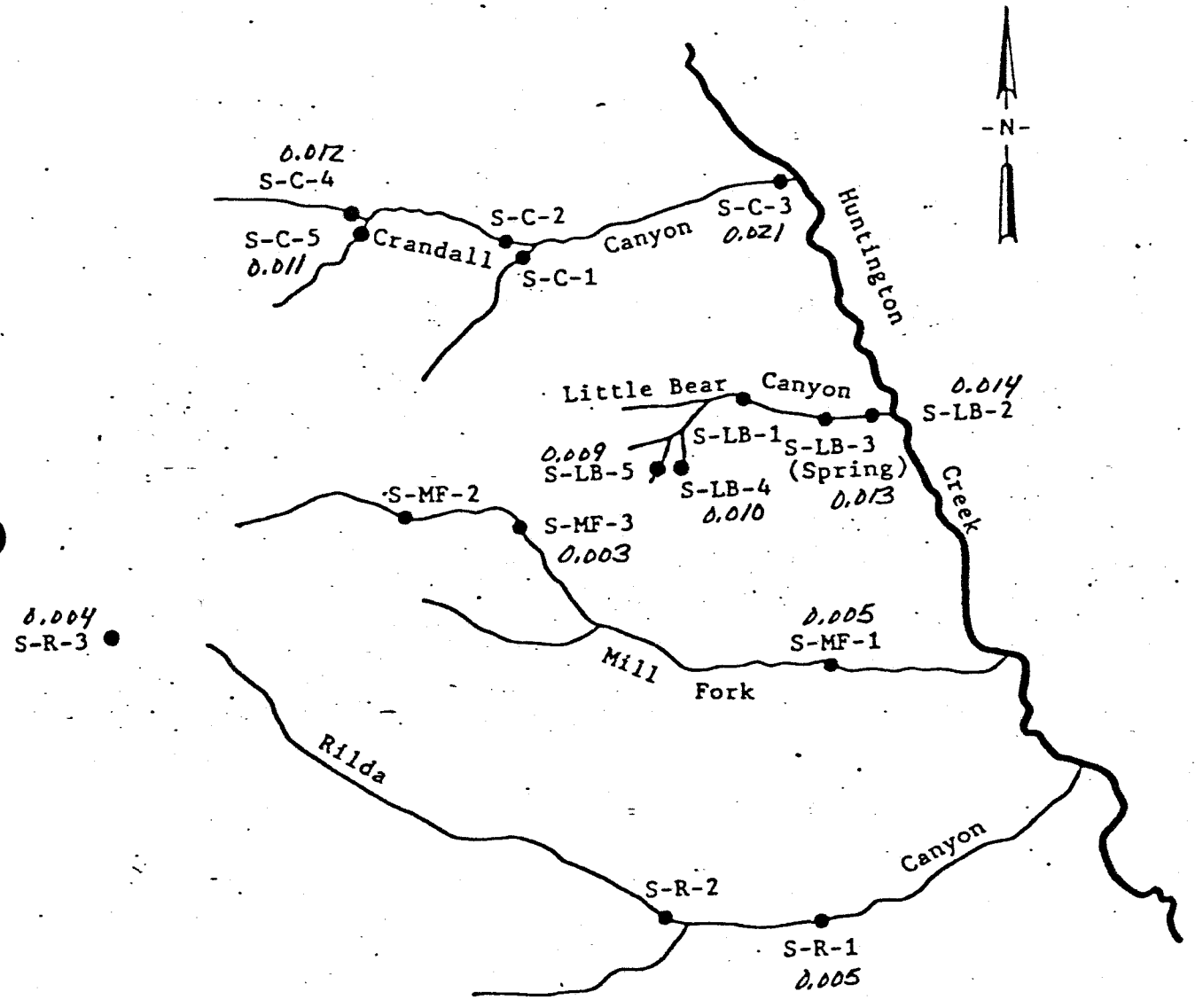
NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 5.0 mg/l Recommended

Laughn Hansen Associates
720 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

WATER QUALITY SAMPLING LOCATIONS
HUNTINGTON CREEK MINE 4
SWISHER COAL COMPANY



Parameter Zinc
Date May 31 to June 4, 1977

NOTE: Stations marked in red are outside of state limits for the sample taken during the above sampling period.

LIMITS:
lower
upper 5.0 mg/l Recommended

ghn Hansen Associates
5620 South 1475 East
Salt Lake City, Utah 84121

1 ½ 0 1 2 miles
Scale

A PLAN FOR THE COLLECTION, RECORDING AND REPORTING OF GROUND AND SURFACE WATER QUALITY AND QUANTITY DATA

This plan is hereby submitted to Part 784.14 (b)(3), and is based on the requirements in Part 817.52, and also the "Proposed Guidelines for Surface and Groundwater Monitoring", published by the State of Utah, Department of Natural Resources, Division of Oil, Gas and Mining.

The Crandall Canyon watershed covers approximately 5.7 square miles and Crandall Creek is the only water body present in the entire watershed area. (no springs or intermittent drainages? ephemeral)

The drainage boundaries are shown on the map (what map?) that accompanies this plan. Crandall Creeks flows in a northeasterly direction and merges with Huntington Creek which upon merging with Ferron Creek forms the San Rafael River which is a tributary to the Green River. The water in Crandall Creek consists of runoff and flow from springs higher up in the canyon. The ridges surrounding Crandall Canyon are sharp and the sides of the canyon are steep. The location of our permit area in relationship to the creek and springs is also shown on the accompaning map. (which map? enclosure #?)

Water discharge information for Crandall Creek was obtained from the U. S. G. S., Water Investigations Division for the 1979 water year. Their information indicates that the minimum discharge of water for any one day that year was .37 cubic feet per second, maximum discharge ~~was~~ for any one day was 19 cubic feet per second, with an daily average of 2.19 cubic feet per second. The (computer print-out) (?where) of this information accompanies this plan. This print-out also gives some of the seasonal variations showing that from the end of September through the middle of March the

stream flow remains relatively the same, then gradually picks up to its peak flow around the latter part of May then gradually drops throughout the summer.

Water quality information for Crandall Creek was taken from the Vaughn Hansen and Associates Study done in 1977 for Swisher Coal Company. The locations sampled in Crandall Canyon during Hansen's study are indicated as S-C-1, 2, 3, 4, and 5 in the "Water Quality Sampling Location Maps", inserted as Appendix B of the study. This entire study is included as item VII-7 of our mine permit application and I will reference the following seasonal variation of water quality to the study by Hansen.

Location S-C-3 was located at the mouth of Crandall Creek above confluence with Huntington Creek and I will present the data from that location as being most representative of the creek in its entirety as far as seasonal variation of water quality is concerned.

2 samples do not identify seasonal water quality variation

S-C-3 SAMPLES (HANSEN STUDY)

	Sample #1 May 31 to June 4		Sample #2 November 8 - 12	
Sulfate	40	mg/l	27.7	mg/l
Total Disolved Solids	390	mg/l	450	mg/l
Turbidity	1.00		2.20	
Bicarbonate	263.5	mg/l	312.3	mg/l
Alkalinity (total)	216	mg/l	256	mg/l
Hardness	248	mg/l	270	mg/l
Barium	0.099	mg/l	0.015	mg/l
Boron	0.001	mg/l	0.001	mg/l
Calcium	48	mg/l	86.4	mg/l
Chloride	4	mg/l	4	mg/l
Copper	0.035	mg/l	0.024	mg/l
Flouride	0.20	mg.l	0.17	mg/l
Iron (total)	0.147	mg/l	0.158	mg/l
Magnesium	30.72	mg/l	12.96	mg/l
Manganese	0.0009	mg/l	0.006	mg/l
Potassium	1.435	mg/l	0.90	mg/l
Sodium	5.66	mg/l	9.00	mg/l
Zinc	0.021	mg/l	0.049	mg/l

All samples taken in Crandall Canyon and in particular at this S-C-3

location at the mouth of Crandall Creek were within state limits for acceptable concentrations. for what use??

Crandall Creek does not flow through our permit area, however, we feel it is adjacent enough to our permit area that it could be affected by our surface facilities or operations. We therefore proposed to sample the creek for water quality, at the location indicated on the map that accompanies this plan, to determine the effect, if any, our operation has on the water quality in Crandall Creek. We will sample at the designated station monthly for the following parameters; temperature (air and water), specific conductance, pH, total dissolved solids, total suspended solids, total iron, dissolved iron, total manganese, oil and grease, sulphate, acidity (if pH less than 8.3) plus any additional parameters deemed necessary by the State of Utah, Division of Oil, Gas and Mining. This station will also be sampled for a complete water quality analysis once a year during low flow period in the fall. There will be no mine water discharge point to be sampled. Our sediment pond discharge will be sampled in accordance with the fequency and parameters required by our N. P. D. E. S. discharge permit. Results of all sampling will be reported quarterly. Upon our cessation of mining operations, during reclamation and after reclamation has been completed, our sampling, for the same parameters, during the same intervals will continue to be done and will still be reported quarterly until the State of Utah, Division of Oil, Gas and Mining deems the sampling unnecessary and of no further consequence.

Our groundwater base data is compiled from information in the Vaughn Hansen Study done for Swisher Coal Company, published in 1977, and also from Utah Power and Light Company's 1979 Annual Report of their hydrologic monitoring program. This information as to the geologic setting of the groundwater system is contained in this application as Part 783.14 (a)

and Part 783.15 (a)(1) and (a)(2). And again, no major faulting has been described or mapped in the permit area and our own geologic investigation reveals no major faulting in the permit area. Our groundwater quality information has been compiled from U. S. G. S., water investigations division, UPL, and Vaughn Hansen hydrologic sources. U. S. G. S., in particular, has reported the location of two major springs in Crandall Canyon. Neither of these is located within the permit area, but are close enough to the permit area to provide information pertinent to this application and this plan. These springs have been identified and sampled in the Vaughn Hansen study. One is stationed coded by Hansen as S-C-4 and is located 2.5 miles up Crandall Canyon on the right fork of the east branch, the other is station coded by Hansen as S-C-5 and is located 2.5 miles up Crandall Canyon on the left fork of the east branch. Vaughn Hansen has also sampled another spring which is closer to the permit area, however, on the side at the canyon opposite our permit area. Hansen has station coded the closer spring as S-C-1.

Flow data was available on S-C-4 and S-C-5 from U. S. G. S. and is as follows:

STATION CODE	U.S.G.S. LOCATION	DATE	FLOW GPM
S-C-5 (elevation 8320ft)	D-16-6 1ACA	4/26/78	8
		11/08/78	2.2
		8/23/79	26
		9/17/79	22
		10/16/79	8.8
S-C-5 (elevation 8680ft)	D-16-6 1CCA	10/22/78	33

No flow data was available from any source on the spring station coded as S-C-1 by Vaughn Hansen. He gives a .002 c.f.s. flow rate recorded on November 12, 1976. Results of water quality analysis for these three stations, taken from the Vaughn Hansen study, is as follows (all in

mg/liter):

	S-C-1	S-C-4	S-C-5
Sulfate	40	36	35
Total Dissolved Solids	448	420	422
Turbidity	1.10	0.63	0.80
Bicarbonate	300.1	290.4	290.4
Alkalinity (total)	246	238	238
Hardness	234	262	262
Barium	.015	.096	.015
Boron	.001	.014	.010
Calcium	68.8	61.6	64.0
Chloride	1.5	4.0	6.0
Copper	.007	.020	.006
Flouride	.17	.19	.17
Iron (total)	.297	.140	.049
Magnesium	14.8	25.9	24.5
Potassium	.91	1.09	1.14
Sodium	22	8.26	8.25
Zinc	.044	.012	.011

After reviewing the Vaughn Hansen study and our own geologic information on the permit and adjacent areas, and due to the fact that there are no springs within the permit area and the old workings are not making any water at present, we feel that the best locations to use as a sample points for groundwater quality and quantity monitoring would be the Hansen location at S-C-2 and at a point downstream from where Crandall Creek passes over the interface of the Blackhawk-Star Point formations.

These two spring locations will be sampled once in the spring and once in the fall for the following parameters: pH, specific conductance, total iron, dissolved iron, total manganese, total dissolved solids, total suspended solids, sulfate, acidity (where the pH is less than 8.3), plus any additional parameters deemed necessary by the State of Utah, Division of Oil, Gas and Mining. A complete water quality analysis will be run from these locations on a quarterly basis and results from all analysis shall be reported on a quarterly basis.

These two spring locations will be sampled once in the spring for the following parameters: pH, specific conductance, total iron, dissolved iron,

total manganese, total dissolved solids, total suspended solids, sulfate, acidity (where pH is less than 8.3), plus any additional parameters deemed necessary by the State of Utah, Division of Oil, Gas and Mining. Both stations will be sampled for a complete water quality analysis once a year during low flow period in the fall. A water temperature and flow rate will be taken with all samples. Analytical results of all samples will be reported within the quarter they have been taken and analized. Upon cessation of our mining operations, during and after reclamation operations we will continue this same sampling and reporting procedure until the State of Utah, Division of Oil, Gas and Mining deems the sampling unnecessary and of no furthur consequence.

ITEM VII - 4

	DATE	gpm	n/mho	temp
(D - 16 - 6) 1 ACA	4/26/78	8		
Elev. 8320	11/8/78	2.2		
	8/23/79	26	540	4.0
	9/17/70	22	560	4.5
	10/16/79	8.8	520	1.0
(D - 16 - 6) 1 CCA				
Elev. 8680	10/22/78	33		

CW Water Level — T16s R7E S29 NW¼ NW¼ Elev. 7856'
(D - 16 - 7) 29 BBB