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Act/015/015

# SURFACE WATER AND GROUNDWATER

# MONITORING PLAN

EMERY MINE

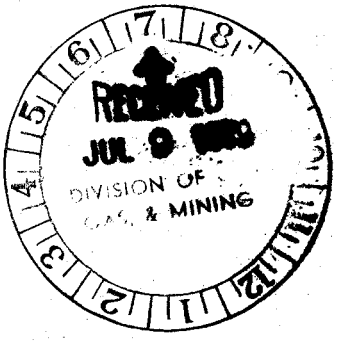
July 9, 1979

# SURFACE AND GROUNDWATER MONITORING PLAN

for
EMERY DEEP MINE

Consolidation Coal Company
P. O. Box 527
Emery, Utah 84522

July 6, 1979



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INTRODUCTION

The Emery Deep Mine is owned by Consolidation Coal Company and Kemmerer Coal Company and is operated by Consolidation Coal Company under State of Utah Permit No. ACT/015/015. The mine is located approximately four miles south of the town of Emery, Emery County, Utah, in the Castle Valley. (See Figure 1.)

Originally, the Emery Deep Mine was known as the Browning Mine which opened in 1881 and intermittantly produced coal until 1930. Since 1930, there has been a constant production of coal from the mine. Consol and Kemmerer purchased the original Browning Mine in May of 1975, and Consol has been mining coal from the Emery Deep Mine since that time. Current production is approximately 600,000 tons per year. Mining is by the room and pillar method in the "IJ" seam of the Ferron Sandstone, which is a member of the Mancos Shale.

This surface and groundwater monitoring plan is prepared to comply with State of Utah, Division of Oil, Gas, and Mining Surface Mining Reclamation and Enforcement Provisions for Coal. Questions or comments regarding this plan should be directed to:

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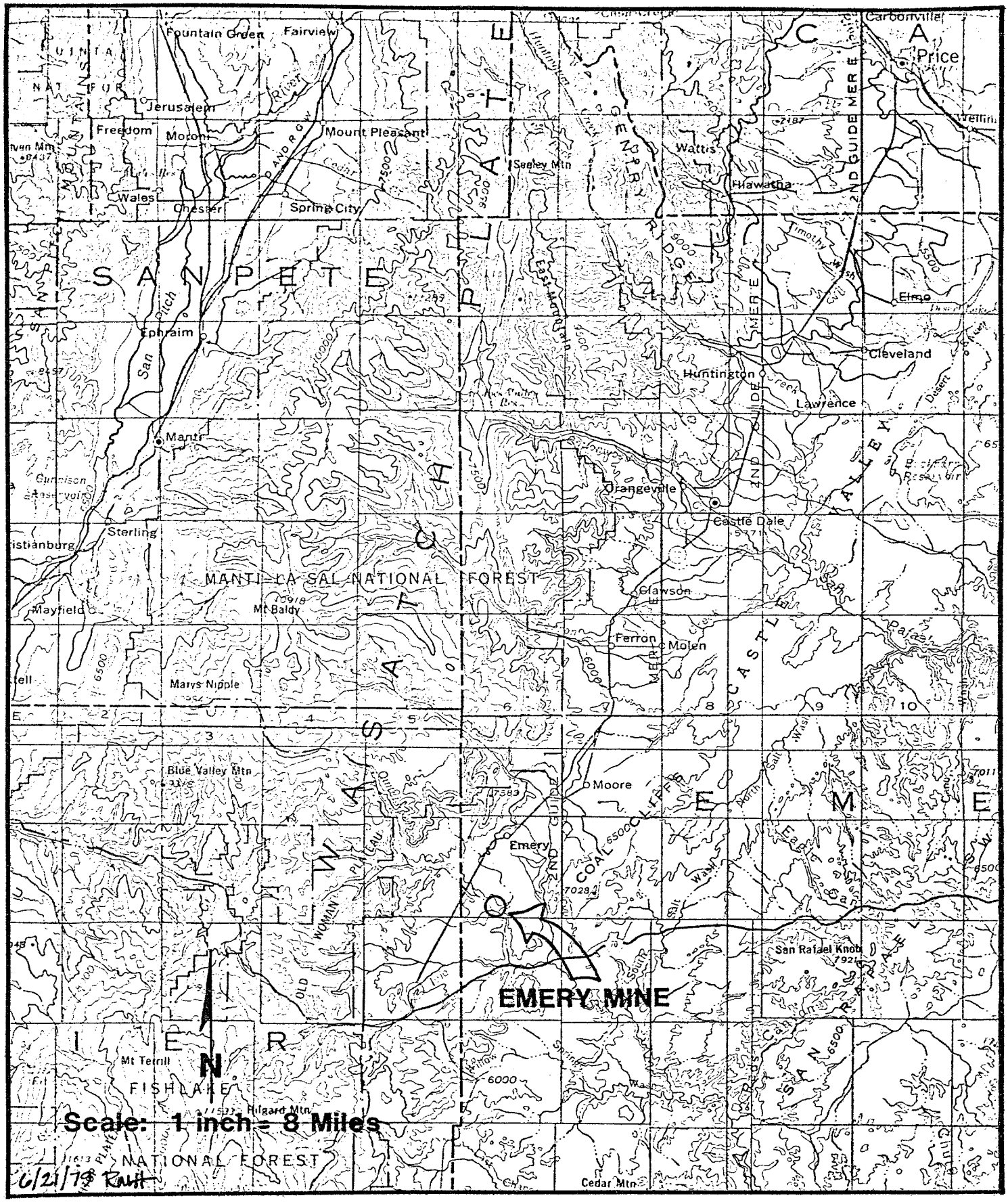



# FIGURE 1

# REGIONAL LOCATION

## DESCRIPTION OF AREA

### Topography

The topography of the area is characterized by gently southeasterly-sloping mesas with surface gradients that range from 4 to 20 percent (see Figure 2). Approximate elevation range for the mine area is from 6,000 to 6,200 feet. Streams have deeply incised the gently inclined surfaces forming steep sided mesas.

### Geology

The geology, topography, and hydrology of the Emery Deep Mine area is controlled by the influences of the San Rafael Swell on the east and the Wasatch Plateau on the west. The area in between these two features, where the Emery Mine is located, is known as Castle Valley.

Castle Valley is underlain by the Cretaceous Mancos Shale. Contained within the Mancos, in order of deposition, are the Tununk Shale, Ferron Sandstone, Blue Gate Shale, and Emery Sandstone members. The major aquifer in the area is the Ferron Sandstone, a cliff-forming member approximately 700 feet thick. It is divided into two units of different depositional history. The lower unit is a light gray, fine-grained, calcareous, cross-bedded, marine sandstone with siltstone and carbonaceous interbeds. The upper unit is yellow-gray and brown, and locally weathers to rust color. Unlike the sheet-like lower unit, the upper unit occurs as lenses and pods of medium-grained sandstone and siltstones separated by interbeds of carbonaceous shale, mudstone, and/or coal. These sediments probably originated in flood plain and swamp environments.

Within the lower third of the upper Ferron Sandstone unit, there are thirteen (13) coal beds. It is the "IJ" coal seam which is presently being mined at the Emery Mine.

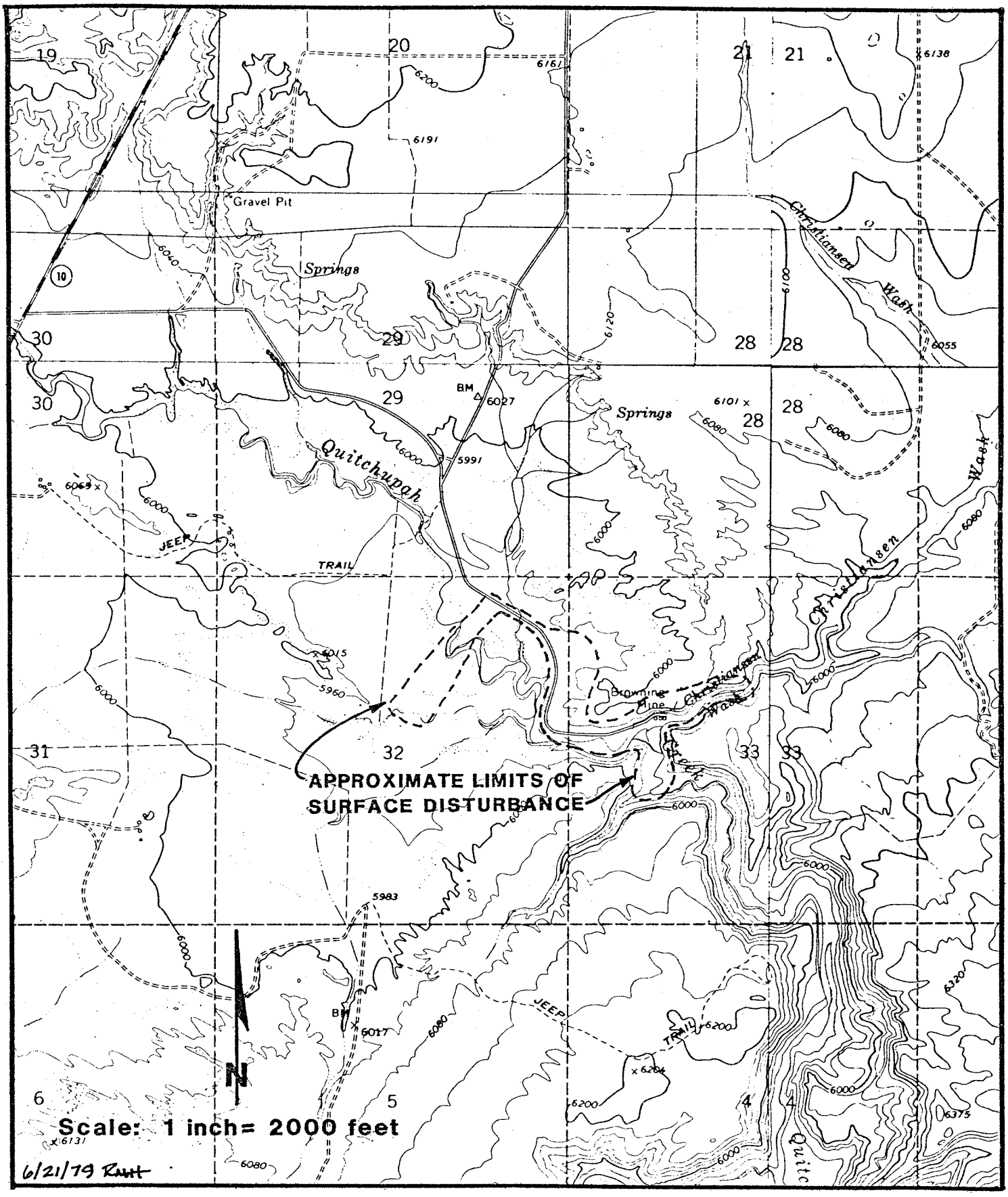
Other geologic influences on the hydrology of the area are the approximately 5 degree dip to the west and northwest induced by the San Rafael Swell and the Joe's Valley-Paradise Fault Zone northwest of the mine site. This fault zone is about 2 miles wide and extends 75 miles. Vertical displacement along the fault zones from 1,500 to 3,000 feet. There is also a prominent NW-NNE to WNW-NE conjugate linear joint set in the area.

### Climate

The climate of the area is semi-arid with an average annual precipitation of 7.55 inches recorded at Emery, Utah. Precipitation increases with altitude. Summer flash floods are common, as precipitation is often torrential. Evaporation rates are high.

### Surface Hydrology

There are two flowing streams in the Emery Mine area, Quitchupah Creek and Christiansen Wash. The confluence of these streams is on the mine




# FIGURE 2

# TOPOGRAPHY OF MINE AREA

property. The general trend of these streams indicate that they follow the geologic joint system.

The Emery Mine is located entirely within the Quitchupah Creek Watershed which covers approximately 20 to 25 square miles. This watershed is a part of the Muddy Creek watershed which covers approximately 430 square miles, with elevations ranging from 5,760 to 11,133 feet (see Figure 3).

Quitchupah Creek, with its headwaters situated on the eastern flank of the Wasatch Plateau, is a perennial stream fed by snowmelt, irrigation caused seepage and runoff, and groundwater discharge. Upper Christiansen Wash is now perennial due to a leak in an irrigation canal and excessive flood irrigation. Lower Christiansen Wash is a perennial stream due to groundwater discharge of the Ferron Sandstone and the influence of upstream irrigation. Maximum and minimum flows for Quitchupah Creek and Christiansen Wash are presented in Table 1.

In Quitchupah Creek maximum flows occur during the winter and spring and in Christiansen Wash maximum flows occur during the fall and spring. The minimum flows are in summer and fall for Quitchupah Creek and winter and summer for Christiansen Wash. These streams fluctuate in response to groundwater discharge, irrigation runoff, snowmelt, leaking irrigation canals, infiltration, evapotranspiration, and Emery Mine discharge.

The water quality in Quitchupah Creek varies from high-salinity, low-sodium to very high salinity, medium-sodium. At best, the water is only useable for irrigation of plants with a high salt tolerance. Waters from Christiansen Wash are only good for use in special agricultural management practices, such as the farming of high salt-tolerant plants.

Groundwater

The primary groundwater source in this area is the Ferron Sandstone aquifer. Field studies indicate that the aquifer is being recharged from the northwest along the Joe's Valley-Paradise Fault Zone and to a lesser extent by numerous joints in the overlying strata. The discharge is to the south-southeast. The aquifer is artesian north and west of the mine site; water table conditions exist to the south and east where it outcrops.

From studies it is apparent that the ground water is flowing generally up-dip and perpendicular to the Joes Valley-Paradise Fault Zone. In the area of the Emery Mine, the hydraulic gradient slopes toward the mine in all directions except from the south (see Figure 4).

Groundwater from the Ferron Sandstone enters the mine primarily through cleats and joints in the roof. Water flow into the mine is currently about 430,000 gpd (.67 cfs). The water is pumped into a sediment pond to allow suspended solids to settle. The sediment pond discharge is monitored under NPDES Permit (UT 0022616) as it enters a channel tributary to Quitchupah Creek.

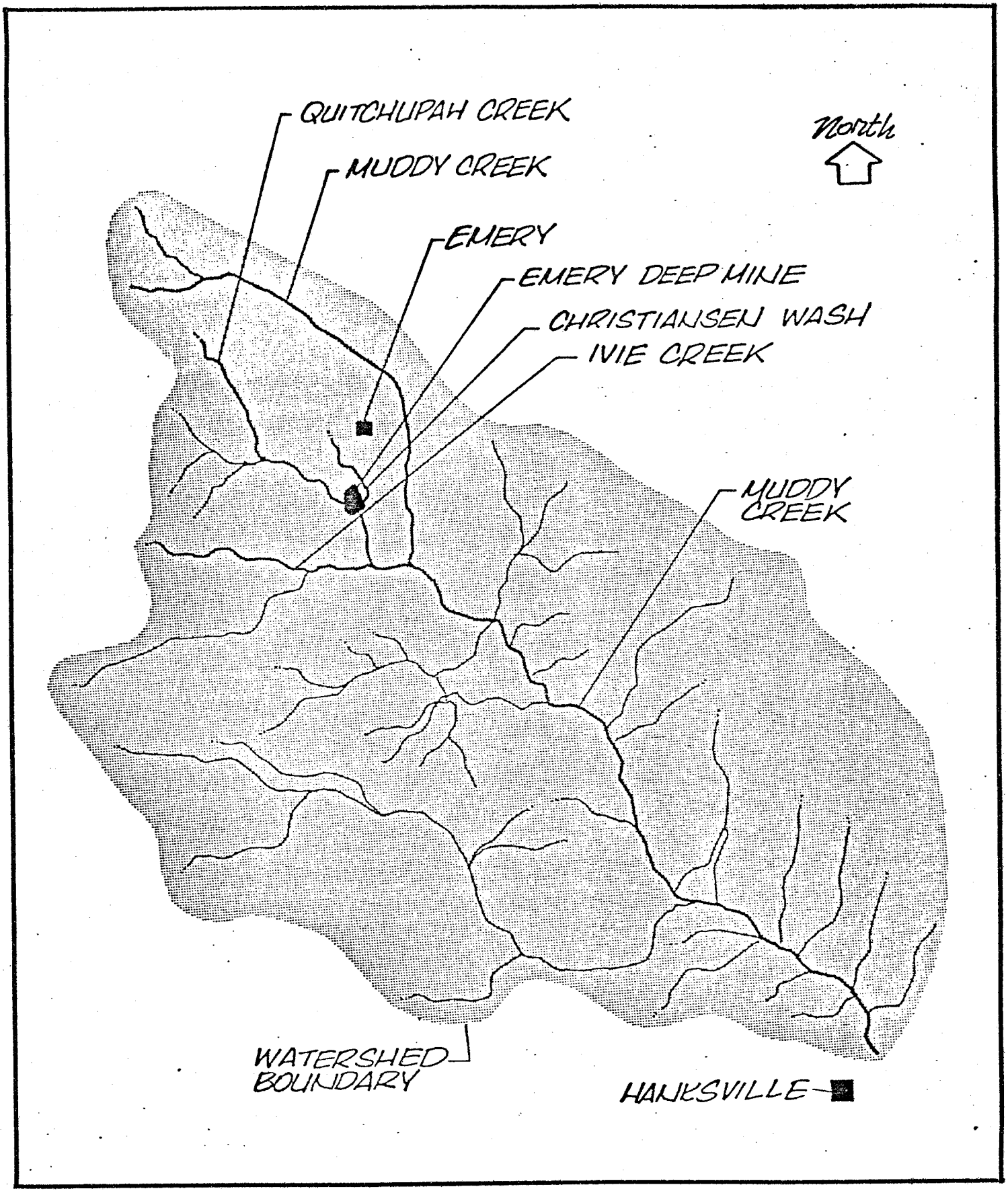



**FIGURE 3**

**MUDDY CREEK WATERSHED**

TABLE 1

MAXIMUM AND MINIMUM FLOWS
QUITCHUPAH CREEK AND CHRISTIANSEN WASH
7-75 THROUGH 9-76

| | Location | Maximum (cfs) | Minimum (cfs) |
|---|---|---|---|
| Quitchupah Creek | S-18 | 2.0 | .01 |
| | S-29 | 12.0 | .50 |
| Christiansen Wash | S-8 | 3.5 | .01 |
| | S-17 | 5.0 | .5 |

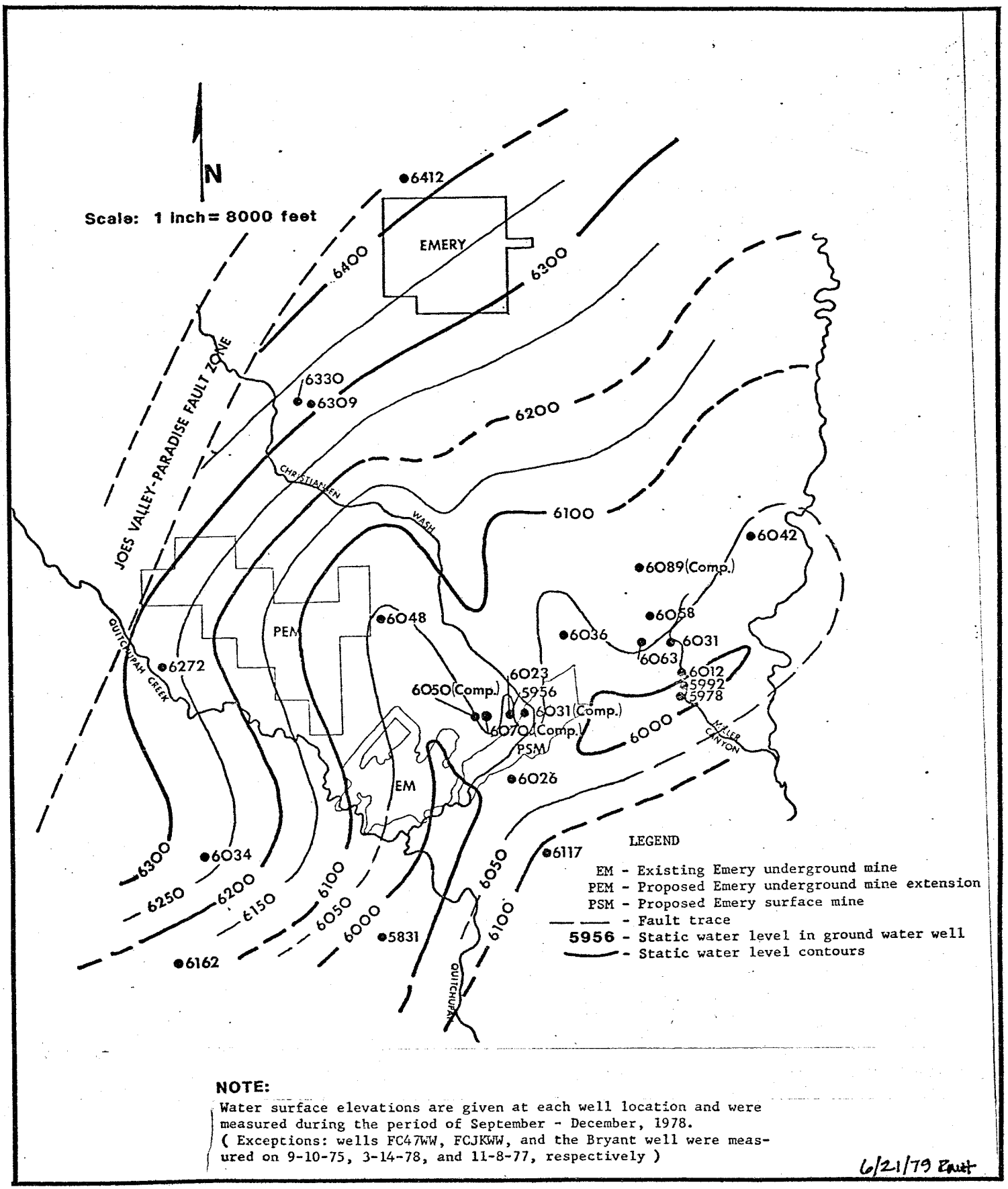
Site Description

S-18 (immediately above Highway 10 crossing)

S-29 (immediately above confluence with Evey Creek)

S-8 (immediately above Highway 10 crossing)

S-17 (immediately above confluence with Quitchupah Creek)




**NOTE:**

Water surface elevations are given at each well location and were measured during the period of September - December, 1978.
( Exceptions: wells FC47WW, FCJKWW, and the Bryant well were measured on 9-10-75, 3-14-78, and 11-8-77, respectively )

6/21/79 Revised

# FIGURE 4

# PIEZOMETRIC CONTOUR OF FERRON AQUIFER

The current methods of mining do not cause the aquifer to be structurally disrupted. The aquifer has not been breached during mining. There is very little vertical movement of water into the mine through the floor. This is probably due to two factors, the five feet of relatively impermeable clay below the coal and the two feet thick coal floor.

The Emery Mine is affecting the hydraulic gradient of the Ferron aquifer. As mining progresses, higher flows of groundwater into the mine are expected. The draw down of the aquifer, which will diminish flow into Christiansen Wash and Quitchupah Creek, is expected to be offset by the increased mine discharge through the settling pond.

SURFACE WATER MONITORING

The United States Geological Survey (USGS), Division of Water Resources, has been and is presently conducting a surface and groundwater monitoring program in the vicinity of the existing Emery Underground Mine. The purpose of this monitoring program is to generate regional environmental data for the Energy Minerals Resource Inventory Assessment (EMRIA) study.

The USGS initiated the surface water monitoring program in the spring of 1978 by installing a continuous-recorder bubble type gaging station immediately upstream of the Emery Mine on both Christiansen Wash and Quitchupah Creek. In August, 1978, the USGS began collecting water samples for chemical analyses at both these stations. In addition, the USGS is performing a stream gain-loss (seepage run) study on Quitchupah Creek and Christiansen Wash. Stream discharges at various locations on each creek are monitored at least twice a year. Water samples are collected for chemical analyses in August at two sites, one of which is at the mouth of the tributary into which the Emery Mine effluent is discharged.

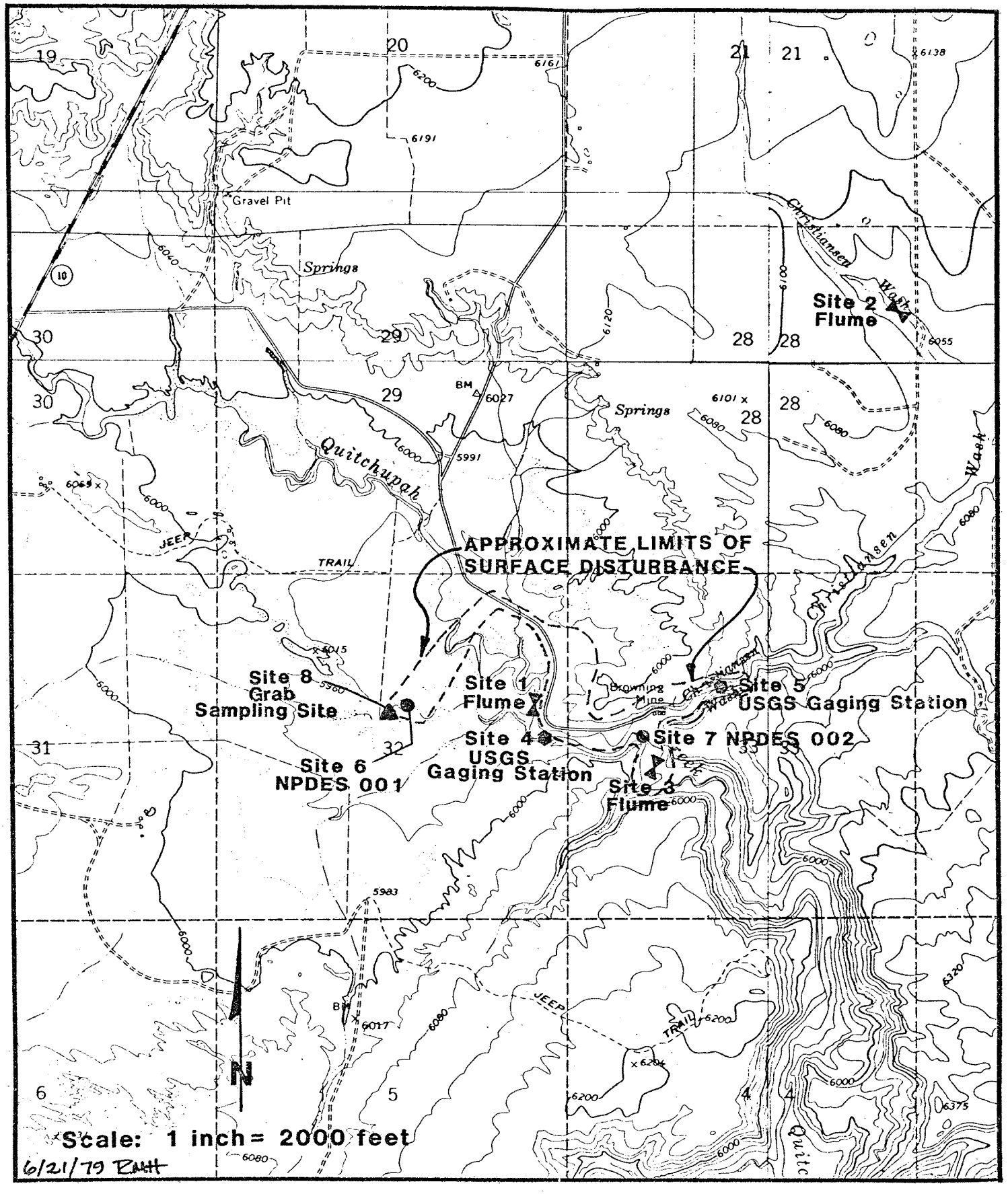
The USGS intends to complete its data collection in September, 1979. The data will be incorporated into a report scheduled to be published in 1981.

Monitoring Sites

Since the USGS intends to stop collecting surface water data at the end of this (1979) summer, Consol is presently negotiating with the USGS in Salt Lake City to take over operation of the gaging station (Sites 4 and 5) on Christiansen Wash and Quitchupah Creek (see Figure 5). Both of these gaging stations are well situated to measure any potential impacts to streams from discharges produced by the Emery Mine.

Consol will also install three Parshall flumes and crest stage gauges at the Sites numbered 1, 2, and 3 on Figure 5. A Parshall flume with a two foot throat width and a continuous recorder at Site No. 1 will be used to measure stream discharge on Quitchupah Creek above the influence of the Emery Mine effluent which is discharged into the unnamed tributary indicated on Figure 5. A two-foot flume can measure discharges of 0.66 to 33.11 cubic feet per second (cfs); this is a normal range of discharge indicated by available data. A crest stage gauge will be used to measure peak discharge from any flood events. In addition, a grab-sample monitoring site (Site 8) will be established on the unnamed tributary immediately upstream from where the Emery Mine effluent is being discharged. A crest stage guage will also be installed at this monitoring site.

Consol will install a nine-inch-throat Parshall flume with a continuous recorder on Christiansen Wash (shown as Site 2 on Figure 5). A nine-inch flume can measure discharges of 0.09 to 6.3 cfs; this range of




# FIGURE 5

# SURFACE WATER MONITORING SITES

discharge is indicated by available data. The flume will be accompanied by a crest stage gauge. This flume location is selected for two reasons. First, it is upstream of the outcrop of the Ferron Sandstone. The Ferron Sandstone is the major aquifer in the vicinity, and it discharges relatively good water into Christiansen Wash. Available data indicate mine pumpage is lowering of the piezometric surface of the Ferron Sandstone aquifer in proximity to the Emery Mine; therefore, the Emery Mine may be influencing stream discharge in Christiansen Wash by reducing groundwater inflow. The nine-inch flume at Site No. 2 will provide data on stream discharge trends prior to any mine influence. The second reason for locating a flume at this site is that it is easily accessible from the county road.

Consol will install a continuously recording two-foot Parshall flume with accompanying crest stage gauge at Site No. 3 (Figure 5) on Quitchupah Creek below its confluence with Christiansen Wash. A two-foot flume will measure normal stream dicharge anticipated in this reach of Quitchupah Creek. This flume would measure all stream discharge below the influence of the mining operations.

Two additional sites (Sites 6 and 7 on Figure 5), will be monitored under NPDES Permit No. UT-0022616. Site 6 is the outfall of the sedimentation pond for the groundwater inflow into the underground workings. A continuous flow monitoring recorder will be installed at the outfall of the pond. Site 7 is the outfall of the final sedimentation pond for drainage from the surface facilities.

Monitoring Parameters and Schedule

Stream Monitoring Sites (Sites 1 - 5)

Each of the five sites will be monitored monthly by a trained Consol technician. During each monthly monitoring period, the continuous recorder and crest stage gauge will be inspected, serviced as needed, and the data retrieved; field measurements of water temperature, pH, dissolved oxygen, and specific conductivity will be taken; air temperature and weather conditions will be noted; and grab samples will be collected to determine iron, manganese, pH, sulfate, total dissolved solids and total suspended solids. Each quarter, grab samples will be collected to determine the following additional constituents: total acidity, alkalinity, bicarbonate, calcium, carbonate, chloride, dissolved iron, fluoride, non-bicarbonate hardness, total hardness, magnesium, nitrate + nitrite, oil and grease phosphate, potassium, sodium adsorption ratio, silicate, sodium, and strontium. Table 2 summarizes the parameters and schedule of monitoring for the stream monitoring sites.

NPDES Discharge Points (Sites 6 and 7)

Both sites will be monitored in accordance with NPDES Permit No. UT-0022616. Each month the site will be visited to retrieve flow

TABLE 2

SURFACE WATER
MONITORING PARAMETERS AND FREQUENCY

| | |
|---|---|
| **MONTHLY PARAMETERS** | |
| Air Temperature ($^{o}C$) | Field |
| *Iron (total Fe) | Lab |
| *Manganese (total Mn) | Lab |
| Dissolved Oxygen (DO) | Field |
| *pH | Field and Lab |
| Specific Conductivity (EC) | Field |
| *Stream Flow (cfs) | Field (Recorder) |
| Sulfate (total $SO_4$) | Lab |
| *Total Dissolved Solids (TDS) | Lab |
| *Total Suspended Solids (TSS) | Lab |
| Water Temperature ($^{o}C$) | Field |
| **ADDITIONAL QUARTERLY PARAMETERS** | |
| Acidity, total | Lab |
| Alkalinity, total | Lab |
| Bicarbonate (total $HCO_3$) | Lab |
| Calcium (total Ca) | Lab |
| Carbonate (total $CO_3$) | Lab |
| Chloride (total Cl) | Lab |
| Dissolved Iron | Lab |
| Flouride (total F) | Lab |
| Hardness (noncarbonate) | Lab |
| Hardness (total) | Lab |
| Magnesium (total Mg) | Lab |
| Nitrate + Nitrite ($NO_4$ + $NO_3$) | Lab |
| Oil and Grease | Lab |
| Phosphate (total $PO_4$) | Lab |
| Potassium (total K) | Lab |
| Sodium Adsorption Ratio (SAR) | Lab |
| Silicate (total $SiO_4$) | Lab |
| Sodium (total Na) | Lab |
| Strontium (total Sr) | Lab |

* NPDES Permit No. UT-22616 data requirements.

data from the continuous recorder to inspect the effluent for oil and grease sheen, and to collect grab samples for determination of pH, TDS, TSS, total iron, and total manganese.

Site 6 is the outfall for the sedimentation pond exclusively receiving mine discharge waters. On a quarterly basis, concurrent with the sampling of the stream sites (Sites 1 - 5), samples from Site 6 will be collected to determine the full suite of chemical constituents listed in Table 2.

Grab Sampling Site (Site 8)

On a quarterly basis, concurrent with the sampling of the stream sites (Sites 1 - 5), samples from Site 8 will be collected to determine the full suite of chemical constituents listed in Table 2.

Sampling, Lab Analysis, and Reporting Procedures

At each sample site, a trained Consol technician will take field measurements of water temperature, pH, dissolved oxygen, and specific conductivity with appropriate calibrated portable meters. Air temperature and weather conditions will also be noted. The Consol technician will collect two one-liter samples at each site during monthly sampling periods. One sample will be collected raw and acidified to a pH of less than 2.0. The second sample will be collected raw and untreated. A third sample will be collected during quarterly sampling periods, field filtered, and acidified to a pH less than 2.0. The sample bottles will be filled completely full to minimize water-air ion exchange. These samples will be properly labeled with the site number, date, whether it is a quarterly, monthly, or NPDES sample, time of collection, and technician's initials. These samples will be refrigerated immediately to $4^{o}C$ via ice and will remain refrigerated until delivered to a laboratory registered with the Environmental Protection Agency. The samples will be delivered to the laboratory within three days to assure analytical accuracy. The laboratory will analyze for all parameters listed in Table 2 except those indicated as "Fields" according to whether it is a monthly, quarterly or NPDES sample. The methods for collecting water samples and performing analyses is outlined in the Environmental Protecion Agency's Manual of Methods for Chemical Analysis of Water and Wastes (1976).

Consol will maintain a surface water monitoring activities log book at the mine office. This log book will contain dates of instrument calibration, discharge records, field data, and results of chemical analysis. Within 30 days after the end of each calender quarter, Consol will forward a copy of all monitoring data, a copy of the NPDES discharge report, and a summary of monitoring data and activities to the Utah Division of Oil, Gas, and Mining.

## GROUNDWATER MONITORING PROGRAM

### Monitoring Sites

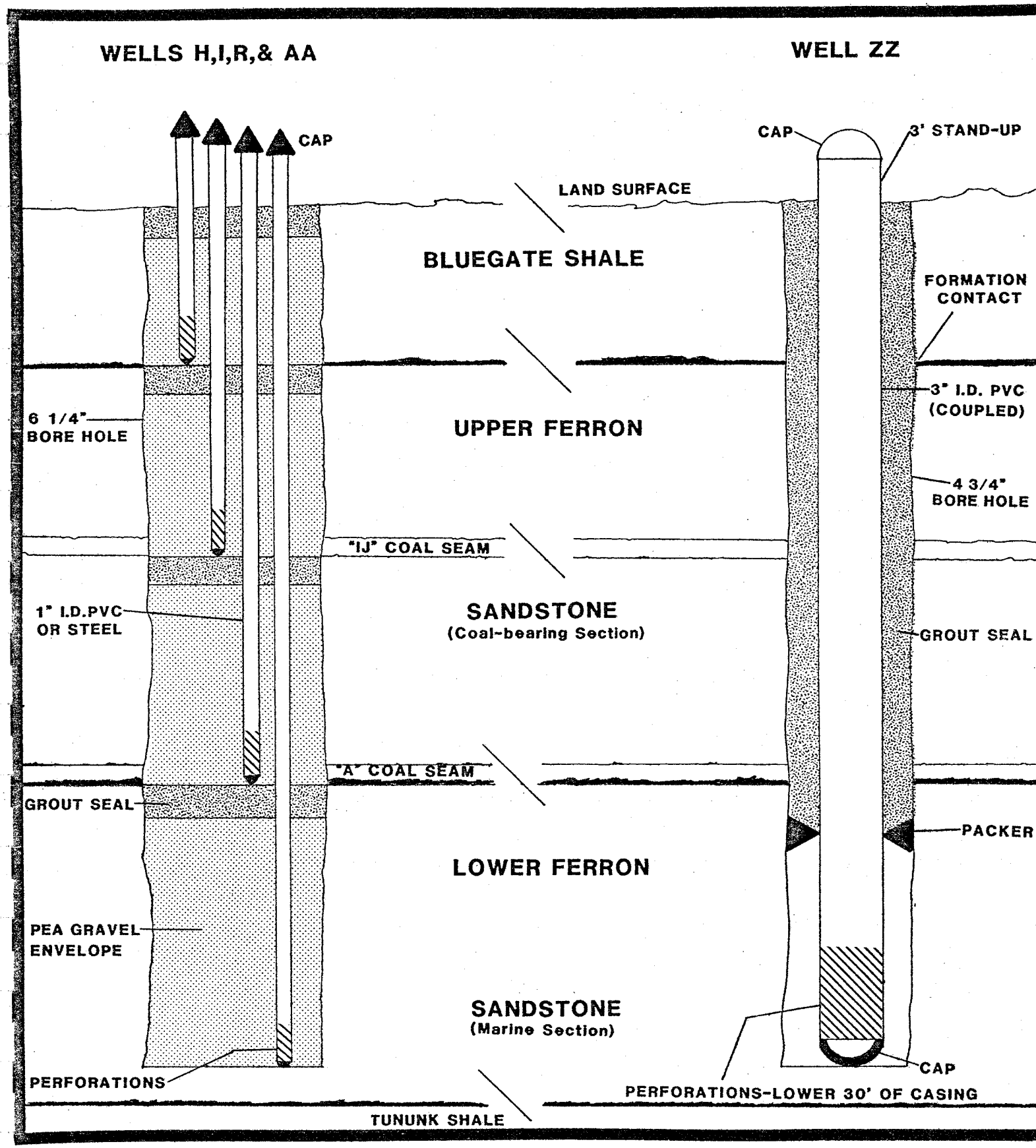
As part of the hydrologic study of the Emery area, the USGS is presently monitoring static water levels in eighteen groundwater wells on a monthly basis (see Plate 1). From the distribution of these monitoring wells and the particular geologic unit being monitored in each well, a more than adequate number are located to the east and northeast of the Emery Mine; however, it is apparent that additional monitoring wells are needed to the west and south of the Emery Mine in order to better determine the hydraulic gradient and groundwater flow directions in the Ferron Sandstone aquifer.

Consol is presently negotiating with the USGS to take over monitoring of all the wells which the USGS is presently monitoring. In addition, five monitoring sites will be established during 1979 (wells H, I, R, AA and ZZ on Plate 1) from which monthly static water levels will be measured. At each of these monitoring sites (except Site ZZ), a hole will be drilled to the base of the Ferron Sandstone and four 1 inch I.D. piezometer pipes will be installed. Each of the pipes will isolate a portion of the Ferron Sandstone such that the lower Ferron Sandstone composed of marine sediments, the upper coal-bearing portion of the Ferron Sandstone between the "A" and "IJ" coal seams, the upper coal-bearing portion of the Ferron Sandstone above the "IJ" coal seam and the Bluegate Shale will each be monitored separately for static water levels (see Figure 6). Well ZZ will monitor the lower Ferron Sandstone. From this additional data, the groundwater hydrologic regime will be better monitored and consequently, better understood.

Groundwater inflow to the Emery Mine is presently being monitored by calculating the amount of mine water periodically being discharged by both a centrifugal and turbine pump. Because of the potential inaccuracy and unreliability of this approach, a continuously recording flow meter will be installed at the effluent end (Site 6) of the sedimentation pond into which this mine water is pumped. In this manner, continuously recorded mine discharge data can be interfaced with static water level measurements and flow data obtained from the permanent surface water monitoring sites on Quitchupah Creek (and the unnamed tributary to Quitchupah Creek - see Surface Water Monitoring). The result of this approach will provide a better understanding of the ground and surface water hydrologic balance.

### Aquifer Characteristics

At present, the USGS has performed five aquifer tests on the Ferron Sandstone and is planning on conducting two additional tests this (1979) summer (see aquifer test site locations on Plate 1; a pump test site at the Dog Valley Mine located 6.5 miles due south of the Emery Mine is not shown). From these tests, the USGS and Consol will be able to determine the parameters of permeability, transmissivity and storage coefficient for the Ferron Sandstone.




# FIGURE 6

# WELL CONSTRUCTION CRITERIA

Having these sets of aquifer coefficients will make it possible to better construct flow nets, to calculate both drawdown with distance curves and stream depletion rates, and to better estimate what future flow rates into the Emery Mine might be as mining progresses.

Springs and Seeps

According to Dan Morrissey of the USGS EMRIA team, very few springs were located in the vicinity of the Emery Mine as a result of an intensive survey of the area. Of those discovered, all were flowing at less than one gallon per minute. Consol will conduct an inventory of springs and seeps in the vicinity of the mine during the summer and fall of 1979 and will sample springs within one mile of the mine in the spring and fall of each year concurrent with surface water quarterly sampling. Samples will be analyzed for the full suite of constituents listed in Table 2.

Water Levels

Static water levels will be measured monthly at each of the twenty-three monitoring wells shown in Plate 1.

Sampling Parameters and Schedule

The general chemical quality of groundwater in the Ferron Sandstone has been fairly well determined by previous work by Consol and the USGS. Thus, groundwater from wells FC6WW, EMRIA #2, USGS 1-1, USGS 1-2, Well ZZ and the Bryant well will be pumped and sampled on a semi-annual basis for the chemical constituents listed in Table 3.

Sampling, Lab Analysis, and Reporting Procedures

At each sample well, a trained Consol technician will take field measurements of the static water level, water temperature, pH, and specific conductivity. Air temperature and weather conditions will also be noted. The Consol technician will collect three one-liter samples at each well. One sample will be field filtered through a 0.45 micron filter and acidified to a pH of less than 2.0 with redistilled nitric acid ($HNO_3$). A second sample will be collected raw and acidified to a pH of less than 2.0. The third sample will be collected raw and untreated. All three sample bottles will be filled completely full to minimize water-air ion exchange. These samples will be properly labeled with the site number, date, time of collection, and technician's initials. These samples will be refrigerated immediately to $4^{o}C$ via ice and will remain refrigerated until delivered to a laboratory registered with the Environmental Protection Agency. The samples will be delivered to the laboratory within three days to assure analytical accuracy. The laboratory will analyze for all parameters listed in Table 3 except those indicated as "Field." The methods for collecting water samples and performing analyses is outlined in the Environmental Protection Agency's Manual of Methods for Chemical Analysis of Water and Wastes (1976).

TABLE 3

GROUNDWATER
MONITORING PARAMETERS

| | |
|---|---|
| Air Temperature ($^{o}C$) | Field |
| Acidity, total | Lab |
| Alkalinity, total | Lab |
| Bicarbonate (total $HCO_3$) | Lab |
| Calcium (total Ca) | Lab |
| Carbonate (total $CO_3$) | Lab |
| Chloride (total Cl) | Lab |
| Flouride (total F) | Lab |
| Hardness (noncarbonate) | Lab |
| Hardness (total) | Lab |
| Iron (total Fe) | Lab |
| Dissolved Iron | Lab |
| Magnesium (total Mg) | Lab |
| Manganese (total Mn) | Lab |
| Nitrate + Nitrite ($NO_4$ + $NO_3$) | Lab |
| pH | Field and Lab |
| Phosphate (total $PO_4$) | Lab |
| Potassium (total K) | Lab |
| Silicate (total $SiO_4$) | Lab |
| Sodium (total Na) | Lab |
| Sodium Adsorption Ratio (SAR) | Lab |
| Specific Conductivity (EC) | Field |
| Static Water Level (ft amsl) | Field |
| Strontium (total Sr) | Lab |
| Sulfate (total $SO_4$) | Lab |
| Total Dissolved Solids (TDS) | Lab |
| Total Suspended Solids (TSS) | Lab |
| Water Temperature ($^{o}C$) | Field |

Consol will maintain a groundwater monitoring activities log book at the mine office. This log book will contain dates of instrument calibration, static water level records, aquifer pump test data, field data, and results of chemical analysis. Within 30 days of the end of each calander quarter, Consol will forward a copy of all monitoring data and a summary of well and spring information to the Utah Division of Oil, Gas and Mining.