CASTLE GATE

COAL MINE

MINING & RECLAMATION PLAN

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CHAPTER 7
HYDROLOGY

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CHAPTER 7

HYDROLOGY

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CHAPTER 7

HYDROLOGY

7.1 GROUNDWATER HYDROLOGY

This report has been prepared at the request of Price River Coal Company to respond to the State of Utah Division of Oil, Gas and Mining (DOGM) "Apparent Completeness Review (ACR) Comment UMC 783.15 Groundwater Information". In the above referenced comment, DOGM indicates,

> Inadequacies in the description of the hydrogeologic system present at the Price River Mine Complex were a major topic of concern in the April 1981 ACR. To date these inadequacies have not been rectified... The applicant needs to provide a more detailed description of the hydrogeology of the area...

The purpose of this report is to provide the more detailed description of the hydrogeology of the Price River Coal Company mine plan and adjacent areas.

Castle Gate Coal Company took over operation of the mines in May of 1986. The mines, now owned by the Castle Gate Coal Company, will be referred to as the Castle Gate mines throughout this report. Reference will be made to appropriate exhibits submitted to DOGM as part of the Mining and Reclamation Plan.

7.1-1 Regional Groundwater Hydrology

The Castle Gate mine plan area is located along the western edge of the Book Cliffs coal field which extends from the Utah-Colorado state line to Castle Gate, Utah (see Figure 7-1). As indicated in Chapter 6 "Geology" of the Mining and Reclamation Plan, "the strata strike northwest to west and dip 3 to 6 degrees north into the Uinta basin". According to Spieker (1925), the strike of the strata coincides with the trend of the cliffs.

The geologic formations exposed on or adjacent to the mine plan area are either Upper Cretaceous or Tertiary (see Exhibit 7-1 and Exhibit 6-1).

Mancos Shale - The Mancos Shale is a gray marine shale, locally heavily charged with carbonaceous material, slightly calcareous and gypsiferous (Doelling, 1972). The material (ranging from fine clay to siltstone) is nonresistant, forming flat desert surfaces and rounded hills and badlands.

In the vicinity of the mine plan area, the Mancos Shale is separated into tongues by westward projecting littoral sandstone (Doelling, 1972). The sandstones are fine to medium grained, yellow gray to tan, medium bedded to massive, and cliff forming (Doelling, 1972).

Because of the marine environment associated with the formation of the Mancos Shale, groundwater percolating into the Mancos contacts soluble evaporites such as gypsum resulting in a rapid degradation of water quality. According to Freeze and Cherry (1979), if calcite and gypsum dissolve in fresh water, the water will become brackish with total dissolved solids of about 2100 to 2400 mg/l. If sufficient calcite and gypsum are present, the water will evolve quickly and directly to this degraded phase (Freeze and Cherry, 1979).

Star Point Sandstone - According to Doelling (1972), the Star Point Sandstone consists of massive, medium to light colored littoral sandstone tongues projecting easterly, separated by gray marine shale tongues projecting westerly. This formation, present only in the western portion of the Book Cliffs area, consists of three sandstone tongues (the Panther, Storrs and Spring Canyon, in ascending order). The Star Point Sandstone is relatively impermeable, with significant groundwater movement occurring on a regional level only as a result of secondary porosity, i.e. fractures.

Blackhawk Formation - Overlying the Star Point is the Blackhawk Formation which is the primary coal bearing formation of the Mesaverde Group. The Blackhawk consists of alternating sandstone, shale, and coal beds and ranges from 900 to 1300 feet thick in the Castle Gate areas, with the better coal beds assembled in the lower 500 feet (Doelling, 1972).

The sandstone is medium to fine grained, composed largely of semi-rounded quartz grains cemented by carbonate of lime and is reasonably well consolidated (Clark, 1928). Due to the cemented and consolidated nature of sandstones in the Blackhawk Formations, and apparent low specific yield (Cordova, 1964), water yielding capabilities of the Blackhawk are of only local importance.

According to Doelling (1972), shales of the Blackhawk are Mancos-like shales. Shales act as effective barriers to groundwater movement within the Blackhawk Formation, particularly perpendicular to the bedding plane of the shale.

Castlegate Sandstone - The Castlegate Sandstone is a fine to medium grained, argillaceous to slightly calcareous normally massive bedded unit overlying the Blackhawk Formation (Doelling, 1972). Within the vicinity of the mine plan area, the unit is fluvial, becoming lagoonal toward the eastern portion of the Book Cliffs area. According to Clark (1928), the basal portion of the Castlegate consists of thin bedded rocks grading from sandy shale into sandstone, and in many locations shale and sandy shale are near the top of the member.

Price River Formation - The Price River Formation consists of yellow-gray to white, medium grained sandstone and shaley sandstone with gray to olive green shale (Doelling, 1972). The apparent low permeability of the Price River Formation (Cordova, 1964) reduces its water yielding capabilities except through fractures.

North Horn Formation - The North Horn Formation consists of a series of shale, sandstone, minor conglomerate and freshwater limestone (Doelling, 1972). Like the Blackhawk Formation, shales in the Castlegate, Price River, and North Horn Formations act as effective barriers to the vertical movement of water within these formations. Therefore, a significant portion of the water which reaches these formations probably percolates downward until encountering a shale layer, which then causes horizontal movement to the surface or another "drain" (i.e. sandstone finger within the formation).

Flagstaff Limestone - According to Doelling (1972), the Flagstaff Limestone consists of thin bedded limestones, shales and sandstones. The shales are interbedded with microcrystalline limestone and the sandstones are calcareous and fine to medium grained.

The Flagstaff Limestone forms much of the ridge top locations within and adjacent to the mine plan area. The limestone caps are relatively flat and low surface relief allowing larger quantities of water to infiltrate the surface soils. Water transmitting abilities of the Flagstaff are mainly due to solution channels and fractures (Danielson, et al., 1981). However, as discussed previously, nearly impermeable shale layers in the underlying North Horn and Price

River Formations cause much of the water percolating down from the Flagstaff to issue from the North Horn and Price River Formations as springs.

Faults - On a regional level, the ability of various formations to readily transmit water is primarily due to faulting and fracturing. However, as indicated in Chapter 6 of the Mining and Reclamation Plan, "faulting is relatively minor in the region and absent within the Mine Plan Area boundaries". "Folding is present only in very broad, gentle flexures, resulting in dip variations of less than 4 degrees." Therefore, the absence of large springs within the mine plan area can be attributed to the absence of faulting within the mine plan area. In general it has also been found that springs within the Blackhawk Formation are not fault related since shales tend to seal faults, preventing significant transmission of water through faults.

711-2 Regional Groundwater Characteristics

Waters recharging the groundwater system are primarily from snowmelt, with the quantity of recharge being highly variable from site to site as a result of topographic variation and variation in intake rates of the strata. Principal recharge areas for the groundwater system are the higher plateaus which receive higher precipitation and produce most of the runoff. The flatter slopes or low surface relief along ridge-tops of the higher plateau regions encourage infiltration. However, in general within the vicinity of the mine plan area the ridge-tops are narrow, providing less recharge area, and the canyon slopes are steep, inducing mostly runoff with less infiltration opportunity and therefore less recharge to the groundwater system. All of the geologic formations which outcrop in the area have relatively low primary permeabilities which further reduces the quantity of recharge to the groundwater system. According to Price and Arrow (1974) and the U.S. Geological Survey (1979), annual precipitation recharging the groundwater system is probably much less than 5 percent. Limited groundwater recharge also occurs along areas of outcrop for some of the more permeable strata at stratigraphically lower positions. However, in general these outcrop zones are narrow and located on steep slopes thereby limiting recharge potential.

Groundwater movement is from areas of recharge (primarily plateaus with low surface relief or basins on the windward side of the ridge which collect and retain more snow) to areas of discharge, including springs and stream courses. In general, most springs issue either above or below the Blackhawk Formation except in areas where the Blackhawk is the exposed formation along ridge-tops. Springs issuing from the Price River, North Horn, or Flagstaff Formations are discharge areas for a perched aquifer system(s) within these formations. The perched aquifer condition results from the shale layers which impede vertical percolation forcing the groundwater to issue at a sandstone-shale interface as a spring. Groundwater discharging from the Blackhawk Formation either as springs or into stream courses is associated with the regional water table.

Within areas of the Wasatch Plateau-Book Cliffs region, it has been demonstrated that principal groundwater discharge areas for formations overlying the Blackhawk and for the Starpoint Sandstone beneath are fault or fracture related. A site specific lineament study conducted on a portion of the Huntington Creek drainage basin demonstrated that nearly all seeps or springs issuing from the Price River, North Horn, and Flagstaff Formations above the Blackhawk and from the Star Point beneath encountered during an intensive field survey were either fracture or fault related. Danielson et al. (1981) have indicated that within the formations of the Huntington Creek area, groundwater movement is primarily through fractures, along layer contacts, and through solution openings. The same formations exist within the Price River Coal mine plan area, therefore, groundwater movement is assumed to be similar.

Groundwater chemical quality is generally good in strata above the Blackhawk Formation within the Book Cliffs coal field. The total dissolved solids (TDS) concentrations of springs issuing from the Flagstaff or North Horn Formations can generally be expected to be less than 500 mg/l. Springs issuing from the Price River Formation can be expected to contain TDS concentrations of less than 700 to 800 mg/l. Waters percolating through the Blackhawk and Mancos Shale Formations quickly deteriorate in quality, with TDS concentrations of the Mancos Shale frequently exceeding 3000 mg/l.

7.1-3 Mine Plan Area Aquifers, Seeps and Springs

Summarized within this section is a description of the mine plan area groundwater system under existing conditions. The existing hydrogeologic conditions within the mine plan area are highly complex as a result of the extensive historical disturbance to the hydrogeologic system that has occurred from prior mining activities. There have been 50 major coal mines which have historically mined coal within the limits of the plan area (some dating prior to 1900), 48 of which are now abandoned. All nine coal seams have been mined at one point or another with abandoned mine workings extending from the western to eastern edge of the mine plan area, a distance of some 14 miles (Adair, 1983). Therefore, the groundwater system has experienced disturbance in some form for over 85 years.

7.1-4 Description of Mine Plan Area Aquifers

The groundwater system of the Price River Coal mine plan area is highly complex due to the inter-bedded nature and presence of nearly impermeable shale layers of the Blackhawk, Price River, North Horn, and Flagstaff Limestone Formations. Additional complexity to existing aquifer systems is present as a result of the previously described extensive mining activities historically conducted within the mine plan area.

Three distinct aquifer systems (segregated by aquifer characteristics or locations) can be identified within the mine plan area; a perched aquifer system(s) in the Price River, North Horn, and Flagstaff Limestone Formations; the regional aquifer system probably originating in the Blackhawk Formation and extending into the underlying formations; and the alluvial aquifer systems, consisting of very narrow bands of alluvial deposits in the canyon bottoms of perennial streams within the mine plan area. Although the alluvial and regional aquifer systems are interconnected (the alluvium serving as either recharge or discharge area for the regional system), the alluvial aquifers can be distinguished from the aquifer system of the Blackhawk and underlying formations by differences in aquifer characteristics, the alluvial system in general being much more permeable than the surrounding formations.

Perched Aquifer System - The perched aquifer system(s) of the Price River, North Horn and Flagstaff Formations consists of "small, discontinuous groundwater bodies which receive natural recharge from local precipitation and discharge as small seeps and springs, many of which flow only seasonally (USGS, 1976)". The seeps and springs are located high in the watershed, generally at a sandstone-shale interface. The locations of springs will be discussed in a subsequent section of this report. As discussed previously, the shale layers within these formations impede groundwater movement perpendicular to the bedding plane, forcing the groundwater to move primarily parallel to the bedding plane and to issue as a seep or spring at the outcrop of the sandstone-shale interface. The shale layers are not absolutely impermeable; therefore, some leakage occurs through the shale layers, discharging limited quantities of water from the perched system to the underlying regional aquifer system.

Principal recharge areas for the perched aquifer system(s) are the higher plateau regions or ridge-top locations which receive higher precipitation and regions which have flatter slopes, thereby encouraging more infiltration; or are local areas (or pockets) with higher than average snowfall accumulation. As indicated previously, the annual precipitation recharging the groundwater system is much less than 5 percent (Price and Arrow, 1974; and the USGS, 1979).

As indicated by the USGS (1976):

> The rocks (including coal-bearing beds) that underlie the coal-lease area consist chiefly of poorly permeable shales, mudstones, siltstones, and fine grained sandstones that yield water slowly to wells and springs. A regional map showing general availability of groundwater in the upper Colorado River Basin (Price and Arrow, 1974) indicates that rocks in the coal-lease area are capable of yielding only 1 to 10 gal/min of water to individual wells. Most observed springs discharging from these same rocks in the general area of the coal lease yield less than 1 to 10 gal/min.

7.1-5 Regional Aquifer System

The regional aquifer system within the mine plan area is first encountered in the Blackhawk Formation and extends down into the Starpoint and Mancos Shale Formations, which also outcrop within the mine plan area (see Exhibit 7-1). According to the USGS (1976):

> The Blackhawk Formation which contains the coal beds to be mined, is above the regional water table in the outcrop areas, but apparently extends beneath the regional water table to the north and between major canyons (where the altitude of the regional water table is the highest).

The rocks of the Blackhawk also consist chiefly of poorly permeable shales, mudstones, siltstones and fine grained sandstones. The low permeability of the Blackhawk Formation has been verified by testing three wells within the mine plan area (MC-205, MC-206, and MC-207, see Exhibit 7-2 for location). Aquifer testing was conducted by Golder Associates. Procedures used in the testing as outlined by Golder, are presented in Appendix 7-1. The drill logs as well as aquifer test results for the intervals over which each hole was tested are presented in Chapter 6 "Geology" of the Mining and Reclamation Plan. From the hydraulic conductivity values indicated on the logs for the various zones tested, a total transmissivity for each hole was determined by multiplying the thickness of each zone tested by the hydraulic conductivity of that zone and then summing the transmissivity values for all zones within each well. An average hydraulic conductivity was determined for holes MC-205 and MC-206 by dividing the total transmissivity by the total thickness of the tested zones. As illustrated by the results presented in Table 7-1, the entire Blackhawk Formation is extremely tight, having transmissivities on the order of 17 gpd/ft over a test zone of 808 feet and 65 gpd/ft over a test zone of 651 feet. Also as indicated on the log of hole MC-206, a test conducted over a 233-foot zone including multiple layers of coal yielded a hydraulic conductivity of only 1.0 x 10-6 cm/sec (transmissivity equal to 5 gpd/ft). Therefore, the coal is just as impermeable as other portions of the formation.

The Blackhawk, Starpoint and Mancos Shake Formations receive a limited quantity of recharge from exposed surfaces within the mine plan area. Direct recharge to strata of the Blackhawk and underlying formations is limited because of steep surface slopes and limited area of exposure throughout most of the mine plan area. Some additional infiltration opportunity is available for the Blackhawk Formation along several ridges where the Blackhawk Formation is exposed. However, in general these ridges are narrow, providing little recharge area with lower relief. Movement of groundwater from overlying formation down into the Blackhawk is also quite limited due to the presence of shale layers within the Blackhawk and overlying formations. Consequently, recharge to the Blackhawk Formation is small, much less than the previously referenced 5 percent of annual precipitation as will be discussed in a subsequent section.

Discharge areas for the regional aquifer system within the mine plan area consist of a few springs (primarily alluvial in nature), water courses, and man-made sinks created by historical mining in the area. Springs issuing from the Blackhawk, Starpoint, and Mancos Shale Formations are illustrated on Exhibit 7-1 and will be discussed in more detail in a subsequent section. Principal water courses within the mine plan area include Spring Canyon Creek, Willow Creek, and the Price River. The major stream courses within the mine plan area have served as discharge zones for the regional system at one time or another. However, as demonstrated by the extremely low permeabilities of the Blackhawk Formation, recharge to the stream courses from the Blackhawk are very small. This is further illustrated by inflow into old abandoned mine workings.

The abandoned mine workings, as well as active workings which extend beneath the regional water table, currently serve as sinks in the regional aquifer system. However, seepage into these mines is extremely slow. Water inflow within Castle Gate No. 3 and No. 5 mines is outlined in Table 7-2. As indicated on Table 7-2, discharge into the No. 3 mine is only 33.4 gpm or 0.04 gpm/acre, and total discharge into the No. 5 mine is 3.5 gpm or 0.15 gpm/acre.

The abandoned mine workings are filling with water and, although those accumulations are substantial, the seepage rate into these mines is again very low. In fact, "substantial accumulations" have taken years to accumulate. For example, according to the USGS (1976) by 1976 the Kenilworth "A" Seam mine had accumulated an estimated 506 acre-feet of water over a 13 year period. This represents an average inflow of only 20 gpm. Measurements made by the Price River Coal placed the seepage rates into the old Kenilworth workings at 30 gpm. Seepage rates into the old Aberdeen, Utah Fuel No. 1, and Royal mines have been measured at 2.9 gpm, 12 gpm, and 30 gpm, respectively. * Personnel of Price River Coal who made the above measurements have estimated that over 90 percent of the water in the old Kenilworth workings comes from the pillared areas where subsidence has occurred. Similar to a recovering well, the old mine workings will continue to fill and serve as sinks until equilibrium in the regional groundwater pattern is again established.

7.1-6 Alluvial Aquifer System

The principal alluvial aquifer systems within the mine plan area are located along the perennial stream courses of the Price River and Willow Creek; and the intermittent stream course of Spring Canyon Creek. Price and Wadell (1973) indicate that alluvial deposits along the Price River are quite permeable as indicated by the fact that wells developed into these alluvial deposits can be expected to yield flows of up to 500 gpm.

Primary recharge to alluvial deposits within the mine plan may be occurring from the regional aquifer system; however, due to the existence of abandoned or active mine workings which serve as sinks to the regional system and due to the low permeabilities of the Blackhawk and underlying formations, this recharge is small.

7.1-7 Piezometric Contour

It was indicated in the January 13, 1984, ACR comments review meeting with the State of Utah Division of Oil, Gas, and Mining, that due to the extensive historical disturbance from mining over the past 85 years, a piezometric contour would be indeterminable. Personnel of both DOGM and U.S. Office of Surface Mining (OSM) in attendance at the above indicated meeting agreed that a piezometric contour map would not be required.

Variations in groundwater level since 1980 are illustrated on Figure 7-2 for observation wells MC-205 (located in Sowbelly Canyon), MC-206 (located in Bear Canyon), and MC-207 (located in Crandall Canyon). The locations of these wells are illustrated on Exhibit 7-2.

7.1-8 <u>Description of Mine Plan Area Seeps and Springs</u>

An onsite field survey of springs within the mine plan area has not been conducted; however, the locations of springs within and adjacent to the mine plan area have been determined using available information. Groundwater rights were inventoried to determine the locations, uses, and appropriated flow of all springs or wells for which a water right has been filed. Publications presenting hydrologic related information for the Book Cliffs coal field were reviewed and valuable insight as to the locations of prominent springs was gleaned from personnel of Price River Coal Company familiar with the mine plan area. The locations of all springs found during the above described survey are illustrated on Exhibit 7-1.

As illustrated on Exhibit 7-1, most springs issue from the Price River, North Horn and Flagstaff Limestone Formations overlying the Blackhawk Formation or from the Starpoint and Mancos Shale Formations which underlie the Blackhawk (most of which issue from channel bottoms). A total of sixty-one springs were located in the survey. Of these springs, forty-eight springs were found to be issuing from formations overlying the Blackhawk (six springs from the Flagstaff, sixteen springs from the North Horn, twenty-two springs from the Price River, and four springs from the Castlegate). Only three springs were located issuing from the Blackhawk, one of which is issuing from the portal on the downhill side of an abandoned mine (Section 1, T13S, R8E), and one of which is located near a ridge-top (Section 7, T13S, R10E) where the Blackhawk forms the surface formation along the ridge-top or recharge zone for this spring. Ten springs were located issuing from formations underlying the Blackhawk (two springs from the Starpoint and eight springs from the Mancos Shale). It is interesting to note that all of the springs issuing from the Mancos are located in channel bottoms and that the four springs issuing from the Mancos, located in each major canyon beginning near the town of Kenilworth and moving east, are located at approximately the same elevation and in an approximate line which parallels the strike of the formation.

Quantity - According to the USGS (1976), most observed springs discharging from rocks within the "general area of the coal lease yield less than one to about 10 gpm".

This is particularly true of springs issuing from the Starpoint Sandstone. The quantity of appropriated flow for all springs, except eight springs issuing from the Star Point and overlying Formations, is less than 5 gpm. The quantity of appropriated flow for three of the eight springs is less than 10 gpm. The five remaining springs list an appropriated flow of 0.11 cfs (50 gpm) each. However, four of these springs (located in Section 32, T12S, R9E) are located near a narrow ridge-top and do not appear to have sufficient recharge area to support this flow. It is anticipated that the flows of these springs are more on the order of 0.011 cfs (less than 5 gpm). The only spring expected to be capable of having a flow greater than 10 gpm is the spring located in the SW1/4 of the NW1/4, Section 34, T12S, R10E, owned by the Bureau of Land Management and having an appropriated right of 0.11 cfs (50 gpm). As indicated by Mark Page, (Price Area Engineer, State Engineers Office), since most of these rights are diligence claims, the quantity of appropriated flow as listed on the water rights documents has probably never been measured and was estimated at the time of adjudication in 1956. Actual flows are probably less than the appropriated flow and many of the springs are probably intermittent, drying up during low flow periods of the year.

Appropriated flows for the four springs issuing from the Mancos Shale on the east side of the Price River is less than 5 gpm for each spring. However, appropriated flows for the 3 springs (Gravel Spring, Crystal Spring, and Goat Spring) issuing from the Mancos Shale west of Price River are 0.455 cfs (204 gpm), 1.0 cfs (449 gpm), and 0.15 cfs (67 gpm), respectively. Although the appropriated flow on Gravel Spring is 0.455 cfs, in April of 1975 a maximum sustained flow of only 50 gpm (0.11 cfs) was measured by personnel of the Price River Coal Company. Most rights associated with these springs are again diligence claims, and it is probable that flows were not measured from the springs when the rights were adjudicated and that the flows are overstated. Most water rights on Crystal and Goat Springs are held by the Elegante family. Water is piped from the springs through a small pipe of less than 2-inches in diameter to three homes which use the water for domestic needs and to water lawns. Mrs. Bertha Elegante (1983) indicated that when there is sufficient water, water from the springs is also used to irrigate a small orchard. However, the orchard has been abandoned for some 11 to 12 years due to insufficient water from the springs to supply the orchard. It is, therefore, expected that flow from Crystal Springs is much less than the 1.0 cfs of appropriated right. Excess flow not diverted into the pipeline from Crystal Spring was measured on May 12, 1983 at only 15 gpm. Mrs. Elegante indicated that flows are much higher this year (which would be expected due to the above normal water year that has occurred thus far). Considering the size of pipeline, the limited use of the water from Crystal Spring for only three homes, the excess flow of only 15 gpm, and the spring period with above normal precipitation when the measurement was taken (i.e. limited outdoor use of the water) actual flow from Crystal Spring is probably less than 50 to 100 gpm. The excess flow from Goat Spring was measured at 49 gpm.

Recharge - Primary recharge to springs issuing from formations overlying the Blackhawk Formation (the perched aquifer system) occurs along the flatter slopes along ridge-tops of the higher plateau regions, which encourage infiltration and which receive higher precipitation. Within the mine plan area, ridge-tops are narrow (providing less recharge area) and canyon slopes are steep (inducing mostly runoff with little infiltration opportunity). In general, springs occur near local areas of recharge, primarily high in the watershed near local ridge-top recharge areas or downdip from pockets of above normal snowpack areas (i.e. in a canyon where wind patterns produce above normal accumulations of snowpack, generally on the east side of a ridge). As indicated previously, recharge to the groundwater system is probably much less than 5% of annual precipitation. According to Jeppsen et al. (1968), within the mine plan area normal annual precipitation varies from 12 to 20 inches. Therefore, normal annual recharge to the perched aquifer system is probably less than one inch.

Springs of the Blackhawk and underlying formations are discharge points for the regional and alluvial aquifer systems. Recharge to the regional aquifer system and associated springs results from leakage through shale layers of the perched aquifer system to the underlying regional system or from limited infiltration along the steep slopes of the outcrop areas of the formations. Since the regional aquifer system receives recharge due to leakage from the perched system, recharge to the regional system would be a fraction of the recharge to the perched system (again less than one inch).

Springs issuing from the Mancos Shale, both east and west of the Price River, are alluvial in origin and are recharged primarily from surface stream flow upstream from the springs, which is conveyed down the canyon primarily in the alluvium. Due to the importance of Crystal and Goat Springs in serving as a domestic supply, a site investigation was conducted on May 12, 1983, within the Spring Canyon area. Stream flow and conductivity measurements were taken from the mouth of Spring Canyon Creek to beyond the junction of the Left and Burnt Tree Forks, the results of which are presented on Exhibit 7-2.

As illustrated on Exhibit 7-3, the main stream disappears and reappears in the form of springs issuing from the channel bottom. At the junction of the two forks in Section 7, T13S, R9E, the total streamflow was measured at 220 gpm. Approximately two miles downstream at Measuring Station No. 8 the flow had reduced to 29 gpm. Just below Station No. 8, streamflow in Spring Canyon Creek was augmented by an additional 29 gpm from an easterly flowing tributary. Within one-half mile from the junction of the tributary with the creek, the surface streamflow had dropped to 11 gpm and then to a dry channel within approximately one mile. The stream was dry until Crystal Springs which was issuing from the bottom of the channel in Section 15, T13S, R9E. Within one-half mile downstream from Crystal Spring, the stream had again dried up and remained dry until Goat Spring which was issuing from the channel bottom near the eastern edge of Section 22, T13S, R9E.

Between Crystal Spring and Station No. 2 a slight degradation in water quality (as indexed by conductivity measurements) was noted. However, the conductivity measurements were surprisingly constant and low, indicating that little recharge is occurring from the Mancos Shale. There were no geologic features evident at the site that would indicate that the springs might be related and, as determined by prior mining activities, no significant faults have been identified within the mine plan area. The Mancos Shale surrounding the alluvial deposits of the creek bottom serves as an effective liner for waters moving within the alluvial deposits and probably prevents any significant loss of water to or inflow from the formation except water loss by transportation. Therefore, primary recharge to the springs issuing from the alluvium is from surface stream flow which infiltrates into the alluvium upstream from the springs and resurfaces as springs due to changes in depth and width within the alluvial formation at the springs locations.

Additional clarification (although not verifiable) was provided by Mrs. Bertha Elegante (principal water rights holder Crystal and Goat Springs) as to the origin of waters from the springs. Mrs. Elegante indicated that since the principal mines upstream from the springs at Mutual, Rains, and Standardville have shut down, she has noticed a drop in the flows of Crystal and Goat Springs. Although flow records are not available on the springs for verification of the above statement, the old mines, when in operation, discharged water into Spring Canyon Creek above the springs, which would have supplied additional recharge for the down stream springs.

7.1-9 Groundwater Quality

A water quality summary of data obtained from groundwater monitoring sites within the mine plan area is presented in Section 7.2 of this Chapter.

Groundwater Use - As indicated by the designated use on water rights, groundwater use within the mine plan area is limited primarily to stock watering. With the exception of one water right, all water rights for springs issuing from the Blackhawk and overlying formations have a designated use as stock watering. One water right for the spring issuing from the Price River Formation (SE1/4, NW1/4, Sec. 33, T1S, R9E) has a designated use of stock watering and domestic. However, considering the lack of access to this spring, it is doubtful that it has been used for domestic purposes.

Of the two springs issuing from the Starpoint Sandstone, both have appropriated rights of less than 5 gpm. The Starpoint Sandstone spring located in the NW1/4 of the SW1/4, Section 7, T13S, R10E lists the designated use as stock watering. The water right for the spring (controlled by Castle Gate) located in the NW1/4 of the SE1/4, Section 8, T13S, R9E lists the use as domestic.

Water rights, listing use as industrial, are all controlled by Castle Gate and have a designated source as "underground water, tunnel".

The seven springs issuing from the Mancos Shale supply water for stock watering, domestic, or irrigation purposes. The Castle Gate owns the first two springs located east of the Price River. The indicated use from water rights for the first three springs east of the Price River is stock watering and for the fourth spring (located in Section 18, T13S, R11E) is stock watering and domestic. West of the Price River, Gravel Spring is controlled by Castle Gate and supplies industrial makeup water for its No. 5 Mine. Crystal and Goat Springs supply the domestic needs for three homes and are used outside for watering lawns and when sufficient supply is available for irrigating a small orchard.

7.1-10 Effects of Mining Operation on Groundwater

The hydrogeologic characteristics of the coal-bearing Blackhawk and overlying formations will effectively limit the extent of impacts to the hydrologic system by the mines of Castle Gate Coal Company. Therefore, impacts from the mines will be of local, as opposed to general regional, significance.

As indicated previously, the groundwater system has been extensively altered by previous mining within the mine plan area which has been conducted over the past 85 years. Over fifty major coal mines have been operated within the mine plan area, forty-eight of which are abandoned. All nine coal seams have been mined at one point or another, with abandoned works and pillared areas extending from the western edge to eastern edge of the mine plan area (14 miles). * Therefore, the groundwater system has experienced disturbance of one form or another from extensive mine workings over the past 85 years. Again, due to the characteristics of the affected formations, impacts are of only local import to water resources within and immediately adjacent to the mine plan area. Potential impacts to the various aquifer systems and uses of these aquifer systems will be discussed separately in this section of this report.

7.1-10(1) Impact Projections to the Hydrologic Balance of the Perched Aquifer System

As evidenced by the locations of springs issuing high in the watersheds from the Price River, North Horn, and Flagstaff Limestone Formations, a perched aquifer system(s) exists within these formations. Most springs issuing from these formations are separated by over 1500 feet of overburden from the underlying coal seams to be mined in the Blackhawk Formation. Therefore, impacts to the perched aquifer system are limited primarily to subsidence. According to the USGS (1976):

> Land subsidence would ultimately occur above mined out areas, and subsidence would have some effect on local water resources. Because much of the coal-lease area has already been undermined, only part of the eventual subsidence would be attributable to the proposed mining operation.

According to Golder Associates (1983):

> Subsidence of the surface is expected. It is our opinion, however, that because of the depth at which mining will take place averaging in excess of 1500 feet, coupled with the comparatively thin seam thickness (in the range of 12 feet), the surface subsidence will result in a relatively minimal amount of disturbance. Longwall mining techniques generally result in relatively controlled and non-catastrophic subsidence in response to coal extraction. As discussed in the application, the predominant main roof sandstone members overlying the coal seams by some 100 to 500 feet are expected to be supported on the siltstones and shales that form the immediate roof above the coal being mined. These siltstones and shales will break and cave behind the retreating wide longwall face. The broken caved material will swell to fill the void created by removal of the coal. The stronger upper sandstone members will then rest on and squeezing broken material without themselves breaking. The squeezing will continue until stable conditions are restored, by which time the predominant sandstones will have subsided slowly without breaking and will permit those overlying members and surface materials to subside correspondingly.

As indicated by Golder Associates, the upper limit of the fracturing and cracking above the subsided coal seam is expected to be less than 500 feet. Elastic deformation will occur within the overlying strata from the limit of the fracture zone to the surface. All of the springs of the perched aquifer system within the mine plan area issue at a location well above the predicted fracturing zone (which should be limited to the Blackhawk Formation). Since fracturing will not extend into the shales, which create the perched aquifer condition in the formations overlying the Blackhawk Formation, perched waters in the overlying formations should be unaffected by mining.

7.1-10(2) Impact Projections to the Hydrologic Balance of the Regional Aquifer System

The abandoned mine workings as well as active workings currently serve as sinks in the regional aquifer system. However, seepage through the Blackhawk Formation into these mines is extremely slow, with a total water inflow in Castle Gate No. 3 and No. 5 mines of less than 50 gpm. As referenced previously, seepage rates into the abandoned mine workings of the Aberdeen, Utah Fuel No. 1, Kenilworth, and Royal mines have been measured at 2.9 gpm, 12 gpm, 30 gpm, and 30 gpm respectively. Seepage into the Adit No. 1 (Utah Fuel No. 1) Mine which is located in the A coal seam also includes seepage from the overlying abandoned mine workings in the C and D coal seams.

Water made within the active mines results in a net depletion of storage in the groundwater system. As indicated previously, recharge to the regional groundwater aquifer is expected to be much less than one inch. Recharge (expressed as a depth) to the abandoned mine workings for which inflow measurements have been made and to the Castle Gate No. 3 and No. 5 mines are presented in Table 7-3. Recharge to the abandoned workings varies from 0.46 of an inch at the Royal Mine to 0.08 of an inch in the Aberdeen Mine. Recharge to the No. 3 mine just after the mine was shut down was 1.02 inches and three months after shutdown had reduced to 0.70 of an inch and falling. As the mine face advances additional water is removed from storage to maintain a recharge rate into the mine in excess of natural recharge to the aquifer system.

As indicated by both the No. 3 Mine and the abandoned mines, as the Castle Gate mines are abandoned and face advance ceases, the mines will continue to fill and serve as sinks until equilibrium to the regional groundwater pattern is again established. As the face advance ceases, storage is depleted and inflow rates reduced until equilibrium between recharge and discharge rates.

It should be noted that although the advancing Castle Gate mines result in a net water depletion to the groundwater system, Castle Gate controls old valid groundwater rights for their underground workings with appropriated flows designated in excess of 2.0 cfs and priority dates of 1882 and 1925. It should also be noted that there apparently are no production water wells or springs located within the Blackhawk Formation that could be impacted by mining. Therefore, Castle Gate holds a valid right to deplete water from storage and to use that water for industrial purposes within the mine and the right to do so has existed since 1882 and 1925.

Once abandoned, the Castle Gate mines which lie below the regional water table will gradually fill until either equilibrium is established within the mines themselves without discharging directly to the surface (i.e. seepage rates into the mines are equal to seepage rates out of the mines to underlying formations) or until equilibrium is established between seepage rates into the mine and seepage out of the mine via an old portal or rock tunnel. Rock tunnels or portals located or intersecting mine working at low points within the mine, control the water levels to which the abandoned works will fill. Water levels in both the abandoned Aberdeen and Adit No. 1 (Utah Fuel No. 1) mines have reached a level of equilibrium as a result of rock tunnels which intersect the mines and serve as spillways or overflows for the underground reservoirs contained therein. Groundwater from the Adit No. 1 Mine discharges from the entrance of the tunnel or portal into the Price River, and groundwater from the Aberdeen Mine discharges into the unnamed wash which flows through the town of Kenilworth. In a similar fashion, the Castle Gate mines once abandoned will gradually fill until either an overflow point is established through an old portal located at a low point in the system or until equilibrium is established between inflow and outflow within the mine itself.

The TDS concentrations of waters contained in the abandoned mine workings do not appear to be significantly different from TDS concentrations of groundwater obtained from monitoring wells in the Blackhawk Formation. Thereby indicating (as indexed by TDS) little degradation in water quality within the abandoned mine workings, as summarized in Appendix 7-2. Data obtained from monitoring wells MC-205 (B-41), MC-206 (B-42), and MC-207 (B-43) indicate that TDS concentrations within the Blackhawk vary from 1120 to 1887 mg/l with an average TDS concentration in MC-205 and MC-207 on the order of 1200 mg/l and an average TDS concentration at MC-206 on the order of 1615 mg/l. Samples obtained from within the abandoned Royal Mine contained TDS concentrations on the order of 1200 mg/l. Discharge from the Adit No. 1 Mine on April 4, 1981, contained a TDS concentration of 1678 mg/l and water obtained from the abandoned Kenilworth Mine contained a TDS of 1210 mg/l on January 19, 1983. In a recent survey of Spring Canyon Creek, the specific conductance of water discharging from the abandoned mine portal located on the north section line of Section 12, T13S, R8E was measured at 1058 mhos/cm, assuming a TDS concentration of 690 mg/l. Thus, the mine water discharge in Spring Canyon was of a better quality than water in the creek (which measured at 1625 mhos/cm).

Primary impact to water quality of waters accumulating in the mines will result from oil and grease accumulations on the surface of mine waters. A heavy layer of oil and grease has accumulated on the water surface within the abandoned Royal Mine. Discharge of oil and grease from mine water to surface waters would result in a degradation of surface water quality until the oil and grease layer has been removed. Mitigation of this impact can easily be accomplished by siphoning off the oil and grease accumulations prior to discharging into surface waters.

Abandoned mine workings which intercept groundwater and discharge to the surface via a rock tunnel or old portal can result in a beneficial impact to the water quality of the Price River drainage system. Throughout much of the mine plan area, under pre-mining conditions most water currently intercepted by the mines would have passed through the Blackhawk into the underlying shales of the Mancos Formation prior to discharging into the stream courses. Interception of the groundwater by the mines short circuits this original groundwater pattern, resulting in groundwater discharge higher in the system before it can accumulate additional salts from the underlying shales. Therefore, overall water quality of the system is improved by the interception and discharge of groundwater higher in the system.

7.1-10(3) Impact Projections to the Hydrologic Balance of the Alluvial Aquifer System

Although it is true as described above that the timing and balance of groundwater discharge from the regional aquifer system courses has and will continue to be affected by mining, low permeabilities of the Blackhawk Formation and yield to abandoned and existing mines verify that this affect will be minor. Under full production, water inflow into the No. 3 and No. 5 active mines was only 50 gpm. As indicated previously, this inflow represents a depth of inflow across the contributing areas within the mines of approximately one inch which is in excess of predicted recharge of less than one inch. Therefore, much of this inflow is being removed from storage within the groundwater system and actual impact to flows into the stream courses is much less than 50 gpm. Under steady state conditions recharge to alluvial courses from the regional aquifer system would be equal to the recharge to the regional aquifer systems of much less than one inch. The ratio of the average depth of recharge to the abandoned mine works to annual recharge to the regional aquifer system is on the order of 0.28 inches. Applying this ratio of 0.28 to 1 to the Castle Gate No. 3 and No. 5 mines, actual impact to the Price River drainage system would be on the order of 14 gpm. From 37 years of historical streamflow records for the Price River near Heiner, Utah, the mean annual discharge of the Price River is 112 cfs. An impact of 14 gpm would represent a reduction in flow to the Price River of only 0.03 percent. Price River Coal Company holds some 1.7 cfs of water rights on the Price River which are more than adequate to mitigate any impact resulting from the minor reduction in yield discussed above.

In addition, Mark Page (Price Area Engineer, State Engineers Office) has indicated that they have noted no measurable impact to flows of the Price River as a result of the extensive mining which has occurred in the area.

Impacts to the stream courses from subsidence should be negligible. Although mining will occur beneath the Price River and Willow Creek, Castle Gate has indicated that areas underlying these perennial surface streams will not be pillared (subsided), thereby preventing damage to these surface sources from subsidence.

According to the USGS (1976), "the proposed mine workings under Willow Creek and other canyons have been laid out in corridors where there is sufficient relatively impermeable rock material between the canyon floors and mine workings to prevent loss of streamflow to the mines". There appears to be a minimum cover of 600 to 800 feet between proposed mine workings extending beneath the river systems and the streambeds of the Price River and Willow Creek. This cover consists of interbedded shales, siltstones, coal, and tightly cemented sandstones, which if not disturbed will provide an effective barrier between the overlying stream and the mines. In order for water from the streams to infiltrate down into the underlying mines, the water must traverse the underlying layered rocks in a direction approximately perpendicular to the bedding planes. Due to the anisotropic nature of shales, permeabilities perpendicular to bedding can be as much as 10 times less than permeabilities parallel to bedding. Permeabilities parallel to bedding have been outlined previously in this text and have been shown to be extremely low. Therefore, movement of water from the streams to the mine perpendicular to bedding planes will be even more effectively inhibited than if flow were parallel to bedding.

Impacts to identified springs issuing from the alluvium in the canyons are also anticipated to be negligible. The field investigation conducted to determine the source of the major springs issuing from the channel bottoms of Spring Canyon showed that primary recharge for these springs is surface stream flows which recharge the alluvial deposits along the creeks upstream as higher elevations from the springs. Mining should have no impact on the surface runoff feeding these springs and, therefore, impact to these springs from mining is not anticipated. In fact, Mrs. Elegante, principal water rights holder on Crystal and Goat Springs (see Exhibit 7-1), indicated that spring flow has decreased since the mines that once discharged water to the creek upstream from the springs have been shut down. In other words, historically, mine water discharged into the stream provided additional recharge to the springs.

7.1-10(4) Impacts to Alluvial Valley Floors (AVF)

The Utah Division of Oil, Gas, and Mining has made a determination regarding the existence of an alluvial valley floor within the mine plan area and impacts to potential AVF's from mining. The entire DOGM report is presented in Appendix 7-3; however, the last paragraph is summarized below:

> The Division has made the determination that present and future mining will not change the status or condition of the water resources, soils or geology relating to alluvial valley floors in or adjacent to the mine plan area. Mining will not interrupt or cause dilution of the existing groundwater or irrigation waters in a significant manner.

7.1-10(5) Groundwater Intercepted by the Mine

The inflow (50 gpm) into the No. 3 and No. 5 mines represents a depth of inflow across the contributing areas within the mines of approximately one inch which is in excess of predicted recharge of less than one inch. Therefore, much of this inflow is being removed from storage within the groundwater system and actual impact to flows into the stream courses is much less than one inch. Under steady state conditions recharge to alluvial courses from the regional aquifer system would be equal to recharge to the regional aquifer system of much less than one inch. Assuming recharge to the regional aquifer system to be equal to the average depth of recharge to the abandoned mine works, which is felt to be still somewhat higher, annual recharge to the regional aquifer system might be on the order of 0.28 inches.

At the end of 5 years, the mine will have extended beneath approximately 3500 acres of recharge area which at a rate of 0.28 inches per year would represent an impact to the Price River system of 51 gpm. Over the life of the mine, approximately 19,950 acres of recharge area will be disturbed which, at a rate of 0.28 inches per year, would represent an impact to the Price River drainage system on the order of 289 gpm (0.64 cfs). From 37 years of historical streamflow records from the Price River near Heiner, Utah, the mean annual discharge of the Price River is 112 cfs. The 5-year impact of 51 gpm would represent a reduction in flow to the mean annual discharge of the Price River of only 0.1 percent, and the life-of-mine impact of 280 gpm represent a reduction in flow to the mean annual discharge of the Price River of only 0.6 percent. Castle Gate holds some 1.7 cfs of water right on the Price River which are more than adequate to mitigate impacts resulting from the minor reduction in yield discussed above.

7.2 SURFACE WATER HYDROLOGY

The Mine Plan Area is drained by two perennial streams, namely Willow Creek and the Price River. In addition, an intermittent stream, Spring Canyon, and numerous ephemeral streams dissect the landscape and provide channels from the drainage of precipitation. Flows in the perennial streams are definitely seasonal. Data from flows in these streams are presented in this chapter.

Monitoring of water quality and quantity has been underway since April, 1977, to assess the impacts of the mining activities on the regional hydrology. It is pertinent to note that springs that have been mapped prior to mining are still present and exhibit no observable reduction in discharge, indicating little or not impact as a result of mining activities. Section 7.3 provides a summary of monitoring data.

7.2-1 Existing Surface Water Regime

The major perennial drainages included in this study are the Price River and Willow Creek. Minor drainages include Sowbelly Gulch, Spring Canyon, Sulfur Canyon, Hardscrabble and Ford Canyon creeks. Generally the minor drainages are ephemeral in nature.

Flows in the area range from 1.0 to 450 cfs in the Price River, 0 to 50 cfs in Spring Canyon Creek, and 0 to 242 cfs in Willow Creek. High flows in the ephemeral drainages are generally the direct result of thunderstorm activity.

Streams on or adjacent to the mine plan area fall into two use classes as defined by the Utah State Division of Health. The Price River and associated tributaries below the Price

City water treatment plant are in the 3C class. The Price River an associated tributaries above the treatment plan are classified as 1C and 3A waters

Waters classified as 1C are "protected for domestic purposes with prior treatment by complete treatment process". Class 3A waters are those "protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain". Standards for these waters are given in Table 7-4.

Waters classified as 3C (Table 7-5) are "protected for non-game fish and other aquatic life, including the necessary aquatic organisms in their food chain". Standards for this class will be determined on a case-by-case basis.

The watershed boundaries for the Price River (above the downstream limit of the mine complex), Willow Creek, Sowbelly Gulch, Spring Canyon, Bear Canyon, Crandall Canyon, Sulphur Canyon Creek, and Ford Creek are outlined on Exhibit 7-3 and 7-4. The watershed boundaries for Hardscrabble Canyon are outlined on Exhibit 3.3-3A. Tributary areas for the above indicated creeks are presented on Table 7-6.

The mean annual discharge of the Price River near Heiner from 37 years of records is 112 cfs (81,140 ac-ft/yr). Only two years of records are available for Willow Creek near its mouth (at Castle Gate). However, 19 years of available records for Willow Creek at the USGS gage near Castle Gate (see Exhibit 7-3) indicate the mean annual discharge to be on the order of 8.2 cfs (5,900 ac-ft/year). A comparison of the two years of overlapping records from the two gaging stations on Willow Creek indicates that at 8.1 cfs (5,900 ac-ft/year) at the upper site, an average discharge of approximately 9 cfs (6,5000 ac-ft/year) can be expected at the mouth of Willow Creek (an increase of approximately 10 percent between the two sites). Only three years of stream flow records are available at the USGS gage on Spring Canyon Creek. However, as indicated by these records, the yield from over 1,400 acres of drainage area is extremely low, averaging only 0.3 cfs (214 ac-ft/year). Stream flow records are not available for the non perennial tributary drainages in the area.

7.2-2 Hydrologic Design Methodology

7.2-2(1) Design Overview

This section presents the methodology used to perform hydrologic and hydraulic calculations for both operational and reclamation phases of all areas within the Castle Gate Mine complex. The hydrologic calculations explained below consist of the determination of runoff volume, peak runoff discharges, watershed sediment erosion, and sediment pond storage capacities. The methods used to perform hydraulic calculations to design temporary diversions, permanent stream channels and temporary spillways are discussed. Riprap and filter material design methods are also discussed.

7.2-2(2) Runoff Calculations

7.2-2(2)A Operational Phase

The watershed boundaries used to determine precipitation runoff within each canyon are shown on their respective existing drainage structures map (Sowbelly Canyon: 3.2-2B, Hardscrabble Canyon: 3.3-3A, Castle Gate Preparation Plant: 3.4-2, Adit No. 1: 3.5-2, Gravel Canyon: 3.6-2, and Crandall Canyon: 3.7-7). With the exception of Hardscrabble Canyon, the undisturbed watershed boundaries not shown on the above-mentioned exhibits are indicated on Exhibit 7-3. The Hardscrabble Canyon undisturbed watershed boundaries are all contained within Exhibit 3.3-3A. Each operational phase watershed is labeled according to basin, watershed and whether it is disturbed or undisturbed. The following basin codes are used in this labeling system: Sowbelly Canyon - SB, Hardscrabble Canyon - HC, Castle Gate Preparation Plant - CG, Adit No. 1 Canyon - AC, Gravel Canyon - GC, and Crandall Canyon - CC. The letters 'U' and 'D' are used to differentiate between predominately undisturbed and disturbed watersheds. Occasionally, watersheds are partitioned into subwatersheds, in which case the suffix letters A, B, C or D are used. For example, SBWS-D7A refers to Sowbelly Canyon operational disturbed Subwatershed No. 7A.

According to the U.S. Soil Conservation Service (1972), the algebraic and hydrologic relations between storm rainfall, soil moisture storage, and runoff can be expressed by the equations,

$$Q = \frac{(P-0.2S)^2}{P+0.8S} \quad (1)$$

and

$$S = \frac{1000}{CN} - 10 \quad (2)$$

where,

	Q	=	direct runoff volume (inches)
	S	=	watershed storage factor (inches)
	P	=	rainfall depth (inches)
	CN	=	runoff curve number (dimensionless)

It should be noted that (a) Equation (1) is valid only for $P \geq 0.2S$ (otherwise $Q = 0$), (b) Equation (2), as stated, is in inches, with the values of 1000 and 10 carrying the dimensions of inches, although metric conversions are possible, and (c) CN is only a convenient transformation of S to establish a scale of 0 to 100 and has no intrinsic meaning.

A curve number for each undisturbed area was chosen using professional judgement and the tabulated values presented in Figure 7-3, using approximate cover densities as reported in Chapter 9. Curve numbers ranging from 65 to 85 were obtained for the various undisturbed areas, assuming a hydrologic soil group of C. Soils in group C have a slow infiltration rate when wet, and are chiefly moderately deep, well-drained soils of moderately fine to moderately coarse texture (Barfield, 1981).

The curve number for disturbed areas was chosen from professional judgement and tabulated values presented by the U.S. Soil Conservation Service (1972). Accordingly, a value of 90 was used for all areas within the disturbed area boundary.

The design calculations for the operational phase diversion structures in Sowbelly and Crandall Canyons are based on the 10-year, 24-hour storm event, in accordance with the 1987 Utah Division of Oil, Gas and Mining, Utah Coal Mining and Reclamation Regulatory Program. Similarly, the spillway design calculations for the Sowbelly Canyon sedimentation ponds (003, 004, 005) and Crandall Canyon Pond 014 were performed using the 25-year, 24-hour storm event. Since the submission of those designs, DOGM has changed the regulations regarding the design storm event. The 10-year 6-hour storm is now the required storm event for the design of temporary intermittent and perennial diversions (R645-301-742.323, DOGM, 1991). The 25-year 6-hour storm is now the required storm for the design of non-MSHA pond spillways, inflow and outflow structures (R645-301-742.223).

Recent modifications to several sedimentation ponds implemented the 25-year, 6-hour storm event requirement. Calculations performed during the pond modifications were compared to the peak flow and runoff volume from the previously required 24-hour storm. In all cases, the peak flow and runoff volume computed using the 6-hour storm duration were significantly less than from the 24-hour storm duration. Therefore, the original design calculations for drainage diversions and sedimentation pond spillways performed using the 24-hour storm duration are adequate.

Calculations for drainage structures in all the other areas within the Castle Gate Mine complex have been updated and are based on the 1991, R645 - Coal Mining Rules. The design storm event for temporary perennial and intermittent diversions is the 10-year 6-hour storm. Regardless of the size of the drainage area, none of the operational diversions were considered ephemeral. All diversions, except those in Sowbelly and Crandall Canyon, were evaluated based on the 10-year 6-hour event. Inflow channels, spillways, and spillway outslope channels for all the ponds except 003, 004, 005 and 014 were evaluated using the 25-year 6-hour storm flow. The 10-year 24-hour precipitation event was used to evaluate all operational ponds for capacity adequacy.

The precipitation values for the design storm events were obtained from precipitation-frequency maps for the state of Utah prepared by Miller et al., (1973). The precipitation data are presented in Table 7-7.

To determine a peak flow for the design of the drainage diversions, a computer program, referred to in the calculations as "SCS hydro", was used. The computer code associated with that program was developed by Hawkins and Marshall (1979) to generate runoff hydrographs from watershed and precipitation data. The program uses the triangular unit hydrograph approach developed by the U.S. Soil Conservation Service (1972). To complete the input file for this program, a time of concentration was calculated for each watershed. The parameters for that calculation were determined based on measurements taken from 1" = 100' topographic maps developed from aerial surveys.

The triangular unit hydrograph is shown in Figure 7-4 along with a typical curvilinear hydrograph. The triangular hydrograph is characterized by its time to peak (T_p), recession time (T_r), time of base (T_b), and the relations between these parameters (i.e., $T_r = 1.67T_p$; $T_b = 2.67T_p$). Thus, from the geometry of a triangle, the incremental runoff (Q) can be defined by the equation,

$$Q = \frac{(2.67T_p)(q_p)}{2} \tag{3}$$

or

$$q_p = \frac{0.75(Q)}{T_p} \tag{4}$$

where, q_p = peak flow rate (dimensioned according to Q and T)

When Q is expressed in inches and T_p in hours, q_p will be in inches per hour. The flow at any time $0<t<T_r$ may be determined by simple linear proportioning of the triangular unit hydrograph. The time to peak is related to the familiar expression time of concentration (T_c) by the equation,

$$T_c + t = 1.7T_p \tag{5}$$

in which the factor 1.7 is an empirical finding cited by the U.S. Soil Conservation Service (1972).

The time of concentration may be estimated by several formulas. For this report, T_c was determined from the following equations (U.S. Soil Conservation Service, 1972):

$$L = \frac{l^{0.8}(S+1)^{0.7}}{1900Y^{0.5}} \qquad (6)$$

and

$$T_c = 1.67L \qquad (7)$$

where,

	L	=	watershed lag (hours). This is sometimes labeled as t_L
	l	=	hydraulic length of the watershed, or distance along the main channel to the watershed divide (feet)
	S	=	watershed storage factor defined in Equation (2-2)
	Y	=	average watershed slope (percent)
	T_c	=	time of concentration (hours)

Inflow hydrographs to and outflow hydrographs from the sedimentation ponds were developed using the hydrology and sedimentology model SEDIMOT II (Warner et al., 1980; Wilson et al., 1980). A more recent version of SEDIMOT II titled SEDCAD (version 3, 1992) was also used. These computer programs also use the rainfall-runoff function and triangular unit hydrograph of the U.S. Soil Conservation Service (1972).

7.2-2(2)B Reclamation Phase

Reclamation watershed boundaries used to determine the design precipitation runoff within in each canyon are shown on their respective reclamation topography exhibits (Sowbelly Canyon: 3.2-5, Hardscrabble Canyon: 3.3-5, Castle Gate Preparation Plant: 3.4-3, Adit No. 1: 3.5-3, Gravel Canyon: 3.6-3, and Crandall Canyon: 3.7-9). Boundaries which extend beyond the range of the 1" = 100' maps are contained on supplemental reclamation watershed boundary maps (Sowbelly Canyon: 3.2-6, Hardscrabble Canyon: 3.3-6, Castle Gate Preparation Plant: 3.4-8, Adit No. 1: 3.5-3 and 3.4-8, and Gravel Canyon: 3.6-3 and 3.4-8). Each reclamation phase watershed is labeled according to the basin, followed by a "RWS" to indicate a reclamation watershed. Basin codes used for the reclamation watershed labeling system are the same as those used for the operational phase system. The suffix of each watershed label has a number and either a "U" or "R" to differentiate between predominately undisturbed and reclaimed watersheds. Occasionally, watersheds are partitioned into subwatersheds, in which case the suffix letters A, B, C or D are used. For example, SBRWS-U9A refers to Sowbelly Canyon reclamation undisturbed subwatershed No. 9A.

The same precipitation-runoff relationships used to analyze operational diversions and ponds were used to design the permanent reclamation channels and temporary reclamation sediment ponds. The basis for curve numbers representing undisturbed watersheds remained unchanged, although a curve number of 80 was assigned to all future reclaimed areas within the disturbed area boundary. This value is commonly used for the time period after an area has been recently seeded and mulched, until the full establishment of vegetation.

The permanent perennial and intermittent reclamation channels were designed for the 100-year 6-hour storm event in accordance with R645-301-742.323. Permanent channels for ephemeral drainages were designed for a 10-year 6-hour event in accordance with R645-301-742.333. A drainage was considered ephemeral if (1) the watershed drainage area was less than 640 acres, (2) the drainage channel will flow only in direct response to precipitation or snow melt, <u>and</u> (3) the drainage channel will be above the local water table. All other reclamation channels were classified as intermittent/perennial.

7.2-2(3) Sedimentation Ponds

7.2-2(3)A Pond Capacity

The capacity of each operation and reclamation pond was determined based on runoff and sediment storage volumes. Both operation and reclamation ponds are designed to completely contain the 10-year 24-hour storm (R645-301-742.221.33, DOGM, 1991), and allow for adequate sediment storage capacity (R645-301-742.221.31, DOGM, 1991). In addition, R645-301-742.221.36 requires that sediment be periodically removed to maintain adequate volume for the design event. The runoff calculations for those watersheds contributing to each pond were performed as described in Section 7.2-2(2)A.

The annual sediment volumes entering the ponds were calculated using a modified version of the universal soil loss equation (Israelson et al., 1984). The modified universal soil loss equation is:

$$A = R \times K \times LS \times VM \qquad (8)$$

where,	A	=	computed amount of soil loss per unit area for the time interval represented by factor R (tons per acre per year).
	R	=	rainfall factor. R values for Utah presented by Israelson, et al. (1984).
	K	=	soil erodibility factor. K values for Utah presented by Israelson et al. (1984). (tons per acre per year per unit of R).
	LS	=	topographic factor based on length and steepness of slope. (dimensionless).
	VM	=	erosion control factor based on vegetative, chemical, or mechanical measures. This factor is often referred to as C_p. (dimensionless).

The maximum sediment storage volume and the 60% clean-out level was calculated for each pond.

7.2-2(3)B Spillway Analysis

All operation and reclamation sedimentation ponds were designed as temporary structures. Pond 013 at the Castle Gate Preparation Plant site was designed and constructed under MSHA guidelines which require the spillway to pass the 100-year 6-hour storm (R645-301-742.222, DOGM, 1991). The balance of the pond spillways are designed to pass the peak runoff from either the 25-year, 24-hour storm event (DOGM, 1987) or the 25-year, 6-hour storm event (DOGM, 1991), as explained in Section 7.2-2(1). Primary spillways are constructed as a riprapped channel or a corrugated metal pipe. The pipe spillways have either a hooded through-pipe or a rise-type drop inlet. A typical drop inlet design is presented in Figure 7-5. Several ponds also have riprapped trapezoidal emergency spillways.

The discharge capacity of the rise-type drop inlet was verified using methods described by Barfield et al. (1981). At low heads, the hydraulic capacity of the drop inlet spillway behaves as a weir. According to Barfield et al. (1981), the equation for weir-controlled flow is

$$Q = CLH^{1.5} \qquad (9)$$

where,

	Q	=	discharge (cubic feet per second)
	C	=	weir coefficient
	L	=	length of the weir (feet)
	H	=	depth of water above the weir crest (feet)

A weir coefficient of 3.1 was selected, since the structure will act as a broad-crested weir (Barfield et al., 1981). The length of the weir is equal to the circumference of the corrugated metal pipe riser.

As the depth of water increases above the riser in a riser-type drop inlet, the riser acts like an orifice. The equation for orifice flow is (Barfield et al., 1981)

$$Q = CA(2gH)^{0.5} \tag{10}$$

where,
C = orifice coefficient
A = cross-sectional area of the inlet (square feet)
g = gravitational constant (feet per second squared)

with all other parameters previously defined. A value of 0.60 was selected for the orifice coefficient based on guidelines presented by Barfield et al. (1981).

Pipe flow occurs when the head increases sufficiently to cause the outlet of the discharge pipe leading from the riser to flow full. The discharge capacity of the culverts under pipe flow conditions was determined using the equation,

$$Q = A(2gH')^{0.5}/(1+K_e+K_b+K_cL)^{0.5} \tag{11}$$

where,
H' = head on the pipe (feet)
K_e = entrance loss coefficient
K_b = bend loss coefficient
K_c = friction loss coefficient

with all other parameters previously defined. Values of 1.0 and 0.5 were used for K_e and K_b, respectively based on information provided by Barfield et al. (1981). The value for K_c varies with the diameter of the pipe.

The discharge capacity of the riprapped overflow spillways was determined using a method developed by the U.S. Soil Conservation Service (1968) and expanded by Barfield et al. (1981) for broad-crested weirs. According to this methodology, the critical specific energy head (H_{ec}) is determined for selected values of the energy head of water in the pond (H_p) from Figure 7-6. The discharge capacity of the spillway is then calculated for the standard 100-foot wide rectangular section from the equation,

$$q_r = (0.544)(g^{0.5})(H_{ec}^{1.5})(100) \tag{12}$$

where, q_r = discharge for standard 100-foot rectangular section (cubic feet per second)

with all other parameters previously defined. The flow is then corrected for a trapezoidal section using the equation,

$$q = [(1.5b + zH_{ec})/150](q_r) \tag{13}$$

where,
q = corrected discharge (cubic feet per second)
b = bottom width of channel (feet)
z = channel side slope (run over rise - dimensionless)

Spillway design calculations were performed using the hydrology and sedimentology model SEDIMOT II (Warner et al., 1980; Wilson et al, 1980) or SEDCAD (Warner, 1992). It should be noted that the sedimentology option of SEDIMOT II and SEDCAD was used during design only to permit routing of the hydrograph through the pond. However, since sediment contributions from the 25-year, 24-hour event (or the 25-year, 6-hour event) are not of concern in design of the pond spillways (only sediment yield from the 10-year, 24-hour and smaller storms is of regulatory concern), the sediment inputs to the model were suppressed. Thus, the output from the program indicates sediment concentrations of 0 milligrams per liter. Therefore, sediment yield outputs provided by SEDIMOT II and SEDCAD are meaningless.

It should also be noted that, although detention times shown on the SEDIMOT II output are relatively low (less than one hour), these times have no regulatory meaning for a 25-year event (i.e., regulatory concerns address the detention time only for the 10-year and smaller events). Again, the program was used primarily for its spillway design capabilities and not for dealing with the specifics of sediment yield and detention times from the 25-year design event.

The models SEDIMOT II (Warner et al., 1980; Wilson et al., 1980) and SEDCAD (Warner, 1992) assume that the pond is initially full of water to the elevation of the primary spillway when the storm event occurs. A more reasonable assumption is that the pond is empty of water to the top of the maximum sediment storage level since storm water normally drains out of the pond by seepage, by opening the decant valve, or by manually pumping the water. The SEDIMOT II or SEDCAD models were initially run with the first assumption, and, if the spillway adequately passed the 25-year, 24-hour storm, additional analysis was not necessary. However, if adequate freeboard between the top of the embankment and maximum water level was not obtained, a stage-discharge curve was input to the SEDIMOT II or SEDCAD model which modeled the pond initially empty of water down to the maximum sediment level. The model was run a second time to determine the spillway performance and resulting freeboard.

Sedimentation ponds modified under the new regulations (DOGM, 1991) were designed assuming the ponds were full of water to the spillway flowline when the storm began.

7.2-2(3)C Pond Construction and Maintenance

The existing pond embankments were constructed in maximum lifts of 18 inches and compacted to 95% of the maximum density determined by the AASHTO T-99 compaction test. The inslopes and outslopes were designed not to exceed 1V:1.5H, except in areas where size is restricted. Embankments were keyed into the natural ground surface and unsuitable materials were excluded from the fill. Pond embankments were seeded, as described in Chapter 9, to reduce erosion.

Both the inslopes and the outslopes of the existing pond embankments were analyzed for long term stability. Since Pond 013 is a MSHA structure, the embankments were evaluated to assure that the static factor of safety exceeds 1.5 and the seismic factor of safety exceeds 1.2 (R645-301-533.100). All other sedimentation pond embankments (non-MSHA) were evaluated to address the requirements of R645-301-733.210 and R645-301-533.100 requiring a static factor of safety of 1.3 or greater. Horrocks and Carollo Engineers of American Fork, Utah analyzed the Pond 013 embankment using a computer software program based on the Modified Bishop method of slices. A second computer program, GEOSLOPE (Geocomp, 1988), was used by EarthFax Engineering, Inc. to evaluate the stability of the other pond embankments. Results of these analyses are contained in the permit section pertaining to the canyon where each pond is constructed.

Ponds and impoundments are inspected on a quarterly basis and repaired as needed. Any sign of weakness or failure is indicated on the quarterly reports. The stability of sediment pond embankments and slopes exceeding the limits provided in the regulations of Subchapter K, have been justified by their past performance. Existing slopes have demonstrated stability by past performance over the last ten or more years. Riprap at major inflow points is replaced if needed. Ponds and basins will be cleaned out when 60% of the design maximum sediment storage capacity has accumulated.

The sedimentation ponds will be drained of water, when necessary, to the maximum sediment storage elevation using either a permanently installed decant system, or a portable pump system. Prior to draining each pond, a sample of the water will be collected through the decant system and analyzed in accordance with R645-301-751 (DOGM, 1991). If the laboratory results are acceptable, the water will be drained from the pond to the decant flowline. If a visible higher sediment concentration is noticed during discharge, the process will be discontinued.

The portable pump system will be used on those ponds which are incised in the ground and are difficult to gravity drain with a permanent dewatering device. The intake on the pump system will be designed with a floatation device to collect water from the surface. It will also be designed with an oil skimmer to prevent the oil and trash floating on the surface from being drained. To insure that the sediment from the pond will not be drained, the intake will be designed with a base or frame sufficiently below the flowline.

7.2-2(3)D Alternative Sediment Controls

A list of areas within the Castle Gate Mine Complex which do not currently report to sediment ponds is presented in Table 7-8. The associated alternative sediment controls for each area are also identified in Table 7-8. Table 7-9 summarizes the alternative sediment control (ASC) areas and controls for the reclamation phases. Alternative sediment controls are used minimize the disturbance to the hydrologic balance. For the location of operational phase ASC areas, refer to the respective operational drainage structure exhibits for each canyon. For the location of initial reclamation ASC areas, refer to the appropriate reclamation topography exhibit for each canyon.

7.2-2(4) Operational Diversion Structures

7.2-2(4)A Berms

Earthen berms with a minimum height of 1.5 feet are constructed around the perimeter of many of the disturbed areas. The location of the berms are presented on the base map for each basin area (Exhibits 3.2-2A, 3.3-3, 3.4-2, 3.5-2, 3.6-2 and 3.7-7). The berms are labeled based on the basin and berm number. For example, GCB-2 represents Gravel Canyon berm No. 2. The berms are used to prevent random discharge from disturbed areas and to protect natural drainages or diversions. When berm construction is physically infeasible, staked straw dikes are used in their place. These berms are routinely maintained.

7.2-2(4)B Drainage Diversions

The location of diversion ditches are presented on the base map for each basin area (Exhibits 3.2-2A, 3.3-3, 3.4-2, 3.5-2, 3.6-2 and 3.7-7). The ditches are labeled based on the basin and diversion number. For example, CCD-5 represents Crandall Canyon diversion No. 5.

Diversions were designed to convey runoff from a disturbed or undisturbed drainage area. Grades on the diversion ditches are constructed, where possible, at approximately 5%. Some critical sections are riprapped with rock to reduce erosion. Ditches are routinely maintained by removing sediment and replacing riprap when necessary.

The ditch capacity and flow velocity were calculated using the computer software program called TRAP1 obtained from the Office of Surface Mining and outlined by Weider et al. (1983) or by FLOWMASTER I (Haested, 1990). Both of these programs are based on the Manning and continuity equations presented in Chow (1959):

$$V = \frac{1.486}{n} R^{0.67} S^{0.50} \qquad (14)$$

and

$$Q = AV \qquad (15)$$

where,	V	=	velocity (feet per second)
	R	=	hydraulic radius (feet)
	S	=	hydraulic slope (feet per foot)
	n	=	Manning's roughness coefficient
	Q	=	discharge (cubic feet per second)
	A	=	flow area (square feet)

Peak discharges for the undisturbed drainage areas were calculated as described in Section 7.2-2(1). A Manning's roughness coefficient was calculated based on the average size of the riprap in the diversion in accordance with the following formula presented by Barfield et al. (1981):

$$n = 0.0395 D_{50}^{1/6} \qquad (16)$$

where,	n	=	Manning's roughness coefficient
	D_{50}	=	average riprap diameter in feet

Diversions with no riprap were assigned a Manning's roughness coefficient based on values presented by Barfield et al. (Table 3.1, 1981).

The diversion ditch geometries were measured in the field and approximated with trapezoidal or triangular ditch cross sections. The maximum and minimum hydraulic slopes of each ditch was either measured in the field or approximated from the topographic base maps (scale: 1" = 100', or 1" = 200').

With the values of peak design discharge, bottom width, side slopes, and Manning's coefficient, two trials were performed using FLOWMASTER I to calculate maximum flow depth and maximum flow velocity. For the first trial, the minimum channel slope was entered into the interactive computer program and a maximum flow depth calculated. Adequate freeboard was added to the maximum flow depth resulting in the minimum required diversion depth. In the second trial, the maximum channel slope was entered, yielding the maximum velocity to be used for riprap design. The adequacy of the existing riprap was then verified by following the procedure described in Section 7.2-2(6).

7.2-2(4)C Culverts

The location of operational diversion culverts are presented on the base map for each basin area (Exhibits 3.2-2A, 3.3-3, 3.4-2, 3.5-2, 3.6-2 and 3.7-7). The culverts are labeled based on the basin and culvert number. For example, CCC-5 represents Crandall Canyon culvert No. 5. The location, size, and slope of each culvert were verified in the field.

Peak discharges for the 10-year 24-hour storm event or the 10-year 6-hour storm event were calculated as described in Section 7.2-2(1). The adequacy of each culvert was determined using nomographs prepared by the U.S. Department of Transportation (1977). These nomographs for circular and pipe-arch culverts with inlet control are presented in Figures 7-7 and 7-8, respectively. Based on the known culvert size, entrance type, and peak discharge, the headwater depth/diameter ratio was determined from the nomograph. If this value was 1.0 or less, the culvert was considered adequate to pass the design discharge rate.

If the ratio was greater than 1.0, a closer inspection of the culvert geometry and entrance was necessary.

Exit velocities from each circular culvert were calculated based on equations 14 and 15. A computer program developed by Suchoski (1990) for the calculation of flow characteristics in circular channel sections was used to determine the normal depth and flow velocity in each culvert. Flowmaster I (Haested, 1990) was also used for culvert velocity calculations. A roughness coefficient of 0.024 was used for the calculations, which can be considered typical value for corrugated metal pipe (Chow, 1959).

The exit velocities and normal depth of flow for pipe arch culverts were determined by methods defined by the American Iron and Steel Institute (1983). Hydraulic characteristics were initially determined based on full flow conditions. Figure 7-9 was used to calculate the hydraulic characteristics at the desired peak discharge rate.

The adequacy of the existing riprap at each culvert outlet was determined using the methods defined in Section 7.2-2(6).

7.2-2(5) Reclamation Structures

7.2-2(5)A Culverts

The locations of permanent reclamation culverts are shown on the reclamation topography map for each canyon (Sowbelly Canyon: 3.2-4, Hardscrabble Canyon: 3.3-5, Castle Gate Preparation Plant: 3.4-3, Adit No. 1: 3.5-3, Gravel Canyon: 3.6-3, and Crandall Canyon: 3.7-9). The storm event used to design the reclamation culverts reflect the reclamation precipitation-runoff criteria discussed in Section 7.2-2(2)B. The culvert design procedures discussed in Section 7.2-2(4)C were used to design the reclamation culverts.

7.2-2(5)B **Reclamation Channels**

The location of each reclamation channel is presented on the reclamation topography map for each basin area (Sowbelly Canyon: 3.2-4, Hardscrabble Canyon: 3.3-5, Castle Gate Preparation Plant: 3.4-3, Adit No. 1: 3.5-3, Gravel Canyon: 3.6-3, and Crandall Canyon: 3.7-9). The reclamation channels are labeled based on the basin and watershed number. In several instances, channels are subdivided into sub-reaches for the purposes of riprap design. For example, HCRD-4A represents Hardscrabble Canyon Reclamation Diversion channel No. 4, reach A.

The reclamation channels were designed to approximate the geometry of the natural stream channels. The natural channel sections were measured in the field and approximated with a trapezoidal cross section. Except for existing diversions which will also be used during reclamation, the reclamation channels were designed with 3H:1V side slopes to provide channel stability. The hydraulic slope of each channel was measured from the postmining reclamation topography exhibits (scale: 1" = 100').

Curve numbers for the undisturbed drainage areas were estimated from vegetation data presented in Chapter 9, and by field observations. A curve number of 80 was assumed for the reclaimed areas.

Peak discharges for the drainage areas were calculated as described in Section 7.2-2(2)B. The 100-year, 6-hour storm event was used to determine the peak flow for each channel receiving perennial or intermittent flow, per R645-301-742.323. The 10-year, 6-hour storm event was used to determine the peak flow for permanent ephemeral channels, per R645-301-742.333.

FLOWMASTER I was utilized to size the reclamation channels by following procedures similar to those discussed in Section 7.2-2(4)B. The channel bottom width, side slopes, assumed Manning's coefficient, and peak discharge were input into FLOWMASTER for each channel. The maximum flow depth was calculated using the minimum channel slope, and the maximum velocity was determined using the maximum channel slope. One foot of freeboard was added to the maximum flow depth to determine the minimum reclamation channel depth.

Once the riprap was designed in accordance with Section 7.2-2(6) using the maximum flow velocity, the average stone diameter was inserted into equation (16) to verify that a reasonable Manning's roughness coefficient was used in the FLOWMASTER calculation.

7.2-2(6) Riprap Protection

The use of riprap to line drainage ditches, culvert outlets, channel diversions and spillways is required when flow velocities exceed approximately three to five feet per second, depending on the nature of the soil and vegetation on the bottom of the channel (Barfield, et al., 1981). The size distribution and thickness of the riprap required to resist the erosive forces of the water is determined by first calculating the median riprap size, commonly referred to as the D_{50}. The D_{50} is the particle size for which 50% of the material by weight passes a screen with square openings whose lengths correspond to the particle size. Two methods were used to calculate the D_{50} of the riprap. The first method, developed by Searcy (1967) and later used by the U.S. Department of Transportation (1978), was used to size riprap for all operation phase hydraulic structures. In addition, this procedure was followed to design riprap for all ephemeral reclamation channels and for intermittent reclamation channels with longitudinal slopes less than 10%. The second method, developed by Simons, Li and Associates (1982) was used to size the D_{50} of the riprap for intermittent reclamation channels whose longitudinal channel slopes are equal to or greater than 10%. The Simons, Li and Associates method (1982) was not used to design the riprap for ephemeral channels with slopes greater than 10%, since the graphs associated with that method are not applicable to the low design flows typical of the ephemeral channels.

The method of Searcy (1982) utilizes Figures 7-10A and 7-10B to determine the D_{50} of channel or spillway riprap. The average size of stone, k, is determined by a trial-and-error method which consists of first estimating an average stone size. Using the flow depth, d, associated with flow through the steepest reach of the channel, a ratio of k/d is calculated. The mean velocity, V_m, of the water must then be converted to the velocity against the stone by the use of Figure 7-10A. Knowing the velocity against the stone, V_s, and the channel side slope, (the hydraulic slope was used when it was steeper than the side slopes), the stone size can be determined from Figure 7-10B. The stone size, D_{50}, from Figure 7-10B is the 50 percent (median) size, by weight, of a well-graded mass of stone with a unit weight of 165 pounds per cubic foot. If the stone size from Figure 7-10B agrees with the assumed stone size, it is correct. If not, the procedure is repeated until agreement is achieved.

The method of Simons, Li and Associates (1982) was developed specifically for steep slope conditions. The procedure utilizes various graphs developed from relationships presented by Bathurst (1979) between the flow velocity, flow depth, and the flow resistance in mountain rivers. The graphs are presented as Figures 7-11A through 7-11E. These graphs relate maximum flow and channel slope for a given trapezoidal channel of specified bottom width and 2H:1V side slopes to a median riprap size (D_{50}). Although Simons, Li and Associates (1982) recommends using 2:1 sides slopes for mining channels, Castle Gate has chosen to design the reclamation channels with 3:1 side slopes for channel stability and ease of construction. Since the flow area of a trapezoidal channel of specified bottom width and depth with side slopes of 3:1 is larger than the area of a channel with similar bottom width and depth with 2:1 side slopes, the velocity will be less in the channel with 3:1 side slopes. Consequently, the use of Figures 7-11A through 7-11E, developed for channels with 2:1 side slopes, yields conservative results when applied to channels with 3:1 side slopes.

To determine the D_{50} riprap size of a given reach of a channel, the appropriate graph corresponding to the channel bottom width must be selected. For bottom widths other than the ones the graphs were prepared for, Simons, Li and Associates (1982) allows linear interpolation of the results from the graphs bracketing the desired bottom width. Using the maximum flow rate, in cubic feet per second, and the channel slope (interpolating as necessary), the D_{50} can be determined from the appropriate graph. Table 7-10 is then used to select the design D_{50} of the riprap.

A detailed riprap gradation design for the reclamation channels is not presented in the permit documents, but will be prepared when the filter blanket gradation is designed. The commitment to prepare a filter blanket design is discussed below. The riprap gradation for the ephemeral channels and the mild slope sections of the intermittent channels will be engineered based on methods presented in Barfield, et al. (1981). The procedure presented by Simons, Li and Associates (1982) will be used to design the riprap gradation for steep-slope intermittent reclamation channels.

Where the method of Searcy (1967) was used to calculate the riprap D_{50}, the thickness of the riprap was assumed equal to two times the D_{50}. If the method of Simons, Li and Associates (1982) was used to calculate the D_{50}, a riprap thickness equal to 1.25 times the D_{50} was assumed. To determine the width of riprap placement in a channel, the transverse length across the channel along the proposed ground surface was calculated. This length is referred to as the perimeter. The riprap volume is equal to the length of the channel reach multiplied by the perimeter, multiplied by the thickness (in feet). The weight of the riprap materials associated with the reclamation plan for each canyon was calculated assuming an in-place riprap density of 140 pounds per cubic foot.

Usually it is necessary to place a filter layer between the riprap and the underlying soil to prevent the migration of the soil out through the riprap (Simons, Li and Associates, 1982). The reclamation filter blanket will consist of a properly graded coarse-grained soil; a synthetic fabric will not be used. A detailed filter gradation design has not been prepared, since adequate soil samples were not available at the time these documents were compiled. Castle Gate is committed to preparing a detailed design for both the riprap and filter blanket gradations for the reclamation channels. In each canyon, soil samples will be taken once the reclamation grading has progressed sufficiently to expose the base of the reclamation channels. A sieve analysis of the soil samples will be performed in accordance with the procedures delineated in ASTM D117 (Materials Finer than the #200 Sieve in Mineral Aggregate by Washing) and ASTM D136 (Sieve Analysis of Fine and Coarse Aggregates). Using the test results, the filter gradation designs for each canyon will be prepared as described below and then submitted, along with the riprap gradation designs, to the Division of Oil, Gas and Mining for approval. Submittal will occur prior to delivery of filter materials to the canyon undergoing reclamation.

According to Barfield et al. (1981), a filter material is required when the ratio of the D_{50} of the riprap to the D_{50} of the underlying soil exceeds 40. Regardless of the method used to design the riprap, the filter material gradation will be engineered using the three criteria presented by Barfield et al. (1981) and reproduced below. The following criteria evaluates the size relationship between the base material and the filter material and between the filter material and the riprap material. These criteria are:

Criteria 1

$$\frac{D_{50}(filter)}{D_{50}(base)} < 40 \quad \text{also} \quad \frac{D_{50}(riprap)}{D_{50}(filter)} < 40 \qquad (17)$$

Criteria 2

$$5 < \frac{D_{15}(filter)}{D_{15}(base)} < 40 \quad \text{also} \quad 5 < \frac{D_{15}(riprap)}{D_{15}(base)} < 40 \qquad (18)$$

Criteria 3

$$\frac{D_{15}(filter)}{D_{85}(base)} < 5 \quad \text{also} \quad \frac{D_{15}(riprap)}{D_{85}(filter)} < 5 \qquad (19)$$

where: D_x = Diameter corresponding to the "x" percentage of soil passing through a specific screen, by weight. The screen has square openings which have lengths equal to the particle's "diameter."

The filter material which meets these criteria will minimize the possibility of piping under the riprap.

For reclamation volume calculations, the thickness of all the filter materials is set at one half the thickness of the riprap, but not less than 6 inches (Barfield et al., 1981). The width of filter placement in each channel is based on the perimeter of the channel, as defined above. Again, the volume of the filter blanket is equal to the length of the channel reach multiplied by the perimeter multiplied by the thickness (in feet). The weight of the filter materials associated with the reclamation plan for each canyon was calculated assuming an in-place filter density of 130 pounds per cubic foot.

7.3 SUMMARY OF WATER MONITORING DATA

In 1977, in response to regulations set forth by both the DOGM and the OSM, Price River Coal Company (then Braztah Corporation now Castle Gate Coal Company) retained Vaughn Hansen Associates to design and conduct a water monitoring program for those areas which could be impacted by the Price River Coal Company mining operations.

The overall objective of the program was to allow determination of impacts on the surface and groundwater regimes in the Price River mine plan area.

Scope - The scope of this report is to describe the existing surface and groundwater hydrologic conditions of the Price River mine plan and adjacent areas. The report will cover the following topics: Methodology, Groundwater Resources, Surface Water Resources, and Impact of Mining Operations.

Methodology - Following promulgation of the DOGM and OSM regulations, Price River Coal Company (then Braztah Corporation now Castle Gate Company) had Vaughn Hansen Associates set up a twelve (12) station monitoring programs to determine baseline conditions (see Figure 7-12). These stations were monitored monthly when water was present. Under this initial program, forty-one (41) parameters were sampled to determine baseline conditions (see Table 7-11). This phase of the program was initiated in April, 1977, and continued until May, 1978.

As the study continued and federal and state requirements changed, the original program was modified in June, 1978 to meet the new requirements. Several modifications were also made to the monitoring program based on the data collected at that time. Review of the data showed that nineteen (19) stations were required to monitor the mine plan area (see Figure 7-13). Ten of the stations were monitored every other month and nine (9) were monitored twice per year. A review of the data showed that several parameters (aluminum, ammonia, boron, carbonate, chemical oxygen demand, copper, hydroxide, mercury, total phosphate, silica, total alkalinity, total hardness and turbidity) varied very little or were consistently below levels of concern as defined by state water quality standards. These parameters were dropped from the routine analysis and included in a system of spot checks. On a random basis, these parameters were analyzed to provide sporadic checks on parameter levels. Table 7-12 lists the water quality parameters analyzed.

In 1979, DOGM published guidelines "Proposed Surface and Groundwater Monitoring Guidelines", delineating the level of detail required in monitoring programs under the interim regulations. In the summer of 1979, Price River Coal Company (then Braztah Corporation now Castle Gate Coal Company) submitted a monitoring program based on the two previous years' data. Collection of water quality samples occurred at a bi-monthly frequency for surface water stations and springs. Bi-annual monitoring of groundwater wells was conducted in the spring and fall. The parameters analyzed are listed in Table 7-13. The sample stations remained unchanged through December of 1979.

Early in 1980, several monitoring stations were added to the program. Surface water station B-12 allowed for the determination of impacts above and below facilities in Hardscrabble and B-25 and B-26 allowed the determination of impacts proposed for Crandall Canyon. These stations and all those monitored from January 1980 to the present are shown on Figure 7-14.

Late in 1995, the Division raised a concern regarding the sampling of B-22 prior to November 1995. The Division's concerns are based on the fact that various places within Crandall Canyon have been called B-22 in the past and may have been sampled as such and not representative of water coming from B-22, i.e. a well near the Crandall Canyon shafts, one-half mile above Highway 50 & 6, and the culvert at the canyon mouth.

With this in mind, and not to compare past data with future data, yet still tie future data to past, Castle Gate Coal Company established a new site to monitor the flow emanating from the alluvium within the stream channel and number it as B-22-1. The sampling point will vary depending on the location of the groundwater emanating from the alluvium within the streambed. During late spring and early summer, flow may emanate further up canyon within the stream channel with flow emanating further down the channel during drier periods.

Table 7-14 lists each of the monitoring stations with its townships, ranges, and section coordinates.

Analyses for dissolved oxygen were discontinued early in 1980. This was done because the concentrations of dissolved oxygen had remained stable since the summer of 1979. Table 7-15 lists the parameters that were monitored from January 1980 through March 1984.

The USGS has maintained stream flow gaging stations (from which daily flow records are available) on all perennial streams located within the mine plan area. The locations of these gaging stations are illustrated on Exhibit 7.2. Two gaging stations have been maintained on Willow Creek, one upstream from the mine plan area (Willow Creek near Castle Gate) and one near the confluence of Willow Creek with the Price River (Willow Creek at Castle Gate). The gaging station on the Price River (Price River near Heiner) is located near the downstream limit of the mine plan area.

Data Collection - All water quality data was collected, field tested, and handled for shipment by qualified personnel. Stream flow is determined in the field at the time of sample collection by determining average velocity, width and depth of channel, and applying the appropriate factor for the type of stream channel and flow (a factor of 0.85 is applied to stream flow data from the Price River drainage area). Air temperature, water temperature, and pH were also determined in the field by acceptable methodology. Approximately 5 liters of water was collected at each sampling location, properly preserved and transported to a certified laboratory for the remaining analyses.

7.3-1 Groundwater Quality

A summary of groundwater quality data collected within ~~and adjacent to the mine~~ plan area with maximum, minimum, and average of parameter concentrations ~~of interest to DOGM~~

are presented Appendix 7-2. Also included are the raw groundwater quality data in chronological order (Appendix 7-4).

The data collected so far provides a representative description of groundwater baseline conditions in the mine plan area. General comments are presented below regarding parameters which were high or variable over time:

Conductivity - Values of conductivity varied greatly over the mine plan area, ranging from a high of 5150 µmhos/cm at Station B-001 to a low of 390 µmhos/cm at Station B-33. Variability is felt to be tied to the variability of the natural formations.

Total Dissolved Solids - TDS concentrations varied in a similar fashion to conductivity, mainly for the same reasons. Concentrations ranged from a high of 4420 mg/l to a low of 255 mg/l for stations B-001 and B-33, respectively.

Oil and Grease - Concentrations of oil and grease were found in varying concentrations ranging from 25,000 mg/l in well B-43 to 1.0 mg/l at stations B-001 and B-33. The high concentration in well B-43 may indicate that the well has not been developed and prepared correctly to be used as hydrologic monitoring well. Oil and grease concentrations were also found in undisturbed areas indicating the presence of concentrations in the natural environment.

Phenol - Moderately high concentrations of phenols averaging 0.025 mg/l are found at stations B-32, B-42, and B-43. Station B-32 is located in Mathis Canyon, an undisturbed area, and indicates naturally occurring phenols. Stations B-42 and 43 are wells that monitor water at depth in the Blackhawk Formation. The phenols in the natural environment are probably a constituent of the natural residue of coal coking (Sawyer & McCarthy, 1964). The coal seam outcrop in the mine plan area shows evidence of coal burns. These burns range 500 to 1000 feet back from the outcrop (Stephens, 1981). Some coking of coal by the burn is very likely, and the residue would be picked up by the groundwater.

Sulfate - High concentrations of sulfate averaging 324.9 mg/l are found in stations B-22, B-33, B-41, B-42, B-43, BM-25, BM-26, BM-27, and BM-28. With the exception of springs B-22 and B-33, the potential does exist that high surface concentrations are naturally occurring and associated with coal seams. Additional monitoring is needed to define this occurrences.

All other parameters which were monitored were rather consistent. The values measured for these parameters cause no concern.

7.3-2 Surface Water Quality

A summary of surface water quality data containing the maximum, minimum, and average of parameters of interest to DOGM are presented in Appendix 7-5. The raw surface water quality data are presented in Appendix 7-6.

The data collected to date give a representative description of surface water baseline conditions in the mine plan area. The following general comments are given regarding some of the measured parameters.

pH - Measurements of pH are variable, ranging from a high of 9.6 to a low of 6.9 across the mine plan area. High pH values are seen above and below the Castle Gate Preparation Plant on the Price River. Hardscrabble Creek also had some high values. The variability of the results and the presence of high pH above and below disturbed areas indicate that mining activities are not the cause of high pH measurements.

Dissolved Oxygen - Low levels of dissolved oxygen averaging 4.1 mg/l were found in Hardscrabble Creek early in the monitoring program. Since the summer of 1979, there has been a decrease in the impact on the creek. Dissolved oxygen levels have increased to acceptable levels averaging 6.1 mg/l. This is felt to be caused by implementation of sediment control measures in the canyon.

Oil and Grease - During the early part of the monitoring program, high oil and grease concentrations averaging 15.3 mg/l were found in Hardscrabble Creek due to mining activities. Similar to dissolved oxygen concentrations mentioned above, oil and grease concentrations have been markedly reduced since the summer of 1979. Oil and grease concentrations averaged 10.2 mg/l since the summer of 1979. Implementation of sediment control measures is felt to be the cause of the reduction.

Phenol - Moderately high concentrations of phenol averaging 0.02 mg/l are found in Hardscrabble Creek at the confluence of Sulfur Canyon Creek, and the Price River and in the Price River itself. These concentrations probably result form natural coking of coal and consequently are naturally occurring.

Sulfate - High concentrations of sulfate averaging 309.7 mg/l have been found to be occurring regularly in Willow Creek, Hardscrabble Creek and Sowbelly Gulch. The high concentrations in Willow Creek can be shown to be naturally occurring due to high concentrations above the disturbed area. Concentrations in Hardscrabble Creek and Sowbelly Gulch are probably originating from waters in the coal seam.

Total Dissolved Solids - Total dissolved solid concentrations averaging 778.8 mg/l have been found in Willow Creek, Hardscrabble Creek, and Sowbelly Gulch. The high TDS concentrations in Willow Creek can be shown to be naturally occurring due to high concentrations above the disturbed area. Concentrations in Hardscrabble Creek and Sowbelly Gulch probably originate from mine water discharge at the mine facilities.

Fluoride - Moderate fluoride concentrations averaging 1.9 mg/l have been found regularly in the holding pond below the No. 2 mine. Occasionally concentration levels ranging up to 1.6 mg/l have been observed in Hardscrabble Creek below the No. 3 mine. The fluoride concentrations are probably naturally occurring.

Iron - High total iron concentrations averaging 18.25 mg/l have been found in Willow Creek, Hardscrabble Creek, in the Price River above Sulfur Canyon Creek. These concentrations are all felt to be naturally occurring due to the association of iron with suspended solids in the river flows. The cementing agents of the Blackhawk Formation have high iron concentrations (Vaughn Hansen Associates, 1979).

All other parameters which were monitored have been either consistently below state standards for Class "C" waters, or parameters were rather consistent. The values measured for these parameters cause no concern.

7.3-3 Impact of Mining Activities

The Price River (now Castle Gate Coal Company) mine plan area has been actively mined for the last 85 years (Doelling, 1972). Extensive areas have been undermined by mining in the various coal seams in the area. Determination of the impact of the Price River mining activities versus the cumulative impact to the hydrologic regime by previous mining is difficult to separate.

As indicated previously, the surface operation activities have had a minor impact on the hydrologic balance of the mine plan area. Concentrations of total dissolved solids, sulfate, and oil and grease have been found in areas associated with mining in fairly high concentrations. However, monitoring over the last one and one-half years has indicated that these concentrations are being reduced as the mine facilities are brought into compliance. The initiation of sediment control measures on the mine sites has markedly reduced impacts on the hydrologic balance.

7.4 WATER RIGHTS AND REPLACEMENT

No known private water supplies exist within the coal bearing portions of the Mine Plan Area, and, thus, dewatering of individual supplies is unlikely.

However, in the event of loss of either surface or sub-surface water rights by any party as a result of Castle Gate Coal Company mining activity, Castle Gate will replace and provide (through assignment or transfer of its existing water rights to the party), water of quality and quantity comparable to that which was lost.

7.4-1 Alternative Water Supply Information

There are four basic sources of water available to meet the mining requirements as projected. These sources are as follows:

1. Direct Floor Rights (Price River)
2. Reservoir Rights (Schofield Reservoir)
3. Mining, Springs and Other Sources
4. Price River Water Improvement District

A summary of the available water owned or optioned by Franklin from these sources is as follows:

Direct Flow Rights (Source)	Class	Claim	Flow (cfs)	Comments
Price River (Owned)	1st	3013	0.994	Morse Decree: 1874 priority one of earliest rights on Price River, one of two rights not limited to irrigation season. Use: Industrial, mining and domestic
	2nd	3584	0.20	Morse Decree: 1876 priority
	7th	3585	0.228	2nd and 7th Class rights can only be used if flow of water in Price River is sufficient to satisfy 1st Class rights enumerated in Morse Decree.

Reservoir Rights	Schofield Shares	Comments
Spring Glen Canal Co. (Owned)	39	Acquired from Kanawha & Hocking Coal & Coke Co. on Dec. 28, 1973. Represented by 336.47 shares of Spring Glen Canal Co. Use is dependent on filing and receiving approval for change of use and point of diversion with the Canal Company.
Optioned: 1. Price River Water Users Association (PRWUA)	300	Acquired from Kanawha & Hocking Coal & Coke Co.
2. PRWUA	250	MCO acquired from Marshing on Feb. 11, 1975. Purchase contingent on seller filing and received approved change application with State Engineer to allow industrial use for irrigation water along with change in point of diversion.

7.4-2 Mine, Springs and Other Sources

The availability of water from our mines and springs is at best a judgement. No definitive studies have been completed recently to measure either the sustained flow rates at our mines or springs, or the quantities of water stored within our mines. It must be noted that the flow rates in the field claims are not absolute and must not be relied upon as a measure of the available water.

The following summary of filed water users' claims, along with abstracts of letters written in prior years, represent the current knowledge about additional potential sources of water for the mining operations.

Additional water rights evidenced by water users' claims owned by Franklin are as follows:

Source (Castle Gate Project)	Claim(s)	Flow (cfs)	Comments
Kenilworth Mine Tunnel	2592	0.923	1882 priority, type of right; Underground Water (UGW). Use: Industrial
Castle Gate Mine Tunnel #2	3593	1.810	1892 priority, Right: 1892 priority, Right: UGW. Use: Industrial
Castle Gate Mine Tunnel #3	3594	0.545	1925 priority, Right: UGW. Use: Industrial
Royal Mine Tunnel	324	0.668	1936 priority, Right: UGS Use: Industrial
Total Castle Gate Project		3.946 cfs	

Source (Spring Canyon Project)	Claim(s)	Flow (cfs)	Comments
Spring Canyon Creek	26, 29 & 62	0.230	See Note 1
Burnt Tree Fork	25, 27, 34 & 40	0.155	See Note 1
Mine Tunnel	325	1.114	Right: UGW (See Note 2)
Gravel Spring	18	0.455	See Note 2
Unnamed Spring	30	0.004	See Note 2
Total Spring Canyon Project		1.958 cfs	All used for industrial and domestic.

Source (Carbon Fuel Project)	Claim(s)	Flow (cfs)	Comments
Carbon Fuel	3858	N/A	Right: UGW (See Note 5)

NOTES:

1. These water user claims are subject to conditions of court decree signed by Judge Christensen, December 19, 1914.
2. Price River Coal Company will have exclusive use of all water at Gravel Spring (Claim #18) and Mine Tunnel (Claim #325) for industrial and domestic purposes per Christensen decree. As a result of recent efforts (late spring, 1975) to redevelop the flow from this spring for use in the No. 5 mine, a maximum sustained flow rate of 50 gallons per mine (0.111 cfs) has been realized during the month of May, 1975.
3. Legal filings were made during the fall of 1974 with the State Water Engineer to re-establish the validity of these claims.
4. The value of any of these water rights is dependent primarily upon the ability of these sources to deliver water at the rates claimed on a sustained basis. If the supply is firm and can be depended upon, these rights become very valuable. It must be emphasized that no measurements on a sustained basis (other than Gravel Spring during May, 1975) have been performed recently; therefore, the claimed rates of flow per the water users claims are, at best, arbitrary.

5. Memo of February 4, 1936, by L.P. Pearce (Engineer, Independent Coal & Coke). Subject: Possibility of developing water supply at Kenilworth. Summary: No groundwater: possibility of 20,000 gallons per day (gpd) surplus mine water, not effective springs.
6. Letter of December 5, 1956, by L.L. Arnett (Coal Industrial Board of Review, State of Utah). Subject: Proposed plan for water storage and pumping in Castle Gate Mine (set forth by W.L. Potter, November 28, 1956). Summary: Granted, provided barrier pillar 75 feet thick maintained along with concrete dams being built.
7. Letter of August 7, 1968, by W. Guy (North American Coal Company). Subject: Water contained in inactive mines.

Summary

Castle Gate No. 2 Mine (1,313 acre feet)	428 million gallons
Castle Gate No. 3 Mine (392 acre feet)	128 million gallons
Kenilworth A Seam (506 acre feet)*	165 million gallons

* Per measurements made from Kenilworth Seam (active estimate 100 gpm (0.22 cfs) steady flow.

7.5 OPERATIONAL WATER QUALITY MONITORING PLAN - APRIL 25, 1984

The following operational water quality monitoring program outline is a coalescence of Castle Gate Coal Company's water monitoring program since 1978, proposals made during 1983-1984 by Price River Coal Company, and various discussions and requirements with and by the Office of Surface Mining during 1984.

Three kinds of monitoring will be conducted: Surface Water Sites, Groundwater Sites and Active Mine Monitoring.

7.5-1 Surface Water Monitoring

Surface water stations will be sampled four (4) times per year on or about the following dates (plus or minus 2 weeks):

March 15th
June 10th
Sept. 5th
Nov. 30th

These dates are chosen to attempt to coincide, respectively, with first thaw, Spring high flow, end of Summer low-flow and a last sample before freeze up. Samples are generally unobtainable from early December to late February due to freeze up and inaccessible roads.

The eight (8) sample points will be those indicated on Exhibit 7-3 (B-5 (Price River), B-6 (Price River), B-11 (Hardscrabble Canyon), B-12 (Hardscrabble Canyon), B-25 (Crandall Canyon), B-26 (Crandall Canyon), B-45 (Sowbelly Canyon) and B-28 (Sowbelly Canyon). In August 1996, sample point B-17 was dropped and a replacement point, B-45 was added up-canyon at the gate in Sowbelly Gulch.

Points B-3 and B-27 were dropped from the Permit when Castle Gate Coal Company acquired the Western Reserve in May, 1986.

Sampling will combine field analyses of certain parameters and the obtaining of a bottled sample for abbreviated laboratory analysis. Parameters to be included in the active monitoring program are listed in Table 7-16.

Sampling and analysis will be done according to the current edition of "Standard Methods for the Examination of Water and Wastewater". Sample reports will be provided to DOGM for each sampling period. A summation will be provided at the end of each sampling year.

Surface water sampling for Hardscrabble, Sowbelly, Crandall and Castle Gate will continue until bond is released, as required by R645-301-731.224. Two years after the area has been seeded, the water quality will be evaluated to determine: 1) if the surface water leaving the reclaimed area is suitable to support the postmining land uses, and 2) if monitoring is no longer necessary to achieve the purposes set forth in the monitoring plan consistent with R645-301-731.224.1 and R645-301-731.224.2.

In order to establish that the runoff from the reclaimed areas will not degrade the quality of the receiving stream waters outside the permit area (R645-301-731.121), additional monitoring will be done for a six month period prior to the request to abandon a sediment pond. Samples will be taken at the inlets to ponds 011, 012, 013, 014, and 015. The samples will be tested for field parameters and abbreviated laboratory analysis as described in this section.

Because of the small drainage areas flowing into the sediment ponds, there is very little or no flow into the ponds except during very large storm events. In the event that there is not enough flow into a pond to get an adequate sample, then a sample of the water in the pond will be used to perform the analysis.

7.5-2 Groundwater Sampling

Groundwater sampling will be carried out at the four (4) points indicated on Exhibit 7-3; B-22-1 (Crandall Canyon), and BM-30 (Adit No. 1), BM-31 (Near Mutual Spring), and B-32 (Gravel Springs). Point BM-29 was dropped by Castle Gate Coal Company after acquisition of the property. Sample point B-22 was dropped in the summer of 1996, following some discrepancies over its location and was replaced with B-22-1. Sampling frequency will be four (4) times per year and on dates similar to those for surface water monitoring. It is possible that flows from points B-22-1 and B-32 could be masked by storm or melt water surface flows, distorting the true values and disrupting long term evaluations. Should this occur, sampling will be withheld until the event passes. Sample analyses are listed in Table 7-16. Quarterly reports and annual summations will be provided. Castle Gate will follow sample procedures as outlined in Division policy for surface and groundwater sampling.

Groundwater will be sampled for a period of two years after sealing of the mine unless significant changes in quality of the water occurs from previous years of data.

7.5-3 Active Mine Monitoring

It has been observed and generally agreed upon that Castle Gate No. 5 and No. 3 are usually dry. Some monitoring, however, may be appropriate to satisfy the regulatory requirements. The intent of in-mine monitoring is to identify and analyze significant groundwater flows, should they be encountered, so as to try to assess the impact of mining upon the quantity and quality of the groundwater resource.

Most in-mine water is generated at the working face. Sampling these areas is not only unsafe but also unrepresentative of groundwater flows or quality due to the mining machine dust sprays which can deliver 80 to 200 gpm. "Leakers" appearing at the face usually disappear as the mining proceeds, within a few hours or days. Small flows (3-5 gpm) are often immeasurable. They may seep down a rib and be absorbed by rock dust or rapidly evaporated away in the ventilation system. A discernible flow may include combined seepage points from several or even several dozen mining sections.

Water from the mine is collectively pumped to the surface and discharged into the process water pond after the water passes the water treatment system. The treatment system is located in the preparation plant area, Exhibit 3.4-1. The water treatment system is monitored and maintained daily by Culligan of Price (when the mine is in operation and the treatment system is necessary based on the quality of water). The plant requires chemicals to be mixed and injected continually into four large regenerating tanks. These softeners remove the oil present in the mine water, as well as some of the total dissolved solids.

Flocculent, a material that bonds oil particles together, is injected into the system so that the mixed bed softeners can remove the oil from the water as it passes through. These are control timers on each of the four units that regulate the regeneration time and frequency. The clean water then reports to Pond 012.

A totalizing flow meter will be installed at the point of discharge into the process water pond, therefore the quantity of water discharged from the mine will be recorded. An annual monitoring report of the mine discharge water will be prepared.

Field parameters will be measured quarterly. Every quarter bottled samples will be collected and analyzed as per the abbreviated lab analysis schedule. The parameters analyzed for are listed in Table 7-16. The locations of the in-mine water sampling locations are shown on Exhibit 7-5. Trace metals will be analyzed every two (2) years. The reports will be summarized on a yearly basis. They will be kept at the mine and available for inspection upon request.

7.5-4 Water Budget Analysis

A mine water budget analysis will be calculated along with the annual monitoring report summation. The budget analyses will be an attempt to assess the quantities of water removed or discharged from the mines and the quantities pumped into the mines or generated from groundwater storage. Estimates made will be very general "order of magnitude" calculation and not based on exact measurement in some cases. The equipment and personnel needed for precise measurement of all factors relating to water movement are prohibitively expensive for the type of analyses needed.

Several factors affect the movement of water into and out of the mines. These are:

INFLOW SOURCES	OUTFLOW SOURCES
1. Pumped in make-up water	1. Adherent to coal
2. Groundwater inflow	2. Water vapor through ventilation system
3. Water vapor through ventilation system	3. Pumped out

As a matter of interest, we have made a rough calculation on the water budget for the inactive No. 3 Mine. From various underground measurements, average temperature is 58 degrees (F); average mean temperature outside is 41 degrees (F), (taken from monthly average temperatures for gas consumption - Crandall Canyon facilities by Horrocks Engineers); mean relative humidity of intake air is 54% (personal communication with U.S. National Weather Service Forecast, Salt Lake City); measurement at the fan reveals air replacement to be 450,000 cfm through the mine. From the handbook "Mine Ventilation", Mining Engineering 505, University of Utah by J. Wilson, grains of moisture per cubic foot of air at 58 degrees F is 5.424, and at 41 degrees F it is 2.970. Using the above parameters, the amount of water taken out of the mine by the ventilation system, assuming 95% relative humidity at the fan is:

$$\frac{(5.24 \times 0.95 - 2.970 \times 0.54)}{7{,}000} \times 450{,}000 \times 60 \times 24 \times 0.1198 = 39{,}359 \text{ gpd}$$

Since No. 3 mine was making about 34 gpm (1-83) = 30 x 60 x 24 = 48,960 gpd, it is obvious that with no moisture leaving by adherence to coal, the mine has a net accretion of 96000 gpd and must be pumped to avoid flooding the down dip sections.

Various samples taken from the raw coal feed from the mines indicate 10% free moisture adhering to the R.O.M. coal. This percentage to be used in the future water budget calculations converts to a 24 gallon removal per ton of coal mined. For example, should the

No. 3 mine reactivate with a longwall and two development sections producing 3,000 tons per day (tpd), the water removal would be in the range of 72,000 gpd.

Water pumped into the mines is directly related to tons of coal mined, since ventilation losses are relatively constant.

The last monitoring event under the baseline program took place on March 7, 1984. Price River Coal Company began the operational monitoring in June, 1984. Castle Gate Coal Company will continue the monitoring.

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Table 7-1. Aquifer test results in the Blackhawk Formations as derived from Homes MC-205, MC-206, and MC-207.

Drill Hole No.	Thickness Zone Tested Feet	Average Hydraulic Conductivity ft/sec.	Total Transmissivity gpd/ft	Range of Hydraulic Conductivity ft/sec.-ft/sec.
MC-205	651	4.7 x 10-6	65	$2.03x10^{-8}$-$3.02x10^{-7}$
MC-206	808	3.2 x 10-8	17	$3.94x10^{-9}$-$3.94x10^{-8}$
MC-207	-	-	-	$7.55x10^{-8}$-$1.15x10^{-7}$

Table 7-2. Seepage rates into the No. 3 Mine (Sub 3 Seam) and the No. 5 Mine (Castlegate D Seam), data obtained from Laine Adair, 1983.

Measurement Site	Contributing Area Within Mine acres	Flow Rate 11/3/82 gpm	Discharge per Unit Area 11/3/82 gpm/acre	Flow Rate 1/26/83 gpm	Discharge Per Unit Area 1/26/83 gpm/acre
No. 3 Mine	(Sub 3 Coal Seam)				
1st Raise	25	4.5	0.18	3.5	0.14
3rd West	26	9.1	0.35	4.5	0.17
4th West	11	8.2	0.75	3.1	0.28
MNW	196	3.0	0.03	0.6	0.01
MNE		3.8		1.4	
Main Dips	80	0.5	0.01	0.5	0.006
9th East	16	I2.0	0.13	2.2	0.14
7th & 8th East	396	13.4	0.03	13.4	0.03
Main Slope & 2nd East	170	4.2	0.02	4.2	0.035
TOTAL	920	48.7	0.05 Ave.	33.4	0.04 Ave.
No. 5 Mine	(Castlegate D Seam)				
4th West Seal	74	-	-	1.5	0.020
10th West	158	-	-	2.0	0.013
TOTAL	232			3.5	0.015 Ave

Table 7-3. Ground water recharge to accessible abandoned and existing coal mines within the mine plan area.

A - Recharge to Abandoned Mines

Mine	Measured Inflow gpm	Mine Area acres	Yield/Unit Area gpm/acre	Recharge in./yr
Aberdeen	2.9	770	0.004	0.08
Utah Fuel No. 1	12	680	0.018	0.35
Royal	30	1250	0.024	0.46
Kennilworth	30	2790	0.011	0.21

B - Recharge to Castle Gate Coal Company's Carbon County Mines

Mine	Measured Inflow gpm	Mine Area acres	Yield/Unit Area gpm/acre	Recharge in./yr
No. 3 (11/3/82)	48.7	920	0.053	1.02
No. 3 (1/26/83)	33.4	920	0.036	0.70
No. 5 (1/26/83)	3.5	232	0.015	0.29

TABLE 7-4

NUMERICAL STANDARDS FOR PROTECTION OF BENEFICIAL USES OF WATER

	CLASSES											
	Domestic Source			Recreation & Aesthetics		Aquatic Wildlife				Agriculture	Industry	Special
Constituent	1A	1B	1C	2A	2B	3A	3B	3C	3D	4	5	6
								STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS			STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS	STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS
Bacteriological (No./100 ml)												
(30-day Geometric Mean)												
Maximum Total Coliforms	1	50	5,000	1,000	5,000	•	•		•	•		
Maximum Fecal Coliforms	•	•	2,000	200	2,000	•	•		•	•		
Physical												
Total Dissolved Gasses	•	•	•	•	•	(b)	(b)		•	•		
Minimum DO (mg/l) (a)	•	•	5.5	5.5	5.5	6.0	5.5		5.5	•		
Maximum Temperature	•	•	•	•	•	20°C	27°C		•	•		
Maximum Temp. Change	•	•	•	•	•	2°C	4°C		•	•		
pH	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0		6.5-9.0	6.5-9.0		
Turbidity Increase (c)	•	•	•	10 NTU	10 NTU	10 NTU	10 NTU		15 NTU	•		
Chemical (Maximum mg/l)												
Arsenic, dissolved	.05	.05	.05	•	•	•	•		•	.1		
Barium, dissolved	1	1	1	•	•	•	•		•	•		
Cadmium, dissolved	.010	.010	.010	•	•	.0004(d)	.004(d)		•	.01		
Chromium, dissolved	.05	.05	.05	•	•	.10	.10		.10	.10		
Copper, dissolved	•	•	•	•	•	.01	.01		•	.2		
Cyanide	•	•	•	•	•	.005	.005		•	•		
Iron, dissolved	•	•	•	•	•	1.0	1.0		1.0	•		
Lead, dissolved	.05	.05	.05	•	•	.05	.05		•	.1		
Mercury, total	.002	.002	.002	•	•	.00005	.00005		.00005	•		
Phenol	•	•	•	•	•	.01	.01		•	•		
Selenium, dissolved	.01	.01	.01	•	•	.05	.05		•	.05		
Silver, dissolved	.05	.05	.05	•	•	.01	.01		•	•		
Zinc, dissolved	•	•	•	•	•	.05	.05		•	•		
NH_3 as N (un-ionized)	•	•	•	•	•	.02	.02		•	•		
Chlorine	•	•	•	•	•	.002	.01		•	•		
Fluoride, dissolved (e)	1.4-2.4	1.4-2.4	1.4-2.4	•	•	•	•		•	•		
NO_3 as N	10	10	10									
Boron, dissolved	•	•	•	•	•	•	•		•	.75		
H_2S	•	•	•	•	•	.002	.002		•	•		
TDS (f)	•	•	•	•	•	•	•		•	1200		
Radiological (Maximum pCi/l)												
Gross Alpha	15	15	15	•	•	15(g)	15(g)		15(g)	15(g)		
Radium 226, 228 combined	5	5	5	•	•	•	•		•	•		
Strontium 90	8	8	8	•	•	•	•		•	•		
Tritium	20,000	20,000	20,000	•	•	•	•		•	•		
Pesticides (Maximum ug/l)												
Endrin	.2	.2	.2	•	•	.004	.004		.004	•		
Lindane	4	4	4	•	•	.01	.01		.01	•		
Methoxychlor	100	100	100	•	•	.03	.03		.03	•		
Toxaphene	5	5	5	•	•	.005	.005		.005	•		
2, 4-D	100	100	100	•	•	•	•		•	•		
2, 4, 5-TP	10	10	10	•	•	•	•		•	•		
Pollution Indicators (g)												
Gross Beta (pCi/l)	50	50	50	•	•	50	50		50	50		
BOD (mg/l)	•	•	5	5	5	5	5		5	5		
NO_3 as N (mg/l)				4	4	4	4		•	•		
PO_4 as P (mg/l)(h)	•	•	•	.05	.05	.05	.05		•	•		

TABLE 7-4 (Continued)

NUMERICAL STANDARDS FOR PROTECTION OF BENEFICIAL USES OF WATER

* Insufficient evidence to warrant the establishment of numerical standard. Limits assigned on case-by-case basis.

(a) These limits are not applicable to lower water levels in deep impoundments.

(b) Not to exceed 110% of saturation.

(c) For Classes 2A, 2B, 3A, and 3B at background levels of 100 NTUs or greater, a 10% increase limit will be used instead of the numeric values listed. For Class 3D at background levels of 150 NTUs or greater, a 15% increase limit will be used instead of the numeric value listed. Short term variances may be considered on a case-by-case basis.

(d) Limit shall be increased threefold if $CaCO_3$ hardness in water exceeds 150 mg/l.

(e) Maximum concentration varies according to the daily maximum mean air temperature.

Temp. °C	mg/l
12.0 and below	2.4
12.1 to 14.6	2.2
14.7 to 17.6	2.0
17.7 to 21.4	1.8
21.5 to 26.2	1.6
26.3 to 32.5	1.4

(f) Total dissolved solids (TDS) limit may be adjusted on a case-by-case basis.

(g) Investigations should be conducted to develop more information where these pollution indicator levels are exceeded.

(h) PO_4 as P(mg/l) limit for lakes and reservoirs shall be .025.

TABLE 7-5

NUMERICAL STANDARDS FOR PROTECTION OF CLASS 3C WATER USE

Physical	
Minimum D.O. (mg/l)	5*
Maximum Temperature	27 degrees C**
Maximum Temperature Change	4 degrees C
pH	6.5-9.0
Turbidity Increase (NTU)	15****
Chemical (Maximum mg/l)	
Cadmium, dissolved	0.004
Chromium, dissolved	0.1
Copper, dissolved	0.01
Cyanide	0.005
Iron, dissolved	1.0
Lead, dissolved	0.05
Mercury, total	0.0005
Phenol	0.01
Selenium, dissolved	0.05
Silver, dissolved	0.01
Zinc, dissolved	0.05
Chlorine	0.2
H2S	0.02
Radiological (Maximum pCi/l)	
Gross Alpha	15
Gross Beta	30
Pesticides (Maximum mg/l)	
Endrin	0.004
Lindane	0.01
Methoxychlor	0.03
Toxaphene	0.005
Pollution Indicators***	
BOD (mg/l)	5.0
NO3 as N (mg/l)	4.0

*Minimum D.O. (mg/l) limitation is 4 in the following segments:
San Rafael River and tributaries, from confluence with Green River to confluence with Ferron Creek
Malad River and tributaries, from confluence with Bear River to state line

**Maximum temperature limitation is 35 degrees C in the following segments:
Virgin River and tributaries from state line to headwaters except as listed in APPENDIX B

***Investigations should be conducted to develop more information where these pollution indicator levels are exceeded

****At background levels of 150 NTU's or greater, a 10% increase limit will be used instead of the numeric values. Short term variances may be considered on a case-by-case basis

TABLE 7-6

TRIBUTARY AREAS OF PRINCIPAL WATERSHEDS WITHIN THE MINE PLAN AREA AS DESIGNATED ON EXHIBIT 7-3

WATERSHED	AREA ACRES
Price River	265,600
Willow Creek	49,540
Spring Canyon Creek	14,130
Sowbelly Gulch	1,980
Hardscrabble Canyon Creek	1,800
Crandall Canyon Creek	2,670
Bear Canyon Creek	1,060
Sulphur Canyon Creek	3,800
Ford Creek	2,450

TABLE 7-7

PRECIPITATION DATA FOR CASTLE GATE MINE COMPLEX

WATERSHED AREA	FREQUENCY (YRS)	DURATION (HRS)	PRECIPITATION (IN)
Hardscrabble Canyon	10	6	1.4
	10	24	1.9
	25	6	1.6
	25	24	2.3
	100	6	2.0
Sowbelly Gulch	10	6	1.4
	10	24	1.9
	25	6	1.6
	25	24	2.3
	100	6	2.2
Crandall Canyon	10	6	1.4
	10	24	1.9
	25	6	1.6
	25	24	2.3
	100	6	2.0
	100	24	2.9
Preparation Plant Adit No. 1 Canyon Gravel Canyon	10	6	1.4
	10	24	1.8
	25	6	1.6
	25	24	2.3
	100	6	2.0

Reference: Miller et al., 1973

TABLE 7-8

AREAS THAT DO NOT REPORT TO A SEDIMENT POND WITHIN THE CASTLE GATE MINE COMPLEX - OPERATION PHASE

LOCATION	EXHIBIT	DESCRIPTION OF AREA	SIZE (Acres)	ALTERNATIVE SEDIMENT CONTROL (R645-301-742.240)
Sowbelly Canyon	3.2-2A	Substation and access road	2.8	Gravel
Hardscrabble	3.3-3	Substation	0.5	1" clean rock
Hardscrabble	3.3-3	Powder magazine area	1.2	Vegetation, and straw bales or silt fences
Hardscrabble	3.3-3	Dog Flat	1.8	Vegetation
Hardscrabble	3.3-3	Upper bathhouse	0.3	Vegetation around bathhouse, 1" clean rock on parking lot with berm to prevent flow to undisturbed ditch.
CG Preparation Plant	3.4-2	Unit train loadout	0.5	Vegetation
CG Preparation Plant	3.4-2	Raw Water Pond	3.1	Vegetation, gravel, pond
CG Preparation Plant	3.4-2	Truck scale	1.8	Vegetation, asphalt
CG Preparation Plant	3.4-2	Beltline	0.2	Vegetation
Adit No. 1 Canyon	3.5-1	Area below transfer building	0.5	Straw bales or silt fence
Gravel Canyon	3.6-1	Entire area	5.5	Vegetation
Crandall Canyon	3.7-5C	Topsoil stockpile No. 1 and No. 2	1.0	Vegetation
Crandall Canyon	3.7-5A	Leach Field	0.2	Vegetation
Bear Canyon	3.9-1	Degasification well	0.20	Perimeter berm and vegetation

TABLE 7-9

AREAS THAT DO NOT REPORT TO A SEDIMENT POND WITHIN THE CASTLE GATE MINE COMPLEX - RECLAMATION PHASE[a]

LOCATION	EXHIBIT	DESCRIPTION OF AREA	SIZE (Acres)	ALTERNATIVE SEDIMENT CONTROL (R645-301-742.240)
Sowbelly Canyon	3.2-5	East of SBRD-1C and south of SBRD-2, South of Pond 017, and Substation area.	12	Mulch and silt fences
Hardscrabble Canyon	3.3-5	Entire reclaimed area	39	Mulch and silt fences
CG Preparation Plant	3.4-3A	Truck scale	1.8	Mulch and silt fences
CG Preparation Plant	3.4-3A	Beltline	0.2	Mulch
CG Preparation Plant	3.4-3A	Reclaimed channel below Schoolhouse Canyon	3.2	Mulch and silt fences
CG Preparation Plant	3.4-3A	Disturbed area within CGRWS-U7	6.1	Mulch and silt fences
CG Preparation Plant	3.4-3A	Unit train loadout	0.5	Mulch and silt fences
CG Preparation Plant	3.4-3A	North end of reclaimed area	1.3	Mulch and silt fences
CG Preparation Plant	3.4-3A	West of Pond 011	0.3	Mulch and silt fences
Adit No. 1	3.5-3	Entire reclaimed area	3	Mulch and silt fences
Gravel Canyon	3.6-3	Entire reclaimed area	5.5	Mulch and silt fences
Crandall Canyon	3.7-7A	Leach field	2.4	Mulch and silt fences
Crandall Canyon	3.7-7B	Diversion CCRD-22 area below Pond 014	0.1	Mulch and silt fences
Crandall Canyon	3.7-7B	Diversion CCRD-24 area	0.1	Mulch and silt fences

[a] Roads that do not drain to a sediment pond are excluded.

TABLE 7-10

STEEP SLOPE RIPRAP DESIGN VALUES

D_{50} DETERMINED FROM DESIGN CURVE (FT)	DESIGN D_{50} (FT)
< 0.25	0.25
0.26 - 0.50	0.50
0.51 - 0.75	0.75
0.76 - 1.00	1.00
1.01 - 1.25	1.25
1.26 - 1.50	1.50
1.51 - 1.75	1.75
1.76 - 2.00	2.00
2.01 - 2.25	2.25
2.26 - 2.50	2.50
2.51 - 2.75	2.75
2.76 - 3.00	3.00

Reference: Simons, Li and Associates, Inc., 1982.

TABLE 7-11

LIST OF WATER QUALITY PARAMETERS SAMPLED FROM APRIL 1977 THROUGH MAY 1978

Field Parameters	Lab Parameters	
Water Level or Flow	Aluminum, total	Mercury, total
pH	Ammonia, as NH	Nitrate
Specific Conductance	Arsenic, total	Potassium, total
Temperature (Air & Water)	Barium, total	Phosphate, total
	Bicarbonate	Phosphate, ortho
	Boron, total	Oil and Grease
	Cadmium, total	Selenium, total
	Calcium, total	Silver, total
	Carbonate	Sodium, total
	Chemical Oxygen Demand	Specific Conductance
	Chloride, dissolved	Sulfate
	Chromium, total	Total Alkalinity
	Dissolved Oxygen	Total Dissolved Solids
	Fluoride, dissolved	Total Hardness
	Hydroxide	Total Organic Carbon
	Iron, total	Total Suspended Solids
	Lead, total	Turbidity
	Magnesium, total	Zinc, total
	Manganese, total	

TABLE 7-12
LIST OF WATER QUALITY PARAMETERS SAMPLED FROM JUNE 1978 THROUGH JUNE 1979

Field Parameters	Lab Parameters	
Water Level or Flow	Arsenic, total	Nitrite
pH	Barium, total	Potassium, total
Specific Conductance	Bicarbonate	Phenols
Temperature (Air & Water)	Cadmium, total	Phosphate, ortho
	Calcium, total	Oil and Grease
	Chloride, dissolved	Selenium, total
	Chromium, total	Silica
	Copper, total	Silver, total
	Dissolved Oxygen	Sodium, total
	Fluoride, dissolved	Specific Conductance
	Iron, total	Sulfate
	Lead, total	Total Dissolved Solids
	Magnesium, total	Total Organic Carbon
	Manganese, total	Total Suspended Solids
	Nitrate	Zinc, total

TABLE 7-13

LIST OF WATER QUALITY PARAMETERS SAMPLED FROM JUNE 1979 THROUGH DECEMBER 1979

Field Parameters	Lab Parameters	
Water Level or Flow	Acidity	Nitrate
pH	Arsenic, total	Potassium, total
Specific Conductance	Barium, total	Phenols
Temperature (Air & Water)	Bicarbonate	Phosphate, ortho
	Cadmium, total	Phosphate, total
	Calcium, total	Oil and Grease
	Chloride, dissolved	Selenium, total
	Chromium, total	Silver, total
	Copper, total	Sodium, total
	Dissolved Oxygen	Specific Conductance
	Fluoride, dissolved	Sulfate
	Iron, total	Total Alkalinity
	Lead, total	Total Dissolved Solids
	Magnesium, total	Total Suspended Solids
	Manganese, total	Zinc, total

TABLE 7-14
LOCATION OF PRIOR AND EXISTING WATER MONITORING STATIONS IN AND ADJACENT TO CASTLE GATE COAL COMPANY MINE PLAN AREA

Location			Coordinates
Price River			
	B-5	Price River above Willow Creek	D-12-9-35 ddda
	B-6	Price River above coal processing area	D-12-9-26 cdda
	B-20	Price River above Sulfur Canyon Creek	D-12-9-22 ddca
Ford Creek			
	B-21	Ford Creek at Highway U.S. 50 & 6	D-12-9-8 adcc
Crandall Canyon			
	B-22	Spring one-half mile above Highway U.S. 50 & 6	D-12-9-27 bacc
	B-22-1	Lower Crandall Canyon streambed	D-12-9-27 bacc
	B-25	Crandall Canyon Creek above shaft area	D-12-9-28 dbdb
	B-26	Crandall Canyon Creek below shaft area	D-12-9-28 dbda
	B-43	Drill hole in Crandall Canyon	D-12-9-38 dbda
Sulfur Canyon			
	B-19	Sulfur Canyon Creek above Price River	D-12-9-22 ddca
Royal Mine		(Discontinued April 1978)	
	BM-25	Water at bottom of Royal Mine	D-12-9-27 addb
	BM-26	Royal Mine water 20 feet above bottom	D-12-9-27 addb
	BM-27	Royal Mine water at cross cut #3	D-12-9-26 bccb
	BM-28	Royal Mine water at 40 feet below top of mine	D-12-9-26 bcca
Bear Canyon			
	BW-23	Upper well in Bear Canyon	D-12-9-34 bdcc
	BW-24	Lower well in Bear Canyon	D-12-9-34 caac
	B-42	Drill hole in Bear Canyon	D-12-9-33 daaa
Adit No. 1			
	BM-30	Pipe down slope east of Highway 6	D-12-9-1-bbab

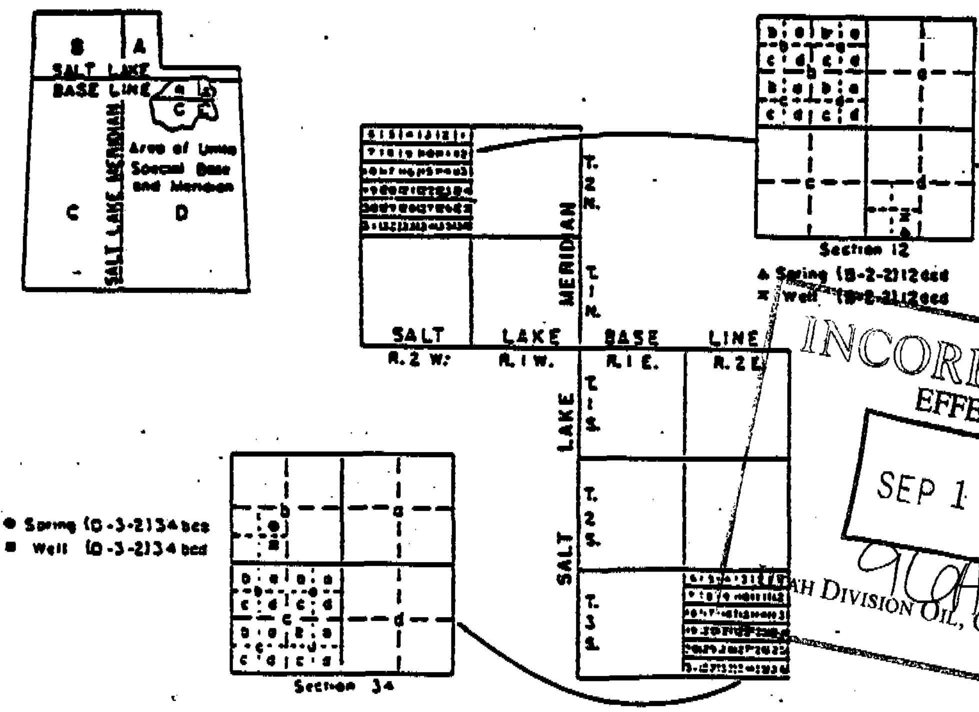
TABLE 7-14 (Continued)
LOCATION OF PRIOR AND EXISTING WATER MONITORING STATIONS IN AND ADJACENT TO CASTLE GATE COAL COMPANY MINE PLAN AREA

Location		Coordinates
Willow Creek		
B-1	Upper Willow Creek	D-12-10-22 bbaa
B-2	Willow Creek above proposed Mine #6	D-12-10-31 acdd
B-3	Willow Creek below proposed Mine #6	D-13-10-6 bbba
Hardscrabble Canyon		
B-9	Holding pond below Mine #2 (Discontinued 5/78)	D-13-9-10 acbd
B-11	Hardscrabble below Mine #3	D-13-9-10 acdb
B-12	Hardscrabble above disturbed area	D-13-9-3 caac
Springs		
B-32	Spring in Mathis Canyon	D-12-10-27 aacd
B-33	Spring in Dry Canyon	D-13-10-3 bdcc
Sowbelly Gulch		
B-14	Holding pond below Mine #5	D-13-9-9 bbba
B-17	Sowbelly Gulch above Spring Canyon	D-13-9-16 abbb
B-28	Sowbelly Gulch above disturbed area	D-13-9-4 cbab
B-41	Drill hole in Sowbelly Gulch	D-13-9-5 aaba
B-45	Sowbelly Gulch below disturbed area by gate	D-13-9-9 bbdb
Spring Canyon		
BM-31	Near Mutual Spring - Old Portal	D-13-8-1 dcdd
B-32	Gravel Springs streambed	D-13-9-17 baab

Numbering System Used to Identify Springs and Wells in Utah

The numbers used in this report to identify springs and wells in Utah indicate the spring or well location by land subdivision according to a coordinate numbering system that was devised cooperatively by the Utah State Engineer and G.H. Taylor of the USGS about 1935. The system in illustrated in Figure 3 and on the following page. The coordinate number used to designate location of a well or spring comprises letters and numbers that designate consecutively the quadrant and township. A capital letter designating the quadrant in relation to the base point of the Salt Lake Base and Meridian; and numbers designating the township and range; the number of the section; the quarter section; the quarter of the quarter section; the quarter of the quarter-quarter section; and the particular spring or well within the 10-acre tract. For example D-3-2-34 bca refer to a spring or well in the NE 1/4 SW1/4 NW1/4 Section 34, Township 3 S, Range 2 E.

TABLE 7-14 (Continued)
LOCATION OF PRIOR AND EXISTING WATER MONITORING STATIONS IN AND ADJACENT TO CASTLE GATE COAL COMPANY MINE PLAN AREA



Numbering system used to designate springs and wells in Utah.

TABLE 7-15

LIST OF WATER QUALITY PARAMETERS MONITORED FROM JANUARY 1980 THROUGH MARCH 1984

Field Parameters

Water Level or Flow

pH

Specific Conductance

Temperature (Air & Water)

Parameters Monitored Intermittently as a Spot Check

Cyanide

Iron, dissolved

Mercury

Nitrate

Phosphate, ortho

Silica

Total Organic Carbon

Lab Parameters

Acidity

Arsenic, total

Barium, total

Bicarbonate

Cadmium, total

Calcium, total

Chloride, dissolved

Chromium, total

Copper, total

Fluoride, dissolved

Iron, total

Lead, total

Magnesium, total

Manganese, total

Nitrate

Potassium, total

Phenols

Phosphate, total

Oil and Grease

Selenium, total

Silver, total

Sodium, total

Sulfate

Total Alkalinity

Total Dissolved Solids

Total Suspended Solids

Zinc, total

TABLE 7-16

LIST OF WATER QUALITY PARAMETERS FOR
ACTIVE WATER MONITORING PROGRAM

Field parameters will include:

Flow (cfs)
Temperature (°C)
Spec. Conductance (μmhos/cm)
pH (s.u.)
Dissolved Oxygen (mg/l) (Perennial streams only)

Abbreviated Laboratory Analyses will include:

pH (s.u.)
TDS (mg/l)
TSS (mg/l)[1]
Oil & Grease (mg/l)[1,2]
Fe (mg/l)(dissolved and total)
Ca (mg/l)
Na (mg/l)
K (mg/l)
Cl (mg/l)
Mg (mg/l)
Bicarbonate (mg/l)
Sulfate (mg/l)
Total Hardness (mg/l) (as $CaCO_3$)
Carbonate (mg/l)
Total Manganese (mg/l)
Cation-Anion Balance (meq/l)

[1] Surface water samples only.
[2] Groundwater samples checked for visual signs.

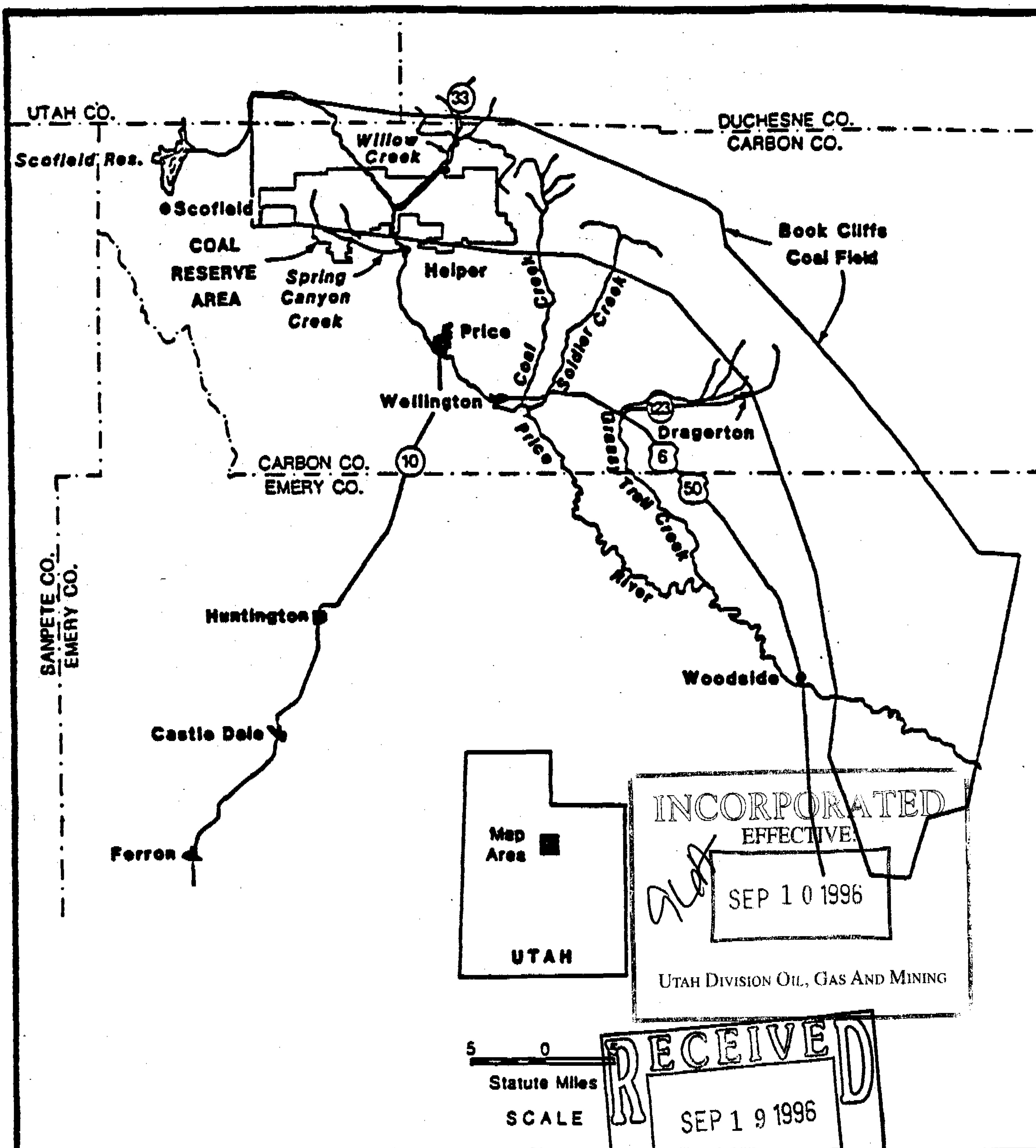


FIGURE 7-1. LOCATION OF THE PRICE RIVER COAL COMPANY MINE PLAN AREA.

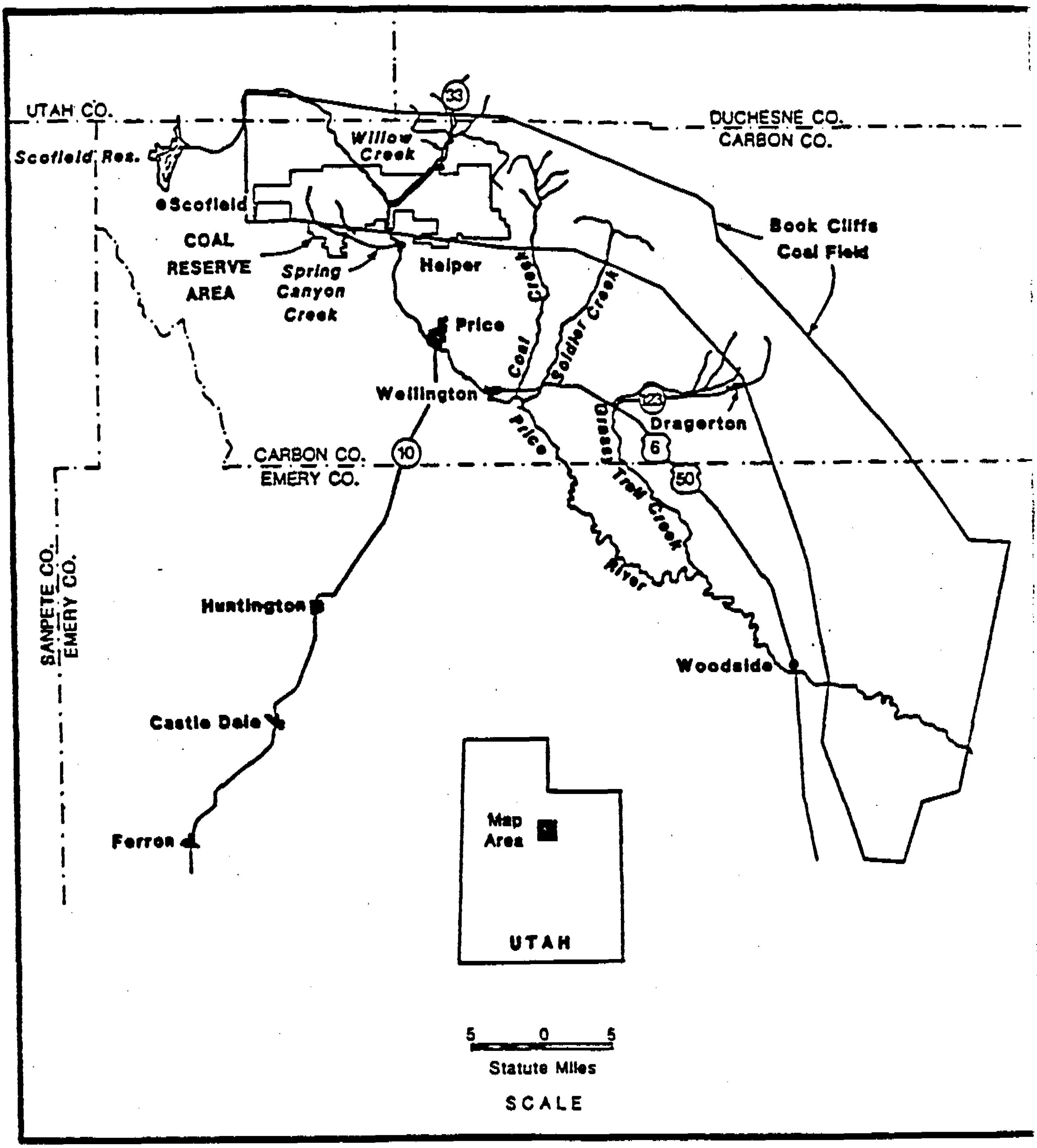


FIGURE 7-1. LOCATION OF THE PRICE RIVER COAL COMPANY MINE PLAN AREA.

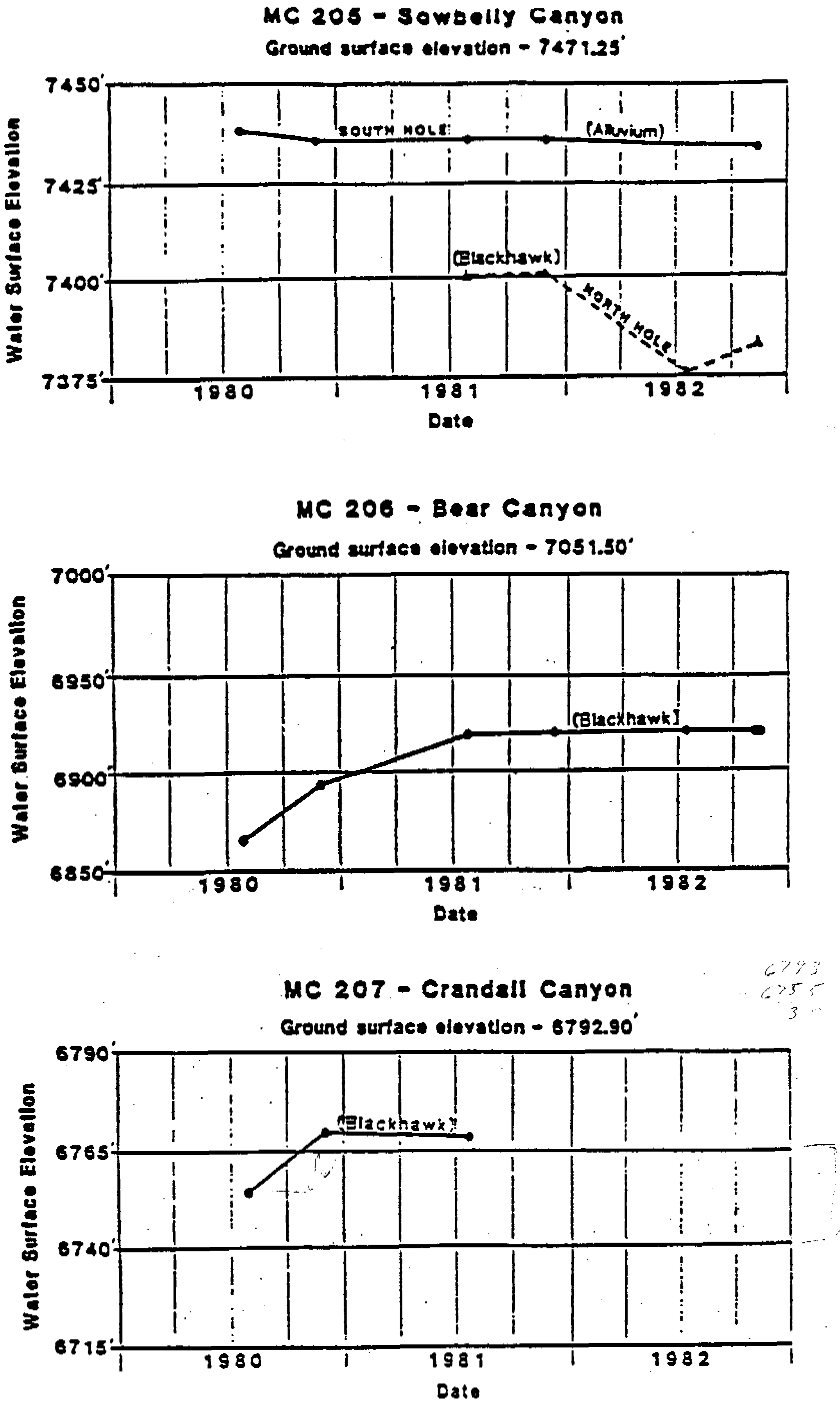
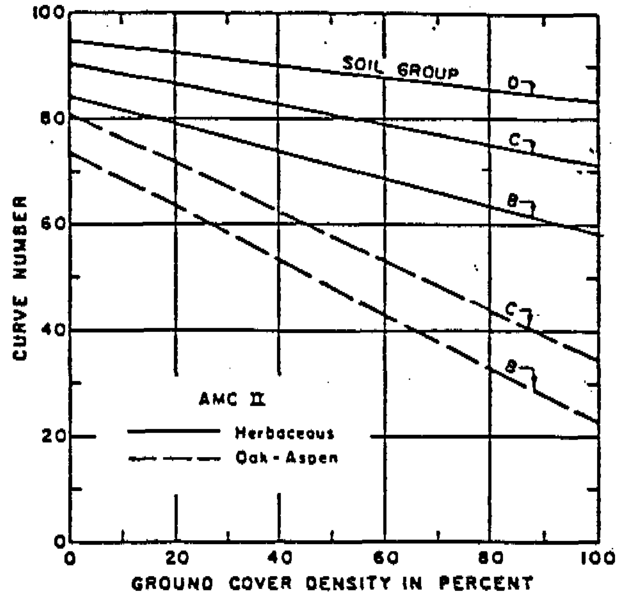
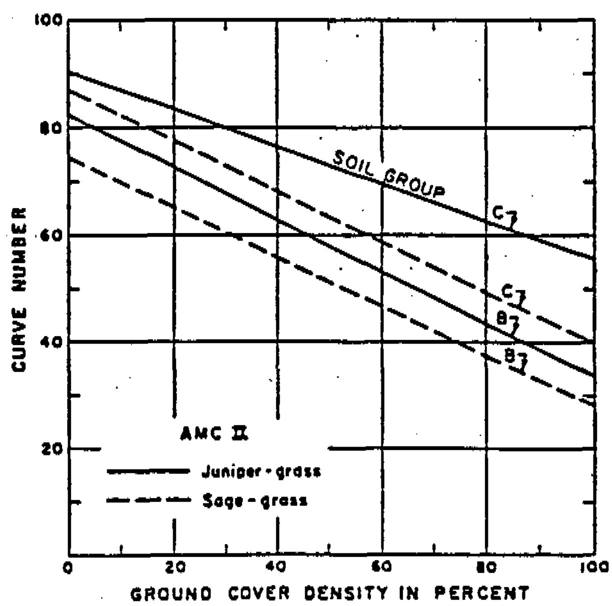


FIGURE 7-2. VARIATION IN WATER SURFACE ELEVATIONS IN OBSERVATION WELLS MC-205, MC-206, AND MC-207 SINCE 1980.



Graph for estimating runoff curve numbers of forest-range complexes in western United States: herbaceous and oak-aspen complexes.



Graph for estimating runoff curve numbers of forest-range complexes in western United States: juniper-grass and sage-grass complexes.

FIGURE 7-3. Curve Number Graphs (U.S. Soil Conservation Service, 1972).

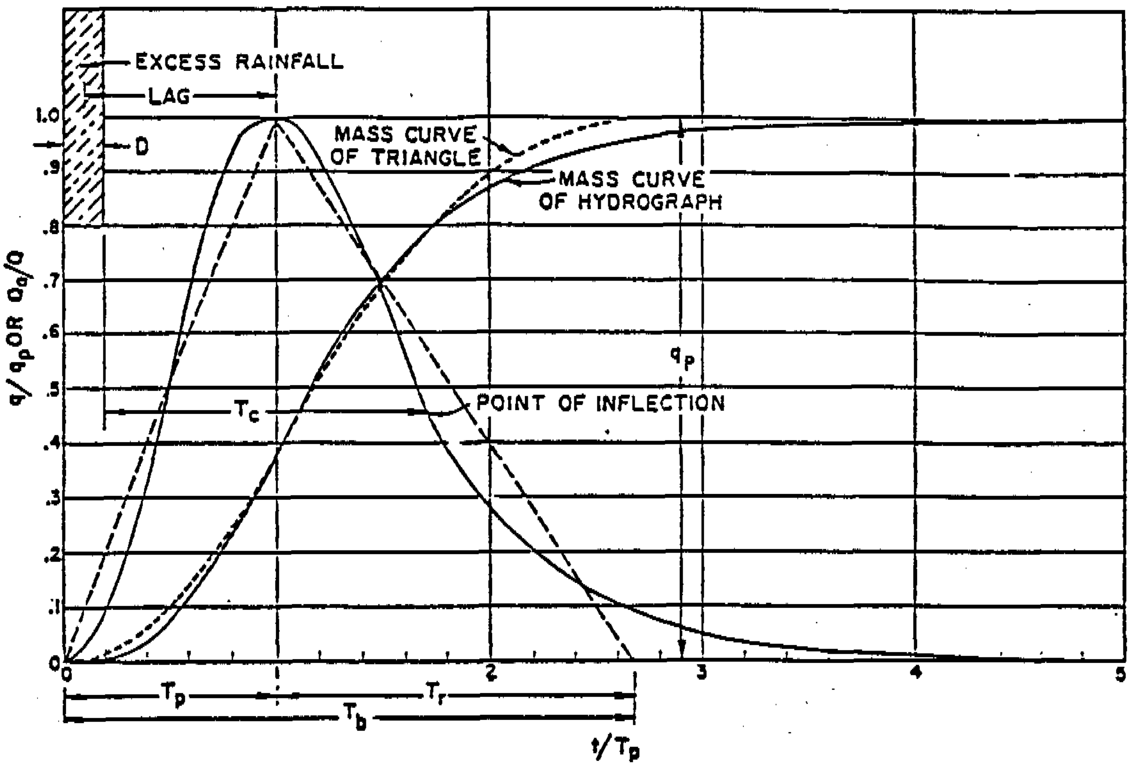


FIGURE 7-4. Curvilinear and Triangular Unit Hydrographs (U.S. Soil Conservation Service, 1972).

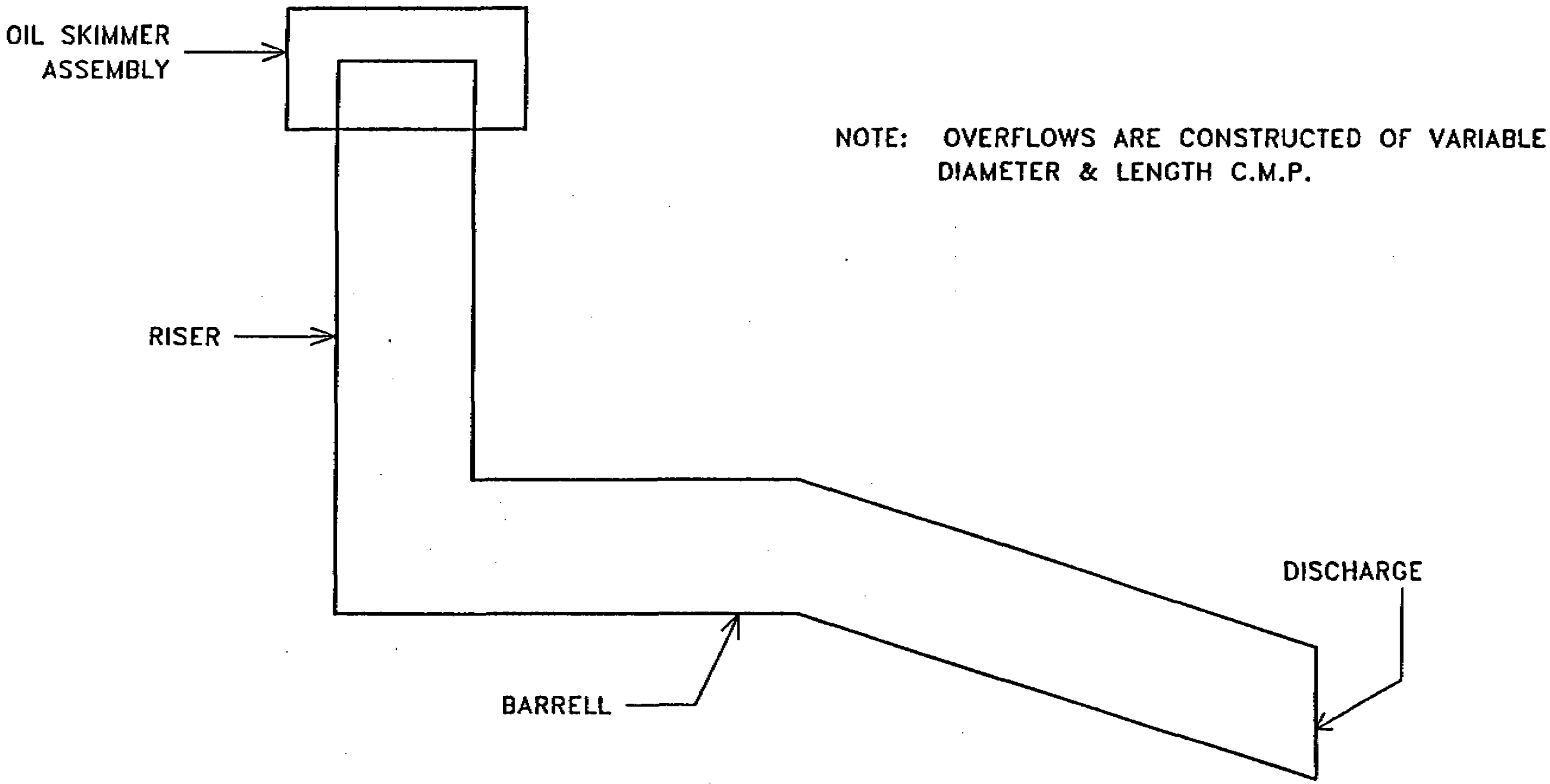
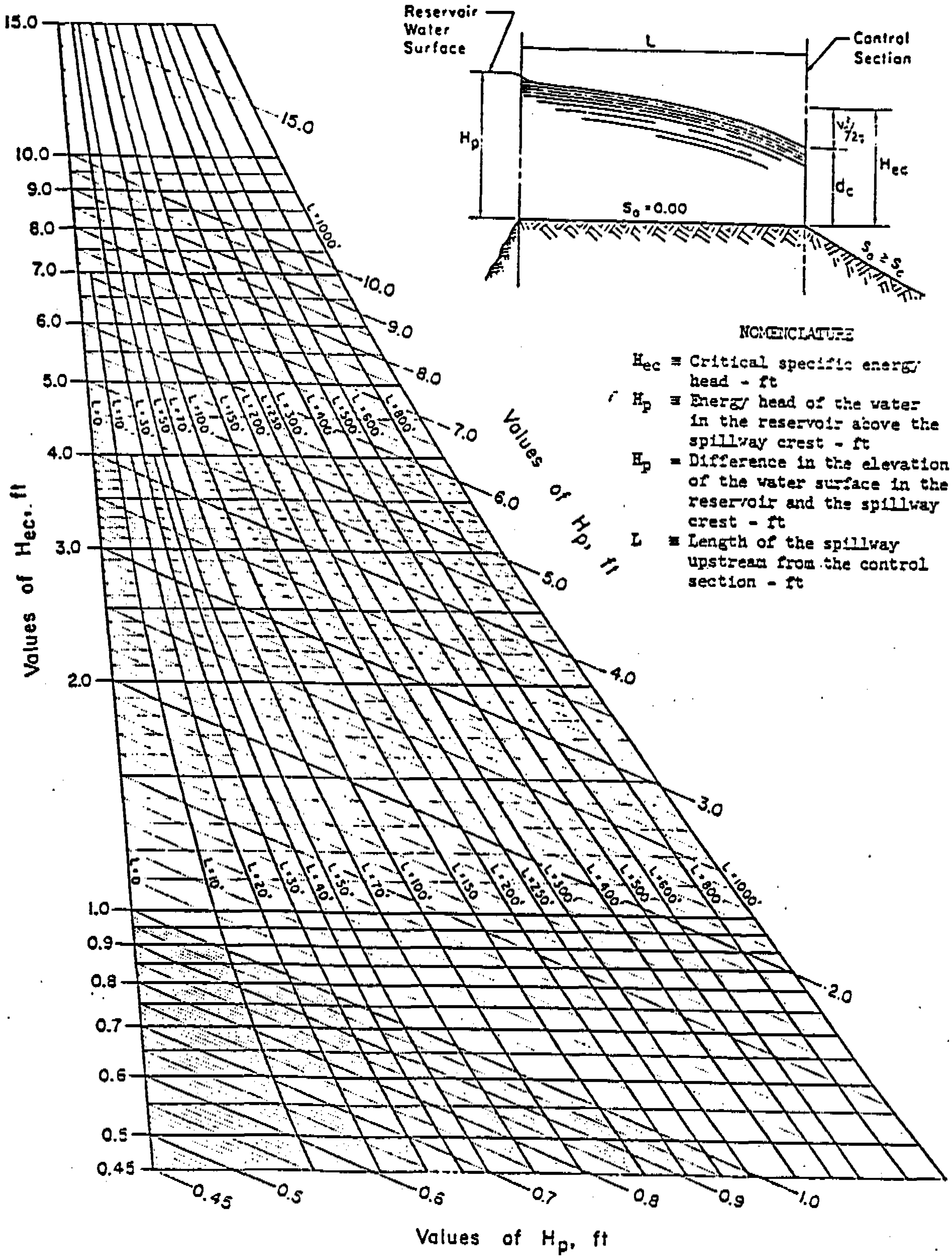


FIGURE 7-5. TYPICAL DROP-INLET OVERFLOW.



NOMENCLATURE

H_{ec} = Critical specific energy head - ft

H_p = Energy head of the water in the reservoir above the spillway crest - ft

H_p = Difference in the elevation of the water surface in the reservoir and the spillway crest - ft

L = Length of the spillway upstream from the control section - ft

FIGURE 7-6. Head relationships for selected broad-crest weirs (U.S. Soil Conservation Service, 1968).

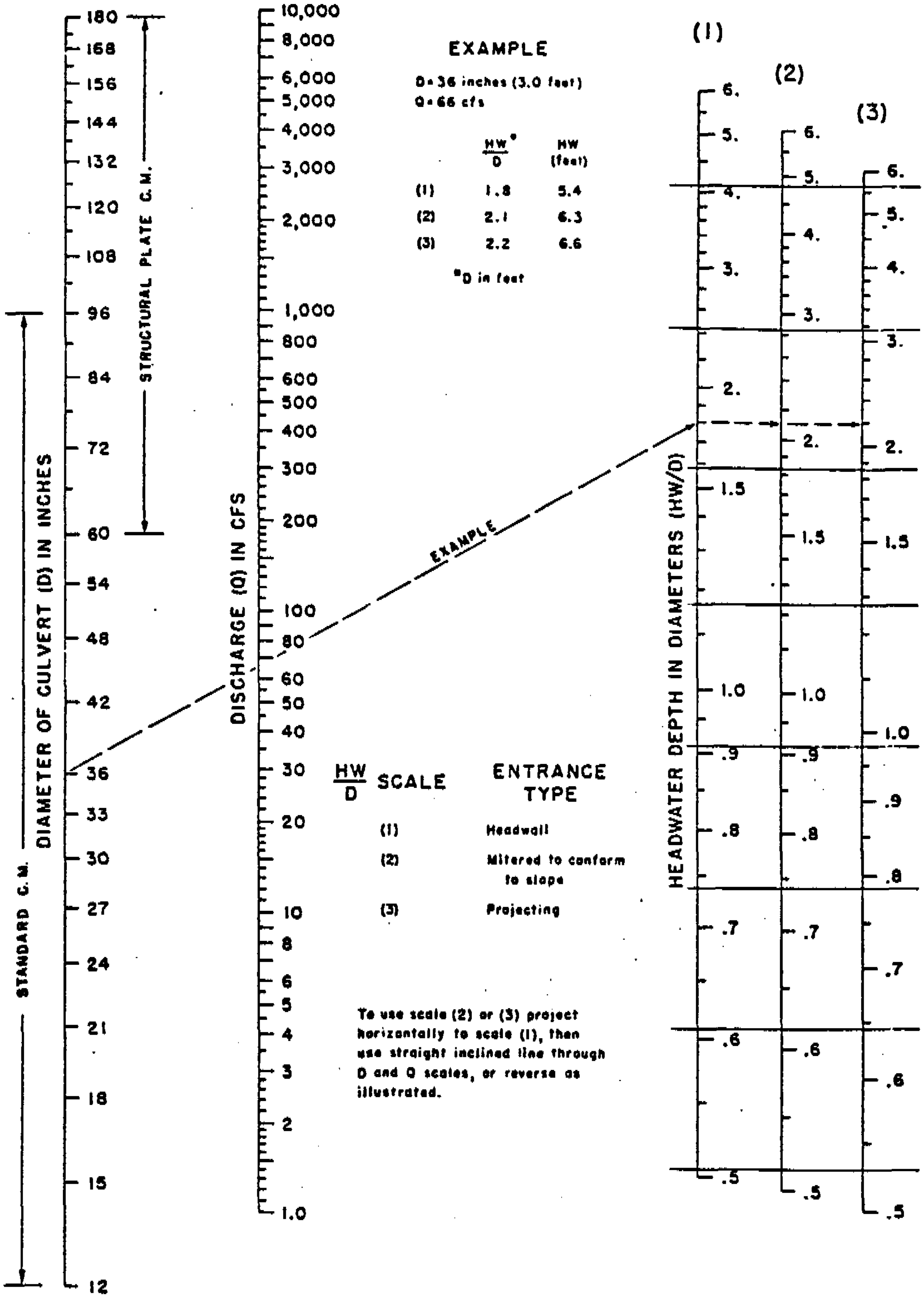


FIGURE 7-7. Headwater depth for C.M. Pipe Culverts with Inlet Control (U.S. Department of Transportation, 1977)

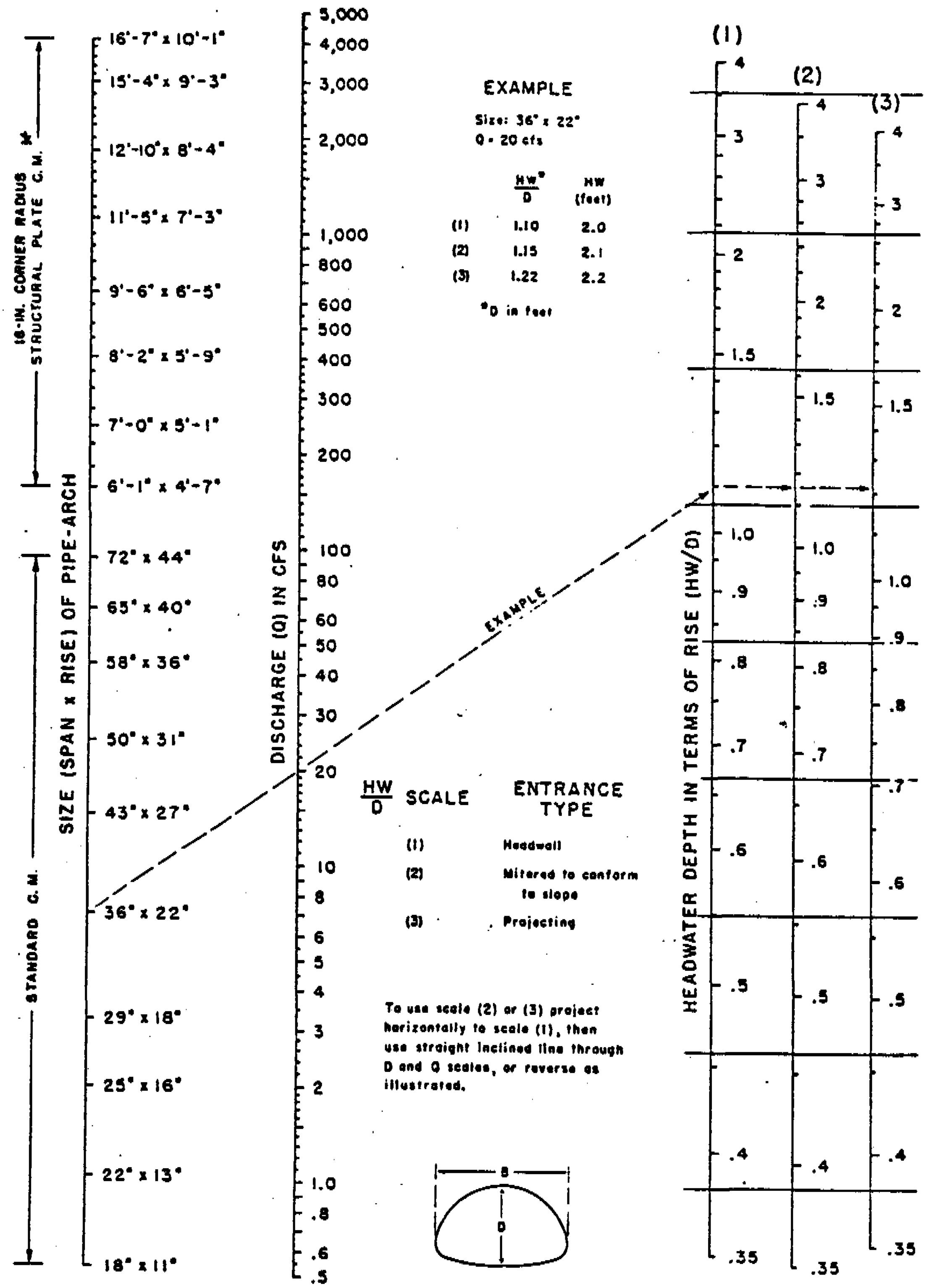


FIGURE 7-8. Headwater Depth for C.M. Pipe-Arch Culverts with Inlet Control (U.S. Department of Transportation, 1977).

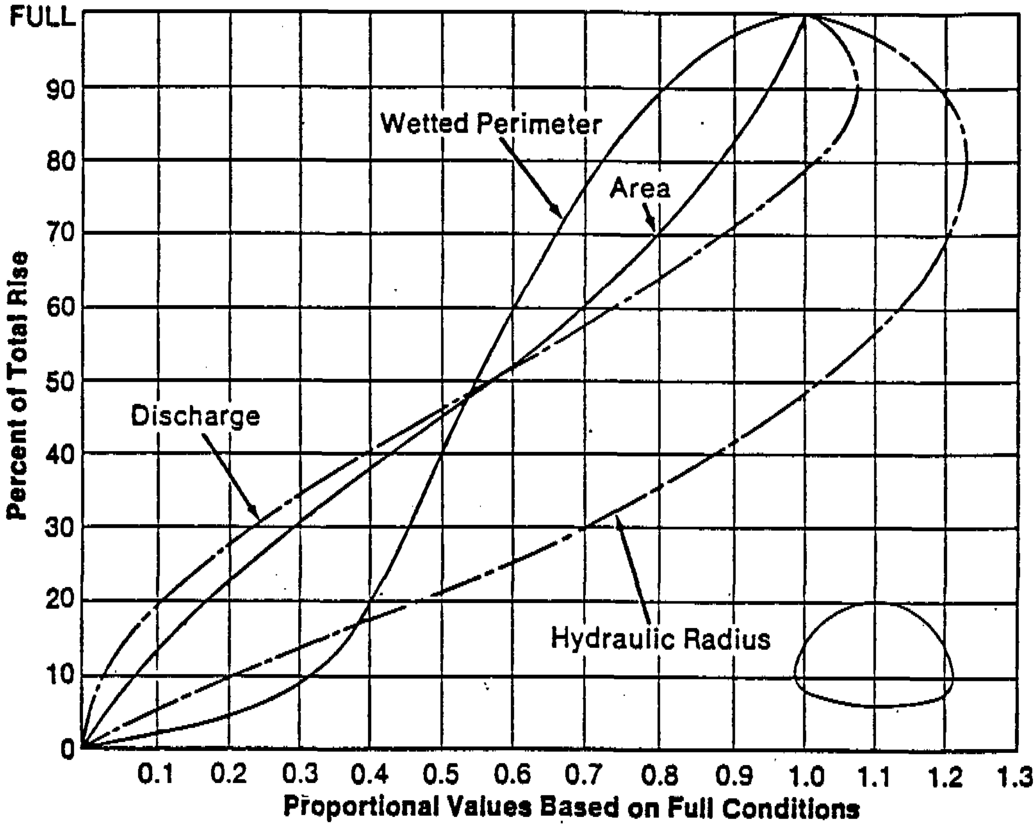


FIGURE 7-9. Hydraulic Properties of Corrugated Steel and Structural Plate Pipe-Arches (American Iron and Steel Institute, 1983).

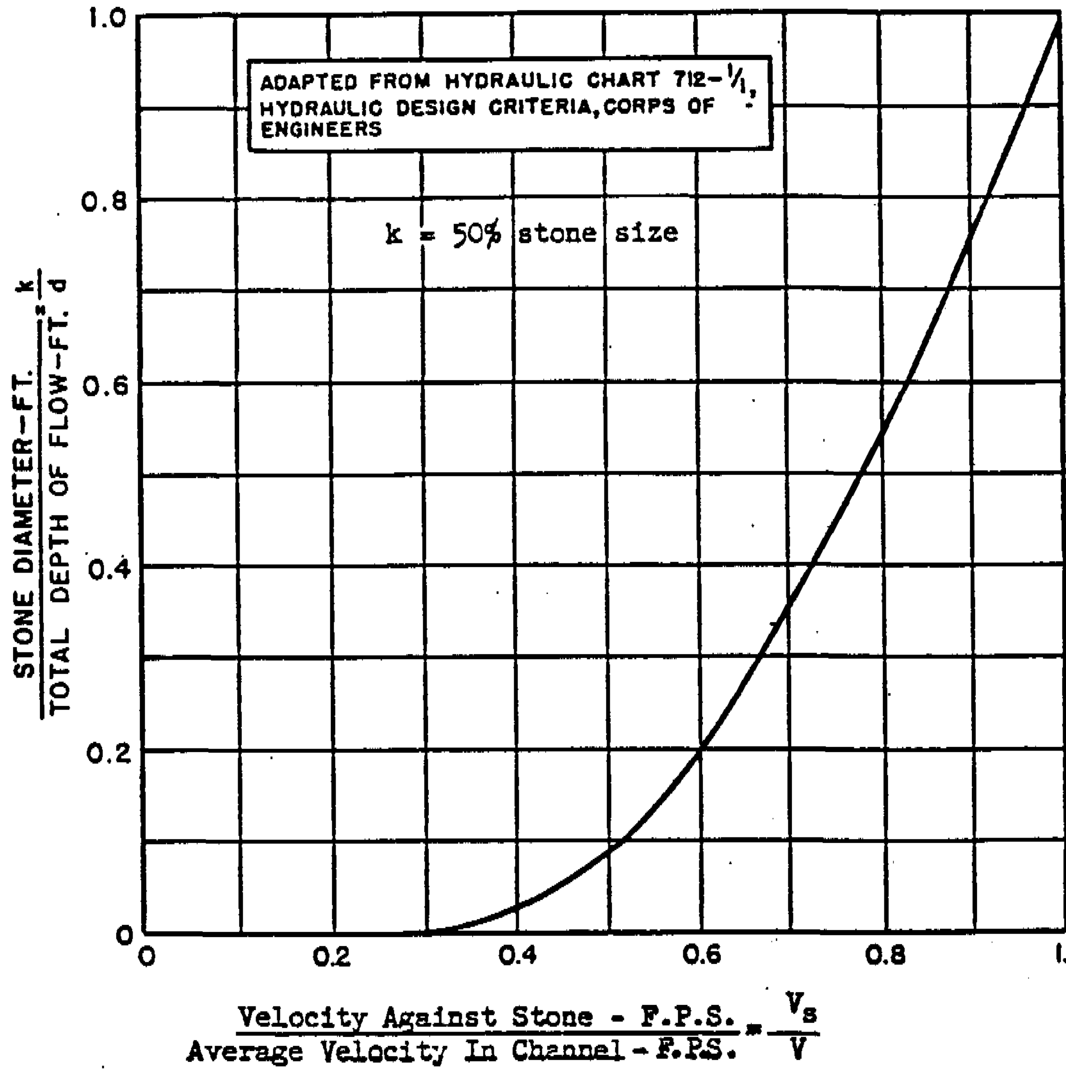


FIGURE 7-10a. Velocity Against Stone on Channel Bottom (U.S. Department of Transportation, 1978).

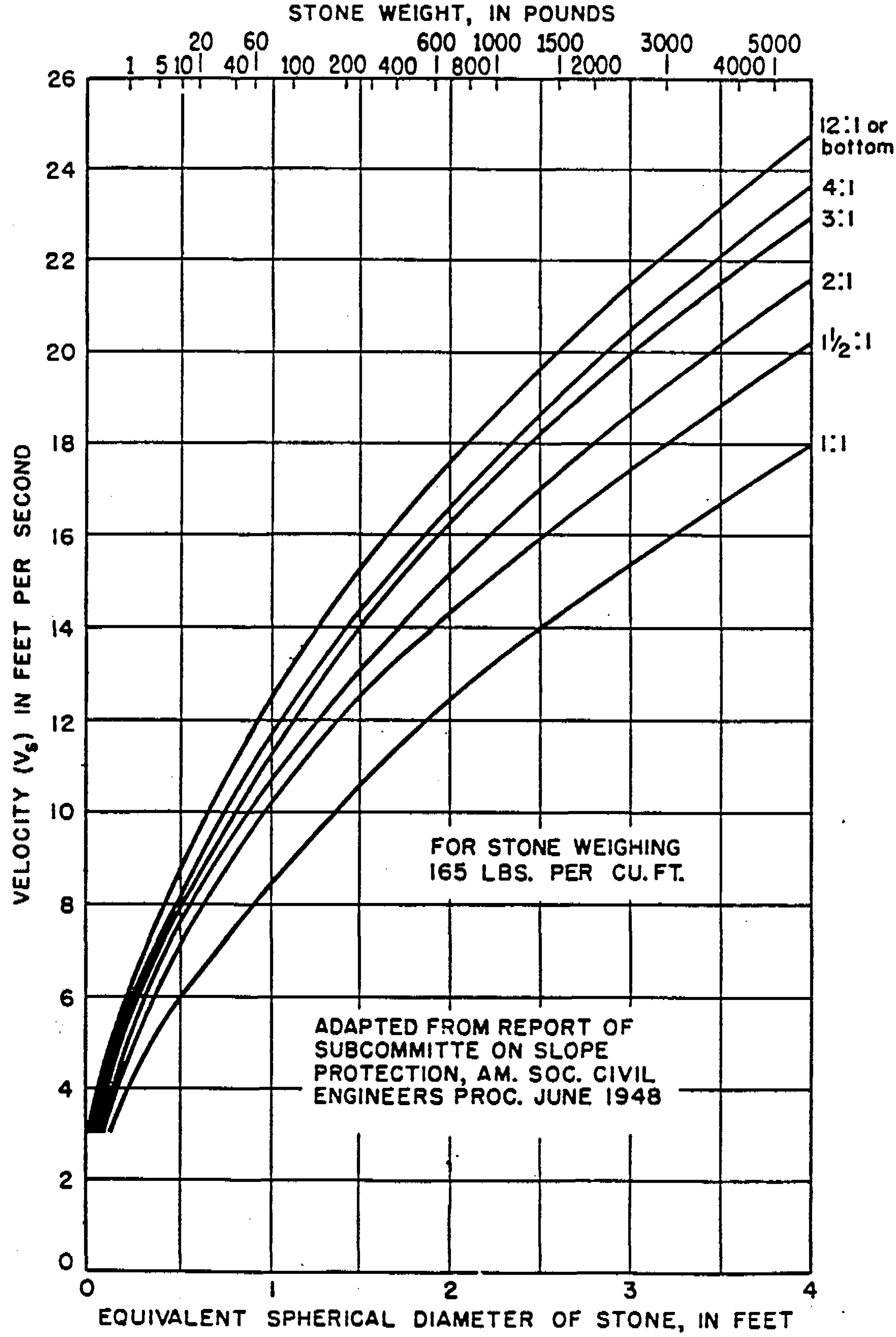
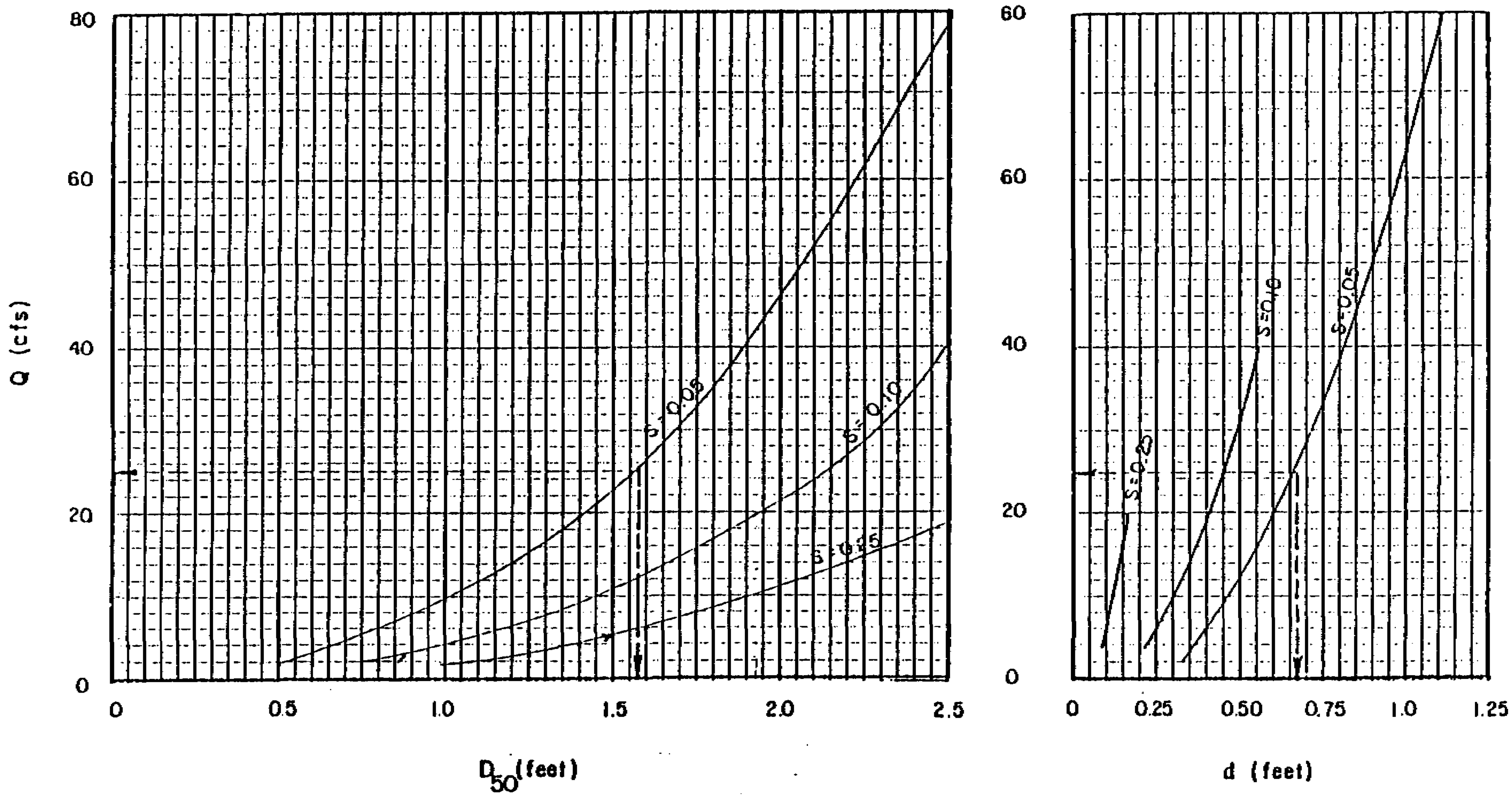
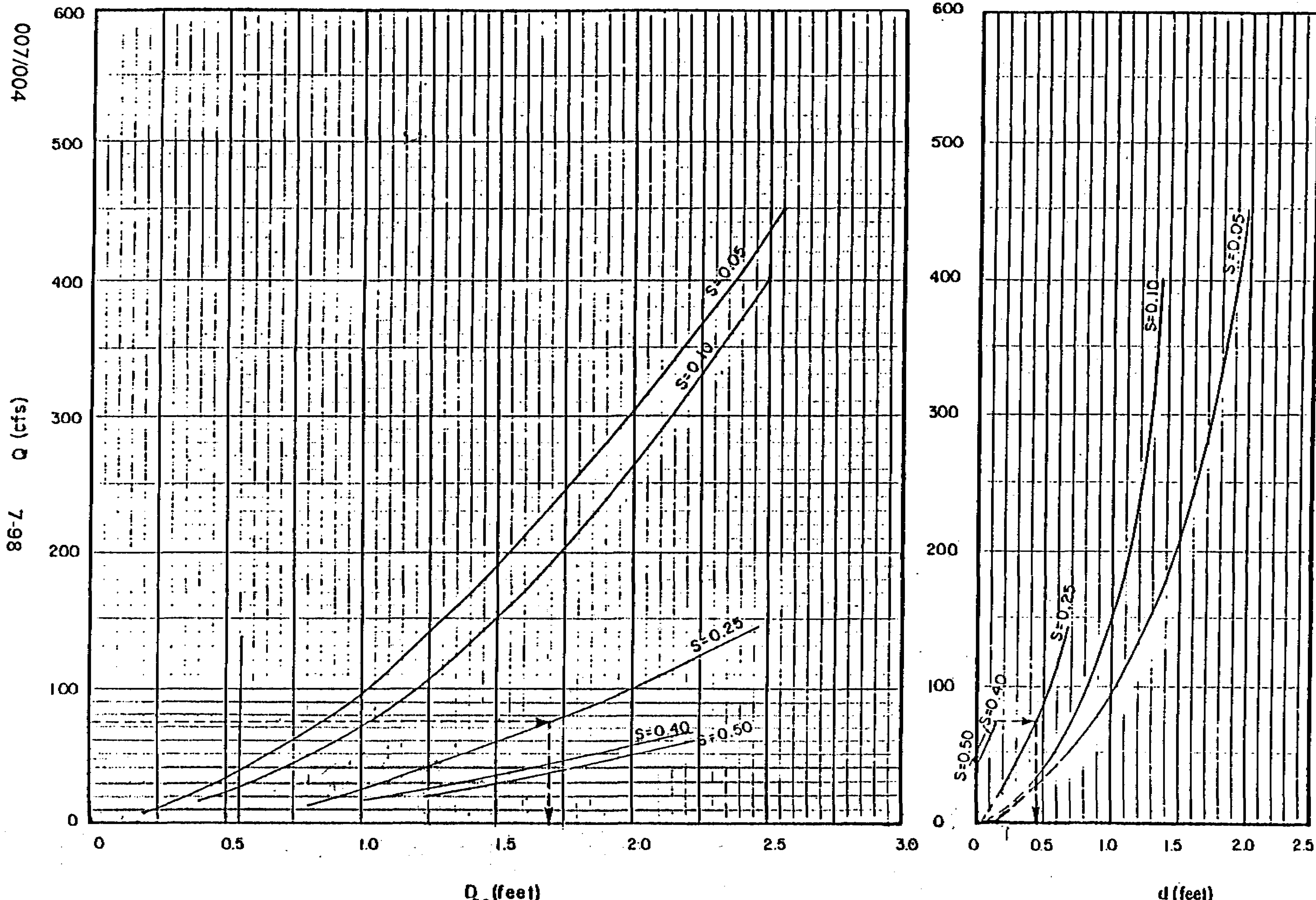


FIGURE 7-10b. Size of Stone that will Resist Displacement for Various Velocities and Side Slopes (U.S. Department of Transportation, 1978).



Reference: Simons, Li and Associates, Inc., 1982.

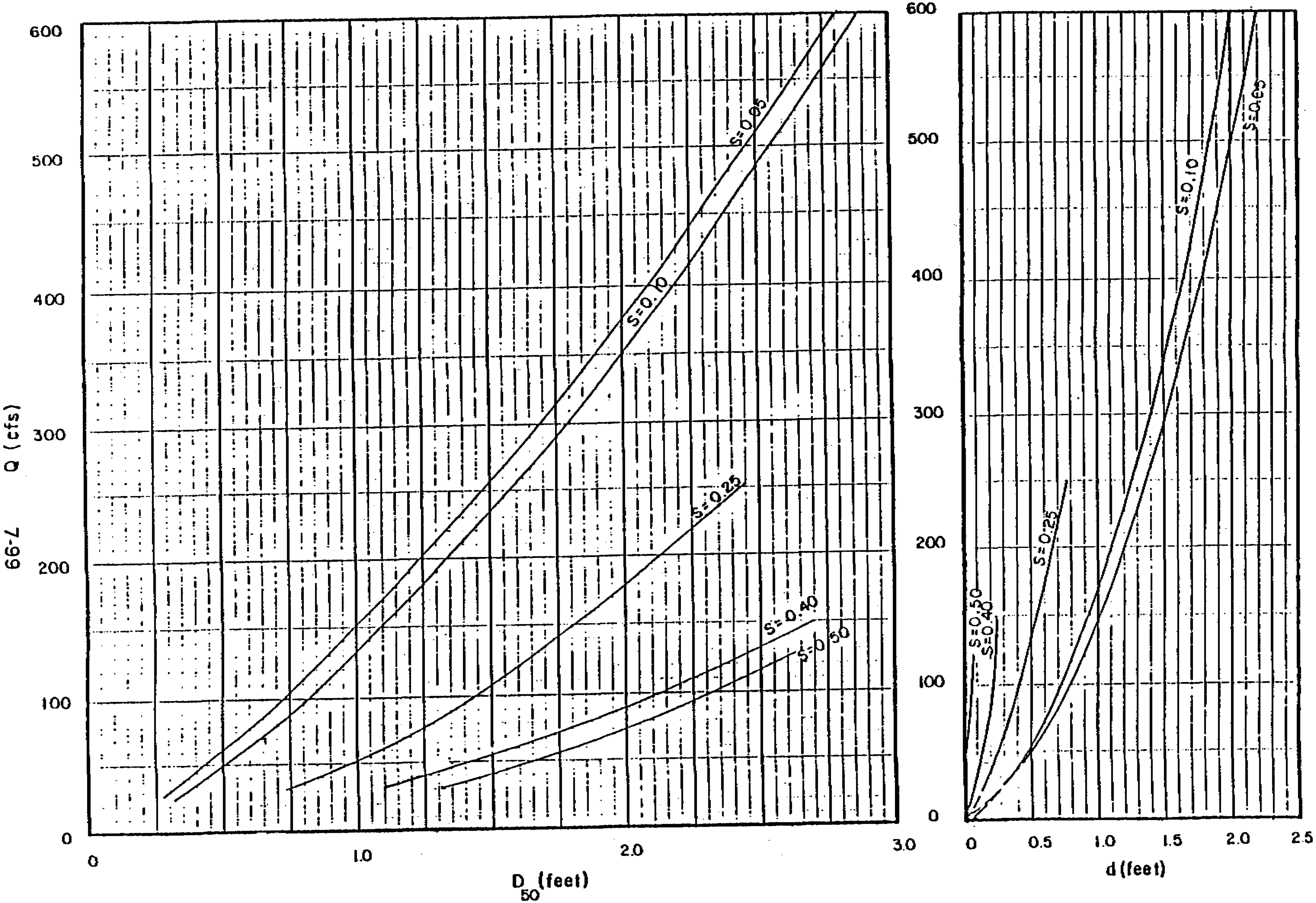
FIGURE 7-11a. STEEP-SLOPE RIPRAP DESIGN CURVES-CHANNEL BOTTOM WIDTH EQUALS ZERO.



Reference: Simons, Li and Associates, Inc., 1982.

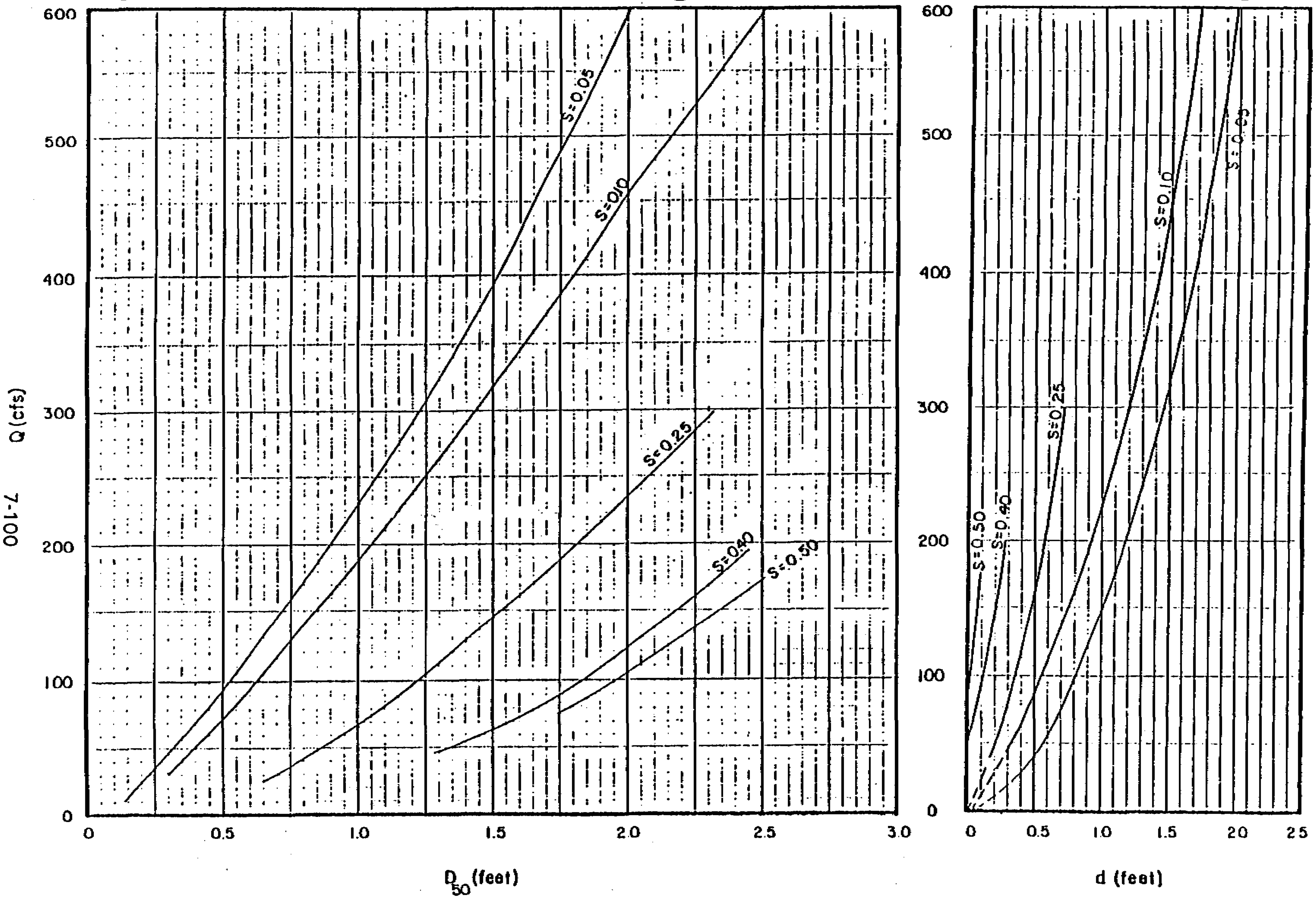
REF: OSM/TR-82-2, SURFACE MINING WATER DIVERSION DESIGN MANUAL. PREPARED BY SIMONS, LI & ASSOC. SEPT. 1982.

FIGURE 7-11b. STEEP-SLOPE RIPRAP DESIGN CURVES-CHANNEL BOTTOM WIDTH EQUALS SIX.



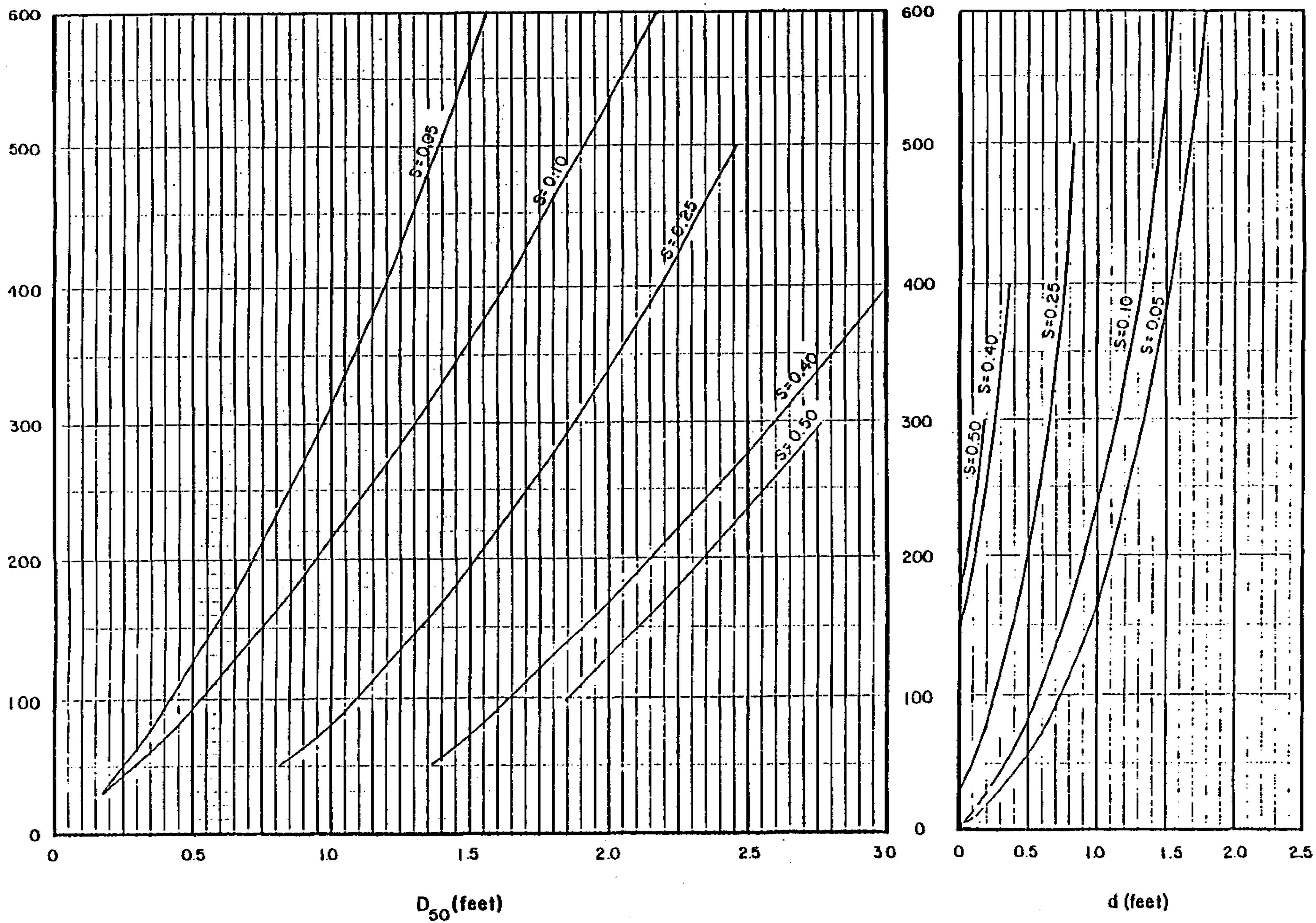
Reference: Simons, Li and Associates, Inc., 1982.

FIGURE 7-11c. STEEP-SLOPE RIPRAP DESIGN CURVES-CHANNEL BOTTOM WIDTH EQUALS TEN.



Reference: Simons, Li and Associates, Inc., 1982.

FIGURE 7-11d. STEEP-SLOPE RIPRAP DESIGN CURVES-CHANNEL BOTTOM WIDTH EQUALS 14.



Reference: Simons, Li and Associates, Inc., 1982.

FIGURE 7-11e. STEEP-SLOPE RIPRAP DESIGN CURVES-CHANNEL BOTTOM WIDTH EQUALS 20.

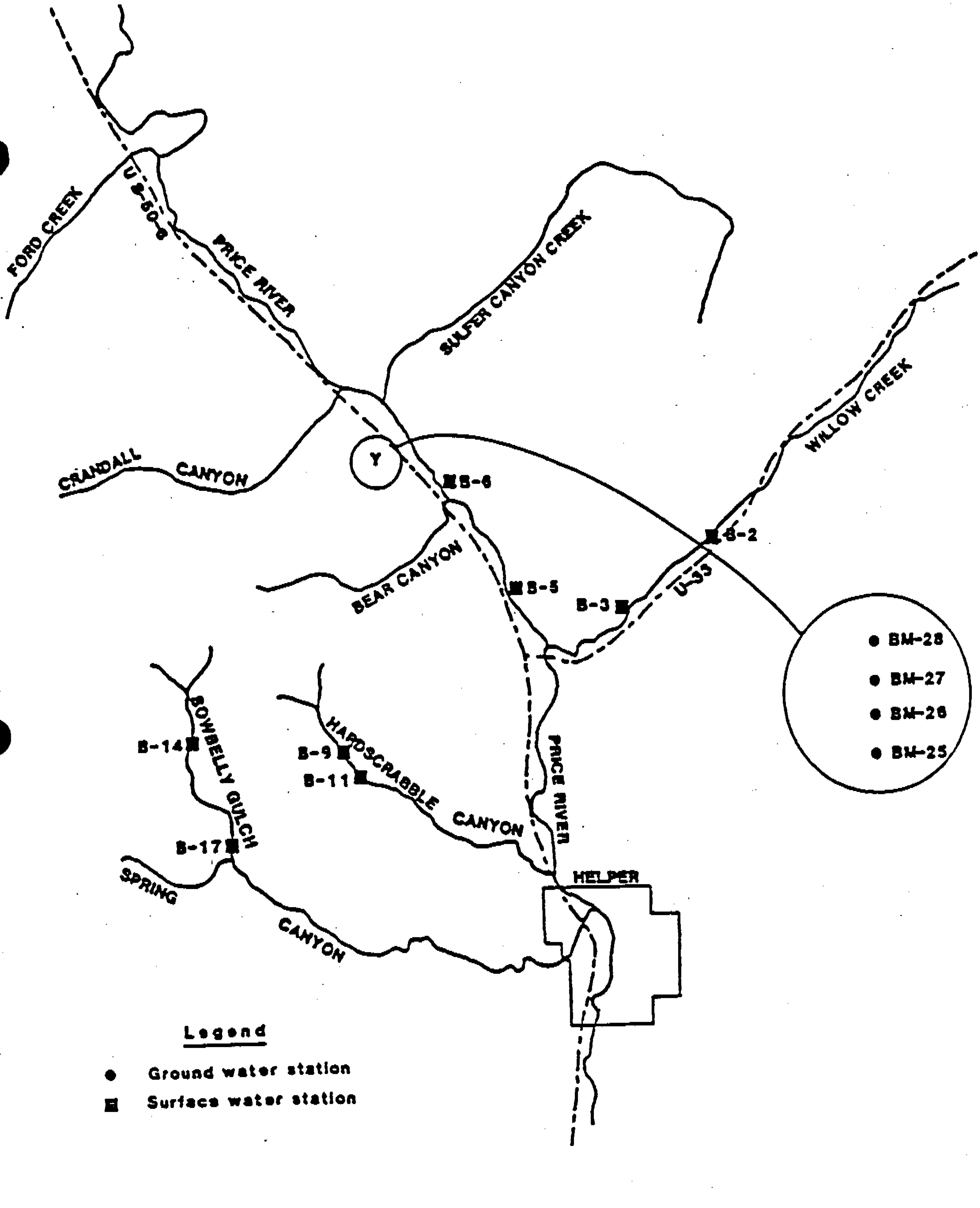


FIGURE 7-12. SAMPLING STATION LOCATIONS FOR PRICE RIVER COAL COMPANY MONITORING PROGRAM FROM APRIL, 1977 THROUGH JUNE, 1978.

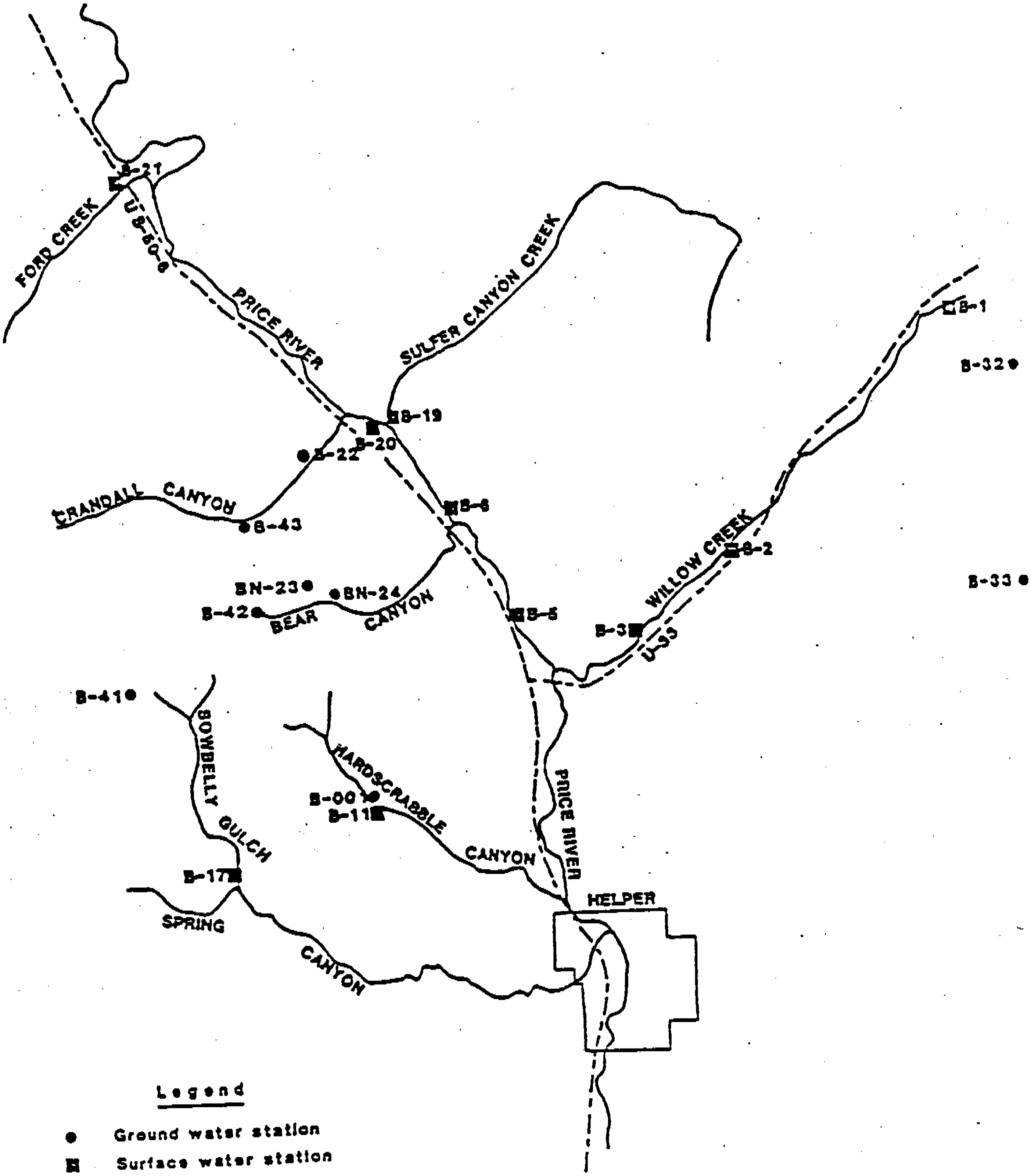


FIGURE 7-13. WATER SAMPLING STATION LOCATIONS FOR PRICE RIVER COAL COMPANY FROM JUNE, 1978 THROUGH DECEMBER, 1979.

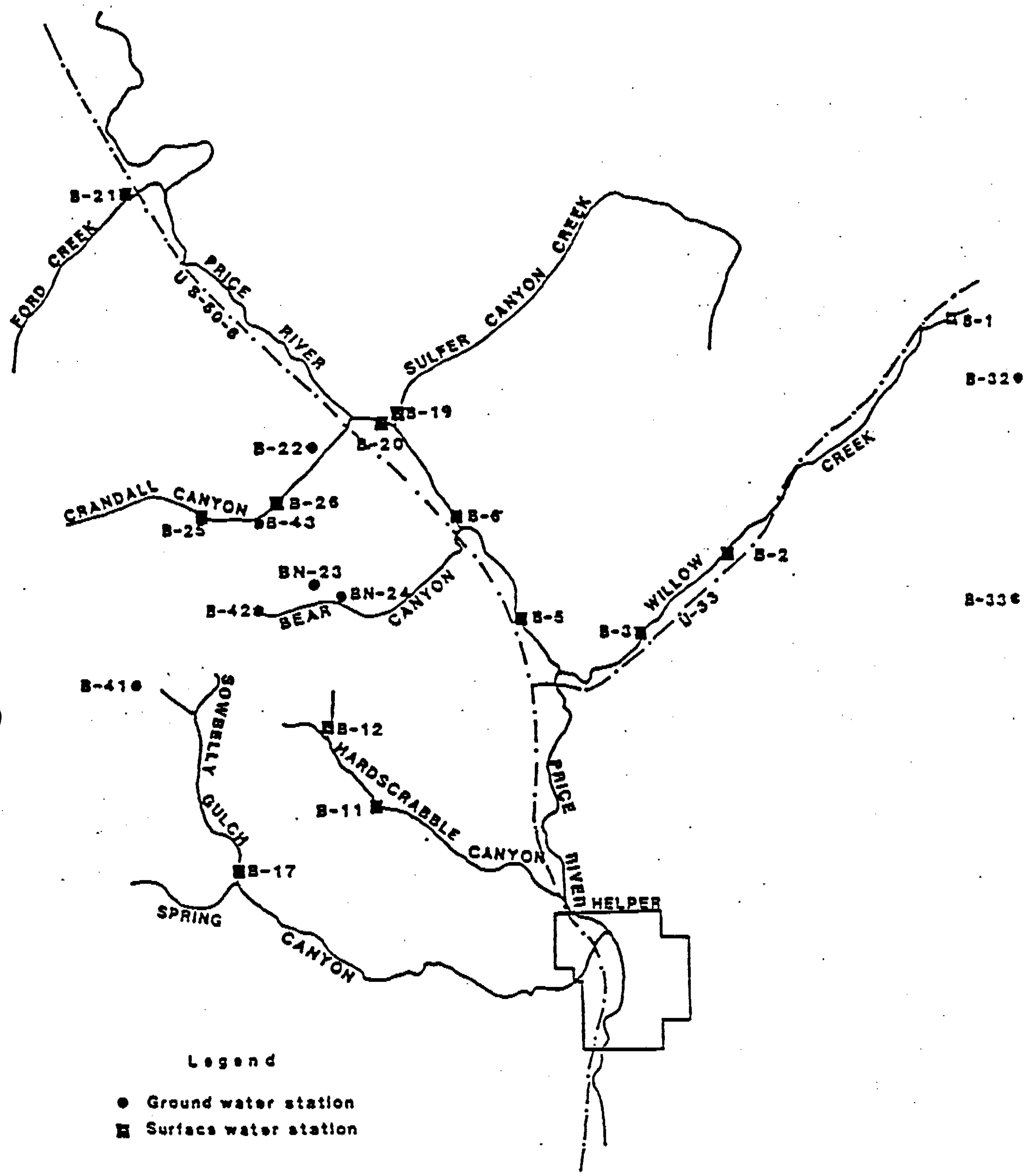


FIGURE 7-14. WATER SAMPLING STATION LOCATIONS FOR PRICE RIVER COAL COMPANY FROM JANUARY, 1980 THROUGH MARCH, 1984.

APPENDIX 7-1

AQUIFER TESTING PROCEDURES

Hydraulic Conductivity Tests

As outlined in a January 20, 1983, letter from Golder Associates, Inc. of Seattle, Washington to Robert Wiley of Price River Coal, the procedures followed by Golder Associates in conducting hydraulic conductivity tests on test wells MC-205, MC-206, and MC-207 were as follows:

> The hydraulic conductivities of the in-situ bedrock materials were obtained from a drilling program by carrying out falling-head permeability tests using through-the-bit inflatable packers. Typically, the tests were carried out in 50-foot long zones at principal strata changes throughout the drillhole stratigraphy.
>
> 1. The drill string is backed off from the bottom of the hole to the top of the interval to be tested;
> 2. A straddle packer system is attached to a wireline cable and placed down the drill rod such that the lower packer protrudes below the bit while the upper packer remains in the drill rod;
> 3. The packers are inflated pneumatically. The test interval is now insulated from the rest of the drillhole;
> 4. Water is added to the drill rod and the rate of decay in the excess water level is measured over time;
> 5. The test is stopped when the water level decays to static.
>
> The Hvorslev method (1) was used to calculate hydraulic conductivity of the test interval.
>
> Values of hydraulic conductivity determined from falling head tests are generally considered index values indicative of the order of magnitude of hydraulic conductivity. This is normally a sufficient estimate for most practical engineering applications. Better accuracy generally requires extensive aquifer testing techniques using multiple hole pump tests, and are typically not warranted in conditions such as those encountered in the Price River area.

APPENDIX 7-2

GROUNDWATER SUMMARY SHEETS

STATION B-001

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0.08	Dry	0.04	Ammonia	-	-	-
pH	8.1	7.8	7.95	Nitrate	-	-	-
Conductivity	-	-	5150	Nitrite	-	-	-
Temp. C degrees (water)	15	14	14.5	Potassium	-	-	-
TSS	34.0	21.0	10.5	Total Phosphate	-	-	-
TDS	4420	1400	2910	Ortho - Phosphate	-	-	-
Hardness	-	-	-	Selenium	-	-	-
Aluminum	-	-	-	Sodium	-	-	-
Arsenic	-	-	-	Sulfate	-	-	-
Barium	-	-	-	Zinc	-	-	-
Boron	-	-	-	Gross Alpha	-	-	-
Carbonate	-	-	-	Gross Beta	-	-	-
Bicarbonate	-	-	-	Oil & Grease	-	-	<1.0
Cadmium	-	-	-	Phenol	-	-	-
Calcium	-	-	-	Alkalinity	668	183	525.5
Chloride	-	-	-	Acidity	100	54.0	77.0
Chromium	-	-	-	Silver	-	-	-
Copper	-	-	-				
Fluoride	-	-	-				

Iron-Total	0.565	0.091	0.292
Iron	-	-	-
Dissolved			
Lead	-	-	-
Magnesium	-	-	-
Manganese	-	-	-
Mercury	-	-	-
Molybdenum	-	-	-
Nickel	-	-	-

STATION BW-23

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0	0	0	Ammonia	-	-	-
pH	WELL	DRY	-	Nitrate	-	-	-
Conductivity	-	-	-	Nitrite	-	-	-
Temp. C degrees (water)	-	-	-	Potassium	-	-	-
TSS	-	-	-	Total Phosphate	-	-	-
TDS	-	-	-	Ortho-Phosphate	-	-	-
Hardness	-	-	-	Selenium	-	-	-
Aluminum	-	-	-	Sodium	-	-	-
Arsenic	-	-	-	Sulfate	-	-	-
Barium	-	-	-	Zinc	-	-	-
Boron	-	-	-	Gross Alpha	-	-	-
Carbonate	-	-	-	Gross Beta	-	-	-
Bicarbonate	-	-	-	Oil & Grease	-	-	-
Cadmium	-	-	-	Phenol	-	-	-
Calcium	-	-	-	Alkalinity	-	-	-
Chloride	-	-	-	Acidity	-	-	-
Chromium	-	-	-	Silver	-	-	-
Copper	-	-	-				
Fluoride	-	-	-				
Iron-Total	-	-	-				
Iron Dissolved	-	-	-				
Lead	-	-	-				
Magnesium	-	-	-				
Manganese	-	-	-				
Mercury	-	-	-				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION BW-24

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0	0	0	Ammonia	-	-	-
pH	WELL	DRY	-	Nitrate	-	-	-
Conductivity	-	-	-	Nitrite	-	-	-
Temp. C degrees (water)	-	-	-	Potassium	-	-	-
TSS	-	-	-	Total Phosphate	-	-	-
TDS	-	-	-	Ortho-Phosphate	-	-	-
Hardness	-	-	-	Selenium	-	-	-
Aluminum	-	-	-	Sodium	-	-	-
Arsenic	-	-	-	Sulfate	-	-	-
Barium	-	-	-	Zinc	-	-	-
Boron	-	-	-	Gross Alpha	-	-	-
Carbonate	-	-	-	Gross Beta	-	-	-
Bicarbonate	-	-	-	Oil & Grease	-	-	-
Cadmium	-	-	-	Phenol	-	-	-
Calcium	-	-	-	Alkalinity	-	-	-
Chloride	-	-	-	Acidity	-	-	-
Chromium	-	-	-	Silver	-	-	-
Copper	-	-	-				
Fluoride	-	-	-				
Iron-Total	-	-	-				
Iron Dissolved	-	-	-				
Lead	-	-	-				
Magnesium	-	-	-				
Manganese	-	-	-				
Mercury	-	-	-				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-32

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0.1	0.08	0.07	Ammonia	-	-	-
pH	8.5	7.9	8.10	Nitrate	0.04	<0.01	0.03
Conductivity	5.90	4.75	5.31	Nitrite	-	-	<0.01
Temp. C degrees (water)	15	8.5	12.13	Potassium	1.43	1.368	1.40
TSS	-	-	11.0	Total Phosphate	0.230	0.060	0.150
TDS	365	325	350.50	Ortho-Phosphate	0.050	0.010	0.03
Hardness	-	-	-	Selenium	<0.001	<0.001	<0.001
Aluminum	-	-	-	Sodium	39.20	28.12	33.71
Arsenic	<0.010	<0.001	0.003	Sulfate	72.0	43.0	56.2500
Barium	0.080	0.01	0.06	Zinc	0.016	0.002	0.01
Boron	-	-	-	Gross Alpha	-	-	-
Carbonate	-	-	-	Gross Beta	-	-	-
Bicarbonate	358.68	295.24	324.52	Oil & Grease	2.60	2.00	2.30
Cadmium	<0.001	<0.001	<0.001	Phenol	-	-	0.104
Calcium	45.60	40.00	42.60	Alkalinity	294	250	273.35
Chloride	10.00	28.00	15.28	Acidity	14.0	<0.01	4.70
Chromium	<0.001	<0.001	<0.001	Silver	<0.001	<0.001	<0.001
Copper	0.020	0.001	0.010				
Fluoride	0.36	0.33	0.34				
Iron-Total	0.980	0.030	0.370				
Iron Dissolved	-	-	-				
Lead	<0.001	<0.001	<0.001				
Magnesium	47.52	37.92	40.82				
Manganese	0.011	0.003	.01				
Mercury	-	-	0.0002				
Molybdenum	-	-	-				
Nickel	-	-	0.010				

STATION B-33

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0.05	–	0.0158	Ammonia	–	–	–
pH	7.0	7.4	7.6250	Nitrate	1.06	0.03	.3065
Conductivity	490	390	4126 6667	Nitrite	<0.01	<0.01	<0.01
Temp. C degrees (water)	7.5	4	5.6250	Potassium	2.25	1.08	1.5058
TSS	68.0	2.0	35.00	Total Phosphate	0.120	0.020	0.0700
TDS	380	255	304.00	Ortho-Phosphate	0.024	0.02	0.0220
Hardness	–	–	–	Selenium	<0.001	<0.001	<0.001
Aluminum	–	–	–	Sodium	12.93	3.50	8.5325
Arsenic	<0.001	<0.001	<0.001	Sulfate	136	43.0	75.500
Barium	0.16	0.060	0.0875	Zinc	0.049	0.009	0.238
Boron	–	–	0.077	Gross Alpha	–	–	–
Carbonate	–	–	–	Gross Beta	–	–	–
Bicarbonate	258.64	236.68	243. 9850	Oil & Grease	4.6	<1.0	2.733
Cadmium	<0.001	<0.001	<0.001	Phenol	–	–	<0.001
Calcium	63.2	52.00	58.00	Alkalinity	212	204	208.00
Chloride	14.0	2.7	8.1758	Acidity	20.	<0.1	10.05
Chromium	<0.001	<0.001	<0.001	Silver	<0.001	<0.001	<0.001
Copper	0.040	0.004	0.0168				
Fluoride	0.25	0.17	0.2167				
Iron-Total	0.640	0.016	.2143				
Iron Dissolved	–	–	0.020				
Lead	<0.001	<0.001	<0.001				
Magnesium	42.7	24.48	31.1950				
Manganese	0.010	0.001	0.0065				
Mercury	<0.0002	<0.0002	<0.002				
Molybdenum	–	–	–				
Nickel	–	–	<0.01				

STATION B-41 *MC 205?*

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	-	-	-	Ammonia	-	-	-
pH	-	-	8.4	Nitrate	-	-	-
Conductivity	-	-	1700	Nitrite	-	-	-
Temp. C degrees (water)	-	-	12	Potassium	-	-	14.40
TSS	-	-	-	Total Phosphate	-	-	-
TDS	-	-	-	Ortho-Phosphate	-	-	-
Hardness	-	-	-	Selenium	-	-	-
Aluminum	-	-	-	Sodium	-	-	90.20
Arsenic	-	-	-	Sulfate	-	-	240
Barium	-	-	-	Zinc	-	-	-
Boron	-	-	-	Gross Alpha	-	-	-
Carbonate	-	-	-	Gross Beta	-	-	-
Bicarbonate	-	-	378.20	Oil & Grease	-	-	-
Cadmium	-	-	-	Phenol	-	-	-
Calcium	-	-	155.20	Alkalinity	-	-	310
Chloride	-	-	380	Acidity	-	-	3.20
Chromium	-	-	-	Silver	-	-	-
Copper	-	-	-				
Fluoride	-	-	-				
Iron-Total	-	-	0.182				
Iron Dissolved	-	-	0.040				
Lead	-	-	-				
Magnesium	-	-	121.44				
Manganese	-	-	0.068				
Mercury	-	-	-				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-42 MC 206

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	–	–	–	Ammonia	–	–	–
pH	8.0	7.7	7.80	Nitrate	0.04	0.01	0.03
Conductivity	2550	1500	2012.50	Nitrite	–	–	–
Temp. C degrees (water)	20	10	15.125	Potassium	7.37	5.00	6.2425
TSS	–	–	–	Total Phosphate	0.550	0.080	0.32
TDS	1887	1350	1614.750	Ortho-Phosphate	–	–	–
Hardness	–	–	–	Selenium	0.001	0.001	0.001
Aluminum	–	–	–	Sodium	588	82.10	381.2750
Arsenic	1.0620	<0.001	0.5407	Sulfate	1160	150	528.500
Barium	0.140	0.045	0.09	Zinc	0.300	0.030	0.17
Boron	–	–	0.150	Gross Alpha	–	–	–
Carbonate	–	–	–	Gross Beta	–	–	–
Bicarbonate	1246.84	195.20	792.3900	Oil & Grease	252.2	22.40	137.30
Cadmium	0.001	<0.001	<0.001	Phenol	0.053	0.004	0.03
Calcium	196.6	20.0	77.950	Alkalinity	1022	160	657.500
Chloride	126	28.0	84.400	Acidity	42.0	<0.01	12.5050
Chromium	0.017	<0.001	0.01	Silver	0.005	0.001	3.0
Copper	0.45	0.020	0.03				
Fluoride	8.07	2.92	5.50				
Iron-Total	264	0.136	66.4340				
Iron	23.60	0.098	11.8490				
Dissolved Lead	<0.001	<0.001	<0.001				
Magnesium	80.64	15.36	47.7200				
Manganese	0.504	0.015	0.1948				
Mercury	–	–	0.0002				
Molybdenum	–	–	–				
Nickel	–	–	0.016				

STATION B-43 MC 207

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	–	–	–	Ammonia	–	–	–
pH	7.783	7.78	7.6125	Nitrate	0.54	0.02	0.3433
Conductivity	1820	1350	167 .500	Nitrite	–	–	–
Temp. C degrees (water)	14	10	11.50	Potassium	11.00	4.50	7.7150
TSS	–	–	363	Total Phosphate	0.800	0.380	.5667
TDS	1679	1120	1024. 75	Ortho-Phosphate	–	–	–
Hardness	–	–	–	Selenium	<0.001	<0.001	<0.001
Aluminum	–	–	–	Sodium	350	310	333.750
Arsenic	0.240	<0.001	0.0807	Sulfate	619	48.0	258.500
Barium	0.100	0.070	0.0820	Zinc	0.220	0.020	0.0917
Boron	–	–	0.130	Gross Alpha	–	–	–
Carbonate	–	–	–	Gross Beta	–	–	–
Bicarbonate	1122.40	795.44	979. 0500	Oil & Grease	25000	107.20	12553.60
Cadmium	0.003	0.001	0.0017	Phenol	0.048	0.015	0.031
Calcium	226.4	48.00	104.200 200	Alkalinity	920	652	802.50
Chloride	66.00	36.8	54.700	Acidity	148	6.0	49.3500
Chromium	0.007	<0.001	0.0030	Silver	<0.001	<0.001	<0.001
Copper	.080	.014	.0513				
Fluoride	1.53	1.50	1.52				
Iron-Total	4.550	0.120	1.42 25				
Iron	0.124	0.080	0.10 20				
Dissolved Lead	.073	.073	.073				
Magnesium	52.80	16.32	37.6 200				
Manganese	.140	0.012	0.0930				
Mercury	–	–	<0.0 002				
Molybdenum	–	–	–				
Nickel	–	–	0.022				

STATION BM-25

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	–	–	–	Ammonia	8.0	0.15	1.4400
pH	8.16	6.9	7.4786	Nitrate	9.00	0.02	1.4786
Conductivity	2050	1390	1646.2857	Nitrite	1.05	1.02	1.0350
Temp. C degrees (water)	13	12	12.50	Potassium	17.80	6.52	10.334
TSS	1900	32.0	354.4286	Total Phosphate	2.80	0.090	0.6451
TDS	1350	906	1080.5741	Ortho-Phosphate	0.54	0.020	0.2051
Hardness	600	530	565.4286	Selenium	<0.001	<0.001	<0.001
Aluminum	0.036	<0.001	0.0185	Sodium	185	6.50	137.1429
Arsenic	<0.001	<0.001	<0.001	Sulfate	580	400	362
Barium	0.110	0.005	0.0534	Zinc	0.408	0.011	0.0913
Boron	0.30	<0.001	0.1494	Gross Alpha	–	–	–
Carbonate	19.20	<0.001	2.7514	Gross Beta	–	–	–
Bicarbonate	558.76	268.4	427.5657	Oil & Grease	4070	3.4	599.2571
Cadmium	<0.001	<0.001	<0.001	Phenol	<0.001	<0.001	<0.001
Calcium	123.2	80.0	7.00	Alkalinity	490	2.54	366.2857
Chloride	150	46.0	99.1429	Acidity			
Chromium	0.013	<0.001	0.0027	Silver	0.051	<0.001	0.0081
Copper	.005	.004	.0043				
Fluoride	0.66	0.50	0.5743				
Iron-Total	3.42	0.072	1.0757				
Iron Dissolved							
Lead	.004	<0.001	0.0017				
Magnesium	79.20	60.94	71.5857				
Manganese	0.218	0.023	0.0734				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum	0.029	<0.001	0.0150				
Nickel	0.169	<0.001	0.0850				

STATION BM-26

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0.01	0.01	0.01	Ammonia	8.00	0.10	7.38
pH	8.2	7.33	7.78	Nitrate	0.84	0.05	0.14
Conductivity	1990	1050	1312.83	Nitrite	<0.01	<0.01	<0.01
Temp. C degrees (water)	9	8	8.25	Potassium	15.51	6.00	6.65
TSS	1228	100	633.67	Total Phosphate	2.30	0.150	0.91
TDS	1300	700	861.00	Ortho-Phosphate	0.150	0.04	0.09
Hardness	522	470	498.67	Selenium	0.005	<0.001	0.003
Aluminum	<0.001	<0.001	<0.001	Sodium	65	18.5	42.64
Arsenic	<0.001	<0.001	<0.001	Sulfate	640	360	430
Barium	0.055	0.012	0.03	Zinc	0.408	0.043	135.72
Boron	0.30	<0.001	0.18	Gross Alpha	-	-	-
Carbonate	<0.001	<0.001	<0.001	Gross Beta	-	-	-
Bicarbonate	270.8	204.96	228.12	Oil & Grease	13.6	1.7	6.90
Cadmium	<0.001	<0.001	<0.001	Phenol	<0.001	<0.001	<0.001
Calcium	112	88	100.67	Alkalinity	277	168	187
Chloride	32.0	24.0	24.33	Acidity			
Chromium	<0.001	<0.001	<0.001	Silver	<0.001	<0.001	<0.001
Copper	0.005	<0.001	0.003				
Fluoride	0.51	0.36	0.43				
Iron-Total	16.430	0.051	6.00				
Iron Dissolved							
Lead	0.003	<0.001	0.001				
Magnesium	62.4	55.2	59.28				
Manganese	0.227	0.021	0.13				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum	0.002	0.002	0.002				
Nickel	<0.001	<0.001	<0.001				

STATION BM-27

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0.002	0	0.001	Ammonia	0.36	<0.01	0.2300
pH	8.0	7.63	7.800	Nitrate	0.70	0.06	0.300
Conductivity	1790	1200	1509.500	Nitrite	<0.01	<0.01	<0.01
Temp. C degrees (water)	9	9	9.0	Potassium	9.11	5.82	7.7925
TSS	14.0	4.0	10.250	Total Phosphate	2.30	0.060	0.6638
TDS	1200	964	1082.500	Ortho-Phosphate	0.040	0.015	0.0238
Hardness	810	740	762.5000	Selenium	<0.001	<0.001	<0.001
Aluminum				Sodium	102	23.0	51.475
Arsenic	<0.001	<0.001	<0.001	Sulfate	660	560	590.00
Barium	0.070	0.050	0.0550	Zinc	0.082	0.020	0.0563
Boron	0.250	0.13	0.1900	Gross Alpha	-	-	-
Carbonate	<0.01	<0.01	<0.01	Gross Beta	-	-	-
Bicarbonate	436.7	200	267.4000	Oil & Grease	5.2	<1.0	2.7500
Cadmium	<0.001	<0.001	<0.001	Phenol			
Calcium	170.4	152	162.1384	Alkalinity	358	164	219.00
Chloride	34.0	28.0	31.00	Acidity			
Chromium	<0.001	<0.001	<0.001	Silver	<0.001	<0.001	<0.001
Copper							
Fluoride	0.50	0.38	0.4350				
Iron-Total	0.409	0.149	0.3198				
Iron Dissolved							
Lead	0.005	<0.001	0.0030				
Magnesium	92.16	84.0	87.2400				
Manganese	0.156	0.004	0.0503				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum							
Nickel							

STATION BM-28

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	–	–	0.005	Ammonia	0.35	0.05	0.1540
pH	7.9	7.2	7.6080	Nitrate	0.06	0.03	0.2240
Conductivity	1850	1380	1538.600	Nitrite	–	–	<0.01
Temp. C degrees (water)	7	4	5.7500	Potassium	7.03	4.76	6.1100
TSS	31.0	7.0	14.6000	Total Phosphate	0.740	0.04	0.1798
TDS	1240	898	1007.2000	Ortho-Phosphate	0.043	<0.01	0.0184
Hardness	830	660	776.00	Selenium	0.004	<0.001	0.0016
Aluminum	–	–	–	Sodium	56.0	15.0	28.000
Arsenic	0.014	<0.001	0.0036	Sulfate	460	360	404.00
Barium	0.057	0.025	0.0404	Zinc	0.074	0.012	0.0368
Boron	0.20	0.075	0.1400	Gross Alpha	–	–	–
Carbonate	<0.01	<0.01	<0.01	Gross Beta	–	–	–
Bicarbonate	488	456.28	467.4960	Oil & Grease	7.4	<1.0	3.1800
Cadmium	<0.001	<0.001	<0.001	Phenol	–	–	–
Calcium	316	180	207.0400	Alkalinity	400	374	383.200
Chloride	32.0	20.0	26.800	Acidity	–	–	–
Chromium	<0.001	<0.001	<0.001	Silver	<0.001	<0.001	<0.001
Copper			0.004				
Fluoride	0.44	0.33	0.3840				
Iron-Total	4.390	0.438	2.9244				
Iron Dissolved							
Lead	0.004	<0.001	0.0018				
Magnesium	96.48	<0.01	62.0180				
Manganese	0.395	0.039	0.2798				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum	–	–	–				
Nickel	–	–	–	–			

APPENDIX 7-3

ALLUVIAL VALLEY FLOORS

- ALLUVIAL VALLEY FLOORS

Alluvial valley floors considerations were not originally thoroughly addressed in the M.R.P. due to company interpretation of the applicable regulations. The following points are considered significant by Price River Coal Company as related to AVF determinations:

1. There are no farmable land units on PRCC property.

2. There has been a negative S.C.S. PFL determination.

3. Their closest serious farming in the Price River valley is in Spring Glen, some 8 miles away from the MPA.

4. Minor hobby and backyard farming occurs within 2 miles of the MPA, in the town of Martin, but is being encroached upon by urban development.

5. Mining and farming have co-existed in the Price River drainage since 1890 with no significant or measured diminution of quantity or quality (statement from Area Water Engineer, M. Page).

6. PRCC and its predecessors have monitored quantity and quality of the Price River since 1977 with no noticeable effects from mining.

7. Several significant surface disturbances by non-mining activities exist between PRCC facilities and potential AVFs, i.e., UP&L power plant, UP&L coal storage piles, treatment ponds and flyash disposal site, a UDOT coal, ash and salt storage site, the DRGW train repair yard. None of these sites benefit from drainage protection for the Price River.

The foregoing facts caused confusion as to the applicability of AVF regulations. In June of 1982 PRCC requested aid from the R.A. in evaluating our situation. The following comments were provided by DOGM as result of a joint field survey on August 9, 1982.

STATE OF UTAH
NATURAL RESOURCES & ENERGY
Oil, Gas & Mining

August 23, 1982

Mr. Rob Wiley
Price River Coal Company
P.O. Box 629
Helper, Utah 84526

RE. AVF DETERMINATION
PRICE RIVER COMPLEX
ACT/007/004
CARBON COUNTY, UTAH

Dear Rob:

Enclosed is the Division determination of the existence and status of alluvial valley floors on and adjacent to Price River Coal Company's mine plan. These determinations were made as a result of the investigation conducted on August 9, 1982.

If you have any questions or comments, please contact me, Tom Tetting or Dave Darby.

Sincerely,

JAMES W. SMITH, JR.
COORDINATOR OF MINED
LAND DEVELOPMENT

cc. Allen Klein, OSM, DENVER
David Darby, DOGM
Tom Tetting, DOGM

JWS/DD/sm

ALLUVIAL VALLEY FLOOR DETERMINATION

OF PRICE RIVER COAL COMPANY'S

MINE PLAN AND ADJACENT AREAS

Introduction

In response to OSM's comments pertaining to alluvial valley floors in the Apparent Completeness reivew dated May 29, 1982, Price River Coal Company requested that a field determination be made of their project and adjacent areas by a regulatory agency to evaluate the existence of any alluvial valley floor.

On August 9, 1982, personnel from the Division of Oil, Gas and mining representing various disciplines toured Price River Coal Company's mine permit area and areas adjacent to the mining project specifically to determine the existence of any alluvial valley floors and if existent, to what extent mining could affect the alluvial valley floors.

Federal and State regulations provide for the protection of alluvial valley floors from mining activities. No coal mining operation can materially damage the quantity or quality of surface or groundwater systems which supply alluvial valley floors, and mining operations may not interrupt, discontinue, or preclude forming an alluvial valley floor. By definition alluvial valley floors are:

> ". . .the unconsolidated stream laid deposits holding streams with water available sufficient for subirrigation or flood irrigation agricultural activities but does not include unplanned areas which are generally overlain by thin veneer of colluvial deposits formed by unconcentrated runoff or slope wash, together

with talus, or other mass-movement accumulations, and windblown deposits"

In a general sense, alluvial valley floors are those areas which are located in topographic valleys, which are underlain any unconsolidated deposits which usually have a landform appearance of floodplains or terraces, which have an agricultural importance derived from the availability of surface or groundwater.

Applicants are required to make initial identifications of alluvial valley floors based on readily or easily obtainable data, and conduct detailed studies only on specific problem areas.

Findings

Tom Tetting, Engineering Geologist; Everett Hooper, Soils Specialist; Lynn Kunzler, Biologist; and David Darby, Hydrologist; from the Division of Oil, Gas and Mining met with Rob Wiley, Environmental Engineer; and Don Stephens, Geologist; representatives of Price River Coal Company.

Preliminary discussions took place at Price River Coal Company's office in Helper, Utah. Maps were examined which depicted historic, present and future mining areas as well as topographic and geomorphic featues. Potential AVF sites along Willow Creek, the Price River, Spring Canyon and Kenilworth, Utah were chosen for investigation.

The conditions along Willow Creek and the Price River within the mine plan area are limited with respect to the existence of AVFs. State highways, railroad tracks, precipitous slopes, river width and narrow canyon walls account for only a few areas that qualify as AVF under the specified size criteria of an area 50 feet wide or 10 acres in size. Such areas have been utilized already for a sewage treatment facility, an electrical power plant and the coal loadout for Price River Coal Company which were there prior to the passage of SMCRA. Several areas up Willow Creek have been used as coal waste dumps during earlier mining times.

Historically there has not been any farming along the Price River or Willow Creek. Price River Coal Company presently owns all surface rights along the rivers and during the process of mining foresees no change in that status.

Outside the mine plan area three sites were investigated for their potential as an AVF. The area surrounding the town of Martin, two miles downstream from the eastern edge of the mine plan area along the Price River, showed good conditions for an AVF. The area lies on a pediment formed by stream laden deposits of the Price River and include several small parcels of land developed (approximately 41 acres) for agriculture (corn and alfalfa and one orchard) by several individuals. Upon further examination, it was learned that irrigation waters for farming are supplied via canal diverted from the Price River. No springs or wells occur near the town of Martin for irrigation or culinary purposes.

Spring Canyon was another area examined where a small orchard (approximately 2 acres) exists. Communications with the owner revealed that the orchard has been abandoned for 11 or 12 years. Water from two springs about 150 yards an about 1/4 miles above the orchard was used for irrigation. The flow rate at the present time is approximatley 35 to 40 gpm. The owner stated that the flow had decreased in the last 20 years although no records or data of flow exist. The most significant decrease took place after several mines closed down.

The area surrounding the town of Kenilworth was investigated due to its location adjacent to the mine plan area. The investigation revealed that it is located on a pediment of the Manchos shale. although flora exists amidst the residential section, there is no farming. Water is supplied through a public water system. The stream channels are ephemeral in nature and do not contribute to irrigation.

Determination

Alluvial valley floor investigations within and adjacent to the proposed Price River Coal Company's permit area has resulted in the determination that the criteria necessary to establish an alluvial valley floor does exist to a small extent within the river channels of the permit area, and to a great extent near the suburbs of Martin immediately south of the mine plan area and in Spring Canyon.

In view of information presented during the tour it was determined that:

1. The Price River is monitored above and below the coal processing plant to access changes in water quality.
2. Historic mining in 30 to 40 mines has existed in and adjacent to the mine plan area along the escarpment which lies above Kenilworth, Spring Canyon, Martin and Helper. Also, the Price River has been mined under several times. It is

speculated that any groundwater that could supply those areas has already been affected. Since present mining occurs farther down dip and away from the AVF there is less chance that mining will have any effect on the AVFs.

3. No farming or agricultural activity takes place on the mine plan area, and therefore the small areas along the river channels that could be classified by definition as AVFs are insignificant due to their isolation and size.

4. There was no finding near the town of Kenilworth that indicated an AVF exists.

5. There are no wells used in and adjacent to the mine plan area. The springs up Spring Canyon are used by one family to water their lawn. All other irrigation uses water is supplied via canal by the Price River which in turn is regulated from Scofield Reservoir. All culinary water is supplied from springs near Scofield Reservoir and from the water treatment plant north of the coal processing facility which takes water from the Price River.

The Division has made the determination that present and future mining will not change the status or condition of the water resources, soils or geology relating to alluvial valley floors in or adjacent to the mine plan area. Mining will not interrupt or cause diminution of the existing ground water or irrigation waters in a significant manner.

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: R-001
Location: Mine #2 discharge

Date	Time	Flow (cfs)	Temp. Air (°C)	Temp. Water (°C)	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD (mg/l)	COD (mg/l)	TOC (mg/l)	Dissolved Oxygen (mg/l)	Oil & Grease (mg/l)	Phenol (mg/l)
11-19-77	16:15	Dry												
12-29-77	09:30	Dry												
1-18-78	10:15	Dry												
1-25-78	14:00	Dry												
2-8-78	10:00	Dry												
2-22-78	11:00	Dry												
3-8-78	11:00	Dry												
3-22-78	09:45	Dry												
4-11-78	09:45	Dry												
4-26-78	09:10	Dry												
5-10-78	11:00	Dry												
5-24-78	14:00	Dry												
6-14-78	09:30	Dry												
6-28-78	14:15	Dry												
7-12-78	17:00	Dry												
7-26-78	11:00	Dry												
8-9-78	7:05	0.01	52	15	7.8	2	<2			1.7		9.3	<1.0	
8-23-78	10:15	0.08	19	14	8.1							7.8		
9-13-78	9:15	Dry												
9-27-78	18:00	Dry												
10-11-78	09:00	Dry												
10-25-78	09:15	Dry												

Date	TSS (mg/l)	Total Settleable Solids	TDS (mg/l)	Total Solids (mg/l)	Total Volatile Solids (mg/l)	Specific Cond.	Turbidity	Alk. as CO_3 (mg/l)	Alk. as HCO_3 (mg/l)	Total Alk. as $CaCO_3$ (mg/l)	Total Hardness as $CaCO_3$ (mg/l)	Acidity as $CaCO_3$ (mg/l)	Gross Alpha	Gross Beta
11-19-77														
12-29-77														
1-18-78														
1-25-78														
2-8-78														
2-22-78														
3-8-78														
3-22-78														
4-11-78														
4-26-78														
5-10-78														
5-24-78														
6-14-78														
6-28-78														
7-12-78														
7-26-78														
8-9-78	24.0		4420			750				668		100		
8-23-78	21.0		1400							183		54.0		
9-13-78														
9-27-78														

Date	Iron Dis. (mg/l)	Iron Total (mg/l)	Comments
11-19-77			
12-29-77			
1-18-78			
1-25-78			
2-8-78			
2-22-78			
3-8-78			
3-22-78			
4-11-78			
4-26-78			
5-10-78			
5-24-78			
6-14-78			
6-28-78			
7-12-78			
7-26-78			
8-9-78		0.091	
8-23-78		4.515	
9-13-78			
9-27-78			

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: E-22
Location: Crandall Canyon Spring

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen: Ammonia	Nitrogen: Nitrate	Nitrogen: Nitrite	Nitrogen: Total Kjeldahl	Nitrogen	Phosphate: Total	Phosphate: Ortho	Sulfate	(col.)	(col.)	TSS	Total Settleable Solids	TDS	Total Solids	Total Volatile Solids	Cond	Turbidity	(col.)	(col.)	Total Alk.	Total Hardness	Acidity	Gross Alpha	Gross Beta
7-23-90	11:25	0.004	29	15.5	7.3																																	
8-31-90	11:35	0.004	10	7	7.1											<0.01				0.070		460					1068			1650			561.24	460		4.0		
6-27-91	11:35	0.004	17	11	7.4								5.40	<0.001		1.13				0.500		240					795			1200			597.80	490		42.0		
10-29-91	10:10		6	7	7.3								3.00	<0.001		<0.01				0.230		300					885			1000			513.49	467		<0.01		
[illegible]	10:51			3	5.7								2.80	0.004		0.06				3.00		291					938			890			714.24	583		30.00		
[illegible]-92	10:25	0.002	12	10	7.3								0.80	0.005		0.96				0.520		300			440		966			750			628	510		30.00		
[illegible]-31-92	10:32	0.006	7	6	7.6								1.2	0.005		<0.01				0.180		470					820			1331			387	368		108		
1-17-93	11:50	0.009	23	23	7.8								<0.1	0.015		<0.05				0.120		258			19.0		950			790			601.00	564.30		26.00		
													0.3	<0.001		0.02				0.18		276					885			1255			694.44	480		20.00		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis.	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide	Fluoride Dis.	Total	Iron Dis.	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica	Silver Total	Sodium Total	Zinc Total	Vanadium Total				Comments
7-23-90			<0.001	0.160			<0.001	148	70.0	<0.001		<0.001					0.540	<0.001	134.40	0.510			0.01	6.00	<0.001			22.60	0.010					
8-31-90			<0.001	0.093		0.050	<0.001	144	11.0	<0.001		0.012	<0.001	0.27		0.035	0.096	<0.001	98.30	0.009	<0.0002			7.40	<0.001		<0.001	16.50	0.077					
6-27-91			0.025	0.040			<0.001	144	26.70	<0.001		0.010		0.49			1.800	<0.001	92.64	0.360				6.40	<0.001		<0.001	22.00	0.122					
10-29-91			0.010	0.045			<0.001	140	27.00	<0.001		0.045		0.37			0.160	<0.001	96.00	0.115				1.40	<0.001		<0.001	33.00	0.020					
[illegible]-91			<0.001	0.030			<0.001	150	22.53	0.120		0.010		0.24			6.250	<0.001	95.00	0.370				6.50	<0.001		<0.001	35.00	0.020					
[illegible]-92			0.003	1.010			<0.001	141	21.20	<0.001		0.020		0.32			6.300	<0.001	92.00	0.470				6.00	<0.001		<0.001	26.00	0.060					
[illegible]-92			<0.001	0.050	<0.001		<0.001	135.60	22.10	<0.001		0.020		0.30			2.950	<0.001	95.44	0.460				2.10	<0.001		<0.001	26.00	0.108	<0.001				
1-17-93			<0.001	0.260			<0.001	138.00	24.0	0.011		0.011		0.28			3.200	<0.001	102.72	0.066				1.8	<0.001		<0.001	31.0	0.065					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station E-22
Location Cordell Canyon Spring

DATE	TIME	FLOW	TEMPERATURE AIR	TEMPERATURE WATER	pH	COLIFORM TOTAL	COLIFORM FECAL	FECAL STREP	BOD	COD	TOC	DISSOLVED OXYGEN	OIL & GREASE	PHENOL	NITROGEN AMMONIA	NITROGEN NITRATE	NITROGEN NITRITE	NITROGEN TOTAL KJELDAHL	NITROGEN ORGANIC	PHOSPHATE TOTAL	PHOSPHATE ORTHO				SOLIDS TSS	SOLIDS TOTAL SETTLEABLE	SOLIDS TDS	SOLIDS TOTAL	SOLIDS TOTAL VOLATILE	SPECIFIC COND	TURBIDITY							
2-26-79	4:40	0.01	23	19	7.2						37.0	6.4	1.6			0.03	<0.01	0.015			0.020	300			1.0		370						642					
1-27-79	11:45	0.02	6	9	7.8						36.0	9.0	1.6			0.02	<0.01	<0.10			0.020	242			7.0		770			1220			505					
6-22-79	19:00	0.04	26	19	26.5							7.5				0.22					<0.010	281					800			1260			460	382		30.0		

DATE																																		COMMENTS
2-26-79			0.021	0.090			<0.001	45.6	22.0	<0.001		0.004		0.44			0.344	0.001	40.72	0.021	<0.0002			2.56	<0.001	23.0	<0.001	30.0	0.344					
1-27-79			<0.001	0.22			<0.001	120	22.0	<0.001		0.010		0.42			0.097	<0.001	65.5	0.585	<0.0002			6.620	<0.001	6.0	<0.001	60.0	0.012					
6-22-79			<0.001	0.05			<0.001	105.8	74.0	<0.001		0.001		0.35			0.560	<0.001	45.12	0.118				6.470	<0.001		<0.001	109	0.009					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station BW-23
Location Bear Canyon - Upper Hole

Date	Time	Water Level (ft)	Comments
6-23-80	11:61	Dry	
10-31-80	[illegible]	Dry	
6-23-81	14:39	Dry	
10-29-81	Inaccessible		
12-3-81	15:30	Dry	Gate Jammed - Gate Locked
6-18-82		Dry	
10-18-82		Dry	
6-29-83	Inaccessible		
8-17-83	Inaccessible		Bad weather. Mud slide Mud slide across road

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station BW-23
Location Bear Canyon - Upper Hole

Date	Time	Water Level (ft)
6-23-80	11:61	Dry
10-21-80	13:44	Dry
6-22-81	11:39	Dry
9-23-81	Inaccessible	
12-3-81	15:30	Dry
6-14-82		Dry
9-8-82		Dry
6-18-83	Inaccessible	
1-17-83	Inaccessible	

Date	Comments
6-23-80	
10-31-80	
6-22-81	
9-21-81	
12-3-81	
6-14-82	Ice! Jammed inlet insert
9-8-82	
6-18-83	
1-17-83	
	Road blocked - Mud slide
	Mud slide across road

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B.W-23
Location: Upper Well in Bear Canyon

Date	Time	
[illegible]	9:35	-0-
[illegible]	9:00	-0-
[illegible]		-0-

Date
[illegible]
[illegible]
[illegible]

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station BW-24
Location Bear Canyon
Lower Drill Hole

Date	Time	Water Level	Temperature Air	Temperature Water
6-23-80	1554	Dry		
9-3-80	1346	Dry		
6-23-81	1132	Dry		
9-24-81	Inaccessible			
12-3-81	1655	Dry		
6-14-82		Dry		
9-8-82		Dry		
6-28-83			Inaccessible	
9-12-83			Inaccessible	

Date	Comments
6-23-80	
9-3-80	
6-23-81	
9-24-81	
12-3-81	
6-14-82	Gate locked: left [illegible]
9-8-82	
6-28-83	
9-12-83	
	Road blocked - Mud slide
	Mud slide across road

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station BW-24
Location lower well in Bear Canyon

DATE	TIME		TEMPERATURE AIR	TEMPERATURE WATER	pH	COLIFORM TOTAL	COLIFORM FECAL	FECAL STREP
5-24-79	14:00	-0-						
[illegible]-27-79	1310	-0-						
[illegible]-21-79		-0-						

DATE	
5-24-79	
[illegible]-27-79	

COMMENTS

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-27
Location: Discharge in Crandall Canyon - 24" CMP Pipe

DATE	TIME	FLOW	TEMPERATURE AIR	TEMPERATURE WATER	pH	COLIFORM TOTAL	COLIFORM FECAL	FECAL STREP	COD	BOD	TOC	DISSOLVED OXYGEN	OIL & GREASE	PHENOL
6-19-82	1525	0.81	13	11	8.0								4.2	6.130

DATE	NITROGEN [illegible]	NITROGEN [illegible]	NITROGEN [illegible]	NITROGEN TOTAL [illegible]	NITROGEN ORGANIC	PHOSPHATE TOTAL as PO_4	PHOSPHATE ORTHO as PO_4	[illegible]	[illegible]	[illegible]	SOLIDS TSS	SOLIDS TOTAL SETTLEABLE SOLIDS	SOLIDS TDS	SOLIDS TOTAL	SOLIDS TOTAL VOLATILE SOLIDS
6-19-82											30.0		820		

DATE	SPECIFIC COND	TURBIDITY	[illegible] as CO_3	[illegible] as HCO_3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6-19-82	1367								

DATE	ALUMINUM TOTAL	ANTIMONY TOTAL	ARSENIC TOTAL	BARIUM TOTAL	BERYLLIUM TOTAL	BORON TOTAL	CADMIUM TOTAL	CALCIUM TOTAL	CHLORIDE DIS	CHROMIUM HEXAVALENT	COBALT TOTAL	COPPER TOTAL	CYANIDE as CN	FLUORIDE DIS	[illegible] TOTAL	IRON DIS	IRON TOTAL
6-19-82																	0.680

DATE	LEAD TOTAL	[illegible] TOTAL	MANGANESE TOTAL	MERCURY TOTAL	[illegible] TOTAL	NICKEL TOTAL	[illegible] TOTAL	[illegible] TOTAL	SILICA as SiO_2	SILVER TOTAL	SODIUM TOTAL	ZINC TOTAL	[illegible] TOTAL				COMMENTS
6-19-82			0.155														

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station [illegible]
Location [illegible]

DATE	TIME		TEMPERATURE AIR	TEMPERATURE WATER	pH	COLIFORM TOTAL	COLIFORM FECAL	FECAL STREP	COD	BOD	TOC	DISSOLVED OXYGEN	OIL & GREASE	[illegible remaining columns]
[illegible]	[illegible]	-0-												
[illegible]	[illegible]	-0-												
[illegible]		-0-												

DATE	[illegible column headings]	COMMENTS
[illegible]		
[illegible]		
[illegible]		

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station [illegible]
Location [illegible] well [illegible] East Corner

Date	Time		Temperature: [illegible]	Temperature: Water	pH	Coliform: Total	Coliform: Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen	Phosphorus	Solids	[illegible]
[illegible]	[illegible]	-0-																
12 27 7[illegible]	1310	-0-																
[illegible]		-0-																

Date	[illegible]	Comments
[illegible]		
[illegible]		

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: BW-24
Location: Bear Canyon
Lower Drill Hole

DATE	TIME	WATER LEVEL	TEMPERATURE AIR	TEMPERATURE WATER	pH
6-23-80	15:64	Dry			
9-31-80	13:46	Dry			
6-23-81	10:42	Dry			
10-21-81	Inaccessible				
12-3-81	16:53	Dry			
6-14-82		Dry			
8-11-82		Dry			
6-28-83			Inaccessible		
8-17-83			Inaccessible		

DATE	COMMENTS
6-23-80	
9-31-80	
6-23-81	
10-21-81	
12-3-81	Gate locked - not found
6-14-82	
8-11-82	
6-28-83	
8-17-83	Road blocked - Mud slide
	Mud slide across road

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station [illegible]
Location [illegible] Spring

DATE	TIME	FLOW	TEMPERATURE AIR	TEMPERATURE WATER	pH	COLIFORM TOTAL	COLIFORM FECAL	FECAL STREP	COD	BOD	TOC	DISSOLVED OXYGEN	OIL & GREASE	PHENOL	NITROGEN AMMONIA	NITRATE	NITRITE	KJELDAHL	ORGANIC	PHOSPHORUS TOTAL	ORTHO	[illegible]	[illegible]	[illegible]	TSS	TOTAL DISSOLVED SOLIDS	TDS	TOTAL	TOTAL VOLATILE	SPEC. COND.	TURBIDITY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5-24-78	9:45	0.1	14	16	7.9						25.0	8.9	2.0			0.04	<0.01	0.12			0.05	34.0			1160		360			560			2278					
1-27-79	13:06	-0-																																				
6-21-79	11:50	0.08	22	11	7.1							8.6				0.04					0.010	52.0					345			590			2548	740		14.0		

DATE	ALUMINUM TOTAL	ANTIMONY TOTAL	ARSENIC TOTAL	BARIUM TOTAL	BERYLLIUM TOTAL	BORON TOTAL	CADMIUM TOTAL	CALCIUM TOTAL	CHLORIDE	CHROMIUM	COBALT TOTAL	COPPER TOTAL	CYANIDE	FLUORIDE	[illegible] TOTAL	IRON	IRON TOTAL	LEAD TOTAL	MAGNESIUM TOTAL	MANGANESE TOTAL	MERCURY TOTAL	MOLYBDENUM TOTAL	NICKEL TOTAL	POTASSIUM TOTAL	SELENIUM TOTAL	SILICA	SILVER TOTAL	SODIUM TOTAL	ZINC TOTAL	[illegible] TOTAL				COMMENTS
5-25-78			<0.01	<0.01			<0.01	454.6	27.1	<0.01		0.016		0.32			1050	<0.001	3436	0.01	0.002			4.9	<0.001	21.40	<0.001	3470	0.010					
1-27-79																																		
6-21-79			<0.001	0.142			<0.001	444.0	15.0	<0.01		0.005		0.25			1250	<0.001	4150	0.003				13.8	<0.001		<0.001	1512	0.003					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: F-32
Location: Mollie Canyon Spring

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen Ammonia	Nitrate	Nitrite	Nitrogen	Nitrogen	Phosphorus Total	Phosphorus Ortho	Sulfate			TSS	Total Dissolved Solids	TDS	Total Solids	Total Volatile Solids	Cond.	Turbidity							
4-25-79	15:40	0.04	21	14	7.0											<0.01				0.060		41.0					222			500			220.0	276		<1.1		
5-31-80	12:16																																					
12-27-80	07:00	--																																				
4-27-81	12:45	0.04	25	11	7.6								2.60	0.104		<0.01				0.210		72.0					362			475			220.0	250		<0.01		
9-27-81	12:21		In-Accessible.			Gate locked!																																
11-6-81	10:10	0.004	6	4	7.5								3.20	0.013		1.18				0.500		81.0					325			270			2630	2030		<2.00		
6-19-82	11:50	0.007	15	6	7.8								<0.2	0.019		1.45				0.040		60.0					218			527			2816	2720		20.00		
11-18-82	17:00	0.009			8.2								<0.1	0.010		1.19				0.060		55.0					295			450			3468	2180		<0.01		
6-27-83	Inaccessible	-																																				
8-17-83	Inaccessible																																					

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride	Chromium Hex.	Cobalt Total	Copper Total	Cyanide	Fluoride		Iron Dis.	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica	Silver Total	Sodium Total	Zinc Total	Total				Comments
4-25-79			<0.001	0.088			<0.001	45.50	19.0	<0.005		<0.001					0.920	<0.001	29.48	1.13			<0.010	1.45	<0.001			21.50	0.017				1	
5-31-80																																		Gate locked Inaccessible
12-27-80																																		Reason: No Flow
4-27-81			0.019	[illegible]			<0.001	40.0	[illegible]	<0.001		0.020		[illegible]			[illegible]	<0.001	11.92	[illegible]				[illegible]	<0.001		<0.001	[illegible]	[illegible]					
9-27-81																																		Gate locked
11-6-81			<0.001	0.040			<0.001	62.00	6.90	<0.001		0.020		0.31			1.010	<0.001	30.00					1.53	0.009		<0.001	8.50	0.034					
6-19-82			<0.001	0.030			<0.001	60.00	4.40	<0.001		0.010		0.20			0.040	0.002	26.90	0.005				1.18	<0.001		<0.001	8.5	0.030					
11-18-82			<0.001	0.045			<0.001	80.00	1.80	<0.001		0.020		0.22			1.220	<0.001	25.92	0.030				1.30	<0.001		<0.001	8.6	0.035					
6-27-83																																		Gate locked
8-17-83																																		Gate locked

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station [illegible]
Location [illegible]

DATE	TIME	FLOW	TEMPERATURE AIR	TEMPERATURE WATER	pH	COLIFORM TOTAL	COLIFORM FECAL	FECAL STREP	COD	BOD	TOC	DISSOLVED OXYGEN	OIL & GREASE	PHENOL	NITROGEN [illegible]	NITROGEN [illegible]	NITROGEN [illegible]	NITROGEN [illegible]	NITROGEN [illegible]	PHOSPHATE TOTAL	PHOSPHATE [illegible]	[illegible]	[illegible]	[illegible]	SOLIDS [illegible]	SOLIDS [illegible]	SOLIDS [illegible]	SOLIDS TOTAL	SOLIDS [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8-29-80	1436	0.002	17	16	7.9											0.98				0.020		42.0					[illegible]			390			27112	[illegible]		[illegible]		
10-31-80	1057	0.004	2	5	7.4								2.60	<0.001		0.06				0.120		45.0					268			400			23414	212		20.0		
6-29-81	1231		Inaccessible																																			
10-29-81	1241		Inaccessible																																			
8-6-81	1240	0.007	9	3	7.7								1.80	0.030		0.50				0.400		66.0					366			358			30652	283		<0.01		
6-14-82	0825	0.016	11	7	8.3								<0.2	<0.001		<0.01				0.090		24.0					388			629			49370	272.0		<0.01		
10-14-82	1510	0.01			8.3								0.4	<0.001		0.17				0.070		78.0					396			600			31690	280.0		<0.01		
6-27-83	Inaccessible																																					
8-17-83	Inaccessible																																					

DATE	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible]	[illegible]	[illegible] TOTAL	[illegible] TOTAL	[illegible]	[illegible]	[illegible] TOTAL	[illegible]	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible]	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL				COMMENTS
8-29-80			[illegible]	0.062			<0.001	54.40	5.0	<0.001		0.040					0.440	<0.001	54.49	<0.01			7.41	1.08	<0.001			8.30	0.05					
10-31-80			<0.001	0.190		1.077	<0.001	52.00	2.7	<0.001		0.011	<0.001	0.17		0.020	0.085	<0.001	29.76	0.010	<0.0002			7.25	<0.001		<0.001	3.50	0.022					
6-29-81																																		
10-29-81																																		[illegible] Gate locked
8-6-81			<0.001	0.145			<0.001	40.50	17.40	<0.001		<0.001		0.26			0.090	<0.001	42.00					1.40	<0.001		<0.001	33.50	0.010					
6-14-82			<0.001	0.050			<0.001	68.50	6.20	<0.001		0.010		0.25			0.030	<0.001	42.60	0.010				1.32	<0.001		<0.001	29.0	0.035					
10-14-82			<0.001	0.090			<0.001	48.80	14.50	<0.001		<0.001		0.24			1.200	0.002	52.80	0.010				1.36	<0.001		<0.001	33.3	0.002					
6-27-83																																		
8-17-83																																		Road closed - [illegible] Gate locked

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station [illegible]
Location [illegible]

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenols	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Phosphate Total	Phosphate Ortho	Sulfate	[illegible]	[illegible]	Solids TSS	Total Settleable Solids	TDS	Total Solids	Total Volatile Solids	Specific Cond	Turbidity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Gross Alpha Activity	Gross Beta Activity
[illegible]-24-79	11:20	0.05	11	4	7.6						10.0	9.5	<1.0			0.05	<0.01	<0.10			1.02	77.0			2.0		315			1190			156.48					
7-23-79	11:20	0.007	19	7.5	7.6						6.0	9.7	4.6			0.11	<0.01	<0.10			1.024	136			67.0		880						244.5					
[illegible]-27-79	12:40	-0-																																				

Date	Total	Total	Total	Total	Total	Total	Total	Total	[illegible]	[illegible]	Total	Total	[illegible]	[illegible]	Total	[illegible]	Total	Total	Total	Total	Total	Total	Total	Total	Total	[illegible]	Total	Total	Total	Total				Comments
[illegible]-24-79			<0.001	0.04			<0.001	6.40	14.0	<0.01		0.004		0.20			0.116	<0.001	28.19	.005	.002			1.551	<0.001	6.40	<0.001	16.9	0.049					
7-23-79			<0.001	0.11			0.001	11.2	5.0	<0.001		0.012		0.25			0.116	<0.001	57.2	.001	<.002			1.362	<0.01	2.0	<0.001	7.40	0.002					
[illegible]-27-79																																		[illegible]

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station MC-205 (B-41)
Location Snowbelly Drill Hole

Date	Time		Temperature Air °C	Temperature Water °C	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenols	Nitrogen Ammonia as N	Nitrogen Nitrate as N	Nitrogen Nitrite as N	Nitrogen Total Kjeldahl	Nitrogen Organic
6-23-80	13:15						2" PVC pipe is warped. Sample will not go down the hole.												
10-31-80	14:56																		
6-29-81	11:20																		
10-23-81	15:60																		
6-19-82	13:20		18	10	6.7														
10-18-82	14:40		16	9	7.8								1.4	0.003		<0.01			
1-17-83	14:40		19	11	7.8								1.0	0.004		0.14			
													<0.2	0.136		0.05			

Date	Phosphorus Total as PO_4	Phosphorus Ortho as PO_4	Sulfate as SO_4	Hydroxide as OH	Carbonate as CO_3	Solids TSS	Solids Total Settleable	Solids TDS	Solids Total	Solids Total Volatile	Cond	Turbidity	Alkalinity as $CaCO_3$	Bicarbonate as HCO_3	Total Hardness as $CaCO_3$	Total Hardness	Acidity as $CaCO_3$	Gross Alpha	Gross Beta
6-23-80																			
10-31-80																			
6-29-81																			
10-23-81																			
6-19-82																			
10-18-82	0.020		538					1150			1485			328.80	376.50		6480		
1-17-83	0.060		777					1320			1990			208.80	172		11.00		
	0.15		448					856			1496			88.34	210		14.00		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Dis	Hydrogen Sulfide Total	Iron Dis	Iron Total	Lead Total
6-23-80																		
10-31-80																		
[illegible]																		
4-29-1																		
6-14-82			0.003	0.100			<0.001	165.50	50.90	<0.001		0.030		0.50			29.500	0.004
10-18-82			<0.001	0.050			<0.001	72.10	47.86	0.017		0.040		1.08			1480	<0.001
1-17-83			<0.001	0.180			0.002	24.00	49.0	0.015		0.010		0.12			70.600	<0.001

Date	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	Total	MC-205A Depth to water (feet)	MC-205 Level to water (feet)		Comments
6-23-80													33.01			
10-31-80													35.20			Not enough water to Sample
[illegible]													35.50	79.95		Not enough water to Sample
4-29-1													35.76	79.05		Not enough water to Sample
6-14-82	115	0.210				13.20	<0.001		<0.001	99.5	0.160			95.44		
10-18-82	43.60	0.301				2.30	<0.001		<0.001	220	0.700		34.96	88.07		
1-17-83	122.40	0.45				2.5	<0.001		<0.001	75.0	0.157			81.98		MC-205A-lost Jammed Shut

VAUGHN HANSEN ASSOCIATES
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WATER QUALITY DATA

Station: NPC 20?

Location: Scrubbily Canyon observation hole

Date	Time		Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenols	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Phosphate Total	Phosphate [illegible]	Sulfate	[illegible]	[illegible]	Solids TSS	Solids Total Dissolved	Solids TDS	Solids Total	Solids Total Volatile	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Alkalinity	[illegible]	[illegible]
5.23.79	14:30			12	8.4																	240					1112			1700			778.20	310		32.0		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Diss.	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide	Fluoride Diss.	[illegible] Total	Iron Diss.	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica Diss.	Silver Total	Sodium Total	Zinc Total	[illegible] Total				Comments
5.23.79								152.70	38.0							0.040	0.182		121.41	.065				19.40				42.26						Water depth: 124.3'

B 1-79

VAUGHN HANSEN ASSOCIATES
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WATER QUALITY DATA

Station: MC 206
Location: Bear Canyon observation hole

Date	Time		Temperature Air °C	Temperature Water °C	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	[illegible]	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Phosphorus Total	Phosphorus [illegible]	[illegible]	[illegible]	[illegible]	Solids [illegible]	Solids [illegible]	Solids [illegible]	Solids Total	Solids [illegible]	Specific Cond.	Turbidity	[illegible]	[illegible]	Total [illegible]	Total [illegible]	[illegible]	[illegible]	[illegible]
1579	1080		24	20	7.0																	1160					1557			1500			19630	140		8.0		

Date	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible]	[illegible]	[illegible] Total	[illegible] Total	[illegible]	[illegible]	[illegible] Total	Iron [illegible]	[illegible] Total	Lead Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible]	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total				Comments
6-79								496.6	77.0							25.60	7.4		5.36	0.524				29.7				82.10						

VAUGHN HANSEN ASSOCIATES
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WATER QUALITY DATA

Station MC 206 (B-42)
Location Bear Canyon Drill Hole

Date	Time	Temperature Air °C	Temperature Water °C	pH	Oil & Grease	Phenol	Nitrogen [illegible]	Phosphate Total	[illegible]	Solids TSS	Solids TDS	Cond	[illegible]	[illegible]	[illegible]
2-23-80	17:10		5.6				0.02	2600	244		1657	2550	1050.[illegible]	344	<0.1
6-11-80	12:50	9	10	7.7	562.2	0.009	0.04	2550	150		1570	2400	1245.[illegible]	322	42.0
8-28-81	11:05	29	17	7.7	22.40	0.004	<0.01	2340	432		[illegible]	[illegible]	712.48	2[illegible]4	<0.01
10-29-81		Inaccessible													
12-23-81	14:40			7.3	26.80	0.022	0.62	2300	540	1460	1525	2280	1082.[illegible]	658	28.00
6-14-82	14:25	11	10	7.5	<0.2	<0.001	<0.01	9880	140		1230	1825	678.[illegible]	520	66.00
9-7-82	13:03		10	8.0	<0.1	0.017	<0.01	8090	279	340	1189	1770	998.[illegible]	162.[illegible]	<0.01
9-14-83	18:45	12	8	7.4	0.4	<0.001	0.11	8880	415		1281	1850	692.[illegible]	568	28.00
[illegible]-83		Inaccessible													
1-[illegible]-84		Inaccessible													

Date	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride	Chromium Hexavalent	Copper Total	Cyanide as CN	Fluoride	Iron Diss	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Nickel Total	Potassium Total	Selenium Total	Silver Total	Sodium Total	Zinc Total	[illegible] Total	Depth to Water (feet)	Comments
2-23-80	<0.001	0.050			<0.001	20.0	176	0.005	0.045				0.660	<0.001	15.36	2.010		0.016	2.00	<0.001		585	0.300		128.81	
6-11-80	<0.001	0.140		0.150	<0.001	24.80	111	<0.001	0.020	<0.001	5.07	2.095	0.156	<0.001	16.80	0.015	<0.0002		5.50	<0.001	0.005	545	0.035		150.95	
8-28-81	1.420	2.040			0.001	23.40	22.40	0.001	0.020		7.93		2.445	<0.001	20.00	0.0[illegible]			7.10	<0.001	<0.001	210	0.070			
10-29-81																										Gate locked Jammed
12-23-81	<0.001	0.040			0.042	93.00	60.91	0.120	1.800		1.71		1.956	2.140	80.00	0.880			24.90	0.003	0.003	322		0.065	124.92	
6-14-82	<0.001	0.060			<0.001	84.50	46.80	0.043	0.040		1.20		1.740	0.060	86.00	0.225			7.10	<0.001	<0.001	240	1.840		124.81	
9-7-82	<0.001	0.040	<0.001		<0.001	83.20	29.40	0.260	0.020		1.99		1.350	<0.001	48.46	0.[illegible]			2.10	<0.001	<0.001	260	0.840	<0.001	124.33	
9-14-83	<0.001	0.40			<0.001	180.00	18.24	0.044	0.030		1.51		18.800	<0.001	182	0.165			14.80	<0.001	<0.001	88.4	0.350		124.90	
[illegible]-83																										Road closed mud slide
1-[illegible]-84																										Mud slide across road

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station MC 206 (B-42)
Location Bear Canyon Drill Hole

Date	Time	Temperature Air °F	Temperature Water °C	pH	Oil & Grease mg/l	Phenol mg/l	Nitrogen mg/l	Phosphate Total mg/l	mg/l	TSS mg/l	TDS mg/l	Cond.	Alk. mg/l	Total mg/l	Acidity mg/l
6-23-80	12:10		15.5												
8-31-80	12:50	9	10	7.7			0.03	0.080	366		1452	2550	1075.84	364	<0.1
6-23-81	11:05	29	17	7.7	252.2	0.053	0.04	0.550	150		1570	2400	1246.??	022	42.0
10-29-81		Inaccessible			22.40	0.004	<0.01	0.240	438		1350	1600	717.??	524	<0.01
12-3-81	16:40			7.9											
6-4-82	11:25	11	10	7.5	2680	0.022	0.62	2.300	540	1440	1535	2200	[illegible]	658	58.00
10-7-82	3:23		10	8.0	<0.2	<0.001	<0.01	0.060	460		1290	1875	[illegible]	580	66.00
11-9-83	15:45	12	8	7.4	<0.1	0.017	<0.01	0.090	279	840	1189	1770	[illegible]	762.?	<0.01
[illegible]		Inaccessible			0.4	<0.001	0.11	0.080	485		1281	1850	[illegible]	568	28.00
[illegible]		Inaccessible													

Date	Arsenic mg/l	Barium mg/l	Beryllium mg/l	Boron mg/l	Cadmium mg/l	Calcium mg/l	Chloride mg/l	Chromium mg/l	Copper mg/l	Cyanide mg/l	Fluoride mg/l	Iron Dis. mg/l	Iron Total mg/l	Lead mg/l	Magnesium mg/l	Manganese mg/l	Mercury mg/l	Nickel mg/l	Potassium mg/l	Selenium mg/l	Silver mg/l	Sodium mg/l	Zinc mg/l	mg/l	Depth to Water Feet	Comments
6-23-80	<0.001	0.050			<0.001	20.0	126	0.003																		
8-31-80	<0.001	0.140		0.150	<0.001	24.80	111	<0.001	0.045				0.660	<0.001	15.36	0.060		0.014	5.00	<0.001		588	0.300		128.??	
6-23-81	1.670	0.045			0.001	20.40	22.80	0.017	0.020	<0.001	8.07	0.098	0.156	<0.001	16.80	0.015	<0.0002		5.50	<0.001	0.005	545	0.035		150.95	
10-29-81									0.070		7.92		1.940	<0.001	20.08	0.200			7.10	<0.001	<0.001	310	0.030			
12-3-81	<0.001	0.060			0.042	98.??	60.91	0.120																		Gate locked Jammed
6-4-82	<0.001	0.060			<0.001	81.50	46.80	0.043	1.800		1.71		1.356	2.360	10.00	0.620			24.30	0.005	0.005	522		0.065	184.??	
10-7-82	<0.001	0.040	<0.001		<0.001	83.80	28.40	0.260	0.040		1.88		1.740	0.060	26.00	0.115			7.80	<0.001	<0.001	286	1.840		184.81	
11-9-83	<0.001	0.80			<0.001	160.00	18.20	0.074	0.020		0.99		1.250	<0.001	22.16	0.270			2.80	<0.001	<0.001	260	0.410	<0.001	184.22	
[illegible]									0.030		0.31		18.800	<0.001	128	0.165			14.60	<0.001	<0.001	88.4	0.350		184.30	
[illegible]																										
																										Road closed mud slide
																										Mud slide across road

VAUGHN HANSEN ASSOCIATES
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WATER QUALITY DATA

Station MC 206
Location Bear Canyon observation hole

Date	Time		Temperature Air °C	Temperature Water °C	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	[illegible]	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen Total [illegible]	Nitrogen [illegible]
7-5-79	10:50		24	20	9.0														

Date	Phosphorus Total as P	Phosphorus [illegible] as P	Sulfate as SO_4	[illegible]	[illegible]	Solids [illegible]	Solids Total Settleable	Solids TDS	Solids Total	Solids Total Volatile	Specific Conductance	Turbidity	[illegible] as $CaCO_3$	[illegible] as $CaCO_3$	Total [illegible]	Total [illegible]	Acidity as $CaCO_3$	Gross Alpha Activity	Gross Beta Activity
7-5-79																			
			1160					1887			1500			1820	160		8.0		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide	Fluoride Dis	[illegible] Total	Iron Dis	Iron Total	Lead Total
7-6-79								169.6	25.0									
																23.60	264	

Date	Magnesium Total	Manganese Total	Mercury Total	[illegible] Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	[illegible] Total				Comments
7-6-79																
	80.46	0.504				237				82.0						

VAUGHN HANSEN ASSOCIATES
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WATER QUALITY DATA

Station MC 207 (8-43)
Location Crandall Canyon Drill Hole

Date	Time		Temperature Air	Water	pH																																	
[illegible]	10:51		23	12	7.75											2.02				0.210		150					1120			1120			[illegible]	772		6.0		
[illegible]	14:10		16	16	7.7								25000	0.048		0.47				2.800		177					1180			1300			[illegible]	860		32.0		
[illegible]	11:10		25	14	7.8								4920	0.015		0.54				0.570		450			362		1125			[illegible]			[illegible]	920		7.40		
[illegible]	11:34		Inaccessible																																			
[illegible]	12:53		No Sample - Hole full of Grease																																			
[illegible]	11:55		Inaccessible																																			
[illegible]			Inaccessible																																			

Date																														Depth to water			Comments
[illegible]			<0.001	0.1[illegible]			0.001	14.80	51.0	0.007		0.016					0.770	0.027	11.56	0.070			0.022	15.40	<0.001			229	0.775		35.61			
[illegible]			<0.001	0.476		0.130	<0.001	76.00	36.8	<0.001		0.014	<0.001	1.60		0.080	0.120	<.001	27.80	0.012	<.0002			4.50	<0.001		<.001	310	0.025		20.40			
[illegible]			0.240	[illegible]			0.002	98.0	61.00	[illegible]		0.01		1.50			8.250	0.073	[illegible]	0.100				4.60	<0.001		<0.001	346	0.030		20.40			
[illegible]																																		
[illegible]																																		Pipe plugged
[illegible]																																		Covered by Construction
[illegible]																																		Covered by Construction
																																	Covered by Construction

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: *MCZ07*
Location: *Crandall Canyon Observation Hole*

DATE	TIME		TEMPERATURE		pH	COLIFORM		FECAL STREP	COD	BOD	TOC	DISSOLVED OXYGEN	OIL & GREASE	PHENOL	NITROGEN					PHOSPHATE					SOLIDS													
			AIR	WATER		TOTAL	FECAL													TOTAL	ORTHO				TSS		TDS											
1.15.79	19:45		15	10	7.1																	619					1479			1920			785.44	452		148		

DATE																																		COMMENTS
1.15.79								776.4	62.0							0.174	0.250		16.32	0.140				4.960				350						Water level 93' 10"

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: MC 207 (B-43)
Location: Crandall Canyon Drill Hole

Date	Time		Temp. Air °C	Temp. Water °C	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Ammonia as N	Nitrate as N	Nitrite as N	Nitrogen Total	Nitrogen Organic	Phosphate Total as P	Phosphate Ortho as P	Sulfate as SO4	as S?	as ?
7.23.80	10:51		23	12	7.85											0.02				0.380		190		
9.24.80	14:10		16	10	7.7								25000	0.048		0.47				0.800		177		
6.23.81	11:10		25	14	7.8								11220	0.015		1.54				1.520		48.0		
10.27.81	14:34		Inaccessible																					
12.3.81	15:53		No Sample - Hole full of Grease																					
6.17.82	09:35		In-Accessible																					
11.8.82			Inaccessible																					

Date	Solids TSS	Solids Total Settleable	Solids TDS	Solids Total	Solids Total Volatile	Cond.	Turbidity	Alk. as CO3	Bicarbonate Alk. as HCO3	Total Alk. as CaCO3	Total Hardness	Acidity as CaCO3	Gross Alpha	Gross Beta
7.23.80			1170			1730			773.46	778		6.0		
9.24.80			1180			1800			1099.20	860		86.0		
6.23.81	363		1128			1750			1122.40	920		11.0		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Dis	Total	Iron Dis	Iron Total	Lead Total
7.23.80			<0.001	0.100			0.001	66.40	54.0	0.007		0.010					0.770	0.037
9.24.80			<0.001	0.076		0.130	<0.001	76.00	36.8	<0.001		0.014	<0.001	1.50		0.080	0.120	<0.001
6.23.81			0.240	0.170			0.002	49.00	66.00	<0.001		0.080		1.53			4.550	0.073
10.27.81																		
12.3.81																		
6.17.82																		
11.8.82																		

Date	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO2	Silver Total	Sodium Total	Zinc Total	Total	Depth to Water (Feet)			Comments
7.23.80	39.36	0.120			0.022	10.40	<0.001			329	0.270		35.51			
9.24.80	52.80	0.012	<0.0002			4.50	<0.001		<0.001	310	0.055		20.49			
6.23.81	42.00	0.100				11.00	<0.001		<0.001	346	0.020		20.90			
10.27.81																Pipe plugged
12.3.81																Covered by Construction
6.17.82																Covered by Construction
11.8.82																Covered by Construction

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station E.W.-25
Location Royal mine at bottom

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen					Phosphate Total	Phosphate Ortho				Solids TDS	Solids	Solids TSS	Solids Total	Solids Total Volatile									
2-8-77					7.36				1929	142			(4070)	<0.001	8.0	0.16		9.10		0.190	0.016	(600)	<0.01	<0.01	1900		(1350)	3255		2060		<0.01	518.8	422	600			
4-18-77	10:10			13	6.9				44.0		37.0		4.0		0.50	0.14				0.440	0.320	(400)	<0.01		78.0		(1100)			1660	30.0	<0.01	214.4	302	590			
[illegible]					7.43				46.0	16.0			(16.5)	<0.001	0.15	9.00	0.05	0.75		0.066	0.040	(580)	<0.01	<0.01	136	<0.01	(1210)	1418		1950	40.0	<0.01	309.9	254	594			
1-4-78	11:00		19	13	7.10				224		219		6.2		0.35	0.36				2.80	0.90	(278)	<0.01		181		(412)	1104		1490	10.0	<0.01	458.7	326	560			
1-22-78	12:00				(8.10)				556		107		(81.3)		0.48	0.04				0.70	0.54	(258)	<0.01		135		(1054)	1170		[illegible]	21.0	19.20	528.8	490	550			
3-22-78	10:45		17	12	7.4				54.0		184		(11.6)		0.30	0.69	0.02			1.090	0.870	(258)	<0.01		52.0		(922)	955		1410	22.0	<0.01	456.37	374	590			
4-26-78	10:40		17	12	7.3				60.0		229		2.4		0.50	0.07				0.24	0.14	(260)	<0.01		69.0		(906)	976		1390	5.0	<0.01	[illegible]	346	594			

Date	Total	Total	Total	Total	Total	Total	Total	Total			Total	Total			Total		Total	Total	Total	Total	Total	Total	Total	Total	Total		Total	Total	Total	Total	Color Units	Tin	Sulfur	Comments
2-8-77	<0.001	<0.001	<0.001	0.019	<0.001	<0.001	<0.001	122.2	46.0	<0.001	0.03	0.004	<0.01	0.57			0.199	<0.001	70.08	0.013	<0.0002	<0.001	<0.001	7.50	<0.001	9.90	<0.001	115	0.025		100	<0.001	<1.0	By [illegible]
4-18-77			<0.001	0.074		0.095	<0.001	148.6	57.0	<0.001				0.66			(1.598)	0.001	76.37	(0.112)	0.0002			17.80	<0.001		<0.001	65.0	0.418					By V.H.A.
[illegible]	0.026	<0.001	<0.001	0.031	0.002	0.180	<0.001	116.0	54.0	0.013	0.048	0.004	<0.01	0.62			(3.47)	0.003	72.46	(0.096)	0.0002	1.529	0.169	7.69	<0.001	8.50	(0.021)	150	0.011		10.0	<0.001	<1.0	By [illegible]
1-4-78			<0.001	0.050		0.250	<0.001	97.0	150	<0.001				0.50			(1.15)	<0.001	71.20	0.032	<0.0002			10.57	<0.001		<0.001	135	0.125					By V.H.A.
1-22-78			<0.001	0.010		0.50	<0.001	116.0	128.0	<0.001				0.82			(0.575)	<0.001	67.40	0.085	<0.0002			6.52	<0.001		<0.001	170	0.042					By VHA
3-22-78			<0.001	0.110		0.12	<0.001	80.0	130	<0.001				0.57			([illegible])	<0.001	79.20	(0.218)	<0.0002			12.59	<0.001		<0.001	197	0.011					By VHA
4-26-78			<0.001	[illegible]		[illegible]	<0.001	112	127	<0.001		0.005		0.62			[illegible]	<0.001	[illegible]	0.020	[illegible]			9.97	<0.001		<0.001	118	0.014					By VHA

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: BM-26
Location: Royal mine 20 feet above water level

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Phosphate Total	Phosphate Ortho	[illegible]	[illegible]	[illegible]	TDS	Total Settleable Solids	TSS	Total Solids	Total Volatile Solids	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					7.33				520	35.[illegible]			(12.8)	<0.001	1.00	0.14		8.95		0.150	0.050	(640)	<0.01	<0.01	1228		(1300)	2530		1990	[illegible]	<0.01	270.6	222	622			
[illegible]	09:54	0.01	14	9	8.2				14.0		10.0		1.7		0.95	0.16				1.710	0.140	(400)	<0.01		889		(880)			1300	1.50	<0.01	234.2	192	470			
[illegible]	11:15	0.01	11	8	8.0				27.0		30.0		3.3		0.25	0.25				2.30	0.04	(400)	<0.01		100		(763)	842		1175	230	<0.01	213.6	180	600			
[illegible]	15:00				7.78				28.0		85.0		4.5		0.20	0.05				0.110	0.150	(400)	<0.01		849		(776)	1126		1190	150	<0.01	222	182	520			
[illegible]	8:00		17	8	7.6				32.0		55.0	8.0	5.7		0.10	0.84	<0.01			0.450	0.010	(380)	<0.01		746		(797)	1495		1152	130	<0.01	271.6	178	500			
[illegible]	10:05	0.01	17	8	8.1				120		12.7		(13.6)		0.10	0.20				0.64	0.16	360	<0.01		490		700	1192		1070	85.0	<0.01	209.8	168	480			

Date	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Diss.	[illegible]	[illegible] Total	[illegible] Total	[illegible]	[illegible] Diss.	[illegible] Total	[illegible]	[illegible] Total	Lead Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible]	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	Tin	Sulfur	Thorium	Comments
[illegible]	<0.001	<0.001	<0.001	0.012	<0.001	<0.001	<0.001	112	30.0	<0.001	0.020	0.015	<0.01	0.10			0.096	<0.001	51.0	0.121	<0.0002	0.002	<0.001	6.08	<0.001	9.50	<0.001	195	6.823		<0.001	<1.0	<0.001	by [illegible] [illegible]
[illegible]			<0.001	0.055		0.210	0.001	88.0	24.0	<0.001				0.51			(7.970)	<0.001	60.0	(0.133)	<0.0002			15.51	<0.001		<0.001	15.0	0.408					by VHA
[illegible]			<0.001	0.033		0.30	<0.001	100	26.0	<0.001				0.34			(3.580)	<0.001	60.0	(0.108)	<0.0002			8.31	<0.001		<0.001	54.0	0.367					by VHA
[illegible]			<0.001	0.030		0.19	<0.001	104	32.0	<0.001				0.41			(16.130)	0.003	62.4	(0.227)	<0.0002			10.50	<0.001		<0.001	43.0	0.386					
[illegible]			<0.001	0.020		0.15	<0.001	108	32.0	<0.001				0.49			(8.980)	<0.001	55.2	(0.146)	<0.0002			8.83	<0.001		<0.001	47.0	0.048					
[illegible]			<0.001	0.03		0.22	<0.001	92.0	32.0	<0.001		<0.001		0.98			0.061	<0.001	60.0	0.082	<0.0002			7.73	0.005		<0.001	45.0	0.222					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station BM-27
Location Royal mine at cross cut #3

Date	Time	Flow	Temp. Air °C	Temp. Water °C	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD mg/l	BOD mg/l	TOC mg/l	Dissolved Oxygen mg/l	Oil & Grease mg/l	Phenol mg/l	Nitrogen: Ammonia as N mg/l	Nitrite as N mg/l	Nitrate as N mg/l	Kjeldahl Total mg/l	Organic mg/l	Phosphate: Total as PO_4 mg/l	Ortho as PO_4 mg/l	Sulfate as SO_4 mg/l	Sulfide as S mg/l	Surfactant as MBAS mg/l	Solids: TSS mg/l	Total Settleable mg/l	TDS mg/l	Total mg/l	Total Volatile mg/l	Specific Cond.	Turbidity	Alk. as CO_3 mg/l	Alk. as HCO_3 mg/l	Total Alk. as $CaCO_3$ mg/l	Total Hardness as $CaCO_3$ mg/l	Acidity as $CaCO_3$ mg/l	Gross Alpha	Gross Beta
4-12-77	10:50		13	9	8.10				250		18.0		<1.0		0.20	0.06				0.115	0.140	(660)	<0.01		4.0		(1200)			1200	1.75	<0.01	112.8	174	810			
11-4-77	11:45	0.007	6	9	7.92				14.0		29.0		2.2		0.35	0.56				2.90	0.22	(560)	<0.01		14.0		(1153)	1079		1190	0.29	<0.01	436.7	358	760			
1-22-78	15:00				7.92				10.0		26.0		3.6		0.36	0.08				0.110	0.020	(560)	<0.01		16.0		(404)	981		1416	1.00	<0.01	200	164	720			
3-22-78	11:20		7	9	7.63				1.5		22.0	19.0	5.2		<0.01	0.70	<0.01			0.060	0.015	(550)	<0.01		7.0		(1409)	1016		1562	1.7	<0.01	279.6	180	740			
4-26-78	11:05	Dry																																				

Date	Aluminum Total mg/l	Antimony Total mg/l	Arsenic Total mg/l	Barium Total mg/l	Beryllium Total mg/l	Boron Total mg/l	Cadmium Total mg/l	Calcium Total mg/l	Chloride mg/l	Chromium Hex. mg/l	Cobalt Total mg/l	Copper Total mg/l	Cyanide mg/l	Fluoride mg/l	Total mg/l	Iron Diss. mg/l	Iron Total mg/l	Lead Total mg/l	Magnesium Total mg/l	Manganese Total mg/l	Mercury Total mg/l	Molybdenum Total mg/l	Nickel Total mg/l	Potassium Total mg/l	Selenium Total mg/l	Silica mg/l	Silver Total mg/l	Sodium Total mg/l	Zinc Total mg/l	Vanadium Total mg/l				Comments
4-12-77			<0.001	0.050		0.250	<0.001	110.4	28.0	<0.001				0.50			0.149	0.003	42.16	0.016	<0.0002			8.61	<0.001		<0.001	97.90	0.054					
11-4-77			<0.001	0.150		0.220	<0.001	152	32.0	<0.001				0.38			(0.325)	0.001	41.80	0.025	<0.0002			7.63	<0.001		<0.001	102	0.071					
1-22-78			<0.001	0.030		0.16	<0.001	160	34.0	<0.001				0.41			(0.409)	0.005	44.0	0.004	<0.0002			5.88	<0.001		<0.001	110	0.010					
3-21-78			<0.001	0.050		0.19	<0.001	156	30.0	<0.001				0.45			(0.341)	0.009	41.00	(0.156)	<0.0002			9.11	<0.001		<0.001	41.0	0.082					
4-26-78																																		

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station BM-28
Location Royal mine 20 feet below top

11-17-77	11:10		9	7	7.2				31.0		26.0		<1.0		0.35	0.09				0.049	0.130	(460)	<0.01		13.0		(1240)			1850	9.00	<0.01	466	382	830			
1-4-78	12:05	0.0005	6	4	7.7				7.0		13.0		<1.0		0.10	0.38				0.03	<0.01	(404)	<0.01		7.0		(965)	973		1487	18.0	<0.01	488	400	800			
1-31-78	15:00				7.51				7.5		21.0		1.7		0.12	0.02				0.140	0.020	(400)	<0.01		13.0		(989)	953		1450	21.0	<0.01	456.22	374	800			
3-27-78	11:45		5	5	7.73				1.8		24.0	6.0	4.8		0.15	0.60	<0.01			0.054	0.012	(400)	<0.01		31.0		(995)	1028		1526	45.0	<0.01	478.42	386	790			
4-26-78	11:30		7	7	7.9				8.0		214		7.4		0.05	0.09				0.04	0.02	(360)	<0.01		9.0		(898)	910		1580	18.0	<0.01	456.2	374	660			

11-17-77			<0.001	0.057		0.576	<0.001	171.2	74.0	<0.001				0.44			(1.390)	0.002	91.48	(0.395)	<0.0002			6.35	<0.001		<0.001	74.0	0.026					
1-4-78			<0.001	0.025		0.165	<0.001	184	30.0	<0.001				0.33			(5.464)	<0.001	81.60	0.059	<0.0002			6.86	<0.001		<0.001	70.0	0.054					
1-31-78			<0.001	0.040		0.15	<0.001	174	28.0	<0.001				0.39			(7.041)	0.004	81.60	(0.186)	<0.0002			4.76	<0.001		<0.001	15.0	0.012					
3-27-78			<0.001	0.060		0.09	<0.001	916	20.0	<0.001				0.49			(4.595)	<0.001	90.01	(0.586)	<0.0002			7.03	0.001		<0.001	46.0	0.024					
4-26-78			(0.014)	0.13		0.20	<0.001	180	32.0	<0.001		0.041		0.35			(0.498)	<0.001	50.40	(0.799)	<0.0002			5.55	0.004		<0.001	56.0	0.018					

VAUGHN HANSEN ASSOCIATES
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WATER QUALITY DATA

Station MCZ07
Location Crandall Canyon Observation Hole

DATE	TIME		TEMPERATURE AIR	TEMPERATURE WATER	pH	COLIFORM TOTAL	COLIFORM FECAL	FECAL STREP	COD	BOD	TOC	DISSOLVED OXYGEN	OIL & GREASE	PHENOL	NITROGEN AMMONIA as N	NITRATE as N	NITRITE as N	KJELDAHL TOTAL	NITROGEN ORGANIC	PHOSPHATE TOTAL as PO4	ORTHO as PO4	SULFATE as SO4	SULFIDE as S	SURFACTANT as MBAS	SOLIDS TSS	TOTAL SETTLEABLE SOLIDS	TDS	TOTAL SOLIDS	TOTAL VOLATILE SOLIDS	SPECIFIC COND	TURBIDITY	ALK as CO3	BICARBONATE as HCO3	TOTAL ALK as CaCO3	TOTAL HARDNESS as CaCO3	ACIDITY as CaCO3	GROSS ALPHA ACTIVITY	GROSS BETA ACTIVITY
[illegible]	19:45		15	10	7.1																	619					1479			1320			785.44	652		14.5		

DATE	ALUMINUM TOTAL	ANTIMONY TOTAL	ARSENIC TOTAL	BARIUM TOTAL	BERYLLIUM TOTAL	BORON TOTAL	CADMIUM TOTAL	CALCIUM TOTAL	CHLORIDE DISS	CHROMIUM HEXAVALENT	COBALT TOTAL	COPPER TOTAL	CYANIDE as CN	FLUORIDE DISS	CHROMIUM TOTAL	IRON DISS	IRON TOTAL	LEAD TOTAL	MAGNESIUM TOTAL	MANGANESE TOTAL	MERCURY TOTAL	MOLYBDENUM TOTAL	NICKEL TOTAL	POTASSIUM TOTAL	SELENIUM TOTAL	SILICA as SiO2	SILVER TOTAL	SODIUM TOTAL	ZINC TOTAL	VANADIUM TOTAL				COMMENTS
[illegible]								276.4	62.0							0.124	1.250		16.32	0.140				4.960				350						water level 43' 10"

APPENDIX 7-5

SURFACE WATER SUMMARY SHEETS

STATION B-26 Crandall Canyon Below Site

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0	0	0	Ammonia	-	-	-
pH	-	-	-	Nitrate	-	-	-
Conductivity	-	-	-	Nitrite	-	-	-
Temp. C degrees (water)	-	-	-	Potassium	-	-	-
TSS	-	-	-	Total Phosphate	-	-	-
TDS	-	-	-	Ortho-Phosphate	-	-	-
Hardness	-	-	-	Selenium	-	-	-
Aluminum	-	-	-	Sodium	-	-	-
Arsenic	-	-	-	Sulfate	-	-	-
Barium	-	-	-	Zinc	-	-	-
Boron	-	-	-	Gross Alpha	-	-	-
Carbonate	-	-	-	Gross Beta	-	-	-
Bicarbonate	-	-	-	Oil & Grease	-	-	-
Cadmium	-	-	-	Phenol	-	-	-
Calcium	-	-	-	Alkalinity	-	-	-
Chloride	-	-	-	Acidity	-	-	-
Chromium	-	-	-	Silver	-	-	-
Copper	-	-	-				
Fluoride	-	-	-				
Iron-Total	-	-	-				
Iron Dissolved	-	-	-				
Lead	-	-	-				
Magnesium	-	-	-				
Manganese	-	-	-				
Mercury	-	-	-				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-25 Crandall Canyon Above Site #3

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0	0	0	Ammonia	-	-	-
pH	-	-	-	Nitrate	-	-	-
Conductivity	-	-	-	Nitrite	-	-	-
Temp. C degrees (water)	-	-	-	Potassium	-	-	-
TSS	-	-	-	Total Phosphate	-	-	-
TDS	-	-	-	Ortho-Phosphate	-	-	-
Hardness	-	-	-	Selenium	-	-	-
Aluminum	-	-	-	Sodium	-	-	-
Arsenic	-	-	-	Sulfate	-	-	-
Barium	-	-	-	Zinc	-	-	-
Boron	-	-	-	Gross Alpha	-	-	-
Carbonate	-	-	-	Gross Beta	-	-	-
Bicarbonate	-	-	-	Oil & Grease	-	-	-
Cadmium	-	-	-	Phenol	-	-	-
Calcium	-	-	-	Alkalinity	-	-	-
Chloride	-	-	-	Acidity	-	-	-
Chromium	-	-	-	Silver	-	-	-
Copper	-	-	-				
Fluoride	-	-	-				
Iron-Total	-	-	-				
Iron Dissolved	-	-	-				
Lead	-	-	-				
Magnesium	-	-	-				
Manganese	-	-	-				
Mercury	-	-	-				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-21 Ford Creek Above U.S. 50 & 6

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	11.6	-	1.28	Ammonia	-	-	-
pH	9.1	7.51	8.16	Nitrate	0.11	<0.01	0.03
Conductivity	580	250	475	Nitrite	-	-	<0.01
Temp. C degrees (water)	16.5	-	8.2	Potassium	1.98	0.96	1.32
TSS	169	1.0	43.3	Total Phosphate	0.34	<0.001	0.16
TDS	370	252	319	Ortho-Phosphate	0.49	<0.01	0.12
Hardness	-	-	1180	Selenium	0.002	<0.001	0.001
Aluminum	-	-	0.037	Sodium	19.0	48.3	9.56
Arsenic	0.015	<0.001	0.001	Sulfate	73.0	4.0	49.32
Barium	0.270	0.050	0.110	Zinc	0.03	<0.001	0.01
Boron	0.05	0.03	0.04	Gross Alpha	-	-	-
Carbonate	-	-	<0.01	Gross Beta	-	-	-
Bicarbonate	390.4	256.2	296.8	Oil & Grease	18.8	<1.0	3.03
Cadmium	<0.001	<0.001	<0.001	Phenol	0.035	<0.001	0.00
Calcium	96.8	64.0	57.4	Alkalinity	320	210	247
Chloride	14.0	4.0	8.6	Acidity	44.0	<0.01	12.01
Chromium	0.002	<0.001	<0.001	Silver	0.001	<0.001	<0.001
Copper	0.02	<0.001	0.006				
Fluoride	0.24	0.15	0.19				
Iron-Total	6.26	0.035	0.86				
Iron Dissolved	-	-	0.01				
Lead	0.004	<0.001	0.0021				
Magnesium	47.40	12.00	35.12				
Manganese	0.09	0.002	0.02				
Mercury	<0.0002	<0.0002	<0.0 002				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-20 Price River above Sulfur Canyon Creek

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	425	20.0	167	Ammonia	-	-	-
pH	9.5	7.0	8.1	Nitrate	0.4	<0.01	0.12
Conductivity	660	280	424	Nitrite	-	-	-
Temp. C degrees (water)	27	-	8.2	Potassium	1.902	0.85	1.40
TSS	1140	1.0	125.5	Total Phosphate	0.35	0.005	0.16
TDS	432	198	303	Ortho-Phosphate	0.04	<0.01	0.01
Hardness	-	-	-	Selenium	0.004	<0.001	0.001
Aluminum	-	-	-	Sodium	88.0	5.92	23.87
Arsenic	0.020	<0.001	0.001	Sulfate	148	5.0	60.6
Barium	0.245	0.060	0.114	Zinc	0.062	<0.001	0.014
Boron	0.07	0.03	0.05	Gross Alpha	-	-	-
Carbonate	-	-	<0.01	Gross Beta	-	-	-
Bicarbonate	366	148.84	256.67	Oil & Grease	57.0	<1.0	5.24
Cadmium	<0.001	<0.001	<0.001	Phenol	0.281	<0.001	0.030
Calcium	88	45.6	60	Alkalinity	266	122	209
Chloride	34	2.0	12.2	Acidity	32.0	<0.01	9.63
Chromium	<0.001	<0.001	<0.001	Silver	<0.001	<0.001	<0.001
Copper	0.030	<0.001	0.006				
Fluoride	0.36	0.001	0.18				
Iron-Total	24.50	0.053	2.35				
Iron Dissolved	0.030	0.020	0.025				
Lead	0.011	<0.001	0.001				
Magnesium	37.92	4.80	22.21				
Manganese	0.339	<0.001	0.072				
Mercury	<0.0002	<0.0002	<0.0 002				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-19 Sulfur Canyon Creek

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	7.0	0.004	1.11	Ammonia	–	–	–
pH	9.2	7.0	8.1	Nitrate	0.34	<0.02	0.04
Conductivity	930	325	663	Nitrite	0.04	<0.01	0.02
Temp. C degrees (water)	21	0	7.1	Potassium	12.5	1.43	1.897
TSS	215	<1.0	35.6	Total Phosphate	0.560	<0.001	0.123
TDS	639	315	455.7	Ortho-Phosphate	0.300	<0.01	0.065
Hardness	–	–	–	Selenium	0.004	<0.001	0.001
Aluminum	–	–	–	Sodium	92.00	19.38	46.70
Arsenic	0.025	<0.001	0.001	Sulfate	166.0	40.0	90.2
Barium	0.25	0.073	0.17	Zinc	0.227	<0.001	0.03
Boron	0.10	0.07	0.09	Gross Alpha	–	–	–
Carbonate	–	–	<0.01	Gross Beta	–	–	–
Bicarbonate	453.84	197.64	349.35	Oil & Grease	24.20	<0.01	3.22
Cadmium	<0.001	<0.001	<0.001	Phenol	0.222	<0.001	0.04
Calcium	120	43.2	68.0	Alkalinity	384	162	266
Chloride	54.3	10.0	28.0	Acidity	38.0	<0.01	11.8
Chromium	0.003	<0.001	0.001	Silver	0.002	<0.001	0.001
Copper	0.040	<0.001	0.008				
Fluoride	0.56	0.21	0.31				
Iron-Total	6.14	0.04	0.80				
Iron Dissolved	0.05	0.04	0.045				
Lead	0.003	<0.001	0.001				
Magnesium	53.76	5.28	37.89				
Manganese	0.150	0.004	0.035				
Mercury	<0.0002	<0.0002	<0.0 002				
Molybdenum	–	–	–				
Nickel	–	–	–				

STATION B-17 Sowbelly Creek above Spring Canyon Creek

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0.34	0	0.03	Ammonia	-	-	0.28
pH	9.1	6.9	7.6	Nitrate	6.2	0.02	3.02
Conductivity	2800	1350	2164	Nitrite	<0.01	<0.01	<0.01
Temp. C degrees (water)	17	5.5	13	Potassium	13.90	8.93	12.5
TSS	22.0	<1.0	7.3	Total Phosphate	0.09	0.04	0.06
TDS	1835	967	1489	Ortho-Phosphate	0.05	<0.01	0.02
Hardness	-	-	1180	Selenium	0.006	<0.001	0.003
Aluminum	-	-	0.037	Sodium	188.0	30.0	80.2
Arsenic	-	-	<0.001	Sulfate	1060	460	809
Barium	0.081	0.03	0.05	Zinc	0.089	0.014	0.03
Boron	-	-	0.425	Gross Alpha	-	-	-
Carbonate	-	-	<0.01	Gross Beta	-	-	-
Bicarbonate	514.84	295.24	442.84	Oil & Grease	4.8	<1.0	1.6
Cadmium	<0.001	<0.001	<0.001	Phenol	0.028	<0.001	<0.001
Calcium	430.4	64.0	288.7	Alkalinity	422	242	374.0
Chloride	58.0	4.0	33.3	Acidity	82.0	20.0	48.0
Chromium	<0.001	<0.001	<0.001	Silver	0.002	<0.001	0.001
Copper	0.009	0.004	0.007				
Fluoride	0.47	0.24	0.38				
Iron-Total	0.188	<0.01	0.075				
Iron Dissolved	-	-	-				
Lead	0.007	<0.001	0.001				
Magnesium	172.8	46.56	1219				
Manganese	0.016	0.009	0.012				
Mercury	<0.0002	<0.0002	<0.0 002				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-14 Holding Pond Below Mine #3

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0	0	0	Ammonia	-	-	-
pH	-	-	-	Nitrate	-	-	-
Conductivity	-	-	-	Nitrite	-	-	-
Temp. C degrees (water)	-	-	-	Potassium	-	-	-
TSS	-	-	-	Total Phosphate	-	-	-
TDS	-	-	-	Ortho-Phosphate	-	-	-
Hardness	-	-	-	Selenium	-	-	-
Aluminum	-	-	-	Sodium	-	-	-
Arsenic	-	-	-	Sulfate	-	-	-
Barium	-	-	-	Zinc	-	-	-
Boron	-	-	-	Gross Alpha	-	-	-
Carbonate	-	-	-	Gross Beta	-	-	-
Bicarbonate	-	-	-	Oil & Grease	-	-	-
Cadmium	-	-	-	Phenol	-	-	-
Calcium	-	-	-	Alkalinity	-	-	-
Chloride	-	-	-	Acidity	-	-	-
Chromium	-	-	-	Silver	-	-	-
Copper	-	-	-				
Fluoride	-	-	-				
Iron-Total	-	-	-				
Iron Dissolved	-	-	-				
Lead	-	-	-				
Magnesium	-	-	-				
Manganese	-	-	-				
Mercury	-	-	-				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-12 Hardscrabble Creek Above Mine #3

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0	0	0	Ammonia	-	-	-
pH	-	-	-	Nitrate	-	-	-
Conductivity	-	-	-	Nitrite	-	-	-
Temp. C degrees (water)	-	-	-	Potassium	-	-	-
TSS	-	-	-	Total Phosphate	-	-	-
TDS	-	-	-	Ortho-Phosphate	-	-	-
Hardness	-	-	-	Selenium	-	-	-
Aluminum	-	-	-	Sodium	-	-	-
Arsenic	-	-	-	Sulfate	-	-	-
Barium	-	-	-	Zinc	-	-	-
Boron	-	-	-	Gross Alpha	-	-	-
Carbonate	-	-	-	Gross Beta	-	-	-
Bicarbonate	-	-	-	Oil & Grease	-	-	-
Cadmium	-	-	-	Phenol	-	-	-
Calcium	-	-	-	Alkalinity	-	-	-
Chloride	-	-	-	Acidity	-	-	-
Chromium	-	-	-	Silver	-	-	-
Copper	-	-	-				
Fluoride	-	-	-				
Iron-Total	-	-	-				
Iron Dissolved	-	-	-				
Lead	-	-	-				
Magnesium	-	-	-				
Manganese	-	-	-				
Mercury	-	-	-				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-11 Hardscrabble Creek Below Mine #3

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0.190	-	0.017	Ammonia	10.25	0.14	5.59
pH	8.60	7.04	7.54	Nitrate	1.40	<0.01	0.27
Conductivity	1900	524	941	Nitrite	-	-	-
Temp. C degrees (water)	25	1	16.4	Potassium	17.9	3.95	8.76
TSS	22596	13	2.598	Total Phosphate	1.10	0.033	0.46
TDS	1260	339	629	Ortho-Phosphate	2.40	0.010	0.001
Hardness	380	104	200	Selenium	0.022	<0.001	0.001
Aluminum	0.15	0.02	0.07	Sodium	330	9.5	108.1
Arsenic	0.004	<0.001	0.001	Sulfate	430	4.0	120.4
Barium	0.37	0.01	0.14	Zinc	0.206	0.015	0.074
Boron	0.860	0.070	0.287	Gross Alpha	-	-	-
Carbonate	19.2	0.070	0.287	Gross Beta	-	-	-
Bicarbonate	705.2	136.6	400.2	Oil & Grease	35.4	1.6	12.7
Cadmium	<0.001	<0.001	<0.001	Phenol	0.143	<0.001	0.03
Calcium	104	20.8	50.9	Alkalinity	578	112	346
Chloride	134	12	45.25	Acidity	56	12	40.5
Chromium	0.007	<0.001	0.001	Silver	0.001	<0.001	<0.001
Copper	0.045	0.006	0.001				
Fluoride	0.045	0.006	0.016				
Iron-Total	117	0.002	12.15				
Iron Dissolved	0.92	0.92	0.92				
Lead	0.011	<0.001	0.003				
Magnesium	60.0	6.24	28.93				
Manganese	0.788	0.018	0.202				
Mercury	<0.0002	<0.0002	<0.0 002				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-9 Holding Pond Below Mine #2

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	-	-	-	Ammonia	0.95	0.30	0.57
pH	8.7	7.0	7.6	Nitrate	0.16	0.02	0.09
Conductivity	3300	1250	2494	Nitrite	-	-	-
Temp. C degrees (water)	19	4	13.6	Potassium	17.20	2.55	9.60
TSS	440	18	98.3	Total Phosphate	0.540	0.015	0.185
TDS	2125	810	1568	Ortho-Phosphate	0.100	0.010	0.049
Hardness	820	44	347	Selenium	<0.001	<0.001	<0.001
Aluminum	0.210	0.016	0.10	Sodium	590	286.8	427.7
Arsenic	0.002	<0.001	<0.001	Sulfate	1000	130	487
Barium	0.146	0.025	0.076	Zinc	0.082	0.003	0.024
Boron	1.40	0.18	0.93	Gross Alpha	-	-	-
Carbonate	12.0	<0.01	1.029	Gross Beta	-	-	-
Bicarbonate	875.4	444	709	Oil & Grease	115.4	12.0	46.6
Cadmium	<0.001	<0.001	<0.001	Phenol	0.008	<0.001	0.005
Calcium	100	5.6	39.7	Alkalinity	-	-	-
Chloride	162	34	131	Acidity	-	-	-
Chromium	<0.001	<0.001	<0.001	Silver	0.002	<0.001	0.001
Copper	0.009	0.004	0.007				
Fluoride	2.90	1.63	1.87				
Iron-Total	3.28	0.064	1.87				
Iron Dissolved	-	-	-				
Lead	0.018	<0.001	0.048				
Magnesium	136.8	6.24	56.99				
Manganese	0.46	0.041	0.154				
Mercury	<0.0002	<0.0002	<0.0 002				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-6 Price River Above Washing Facility

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	612	4	105	Ammonia	0.40	<0.01	0.14
pH	9.5	7.1	8.2	Nitrate	0.88	<0.01	0.18
Conductivity	1080	315	489	Nitrite	–	–	–
Temp. C degrees (water)	20	0.5	8	Potassium	12.61	0.99	2.05
TSS	1556	0.5	164.1	Total Phosphate	0.320	0.030	0.106
TDS	701	194	331	Ortho-Phosphate	1.07	<0.010	0.089
Hardness	278	156	223	Selenium	0.002	<0.001	0.001
Aluminum	0.41	0.009	0.10	Sodium	138	7.00	32.54
Arsenic	0.030	<0.001	0.0015	Sulfate	310	4.0	67.96
Barium	0.22	0.011	0.092	Zinc	0.257	<0.001	0.025
Boron	0.15	0.010	0.067	Gross Alpha	<1	–	–
Carbonate	14.4	<0.01	1.20	Gross Beta	<2	–	–
Bicarbonate	407.48	178.1	255	Oil & Grease	37.0	<1.0	4.09
Cadmium	0.001	<0.001	<0.001	Phenol	0.380	<0.001	0.030
Calcium	68.00	12.0	52.63	Alkalinity	334	146	215
Chloride	26.0	4.0	12.1	Acidity	34	<0.1	10.9
Chromium	0.002	<0.001	0.001	Silver	0.003	<0.001	0.0002
Copper	0.030	<0.001	0.006				
Fluoride	0.30	0.12	0.19				
Iron-Total	25.1	0.015	1.46				
Iron Dissolved	0.030	0.030	0.030				
Lead	0.009	<0.001	0.001				
Magnesium	49.4	4.80	24.94				
Manganese	0.872	0.003	0.074				
Mercury	<0.002	<0.002	<0.002				
Molybdenum	–	–	–				
Nickel	–	–	–				

STATION B-5 Price River Below Washing Facility

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	612	1.7	97	Ammonia	0.40	<0.01	0.19
pH	9.6	7.3	8.16	Nitrate	0.57	<0.01	0.19
Conductivity	672	295	475	Nitrite	-	-	-
Temp. C degrees (water)	21	0.2	8.3	Potassium	4.42	1.01	1.85
TSS	1628	<1.0	175.6	Total Phosphate	0.280	0.040	0.123
TDS	448	200	317	Ortho-Phosphate	1.26	<0.010	0.096
Hardness	294	162	211	Selenium	0.002	<0.001	0.0001
Aluminum	0.380	0.016	0.09	Sodium	51.40	10.00	25.67
Arsenic	0.025	<0.001	0.001	Sulfate	144	5.0	51.96
Barium	0.31	0.018	0.109	Zinc	0.262	0.002	0.027
Boron	0.175	0.030	0.111	Gross Alpha	<1	-	-
Carbonate	12.0	<0.01	1.029	Gross Beta	<2	-	-
Bicarbonate	361.12	200.08	266.03	Oil & Grease	40.0	<1.0	4.2
Cadmium	0.001	<0.001	<0.001	Phenol	0.307	<0.001	0.029
Calcium	68.8	19.2	53.46	Alkalinity	272	152	228
Chloride	32.0	5.45	13.23	Acidity	30.0	<1.0	8.9
Chromium	0.004	<0.001	0.0003	Silver	0.005	<0.001	0.0002
Copper	0.020	<0.001	0.006				
Fluoride	0.29	0.12	0.19				
Iron-Total	29.0	0.024	1.68				
Iron Dissolved	0.680	0.040	0.360				
Lead	0.013	<0.001	0.001				
Magnesium	40.8	3.36	24.63				
Manganese	0.868	0.002	0.079				
Mercury	<0.0002	<0.0002	<0.0 002				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-3 Below Willow Creek Below Mine #6

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	85	0	17.3	Ammonia	-	-	-
pH	9.6	7.4	8.1	Nitrate	0.30	<0.01	0.07
Conductivity	1500	315	813	Nitrite	<0.01	<0.01	<0.01
Temp. C degrees (water)	21	0	8	Potassium	6.420	1.45	2.90
TSS	9550	<1.0	1103	Total Phosphate	1.200	.040	0.252
TDS	988	345	575	Ortho-Phosphate	1.70	0.021	0.219
Hardness	-	-	-	Selenium	0.020	<0.001	0.0015
Aluminum	-	-	-	Sodium	139	35.00	69.71
Arsenic	0.020	<0.001	0.003	Sulfate	510	70.5	194.7
Barium	0.880	0.045	0.236	Zinc	0.175	<0.001	0.025
Boron	0.265	0.090	0.144	Gross Alpha	<1	-	-
Carbonate	<0.01	<0.01	<0.01	Gross Beta	<2	-	-
Bicarbonate	409.92	202.52	-	Oil & Grease	10.60	<0.01	1.48
Cadmium	0.002	<0.001	<0.001	Phenol	0.970	<0.001	0.078
Calcium	111.20	33.60	57.33	Alkalinity	352	166	254
Chloride	66.0	11.7	23.87	Acidity	60.0	<0.1	11.4
Chromium	0.040	<0.001	0.003	Silver	0.002	<0.001	0.0003
Copper	0.110	<0.001	0.011				
Fluoride	.45	0.15	0.26				
Iron-Total	431	0.019	36.49				
Iron Dissolved	0.881	0.040	0.537				
Lead	0.013	<0.001	0.001				
Magnesium	59.52	7.20	41.51				
Manganese	1.220	0.004	0.140				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION B-2 Willow Creek Above Mine #6

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	57	0.04	15	Ammonia	0.30	<0.01	0.16
pH	9.4	7.3	8.2	Nitrate	0.52	<0.01	0.07
Conductivity	1397	328	903.44	Nitrite	-	-	-
Temp. C degrees (water)	24	0	9	Potassium	8.70	1.44	3.64
TSS	8770	1.0	553	Total Phosphate	10.000	0.020	0.567
TDS	910	348	631	Ortho-Phosphate	6.40	<0.010	0.352
Hardness	560	248	391	Selenium	0.002	<0.001	0.001
Aluminum	0.001	0.009	0.04	Sodium	126	37.60	79.35
Arsenic	0.016	<0.001	0.003	Sulfate	485	88.0	226
Barium	0.360	0.005	0.108	Zinc	0.145	<0.001	0.021
Boron	0.280	0.050	0.144	Gross Alpha	-	-	-
Carbonate	7.2	<0.01	1.108	Gross Beta	-	-	-
Bicarbonate	434.3	246.44	330.30	Oil & Grease	33.0	<0.01	2.63
Cadmium	0.002	<0.001	<0.001	Phenol	0.340	<0.001	0.002
Calcium	116	19.2	61	Alkalinity	356	202	274
Chloride	39.60	11.4	24.58	Acidity	26.0	<0.01	9.01
Chromium	0.027	<0.001	0.001	Silver	0.004	<0.001	0.0002
Copper	0.090	<0.001	0.013				
Fluoride	.71	0.15	0.32				
Iron-Total	332	0.013	19.36				
Iron Dissolved	0.58	0.02	0.21				
Lead	0.008	<0.001	0.001				
Magnesium	78.72	7.68	49.25				
Manganese	1.010	0.003	0.116				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION Station B-1 Upper Willow Creek

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	76.5	1.8	16.8	Ammonia	-	-	-
pH	9.4	7.1	8.1	Nitrate	0.22	<0.01	0.05
Conductivity	1190	365	784	Nitrite	<0.01	<0.01	<0.01
Temp. C degrees (water)	24	0	8	Potassium	7.20	1.49	2.64
TSS	7750	<1.0	701	Total Phosphate	1.720	0.030	0.35
TDS	775	365	570	Ortho-Phosphate	6.10	<0.01	0.069
Hardness	-	-	-	Selenium	0.020	<0.001	0.002
Aluminum	-	-	-	Sodium	142	39.30	77.56
Arsenic	0.125	<0.001	0.01	Sulfate	514	75.0	198.3
Barium	0.30	0.025	0.13	Zinc	0.135	<0.001	0.02
Boron	0.130	0.090	0.11	Gross Alpha	-	-	-
Carbonate	-	-	-	Gross Beta	-	-	-
Bicarbonate	412.36	448.88	332.71	Oil & Grease	8.4	<0.001	0.02
Cadmium	0.002	<0.001	<0.001	Phenol	0.240	<0.001	0.02
Calcium	124	40.80	61.98	Alkalinity	358	204	277.38
Chloride	70.0	4.0	23.2	Acidity	42.0	<0.01	11.08
Chromium	0.022	<0.001	0.002	Silver	0.002	<0.001	0.001
Copper	0.230	<0.001	0.02				
Fluoride	1.55	0.16	0.35				
Iron-Total	246.0	0.019	20.90				
Iron Dissolved	0.460	0.010	0.16				
Lead	0.008	<0.001	0.001				
Magnesium	55.68	7.20	39.37				
Manganese	1.150	0.002	0.17				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum	-	-	-				
Nickel	-	-	-				

STATION BM-28

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	–	–	0.005	Ammonia	0.35	0.05	0.1540
pH	7.9	7.2	7.6080	Nitrate	0.06	0.03	0.2240
Conductivity	1850	1380	1538.600	Nitrite	–	–	<0.01
Temp. C degrees (water)	7	4	5.7500	Potassium	7.03	4.76	6.1100
TSS	31.0	7.0	14.6000	Total Phosphate	0.740	0.04	0.1798
TDS	1240	898	1007.2000	Ortho-Phosphate	0.043	<0.01	0.0184
Hardness	830	660	776.00	Selenium	0.004	<0.001	0.0016
Aluminum	–	–	–	Sodium	56.0	15.0	28.000
Arsenic	0.014	<0.001	0.0036	Sulfate	460	360	404.00
Barium	0.057	0.025	0.0404	Zinc	0.074	0.012	0.0368
Boron	0.20	0.075	0.1400	Gross Alpha	–	–	–
Carbonate	<0.01	<0.01	<0.01	Gross Beta	–	–	–
Bicarbonate	488	456.28	467.4960	Oil & Grease	7.4	<1.0	3.1800
Cadmium	<0.001	<0.001	<0.001	Phenol	–	–	–
Calcium	316	180	207.0400	Alkalinity	400	374	383.200
Chloride	32.0	20.0	26.800	Acidity	–	–	–
Chromium	<0.001	<0.001	<0.001	Silver	<0.001	<0.001	<0.001
Copper			0.004				
Fluoride	0.44	0.33	0.3840				
Iron-Total	4.390	0.438	2.9244				
Iron Dissolved							
Lead	0.004	<0.001	0.0018				
Magnesium	96.48	<0.01	62.0180				
Manganese	0.395	0.039	0.2798				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum	–	–	–				
Nickel	–	–	–	–			

STATION BM-27

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0.002	0	0.001	Ammonia	0.36	<0.01	0.2300
pH	8.0	7.63	7.800	Nitrate	0.70	0.06	0.300
Conductivity	1790	1200	1509.500	Nitrite	<0.01	<0.01	<0.01
Temp. C degrees (water)	9	9	9.0	Potassium	9.11	5.82	7.7925
TSS	14.0	4.0	10.250	Total Phosphate	2.30	0.060	0.6638
TDS	1200	964	1082.500	Ortho-Phosphate	0.040	0.015	0.0238
Hardness	810	740	762.5000	Selenium	<0.001	<0.001	<0.001
Aluminum				Sodium	102	23.0	51.475
Arsenic	<0.001	<0.001	<0.001	Sulfate	660	560	590.00
Barium	0.070	0.050	0.0550	Zinc	0.082	0.020	0.0563
Boron	0.250	0.13	0.1900	Gross Alpha	-	-	-
Carbonate	<0.01	<0.01	<0.01	Gross Beta	-	-	-
Bicarbonate	436.7	200	267.4000	Oil & Grease	5.2	<1.0	2.7500
Cadmium	<0.001	<0.001	<0.001	Phenol			
Calcium	170.4	152	162.1384	Alkalinity	358	164	219.00
Chloride	34.0	28.0	31.00	Acidity			
Chromium	<0.001	<0.001	<0.001	Silver	<0.001	<0.001	<0.001
Copper							
Fluoride	0.50	0.38	0.4350				
Iron-Total	0.409	0.149	0.3198				
Iron Dissolved							
Lead	0.005	<0.001	0.0030				
Magnesium	92.16	84.0	87.2400				
Manganese	0.156	0.004	0.0503				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum							
Nickel							

STATION BM-26

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	0.01	0.01	0.01	Ammonia	8.00	0.10	7.38
pH	8.2	7.33	7.78	Nitrate	0.84	0.05	0.14
Conductivity	1990	1050	1312.83	Nitrite	<0.01	<0.01	<0.01
Temp. C degrees (water)	9	8	8.25	Potassium	15.51	6.00	6.65
TSS	1228	100	633.67	Total Phosphate	2.30	0.150	0.91
TDS	1300	700	861.00	Ortho-Phosphate	0.150	0.04	0.09
Hardness	522	470	498.67	Selenium	0.005	<0.001	0.003
Aluminum	<0.001	<0.001	<0.001	Sodium	65	18.5	42.64
Arsenic	<0.001	<0.001	<0.001	Sulfate	640	360	430
Barium	0.055	0.012	0.03	Zinc	0.408	0.043	135.72
Boron	0.30	<0.001	0.18	Gross Alpha	-	-	-
Carbonate	<0.001	<0.001	<0.001	Gross Beta	-	-	-
Bicarbonate	270.8	204.96	228.12	Oil & Grease	13.6	1.7	6.90
Cadmium	<0.001	<0.001	<0.001	Phenol	<0.001	<0.001	<0.001
Calcium	112	88	100.67	Alkalinity	277	168	187
Chloride	32.0	24.0	24.33	Acidity			
Chromium	<0.001	<0.001	<0.001	Silver	<0.001	<0.001	<0.001
Copper	0.005	<0.001	0.003				
Fluoride	0.51	0.36	0.43				
Iron-Total	16.430	0.051	6.00				
Iron Dissolved							
Lead	0.003	<0.001	0.001				
Magnesium	62.4	55.2	59.28				
Manganese	0.227	0.021	0.13				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum	0.002	0.002	0.002				
Nickel	<0.001	<0.001	<0.001				

STATION BM-25

Parameters	Maximum	Minimum	Average	Parameters	Maximum	Minimum	Average
Flow (cfs)	-	-	-	Ammonia	8.0	0.15	1.4400
pH	8.16	6.9	7.4786	Nitrate	9.00	0.02	1.4786
Conductivity	2050	1390	1646.2857	Nitrite	1.05	1.02	1.0350
Temp. C degrees (water)	13	12	12.50	Potassium	17.80	6.52	10.334
TSS	1900	32.0	354.4286	Total Phosphate	2.80	0.090	0.6451
TDS	1350	906	1080.5741	Ortho-Phosphate	0.54	0.020	0.2051
Hardness	600	530	565.4286	Selenium	<0.001	<0.001	<0.001
Aluminum	0.036	<0.001	0.0185	Sodium	185	6.50	137.1429
Arsenic	<0.001	<0.001	<0.001	Sulfate	580	400	362
Barium	0.110	0.005	0.0534	Zinc	0.408	0.011	0.0913
Boron	0.30	<0.001	0.1494	Gross Alpha	-	-	-
Carbonate	19.20	<0.001	2.7514	Gross Beta	-	-	-
Bicarbonate	558.76	268.4	427.5657	Oil & Grease	4070	3.4	599.2571
Cadmium	<0.001	<0.001	<0.001	Phenol	<0.001	<0.001	<0.001
Calcium	123.2	80.0	7.00	Alkalinity	490	2.54	366.2857
Chloride	150	46.0	99.1429	Acidity			
Chromium	0.013	<0.001	0.0027	Silver	0.051	<0.001	0.0081
Copper	.005	.004	.0043				
Fluoride	0.66	0.50	0.5743				
Iron-Total	3.42	0.072	1.0757				
Iron Dissolved							
Lead	.004	<0.001	0.0017				
Magnesium	79.20	60.94	71.5857				
Manganese	0.218	0.023	0.0734				
Mercury	<0.0002	<0.0002	<0.0002				
Molybdenum	0.029	<0.001	0.0150				
Nickel	0.169	<0.001	0.0850				

STATION B-43 MC 207

Parameters	Maximum	Minimum	Average
Flow (cfs)	–	–	–
pH	7.783	7.78	7.6125
Conductivity	1820	1350	167 .500
Temp. C degrees (water)	14	10	11.50
TSS	–	–	363
TDS	1679	1120	1024. 75
Hardness	–	–	–
Aluminum	–	–	–
Arsenic	0.240	<0.001	0.0807
Barium	0.100	0.070	0.0820
Boron	–	–	0.130
Carbonate	–	–	–
Bicarbonate	1122.40	795.44	979. 0500
Cadmium	0.003	0.001	0.0017
Calcium	226.4	48.00	104.200 200
Chloride	66.00	36.8	54.700
Chromium	0.007	<0.001	0.0030
Copper	.080	.014	.0513
Fluoride	1.53	1.50	1.52
Iron-Total	4.550	0.120	1.42 25
Iron	0.124	0.080	0.10 20
Dissolved Lead	.073	.073	.073
Magnesium	52.80	16.32	37.6 200
Manganese	.140	0.012	0.0930
Mercury	–	–	<0.0 002
Molybdenum	–	–	–
Nickel	–	–	0.022

Parameters	Maximum	Minimum	Average
Ammonia	–	–	–
Nitrate	0.54	0.02	0.3433
Nitrite	–	–	–
Potassium	11.00	4.50	7.7150
Total Phosphate	0.800	0.380	.5667
Ortho-Phosphate	–	–	–
Selenium	<0.001	<0.001	<0.001
Sodium	350	310	333.750
Sulfate	619	48.0	258.500
Zinc	0.220	0.020	0.0917
Gross Alpha	–	–	–
Gross Beta	–	–	–
Oil & Grease	25000	107.20	12553.60
Phenol	0.048	0.015	0.031
Alkalinity	920	652	802.50
Acidity	148	6.0	49.3500
Silver	<0.001	<0.001	<0.001

APPENDIX 7-6

SURFACE WATER RAW DATA

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-1
Location Upper Willow Creek

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Phosphate Total	Phosphate Ortho
1-14-77	10:00	16	19	10	7.9						17.0	9.2	<1.0	<0.001		0.02	<0.01	0.12			0.022
4-1-77	14:50	2.5	21	12.5	7.2						9.0	9.0	1.8	0.022							
10-11-78	09:20	2	15	3	7.11						15.0	9.6	2.2	<0.001		0.02	<0.01				0.025
1-17-78	09:25	Ice	-4	0	7.1						15.0	11.0	<1.0	<0.001		0.22	<0.01				0.540
4-15-78	14:35	2.2	1	1	8.3						15.0	9.4	2.4	<0.001		0.07					0.045
7-17-78	12:10	21.3	11	4.5	7.83						4.0	9.1	<1.0	<0.001		0.12					0.10
6-15-79	10:07	40	21	11	8.4							5.15	<1.0	0.240		0.06					<0.10
8-8-79	[illegible]	[illegible]	[illegible]	21	7.9							6.6	<1.0	<0.001		0.02					0.020
10-30-79	11:24	4.5	5	5	7.60							9.7	3.8	<0.001		0.05				0.015	0.040
1-24-79	11:25	1.8	2	1	9.1							10.7	1.6	<0.001		0.02				0.210	0.030

Date	Sulfate	[illegible]	[illegible]	Solids TSS	Solids Total Dissolved	Solids TDS	Solids Total [illegible]	Solids Total Volatile	Conductance	Turbidity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1-14-77	72.0			88.0		465			1455		<0.01	305					
4-1-77	174			3.0		592			1225			229					
10-11-78	169.1			1.0		548			1540			353.8					
1-17-78	216			24.0		665			1220			494.76					
4-15-78	220			22.0		597			1540			341.60					
7-17-78	214			2250		775			1190			[illegible]					
6-15-79	103			43.0		418			1540			219.14	242		14.0		
8-8-79	190			220		612			1250			274.76	258		23.0		
10-30-79	190			32.0		569			1100			307.44	262		42.0		
1-24-79	240			<10		690			1060			[illegible]	330		20.0		

Date	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Dis	[illegible]	[illegible] Total	[illegible] Total	[illegible]	[illegible] Dis	[illegible] Total
1-14-77			0.004	[illegible]			<0.001	[illegible]	70.0	<0.001		0.002	<0.01	[illegible]	
4-1-77			<0.001	0.15			<0.001	45.1	22.0			0.015		0.43	
10-11-78			0.002	0.095			<0.001		22.0	<0.001		0.014		0.24	
1-17-78			<0.001	0.070			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	
4-15-78			<0.001	[illegible]			[illegible]	[illegible]	16.0	[illegible]		0.004		[illegible]	
7-17-78			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		0.001		[illegible]	
6-15-79			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	
8-8-79			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	
[illegible]			0.003	0.250			<0.001	72.0	25.0	0.002		0.004		0.26	
[illegible]			<0.001	0.070			<0.001	94.0	24.0	0.002		0.004		1.55	

Date	[illegible] Dis	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible]	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total				Comments
1-14-77		[illegible]	0.001	[illegible]	[illegible]				[illegible]	<0.001	21.40	<0.001	75.0	0.016					
4-1-77		0.662	0.001		0.002				2.11	<0.001	18.5	0.002		0.029					
10-11-78		0.025	<0.001	43.10	0.011				2.45	<0.001	11.8	<0.001	30.2	[illegible]					
1-17-78		0.001	<0.001	46.0	0.001				[illegible]	[illegible]	12.0	<0.001	105	[illegible]					
4-15-78		0.419	<0.001	57.80	0.017				1.62	<0.001	6.00	<0.001	25.3	0.011					
7-17-78		[illegible]	<0.001	[illegible]	[illegible]				[illegible]	[illegible]	4.00	<0.001	30.40	[illegible]					
6-15-79		[illegible]	0.001	[illegible]	[illegible]				1.599	0.030		<0.001	41.29	0.030					
8-8-79	0.410	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]		[illegible]	[illegible]	[illegible]					
[illegible]		0.290	0.005	24.80	0.016	<0.0002			3.860	<0.001		[illegible]	76.40	0.006					
[illegible]		0.100	<0.001	56.20	0.013	<0.0002			2.170	<0.001		<0.001	81.50	0.006					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-1
Location: Upper Willow Creek

Date	Time																	
2-13-80	4:19	3.6	0	0.5	9.0	11.8	1.40	<0.001	0.06	0.300	0.040	217	16.0	630	750	349.92	286	27.0
4-17-80	9:16	14	15	7	8.8	9.9	3.60	0.012	0.16	1.120		236	2622	621	750	29.19	262	2.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.150		[illegible]	97.5	[illegible]	[illegible]	[illegible]	227	[illegible]
7-?-80		6	29	21	8.1	[illegible]	1.00	0.0??	0.01	0.240		200	1.6	510	910	[illegible]	260	<1.0
10-21-80	12:05	6	5	2	7.6	[illegible]	5.60	0.003	<0.01	1.326		192	42.0	516	485	[illegible]	306	<1.0
12-29-80	11:29	23	10	0	7.6		0.60	<0.001	<0.01	0.150		204	16.0	590	504	275.??	328	<0.1
2-4-81	11:40		-1	0	7.6		0.90	<0.001	<0.01	0.030		214	2.0	688	510	412.34	358	<0.1
4-7-81	11:25	12	8	4	8.1		0.80	<0.001	<0.01	1.670		124	1596	396	365	[illegible]	704	16.0
6-25-81	9:15	1.5	22	22	8.5		1.20	<0.001	<0.01	0.220		198	11.0	510	700	[illegible]	212	<0.01
7-27-81	10:24	4.6	25	15	8.6		0.60	<0.001	<0.01	3.190		210	2.0	591	740	[illegible]	264	<0.01
9-29-81	2:36	16	11	7	8.3		0.40	<0.001	<0.01	1.300		141	439	481	600	320.20	278.??	<0.01
?-?-81	11:55	1.8	4	1	7.9		0.20	0.009	0.58	0.530		248	24.0	698	505	373.??	359	4.00
?-?-82	11:58		2	1	7.9		<1.0	0.086	0.14	0.500		236	11.0	662	645	375	307.40	18.00
?-?-82	11:29	13.8	18	7	7.7		<1.0	0.095	0.7	2.900		720	3085	1198	514	200.??	190.90	2.00
6-14-82	08:25		16	9	8.2		<0.1	0.055	0.08	0.080		98.0	27.0	420	616	308.20	378.10	<0.01
8-3-82	11:44	4.6	25	17	8.3		<0.1	0.018	<0.01	0.085		147	1.0	520	802	351	387.70	<0.01
10-7-82	11:45		15	8	8.3		<0.1	<0.001	<0.01	0.190		120	66.0	497	592	377.??	309.60	<0.01
12-21-82	?:45		-7	0	7.9		<0.1	<0.001	0.27	0.160		150	39.0	599	677	173.??	374.??	<0.01
2-24-93	11:30	1.3	0	1	7.7		<0.2	<0.001	0.18	0.180		200	23.0	612	698	387.80	312.86	<0.01
4-21-93	09:70	27.5	6	3	7.2		<0.2	<0.002	0.25	0.103		190	2291	697	628	329.4?	270	<0.01

Date																								
?-?-80	0.002	0.270			<0.001	17.20	34.0	0.001	<0.001		0.74		1.295	<0.001	19.92	0.030		2.25	<0.001	<0.001	82.0	0.020		
4-17-80	0.011	0.260			<0.001	61.00	25.0	<0.001	0.010		0.20		10.400	<0.001	21.20	1.150		2.24	0.002	<0.001	107	0.010		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	0.001	[illegible]	[illegible]		1.49	[illegible]	<0.001	21.0	[illegible]		
7-?-80	0.002	[illegible]			<0.001	[illegible]	[illegible]	[illegible]	[illegible]		0.24		0.040	<0.002	62.00	0.002		2.19	0.001	<0.001	[illegible]	[illegible]		
10-21-80	<0.001	0.090		0.130	<0.001	45.6?	21.5	<0.001	<0.01	<0.001	1.25	0.010	1.230	<0.002	55.65	0.010	<0.0002	1.92	<0.001	<0.001	45.00	0.004		
12-29-80	0.052	0.032			<0.001	77.00	19.1	<0.001	0.010		0.16		1.360	<0.001	37.40	0.026		1.50	0.003	<0.001	91.00	0.006		
2-4-81	0.002	0.070		0.050	0.002	41.00	34.20	<0.001	0.010		0.29	0.020	2.120	<0.001	41.76	0.010	<0.0002	2.00	0.002	<0.001	142	0.007		
4-7-81	0.014	0.055			<0.001	56.00	18.00	0.022	0.011		0.22		1.285	0.005	27.10	0.165		2.55	0.001	<0.001	47.40	0.125		
6-25-81	0.025	0.071			<0.001	40.80	4.00	<0.001	0.230		0.24		3.110	<0.001	4.76	0.010		2.20	<0.001	<0.001	73.00	0.005		
7-27-81	0.004	0.090			<0.001	47.20	37.50	<0.001	0.020		1.25		8.070	<0.001	50.40	0.010		2.27	0.004	<0.001	55.00	0.020		
9-29-81	0.005	0.065			<0.001	45.00	19.40	<0.001	0.022		1.27		0.880	<0.001	48.64	0.015		2.30	<0.001	<0.001	55.00	0.022		
?-?-81	<0.001	0.095			<0.001	76.00	24.37	<0.001	0.010		0.22		0.900	<0.001	53.00	0.020		11.90	<0.001	<0.001	86.50	0.019		
?-?-82	<0.001	0.050		0.500	<0.001	73.50	24.95	<0.001	0.010		0.19		1.260	0.050	54.00	0.020		1.72	<0.001	<0.001	84.10	0.011		
?-?-82	0.062	0.350			<0.001	265	11.10	0.062	0.090		0.15		45.100	0.005	55.00	1.730		8.75	0.003	0.006	49.5	0.285		
6-14-82	<0.001	0.100			<0.001	57.00	12.80	<0.001	0.020		0.18		0.370	0.005	32.10	0.025		4.00	<0.001	<0.001	46.0	0.015		
8-3-82	<0.001	0.110			<0.001	35.60	20.50	<0.001	0.010		0.25		0.190	0.002	39.30	0.055		2.80	<0.001	<0.001	82.0	0.020		
10-7-82	<0.001	0.095	<0.001		<0.001	57.60	11.50	<0.001	0.020		0.20		1.250	<0.001	42.72	0.010		1.82	<0.001	<0.001	65.5	0.015	<0.001	
12-?-82	<0.001	0.095			<0.001	67.20	26.20	<0.001	0.030		0.24		0.570	<0.001	48.48	0.035		1.80	<0.001	<0.001	82.0	0.005		
2-24-93	<0.001	0.100			<0.001	65.16	7.80	<0.001	0.030		0.19		0.540	<0.001	49.64	0.010		1.75	<0.001	<0.001	88.5	0.015		Improving
4-21-93	0.073	0.670			0.002	60.00	27.40	0.025	0.150		0.26		29.000	0.027	43.20	1.410		2.40	0.003	<0.001	79.0	0.165		

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-1
Location Upper Willow Creek

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Ammonia	Nitrate	Nitrite	Nitrogen Total	Nitrogen Organic	Phosphate Total	Phosphate Ortho	Sulfate	Sulfide	Surfactant	TSS	Total Settleable Solids	TDS	Total Solids	Total Volatile Solids	Specific Cond	Turbidity	Carbonate	Bicarbonate	Total Alk	Total Hardness	Acidity	Gross Alpha	Gross Beta
6-7-83	10:43	274	21	14	7.0								0.8	<0.001		0.66				<.200		118			68.0		468			504			317.20	260		<0.01		
9-17-83	10:20	12.8	20	16	6.8								<0.2	<0.001		0.05				0.14		144			46.0		485			847			317.30	260		6.00		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride	Chromium	Cobalt Total	Copper Total	Cyanide	Fluoride	[illegible] Total	[illegible]	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica	Silver Total	Sodium Total	Zinc Total	[illegible] Total				Comments
6-7-83			0.020	0.460			<0.001	86.00	22.00	0.016		0.010		0.21			28.60	0.002	42.24	0.027				2.26	0.007		<0.001	48.0	0.197					
9-17-83			0.018	0.690			<0.001	96.60	30.0	0.010		0.010		0.19			1.360	0.002	57.80	0.028				2.5	<0.001		<0.001	59.0	0.150					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-2
Location: Willow Creek above mine #6

Date	Time	Flow	Temperature: Air	Temperature: Water	pH	Coliform: Total	Coliform: Fecal	Fecal Strep	B.O.D.	C.O.D.	T.O.C.	Dissolved Oxygen	Oil & Grease	Phenol
4-19-77	14:26	2		11	8.4				11.0		10.0	8.5	<1.0	
5-17-77	14:40	1.5	23	19	8.2				12.0		11.0	8.3	<1.0	
6-7-77	11:45	1.2	26	18	8.4				8.0		6.0	8.6		
7-26-77	12:00	3.5	23	19	8.2				12.0		8.0	7.5	<1.0	<0.001
8-9-77	13:45	0.9	34	24	8.3				12.0		32.0	6.4		
9-8-77	09:30	0.1	17	12	7.9				7.0		4.0	8.2	5.9	
10-12-77	17:15	0.2	12	12					7.0		1.5			
11-9-77	11:15	0.1	0	0.5	9.1				4.0		2.0	9.5	1.5	
12-14-77	12:10	0.04	6	1	8.2				2.0		2.0	11.0		
1-11-78	10:25	0.2	4	0.2	9.2				2.5		1.8	10.4	3.4	
2-8-78	11:20	Dry												
3-8-78	17:55	2	4	1	8.1				10.0		4.6	10.0	2.9	
4-12-78	11:00	92	19	6	8.3				28.0		32.0	9.8	23.0	<0.001
5-16-78	11:15	49	16	7	7.8				4.0		25.0	9.5		
6-14-78	10:30	21	23	10	9.2							9.9	<1.0	

Date	Nitrogen: [illegible]	Nitrogen: [illegible]	Nitrogen: [illegible]	Nitrogen: [illegible]	Nitrogen: [illegible]	Phosphate: Total	Phosphate: Ortho	Sulfate	[illegible]	[illegible]	Solids: [illegible]	Solids: [illegible]	Solids: [illegible]	Solids: [illegible]	Solids: [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4-19-77	0.10	0.06				0.095	0.040	210	<0.01		37.0		720			1090	40.0	<0.01	373.4	262	320		<1	<2
5-17-77	0.15	0.05				0.099	0.040	254	<0.01		20.0		800			1210	1.0	<0.01	394.1	272	362			
6-7-77	0.12	0.10				0.040	0.035	271	<0.01		5.0		810			1220	0.79	<0.01	383.4	252	352			
7-26-77	0.25	0.07				1.025	0.095	172	<0.01	<0.01	477		499			760	17.0	<0.01	283	232	270			
8-9-77	0.15	0.02				1.025	0.030	290	0.01		7.0		695			1013	0.84	<0.01	391.8	258	312			
9-8-77	0.25	0.04				0.095	0.035	396	0.01		8.0		820			1270	0.40	<0.01	372.8	290	500			
10-12-77	0.50	0.05				0.025	0.010	274	0.01		10.0		700			1093	26.00	<0.01	344	310	416			
11-9-77	0.10	0.02				0.025	0.020	380	<0.01		29.0		910			1897	1.30	<0.01	495.2	356	570			
12-14-77	0.28	0.02				0.050	0.040	360	<0.01		21.0		672			1950	1.20	<0.01	422.4	346	540			
1-11-78	0.10	0.02				0.050	0.010	320	<0.01		16.0		805			1742	9.1	<0.01	401.9	336	550			
2-8-78																								
3-8-78	<0.01	0.08				0.045	0.005	200	<0.01		356		610			940	170	7.20	393.4	290	342			
4-12-78	0.25	0.52				0.088	0.015	94.0	<0.01		7070		410			630	300	7.2	275.2	238	248			
5-16-78	0.10	0.18				0.085	0.020	88.0	<0.01		445		404			615	175	<0.01	300.12	246	260			
6-14-78								183			52.0		410			650								

Date	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible]	[illegible]	[illegible] Total	[illegible] Total	[illegible]	[illegible]	[illegible] Total	[illegible]	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible]	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	Comments
4-19-77			<0.001	0.166		0.280	<0.001	60.4	22.0	<0.001				0.34			0.119	<0.001	46.64	0.072	<0.0002			2.95	<0.001		<0.001	91.49	0.016		
5-17-77	0.009		<0.001	0.005		0.280	<0.001	19.2	22.0	<0.001				0.36			0.128	<0.001	75.84	0.026	<0.0002			2.49	<0.001		<0.001	95.9	0.009		
6-7-77	0.010		<0.001	0.009		0.210	<0.001	46.4	23.0	<0.001				0.35			0.107	<0.001	56.44	0.421	<0.0002			3.33	<0.001		<0.001	101.9	0.005		
7-26-77	0.012		<0.001	0.011		0.250	<0.001	68.6	18.0	<0.001		0.006	<0.01	0.33			0.018	<0.001	32.64	0.003	<0.0002			2.90	<0.001	15.0	0.004	77.6	0.012		
8-9-77	0.050		<0.001	0.054		0.076	<0.001	68.4	50.0					0.36			0.205	<0.001	56.44	0.006	<0.0002			3.99	<0.001			96.90	0.014		
9-8-77	0.080		<0.001	0.021		0.19	<0.001	80.0	34.0			0.016		0.45			0.179	<0.001	72.0	0.005	<0.0002			8.70	<0.001			85.2	0.004		
10-12-77	0.025		<0.001	0.069		0.140	<0.001	60.0	26.0	<0.001				0.33			0.179	<0.001	63.84	0.009	<0.0002			4.19	<0.001	15.0		91.8	0.010		
11-9-77	0.029		<0.001	0.076		0.15	<0.001	94.8	34.0			<0.001		0.43			0.211	<0.001	71.36	0.061	<0.0002			7.23	<0.001			71.5	0.003		
12-14-77	0.060		<0.001	0.010		0.050	<0.001	100	36.0					0.40			0.338	<0.001	74.40	0.082	<0.0002			4.03	<0.001			91.0	0.036		
1-11-78	0.014		<0.001	0.070		0.070	<0.001	90.4	34.0	<0.001		0.014		0.44			0.295	<0.001	72.90	0.145	<0.0002			6.59	<0.001	10.0		79.0	0.025		
2-8-78																															
3-8-78	0.062		<0.001	0.140		0.17	<0.001	60.8	30.0					0.24			0.56	<0.001	45.6	0.290	<0.0002			6.18	<0.001			91.0	0.036		
4-12-78	0.070		0.009	0.030		0.11	<0.001	48.8	18.0	<0.001		0.008		0.29			0.019	<0.001	30.24	0.011	<0.0002			1.92	<0.001	14.0	<0.001	52.0	0.007		
5-16-78	0.110		<0.001	0.08		0.15	<0.001	50.4	26.0					0.28			0.042	<0.001	32.16	0.007	<0.0002			1.70	<0.001			85.0	0.002		
6-14-78									20.0								0.069			0.005											

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-2

Location Willow Creek above mine #6

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen Ammonia as N	Nitrate as N	Nitrite as N	Kjeldahl Total	Organic
6-14-78	9:30	31	23	16	7.5							9.9	<1.0						
8-9-78	11:16	1.7	25	15	7.9							8.4	1.4						
10-11-78	09:40	2	16	6	7.26							9.3	2.0						
1-10-79	10:20	Ice	-8	0	6.9						17.0	10.9	<1.0	0.002		0.12	<0.01		
1-15-79	14:07	---																	
4-27-79	14:50	52	18	7	7.55						1.0	2.6	1.5	<0.001		0.11			
6-13-79	14:02	68	26	12	8.6							8.5	1.0	0.004		0.01			
8-9-79	14:16	3.6	28	21	7.9							6.7	<1.0	0.001		0.17			
10-30-79	14:10	0.7	5	6	8.0							9.7	4.4	<0.001		0.16			
12-26-79	9:48	3	2	0.5	9.4							10.6	<1.0	0.034		<0.01			

Date	Phosphate Total as P	Ortho as P	Sulfate as SO4			Solids TSS	Total Settleable	TDS	Total	Total Volatile	Specific Cond	Turbidity	Alk as CaCO3	Bi. Alk	Total Hard	Total	Acidity as CaCO3		
6-14-78			180			57.0		410			650								
8-9-78			194			2.0		586			795								
10-11-78			192			8.0		598			920								
1-10-79		0.060	210			1.0		640			990			1020					
1-15-79																			
4-27-79		0.42	435			2770		778			490			786					
6-13-79		<0.010	110			24.0		410			690			308.05	254		14.0		
8-9-79		0.120	171			2660		855			1200			295.70	242		20.0		
10-30-79	0.140	0.100	212			24.0		568			640			292.40	244		23.0		
12-26-79	0.020	0.015	260			1.0		680			1080			276.50	306		24.0		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis	Chromium Hexav.	Cobalt Total	Copper Total	Cyanide	Fluoride Dis
6-14-78									20.0					
8-9-78									26.0					
10-11-78									24.0					
1-10-79			<0.001	0.072			0.001	70.4	24.0	<0.01		0.002		0.23
1-15-79														
4-27-79			[illegible]	[illegible]			0.001	45.0	[illegible]	[illegible]		0.005		0.25
6-13-79			<0.001	0.12			<0.001	52.0	26.0	<0.01		<0.001		0.30
8-9-79			<0.001	[illegible]			<0.001	[illegible]	[illegible]	<0.01		<0.001		[illegible]
10-30-79			<0.001	0.310			<0.001	45.0	26.0	<0.001		0.004		0.28
12-26-79			0.002	0.060			0.001	84.0	26.0	<0.001		0.004		0.29

Date	Total	Iron Dis	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO2	Silver Total	Sodium Total	Zinc Total	Vanadium Total				Comments
6-14-78			0.262			0.025														
8-9-78			1.119			0.105					<0.001									
10-11-78			0.132			0.024					<0.001									
1-10-79			0.024	<0.001	22.2	0.011				1.55	<0.001	10.0	<0.001	24.2	<0.001					
1-15-79																				
4-27-79			22.7	<0.001	[illegible]	0.280				3.16	0.020	46.0	<0.01	4.0	0.08					
6-13-79			0.180	0.002	[illegible]	[illegible]				1.46	0.002		<0.001	46.0	0.02					
8-9-79		0.580	[illegible]	<0.001	[illegible]	0.005				[illegible]	<0.001		<0.001	56.0	0.007					
10-30-79			0.130	<0.001	51.60	0.036	0.0002			4.910	0.001		<0.001	74.00	0.006					
12-26-79			0.140	<0.001	58.80	0.049	<0.0002			2.63	<0.001		<0.001	84.0	0.007					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-2
Location: Willow Creek above mine #6

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenols	Ammonia	Nitrate	Nitrite	Organic Nitrogen	Nitrogen	Phosphate Total	Phosphate Ortho	Sulfate			TSS	Total Dissolved	TDS	Total	Total Volatile	Specific Cond.	Turbidity	CO_2	Alkalinity as $CaCO_3$	Total Hardness		Acidity as $CaCO_3$		
6-7-83	1410	9.46	24	14	7.5								1.0	.0006		<0.02				0.140		119			68.0		480			519			329.?	270		<0.01		
8-17-83	8:48	20.2	26	19	7.6								0.2	<0.001		0.04				0.13		146			28.0		490			788			306	260		3.00		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride	Chromium	Cobalt Total	Copper Total	Cyanide	Fluoride	Mercury Total	Iron Dis.	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	Vanadium Total				Comments
6-7-83			0.019	0.750			<0.001	48.60	24.00	0.006		0.010		0.22			34.500	0.004	46.24	0.0??				2.50	0.001		<0.001	67.0	0.145					
8-17-83			0.016	1.720			<0.001	44.00	38.0	0.011		0.012		0.19			1.430	<0.001	46.08	0.040				2.4	<0.001		<0.001	63.0	0.166					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-2
Location Willow Creek above mine #10

Date	Time	Flow (cfs)	Temp. Air (°C)	Temp. Water (°C)	pH	Dissolved Oxygen mg/l	Oil & Grease mg/l	Phenol mg/l	Nitrate as N mg/l	Phosphate Total mg/l	Phosphate Ortho mg/l	Sulfate mg/l	Solids TSS mg/l	Solids TDS mg/l	Cond	HCO3 mg/l	Total Alk as CaCO3 mg/l	Acidity as CaCO3 mg/l
2-13-90	13:26	8.6	1	0.5	8.8	11.4	2.00	0.020	0.02	0.180	0.020	229	1.0	634	1350	359.80	790	26.0
4-17-90	10:45	24	16	3	8.75	10.0	6.40	0.002	0.16	0.720		265	1518	470	490	333.38	274	2.0
6-5-90	2:50	22.1	25	11.5	9.2	8.4	1.20	<0.002	0.15	0.700		76.0	13.6	262	560	307.44	260	[illegible]
8-7-90	12:45	6	28	20	7.4	7.0	1.20	<0.001	<0.01	0.510		220	3.0	560	95.0	315.96	320	<1.0
9-27-90	11:43	6	6	2	7.9	11.3	1.0	<0.001	<0.01	0.100		274	26.0	520	890	316.32	296	<1.0
12-28-90	14:12		13	0	7.6		1.00	0.001	<0.01	0.120		231	14.0	340	503	358.48	322	<0.1
2-4-91	11:25		0	1	7.8		<0.01	<0.001	<0.01	0.080		223	13.0	700	522	302.48	354	<0.1
4-1-91	11:07	31	11	4	8.1		1.40	<0.001	<0.01	1.000		92.0	2648	348	228	276.44	202	5.0
6-25-91	12:12		34	22	8.7		1.20	<0.001	<0.01	0.220		189	15.0	508	680	265.96	220	<0.01
8-27-91	10:20	1.3	26	15	8.7		0.20	<0.001	<0.01	1.290		226	1.0	585	700	278.16	248	<0.01
10-29-91	12:20		7	7	8.3		1.32	0.018	0.02	1.200		150	102	483	615	322.8	276.70	<0.01
12-5-91	11:41		4	1	7.9		<0.01	0.009	0.53	0.620		266	150	683	500	387.2	317	1.00
2-15-92	8:45	-0-	Frozen															
4-14-92	8:10		15	5	7.9		2.6	<0.001	0.17	1.240		415	535	788	520	356.??	266.30	<0.01
6-18-92	12:25	39	17	13	8.3		<0.1	0.005	0.16	0.080		74.0	26.0	315	609	374.90	308.40	<0.01
9-1-92	15:05		24	19	8.4		<0.1	0.012	<0.01	0.082		144	5.0	413	753	378.00	278.0	<0.01
10-7-92	12:46		14	6	8.5		<0.1	<0.001	<0.01	0.130		140	46.0	495	634	355.40	291.30	<0.01
12-2-92	[illegible]		-1	0	8.1		<0.1	<0.001	<0.01	0.130		174	34.0	585	663	393.??	316.??	2.00
2-15-93	11:48	2.8	10	1	7.9		<0.2	0.017	<0.03	1.200		210	45.0	600	650	376.20	301.36	<0.01
4-21-93	19:45		7	3	7.8		<0.2	<0.002	0.27	0.90		186	43/0	540	661	372.20	260	<0.01

Date	Arsenic Total mg/l	Barium Total mg/l	Beryllium Total mg/l	Boron Total mg/l	Cadmium Total mg/l	Calcium Total mg/l	Chloride Dis mg/l	Chromium mg/l	Copper Total mg/l	Cyanide as CN mg/l	Fluoride Dis mg/l	Iron Dis mg/l	Iron Total mg/l	Lead Total mg/l	Magnesium Total mg/l	Manganese Total mg/l	Mercury Total mg/l	Potassium Total mg/l	Selenium Total mg/l	Silver Total mg/l	Sodium Total mg/l	Zinc Total mg/l	Vanadium Total mg/l
2-13-90	0.001	0.310			<0.001	71.20	21.0	0.002	<0.001		0.27		0.126	<0.001	45.48	0.030		4.80	<0.001	<0.001	11.0	0.016	
4-17-90	0.002	0.110			<0.001	56.00	24.0	0.001	0.010		0.23		22.800	<0.001	44.40	1.460		2.40	0.001	<0.001	115	0.020	
6-5-90	<0.001	0.020			<0.001	55.30	12.0	<0.001	<0.010		0.27		2.690	0.012	34.65	1.070		1.44	0.009	<0.001	27.60	0.010	
8-7-90	0.001	0.080		1.100	<0.001	51.00	26.0	<0.001	0.010		0.21		0.070	<0.002	52.00	0.032		2.38	0.001	<0.001	70.60	0.105	
9-27-90	<0.001	0.050		0.110	<0.001	46.40	22.3	<0.001	<0.001	<0.001	1.24	0.020	0.590	<0.002	56.16	0.030	<0.0002	2.19	<0.001	<0.001	76.00	0.003	
12-28-90	0.012	0.035			<0.001	30.00	11.4	<0.001	0.010		0.15		0.485	<0.001	48.00	0.070		1.95	0.002	<0.001	23.40	0.008	
2-4-91	0.002	0.510		0.090	<0.001	47.60	29.60	<0.001	0.010		0.29	0.020	0.340	<0.001	52.12	0.040	<0.0002	2.40	0.002	<0.001	126	0.007	
4-1-91	0.016	0.555			0.002	45.10	16.00	0.077	0.090		1.25		11.200	0.015	25.92	1.000		3.90	0.001	<0.001	42.30	0.015	
6-25-91	0.050	0.555			<0.001	54.50	22.00	<0.001	1.040		1.25		0.230	<0.001	44.16	0.020		2.24	<0.001	<0.001	78.00	0.009	
8-27-91	0.004	0.095			<0.001	39.20	40.50	<0.001	0.010		0.28		0.110	<0.001	53.60	0.020		2.95	0.004	<0.001	36.00	0.010	
10-29-91	0.009	0.195			<0.001	44.00	31.10	<0.001	0.009		0.22		0.120	<0.001	42.04	0.022		2.80	<0.001	<0.001	63.00	0.015	
12-5-91	<0.001	0.075			<0.001	70.00	25.00	<0.001	0.010		0.25		0.130	<0.001	58.00	0.042		5.80	<0.001	<0.001	88.00	0.029	
2-15-92																							
4-14-92	0.008	0.030			<0.001	18.0	1.60	0.027	0.100		0.19		24.000	0.002	43.00	1.300		5.08	0.002	<0.001	42.0	0.105	
6-18-92	0.005	0.100			<0.001	66.00	8.60	<0.001	0.010		0.18		1.300	<0.001	38.20	0.056		1.50	<0.001	<0.001	44.5	0.005	
9-1-92	<0.001	0.100			<0.001	38.10	13.30	<0.001	<0.001		0.24		0.660	<0.001	36.10	0.015		2.20	<0.001	<0.001	76.0	0.010	
10-7-92	<0.001	0.110	<0.001		<0.001	49.60	11.10	<0.001	0.020		0.20		0.690	<0.001	45.60	0.070		2.06	<0.001	<0.001	65.6	0.005	<0.001
12-2-92	<0.001	0.080			<0.001	46.60	26.20	<0.001	0.020		0.25		1.320	<0.001	58.98	0.090		3.10	<0.001	<0.001	81.5	0.015	
2-15-93	<0.001	0.100			<0.001	53.60	2.70	<0.001	0.020		0.19		0.410	<0.001	56.20	0.050		1.93	<0.001	<0.001	77.5	0.013	
4-21-93	0.024	0.290			0.002	64.90	39.40	0.053	0.110		0.26		39.900	0.030	45.12	1.400		2.30	0.002	<0.001	74.0	0.175	

Comments: Southead Rain Show

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-3
Location Willow Creek below Braztah mine #6

4/19/77	16:00	0.2		13	(7.7)				15.0	9.0	9.0	8.6	<1.0		0.20	0.02				0.060	0.010	210	<0.01		5.0		(720)			1050	4.25	<0.01	[illegible]	240	220		<1	<2
4-14-78	10:40	34	25	10	7.5						11.0	9.2	<1.0	<0.001		0.06	<0.01	0.10			0.021	840			55.0		378			625		<0.01	72.8					

																																		Comments
4/19/77			<0.001	0.144		0.265	<0.001	43.2	24.0	<0.001				0.82			0.259	<0.001	50.90	0.021	<0.002			3.13	<0.001		<0.001	25.70	0.017					
4-14-78			0.005	0.660			<0.001	44.0	20.0	<0.001		0.001	<0.01	0.21			0.244	<0.001	23.6	0.021				1.721	<0.001	19.8	<0.001	51.0	0.016					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station *B-3*
Location *Willow creek below mine #6*

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen				
[illegible]	10:40	34	25	10	7.6						11.0	9.2	<1.0	<0.001		0.06	<0.01	0.10	
[illegible]	11:10	2	26	18	8.0						12.0	9.8	1.2						
10-11-78	11:50	3.5	16	6	7.35						11.0	9.3	1.4			0.05	<0.01		
[illegible]	10:45	Ice	-2	0	7.1						1[illegible].0	11.4	1.2	<0.001		0.05	<0.01		
[illegible]	12:00	1.1	5	1	8.4						1.0	10.0		0.010		0.02			
[illegible]	[illegible]	44.6	[illegible]	7	7.46						-	9.4	1.7	0.001		[illegible]			
[illegible]	[illegible]	51	20	12.5	8.6							7.4	<1.0	0.005		<0.01			
[illegible]	[illegible]	8.8	[illegible]	21	7.7							6.4	<1.0	[illegible]		0.29			
[illegible]	13:58	1.4	10	6.5	8.0							8.3	<1.0	<0.001		0.30			
9-26-79	15:09	2.6	5	0.5	9.6							7.2	<1.0	<0.001		<0.01			

Date	Phosphate Total	Phosphate Ortho				Solids TSS		TDS											
[illegible]		0.021	86.0			55.0		978			625		<0.01	212.8					
[illegible]			196			4.0		277			845								
10-11-78			199			2.0		576			270			281.8					
[illegible]		0.021	196			25.0		612			940			310.45					
[illegible]		0.044	246			56.0		685			1050			346.47					
[illegible]		[illegible]	[illegible]			[illegible]		[illegible]			1210			[illegible]					
[illegible]		0.160	85.0			26.0		280			540			308.88	264		18.0		
[illegible]		0.080	240			1970		988			1500			302.52	2.6		22.0		
[illegible]	0.116	0.068	207			24.0		562						297.10	240		10.0		
9-26-79	0.100	0.005	245			<1.0		682			1000			366	300		22.0		

Date	Total	Total	Total	Total	Total	Total	Total	Total			Total	Total				
[illegible]			0.003	0.460			<0.001	44.0	20.0	<0.001		<0.001	<0.01	0.21		
[illegible]			<0.001													
10-11-78			<0.001	0.017			<0.001		74.0	<0.001		0.004		0.25		
[illegible]			<0.001	0.010			<0.001	68.8	22.0	<0.001		[illegible]		[illegible]		
[illegible]			<0.001	0.051			<0.001	72.8	14.0	<0.001		0.001		0.26		
[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		
[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		
[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		0.881
[illegible]			0.002	0.31			<0.001	54.0	26.0	<0.001		0.005		0.27		
9-26-79			<0.001	0.050			<0.001	76.0	30.0	<0.001		0.003		0.26		

Date	Total	Total	Total	Total	Total	Total	Total	Total	Total		Total	Total	Total	Total	Comments
[illegible]	0.844	<0.001	23.6	0.171				1.721	<0.001	19.6	<0.001	56.0	0.016		
[illegible]	0.126			0.012					<0.001						
10-11-78	0.072	<0.001	43.20	0.020				2.68	<0.001	10.20	0.002	81.5	0.008		
[illegible]	0.041	<0.001	27.36	0.025				2.824	<0.001	11.0	<0.001	77.0	0.002		
[illegible]	[illegible]	<0.001	21.62	0.012				2.720	<0.001	5.10	<0.001	74.6	0.001		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]	[illegible]	60.0	[illegible]		
[illegible]	0.150	0.002	[illegible]	[illegible]				4.19	[illegible]		<0.001	46.0	0.12		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	<0.001		<0.001	14.8	0.011		
[illegible]	0.125	<0.001	41.38	0.073	<0.0002			4.210	<0.001		<0.001	70.0	0.006		
9-26-79	0.180	<0.001	35.20	0.004	<0.0002			2.62	<0.001		<0.001	84.0	0.003		Estimate through ice

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-3
Location Willow Creek below mine #10

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Ammonia as N	Nitrate as N	Nitrite as N	Nitrogen Total	Nitrogen Organic
2-19-80	12:30	-0-																	
4-12-80	10:30	25	15	3	9.8							10.4	10.60	0.032		0.20			
6-5-80	7:15	95	26	11	9.45							9.2	2.60	<0.002		0.02			
8-7-80	12:13	16.9	35	19	9.6							10.1	0.40	<0.001		<0.01			
10-21-80	11:29	1.6	6	3	7.9							10.6	4.40	<0.001		<0.01			
12-29-80	14:00	2.7	11	2	7.6								1.40	0.052		<0.01			
2-4-81	11:10		-1	1	7.6								<0.01	0.021		<0.01			
4-7-81	11:05	11	5	4	8.0								1.40	0.096		<0.01			
6-29-81	11:51	5	30	18	8.7								1.40	0.070		<0.01			
8-27-81	10:10		22	15	8.7								0.20	<0.001		0.34			
10-27-81	11:53		8	7	8.1								3.40	<0.001		<0.01			
12-8-81	11:28		3	1	7.5								0.20	0.018		0.63			
2-15-82	11:42	---	Frozen																
4-14-82			16	4	7.9								4.0	0.008		0.18			
6-9-82	17:35		16	13	8.5								<0.1	<0.001		0.11			
8-3-82	7:16		25	19	8.5								<0.1	<0.001		<0.01			
10-28-82	7:25		13	6	8.6								1.0	<0.001		<0.01			
12-14-82	11:17		2	1	8.3								<0.1	<0.001		<0.01			
2-24-83	12:00		10	1	8.1								<0.2	<0.001		0.05			
4-21-83	10:58	60	13	4	8.1								<0.2	<0.002		0.27			

Date	Phosphate Total as PO4	Phosphate Ortho as PO4	Sulfate as SO4	Sulfide as S	[illegible]	TSS	Total Settleable Solids	TDS	Total Solids	Total Volatile Solids	Cond	Turbidity	Alk as CO3	Alk as HCO3	Total Alk as CaCO3	Total Hardness as CaCO3	Acidity as CaCO3	Gross Alpha	Gross Beta
2-19-80																			
4-12-80	0.560		220			1386		720			860			324.52	266		2.0		
6-5-80	0.150		70.5			85.0		360			550			312.68	252		1.0		
8-7-80	3.040		200			1.0		540			450			282.62	228		<1.0		
10-21-80	0.120		192			31.0		520			870			352.41	294		<1.0		
12-29-80	0.130		208			37.0		510			515			343.11	286		<0.1		
2-4-81	0.060		222			4.0		695			521			408.32	352		<0.1		
4-7-81	1.200		230			2728		845			315			226.92	186		20.0		
6-29-81	0.240		155			21.0		455			620			266.08	220		<0.01		
8-27-81	0.300		228			6.0		580			695			266.00	238		<0.01		
10-27-81	0.200		147			65.0		520			485			332.30	276.25		<0.01		
12-8-81	0.950		234			170		699			483			427	398		1.00		
2-15-82																			
4-14-82	0.740		196			887		510			535			260.40	213.30		<0.01		
6-9-82	0.060		136			31.0		470			611			332.80	268.20		<0.01		
8-3-82	0.065		160			1.0		525			590			338.40	277.60		<0.01		
10-28-82	0.130		140			27.0		492			1099			362.24	298.70		<0.01		
12-14-82	0.090		155			42.0		540			687			405.00	330.20		4.00		
2-24-83	0.200		195			43.0		585			675			376.40	307.59		<0.01		
4-21-83	1.00		190			4106		565			636			376.92	268		<0.01		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Dis	[illegible] Total	Iron Dis	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO2	Silver Total	Sodium Total	Zinc Total	[illegible] Total				Comments
2-19-80																																		
4-11-80			0.002	0.150			<0.001	66.0	66.0	0.002		0.020		0.22			26.300	<0.001	33.60	0.520				2.52	0.001		<0.001	129	0.020					
6-5-80			<0.001	0.145			<0.001	50.4	14.0	<0.001		<0.010		0.27			2.710	0.004	27.64	0.010				1.45	0.001		<0.001	32.50	0.010					
8-7-80			0.001	0.070		0.110	<0.001	41.50	24.0	<0.001		0.010		0.24			1.160	<0.002	41.30	<0.01				2.42	0.001		<0.001	76.50	0.002					
10-21-80			<0.001	0.070		0.110	<0.001	48.00	21.5	0.015		0.010	<0.001	0.27		0.690	1.920	0.005	52.10	0.020	<0.0002			2.14	<0.001		<0.001	81.00	0.010					
12-29-80			0.002	0.045			<0.001	64.00	11.7	<0.001		0.020		0.15			1.110	<0.001	32.60	0.015				2.10	0.002		<0.001	32.00	0.012					
2-4-81			0.002	0.070		0.020	<0.001	22.00	40.31	<0.001		0.011		[illegible]		0.050	3.120	<0.001	44.64	0.030	<0.0002			2.45	0.001		<0.001	117	0.007					
4-7-81			0.020	0.040			0.002	57.20	20.40	0.011		0.011		0.22			2.100	0.012	24.92	1.250				4.02	[illegible]		0.002	42.00	0.175					
6-29-81			0.050	0.075			<0.001	[illegible]	[illegible]	<0.001		0.11		0.26			0.120	<0.001	41.6	0.010				2.42	<0.001		<0.001	144.00	0.019					
8-27-81			0.015	0.095			<0.001	49.00	49.00	<0.001		0.021		0.28			0.150	<0.001	54.22	0.010				2.90	0.004		<0.001	85.00	0.010					
10-27-81			0.006	0.070			<0.001	43.20	17.90	<0.001		0.012		0.23			0.190	<0.001	46.08	0.012				2.30	<0.001		<0.001	62.00	0.011					
12-8-81			<0.001	0.075			<0.001	65.00	23.87	<0.001		0.010		0.26			0.150	<0.001	65.50	0.040				6.20	<0.001		<0.001	105	0.026					
2-15-82																																		
4-14-82			0.023	0.180			<0.001	90.00	18.87	0.073		0.100		0.16			20.500	0.002	30.09	0.010				2.65	0.002		<0.001	46.0	0.051					
6-9-82			<0.001	0.100			<0.001	87.50	14.20	<0.001		<0.010		0.17			1.420	0.005	32.60	0.035				1.95	<0.001		<0.001	47.4	0.015					
8-3-82			<0.001	0.099			<0.001	68.40	23.30	<0.001		0.013		0.24			0.130	0.002	32.20	0.020				2.20	<0.001		<0.001	42.0	0.010					
10-28-82			<0.001	0.030	<0.001		<0.001	48.60	9.30	<0.001		0.010		0.20			1.110	<0.001	45.60	0.035				2.05	<0.001		<0.001	67.0	0.016	<0.001				
12-14-82			<0.001	0.090			<0.001	65.60	[illegible]	<0.001		0.010		0.25			1.110	<0.001	48.42	0.035				2.10	<0.001		<0.001	81.0	0.003					
2-24-83			<0.001	0.100			<0.001	56.80	6.40	<0.001		0.050		0.19			0.650	<0.001	41.96	0.045				1.94	<0.001		<0.001	81.0	0.013					
4-21-83			0.026	0.710			0.002	56.80	27.40	0.035		0.110		0.26			34.500	0.080	44.64	1.560				2.50	0.003		<0.001	79.0	0.200					Scofield Rain Sh[illegible]

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station *B-3*
Location *Willow Creek below mine #6*

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	[illegible]	Oil & Grease	Phenol	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Phosphorus Total	Phosphorus [illegible]	[illegible]	[illegible]	[illegible]	Solids [illegible]	Solids [illegible]	Solids [illegible]	Solids Total [illegible]	Solids Total Volatile	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6-28-83	11:26		23	14	7.8								0.6	<0.001		0.07				0.180		119			56.0		458			528			31880	258		<0.01	
1-17-85	11:02	16.4	26	20	7.7								<0.2	<0.001		0.03				0.14		140			36.0		470			781			29748	244		4.00	

Date	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Dis	[illegible]	[illegible] Total	[illegible] Total	[illegible]	[illegible] Dis	[illegible] Total	[illegible] Dis	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible]	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	Comments
6-28-83			0.025	0.740			<0.001	48.00	24.00	0.005		0.020		0.22			35.600	0.004	44.16	0.025				2.60	0.002		48.00	60.0	0.215		
1-17-85			0.028	0.780			<0.001	42.40	25.00	0.011		0.040		0.18			1.130	<0.001	38.82	0.030				2.5	0.003		<0.001	66.0	0.199		

VAUGHN HANSEN ASSOCIATES
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WATER QUALITY DATA

Station B-5
Location Price River below coal processing area

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	[illegible]	[illegible]	[illegible]	[illegible]	Oil & Grease	[illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Phosphate Total	Phosphate [illegible]	[illegible]	[illegible]	[illegible]	Solids [illegible]	Solids [illegible]	Solids [illegible]	Solids [illegible]	Solids [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4-13-77	13:25	48	19	9	(8.5)				4.0		6.0	10.0	<1.0		0.28	0.04				0.106	0.045	38.0	<0.01		101		380			670	45.0	<0.01	253.8	202	214		<1	<2
5-9-77	14:00	156	23	12	8.2				14.0		9.0	9.9	<1.0		0.20	0.06				0.280	0.095	24.0	<0.01		287		520			480	55.0	<0.01	222	192	192			
6-1-77	11:15	64	28	14	8.3				9.0		6.0	8.4	<1.0		0.25	0.08				0.140	0.095	31.5	<0.01		47.0		550			500	1.60	<0.01	219.6	180	196			
7-6-77	11:30	25	22	17	7.0				12.0		18.0	8.1	<1.0	<0.001	0.20	0.09				0.150	0.080	25.0	<0.01	<0.01	28.0		285			360	6.00	<0.01	228.0	186	196			
8-5-77	13:00	35	33	19	(8.5)				8.0		56.0	8.2	<1.0		0.35	0.05				0.110	0.080	58.0	<0.01		54.0		228			360	0.76	<0.01	195.9	152	168			
9-8-77	10:15	17	27	13	(8.5)				12.0		13.0	7.8	1.6		0.20	0.02				1.05	0.020	34.0	<0.01		109		200			310	1.16	<0.01	185.4	152	162			
10-12-77	12:10	2.6	16	10	8.7				8.0		2.8		2.9		0.20	0.02				0.110	0.050	62.0	<0.01		24.0		310			482	15.0	<0.01	265.9	218	248			
11-3-77	11:40	1.7	-1	1.5	8.0				24		2.0	10.5	<1.0		0.40	0.30				0.110	0.100	114	<0.01		10.0		494			672	15.20	<0.01	285.5	266	284			
12-14-77	11:47	12.5	6	0.5	8.4				26.0		22.0	14.0	4.9		0.15	0.93				0.080	0.060	68.0	<0.01		506		258			400	55.0	<0.01	264.1	220	254			
1-11-78	11:35	8.5	7	0.6	(8.6)				24.0		19.0	10.9	6.3		0.05	0.84				0.050	0.020	52.0	<0.01		19.0		306			473	6.0	<0.01	277.1	228	250			
2-8-78	10:55	10	1	0.75	8.0				16.0		27.0	11.2	2.0		<0.01	0.23				0.062	0.010	56.0	<0.01		38.0		321			494	22.0	<0.01	278.1	228	254			
3-8-78	11:30	36	5	5	7.6				11.0		15.0	9.8	1.6		<0.01	0.55				0.038	0.010	78.0	<0.01		203		367			570	0.19	2.40	256.32	220	276			
4-12-78	10:40	159	18	6	8.2				40.0		58.0	9.6	(27.6)	<0.001	0.25	0.57				0.110	0.025	58.0	<0.01		1628		368			570	210	12.0	256.[illegible]	230	256			
5-10-78	10:50	204	17	8.5	7.7				8.0		30.0	9.1	4.6		0.12	0.94				0.040	0.025	46.0	<0.01		358		330			500	170	<0.01	297.28	244	256			
6-14-78	12:00	84	29	14	7.6							8.9	<1.0									45.0			91.0		293			410								

Date	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible]	[illegible]	[illegible] Total	[illegible] Total	[illegible]	[illegible]	[illegible] Total	[illegible]	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total	[illegible]	[illegible] Total	[illegible] Total	[illegible] Total	[illegible] Total				Comments
4-13-77			0.001	0.206		0.140	<0.001	48.0	8.0	<0.001				0.20			0.247	<0.001	22.56	0.093	<0.0002			1.69	<0.001		<0.001	15.76	0.021					
5-9-77	0.089		<0.001	0.074		0.170	<0.001	19.2	8.0	<0.001				0.21			(0.782)	<0.001	37.46	(0.245)	<0.0002			1.69	<0.001		0.005	16.50	0.019					
6-1-77	0.050		<0.001	0.027		0.110	<0.001	44.0	8.0	<0.001				0.23			0.299	<0.001	20.64	0.067	<0.0002			1.91	<0.001		<0.001	13.1	0.016					
7-6-77	0.051		<0.001	0.30		0.175	<0.001	52.0	10.0	<0.001		0.002	<0.01	0.25			0.284	<0.001	15.84	0.008	<0.0002			1.99	<0.001	3.20	<0.001	13.35	0.012					
8-5-77	0.016		<0.001	0.140		0.050	<0.001	48.0	8.0					0.19			0.167	<0.001	16.32	0.008	<0.0002			1.95	<0.001			20.00	0.053					
9-8-77	0.043		<0.001	0.018		0.09	<0.001	48.0	8.0			0.041		0.16			0.096	<0.001	13.88	0.002	<0.0002			2.77	<0.001			16.5	0.016					
10-12-77	0.030		<0.001	0.037		0.110	<0.001	58.4	12.0	<0.001				0.20			0.347	<0.001	21.98	0.005	<0.0002			2.02	<0.001	3.60	<0.001	22.0	0.003					
11-3-77	0.061		<0.001	0.047		0.14	<0.001	60.8	14.0					0.22			(0.48)	<0.001	19.49	0.015	<0.0002			2.50	<0.001			48.0	0.003					
12-14-77	0.080		<0.001	0.050		0.15	<0.001	64.4	16.0					0.18			(0.17)	<0.001	21.3	0.014	<0.0002			1.78	<0.001			23.3	0.058					
1-11-78	0.022		<0.001	0.010		0.025	<0.001	56.0	12.0	<0.001				0.20			0.206	<0.001	26.40	0.029	<0.0002			2.63	<0.001	6.2		20.0	0.019					
2-8-78	0.22		<0.001	0.11		0.10	<0.001	66.0	18.0					0.17			(0.322)	<0.001	22.86	0.019	<0.0002			1.655	<0.001			21.6	0.262					
3-8-78	0.320		0.014	0.270		0.15	<0.001	59.4	32.0					0.19			(0.090)	<0.001	86.2	(0.153)	<0.0002			4.42	<0.001			36.0	0.052					
4-12-78	0.040		<0.001	0.160		0.12	<0.001	28.4	12.0	<0.001		0.008		0.25			0.024	<0.001	26.40	0.005	<0.0002			1.72	<0.001	14.0		24.6	0.007					
5-10-78	0.120		<0.001	0.14		0.14	<0.001	54.4	16.0					0.29			0.062	<0.001	26.80	0.004	<0.0002			1.951	<0.001			36.0	0.004					
6-14-78									12.0								(0.619)			0.014														

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-5
Location: Price river below washing facility

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal		COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen					Phosphate Total	Phosphate Ortho																	
6-19-78	12:48	84	29	14	7.6							7.9	<1.0									45.0			91.0		795			410								
9-7-78	12:20	114	31	19	8.1						2.0	8.5	5.4									80.0					738			395								
10-11-78	10:20	60	21	8.5	7.57						14.0	8.4	1.8									6.0			5.0		268			380								
12-13-78	11:52	Ice	[illegible]	0.8	7.5						15.0	11.9	1.4	0.0052		0.22	<0.01				0.020	30.0			20.0		420			640			2111.2					
1-15-79	15:05	44	5	1	8.2						17.0	9.9	7.8	0.0011		0.74					0.066	140			105		448			665			307.54					
[illegible]-79	[illegible]	[illegible]	10	4	[illegible]						[illegible]	11.4	1.0	0.001		[illegible]					1.76	[illegible]			176		425			620			[illegible]					
5-15-79	[illegible]	170	31	15	8.6							8.0	<1.0	[illegible]		0.22					<0.010	26.0			100		270			420			[illegible]	216		16.0		
8-8-79	14:56	170	32	21	7.8							7.5	<1.0	0.010		<0.01					<0.010	13.0			47.0		318			480			[illegible]	272		10.0		
10-30-79	[illegible]	18.8	8	6	7.9							10.1	<1.0	<0.001		0.02				0.145	0.115	75.0			22.0		365			610			372.72	226		27.0		
12-6-79	[illegible]	60	3	1	9.6							12.0	<1.0	<0.001		0.29				0.040	0.010	75.0			<1.0		380			610			[illegible]	738		26.0		

Date																																	Comments
6-19-78									12.0								0.619			.016													
9-7-78			<0.001						8.0								4.231			0.042					<0.001								
10-11-78			<0.001	0.097			<0.001		8.0	<0.001		0.002		0.16			0.094	<0.001		0.032					<0.001		<0.001						
12-13-78			0.001	0.099			<0.001	61.7	16.0	<0.001		0.006		0.14			1.026	0.004	24.8	0.014				1.969	<0.001	11.0	<0.001	21.0	0.012				
1-15-79			<0.001	0.110			<0.001	64.0	10.0	0.001		.006		0.21			0.043	0.004	40.8	0.040				1.919	<0.001	5.1	<0.001	38.0	0.011				
[illegible]			<0.001	[illegible]			<0.001	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	<0.001	[illegible]	<0.001	[illegible]	[illegible]				
[illegible]			[illegible]	0.11			<0.001	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	<0.001		<0.001	11.42	[illegible]				
8-8-79			<0.001	0.090			<0.001	11.0	10.0	<0.001		0.004		0.16			1.170	0.001	2.36	0.100				1.183	<0.001		<0.001	56.70	0.016				
10-30-79			<0.001	0.110			<0.001	50.0	11.0	<0.001		0.004		0.23			0.180	<0.001	[illegible]	[illegible]	<0.0002			1.150	<0.001		<0.001	51.40	0.007				
12-6-79			<0.001	0.080			<0.001	64.0	28.0	0.007		<0.005		0.16			1.200	0.001	53.60	0.017	<0.0002			1.22	<0.001		<0.001	27.10	0.005				

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-5
Location: Price River below washing facility

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen Ammonia	Nitrate	Nitrite	Kjeldahl	Organic	Phosphorus Total	Ortho	Sulfate	[illegible]	[illegible]	TSS	Total Settleable	TDS	Total Solids	Total Volatile	Hardness	Turbidity	[illegible]	Alkalinity	Total [illegible]	Total [illegible]	Acidity	[illegible]	[illegible]
2-13-90	13:50	31	1	0.2	8.6							11.9	2.65	<0.001		0.39				0.110	0.020	66.0			4.0		355			600			276.48	234		34.0		
11-13-90	10:14	240	19	-	7.75							10.5	40.00	0.017		0.40				0.210		43.0			231		298			490			241.56	192		7.0		
6-5-90	12:00	612	22	11	9.4							9.0	1.80	0.020		[illegible]				0.250		15.0			290		258			310			278.16	222		2.0		
8-7-90	12:00	108	25	18	8.2							7.2	<0.01	<0.001		0.02				0.114		40.6			22.0		230			320			208.05	166		<1.0		
10-23-90	11:15	23	6	3	7.3							11.0	2.40	<0.001		0.18				0.400		57.5			38.0		340			520			317.44	252		<1.0		
12-7-90		14	18	3	7.6								0.20	<0.001		0.27				0.100		62.5			10.0		310			318			305	270		<0.1		
2-4-91	10:55		-2	1	7.5								3.60	<0.002		0.22				0.020		[illegible]			11.0		358			255			309.00	262		<0.1		
4-7-91	10:57	24	8	6	8.2								17.40	0.307		<0.01				0.260		56.0			110		400			325			276.88	204		7.00		
6-29-91	11:50		30	20	8.6								1.20	<0.001		<0.01				0.240		25.5			96.0		210			295			222	182		<0.01		
8-27-91	10:00		24	16	8.5								8.60	<0.001		<0.01				0.650		27.0			271		198			253			183	150		1.00		
10-27-91	11:44		7	7	8.0								4.60	0.004		0.08				0.100		42.0			30.0		900			331			214.0	251		<0.01		
12-3-91	11:13		3	1	7.0								0.20	0.010		0.64				0.450		70.0			26.0		365			295			304	268.20		4.00		
2-16-92	11:36		1	1	8.1								<1.0	0.010		0.29				0.880		66.0			9.0		365			394			298.[illegible]	[illegible]		12.00		
4-14-92	10:50		19	5	8.0								8.2	0.008		0.32				0.340		590			1604		1090			600			305.[illegible]	250.70		<0.01		
6-19-92	14:40		15	13	8.4								4.2	<0.001		0.20				0.130		34.5			91.0		266			355			252.[illegible]	203.50		<0.01		
8-3-92	11:23		22	18	8.2								<0.1	<0.001		<0.01				0.125		46.0			472		265			370			297.60	198.70		<0.01		
10-7-92	11:28		14	5	8.1								0.4	<0.001		<0.01				0.090		26.0			72.0		288			406			272.[illegible]	[illegible]		<0.01		
12-11-92	11:38		0	1	7.9								<0.1	<0.001		0.20				0.160		38.0			460		388			534			[illegible]	[illegible]		3.00		
2-24-93	11:10		7	2	7.5								<0.2	0.006		0.09				0.170		15.0			117		270			315			222.[illegible]	182.13		<0.01		
4-20-93	15:20			6	8.6								<0.2	<0.002		0.26				0.24		56.0			444		362			304			[illegible]	208		<0.01		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	[illegible] Dis	Chromium [illegible]	Cobalt Total	Copper Total	Cyanide	Fluoride Dis	[illegible] Total	Iron Dis	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	[illegible] Total	[illegible] Total	Potassium Total	Selenium Total	Silica	Silver Total	Sodium Total	Zinc Total	[illegible] Total	Comments
2-13-90			<0.001	0.150			<0.001	60.80	20.0	<0.001		0.003		0.28			0.200	<0.001	26.40	0.030				1.90	<0.001		<0.001	30.0	0.014		
11-13-90			<0.001	0.120			<0.001	56.00	12.0	<0.001		0.010		0.16			7.040	<0.001	20.40	0.220				1.53	<0.001		<0.001	15.50	0.010		
6-5-90			<0.001	0.080			<0.001	52.60	8.0	0.001		0.011		0.19			5.010	0.013	15.36	0.210				1.28	<0.001		<0.001	23.00	0.020		
8-7-90			<0.001	[illegible]		0.120	<0.001	51.50	19.0	<0.001		0.010		0.32			0.500	0.002	17.20	0.140				1.11	<0.001		<0.001	10.00	0.006		
10-23-90			<0.001	0.040		0.090	<0.001	47.20	13.9	0.004		0.010	<0.001	0.19		1.110	0.920	0.004	26.48	0.030	<0.002			1.59	<0.001		<0.001	21.90	0.020		
12-7-90			0.004	0.092			<0.001	60.00	5.55	<0.001		<0.001		0.14			0.970	<0.001	21.70	0.020				1.60	0.002		<0.001	12.00	0.010		
2-4-91			[illegible]	[illegible]		[illegible]	[illegible]	71.60	21.50	[illegible]		[illegible]		0.22		[illegible]	2.260	0.001	[illegible]	0.020	<0.002			1.20	<0.001		[illegible]	80.00	0.010		
4-7-91			0.002	[illegible]			<0.001	55.60	24.10	<0.001		0.020		0.20			5.600	0.005	[illegible]	0.110				1.25	<0.001		<0.001	23.30	0.020		
6-29-91			0.025	[illegible]			<0.001	44.0	[illegible]	<0.001		0.020		0.15			0.750	<0.001	[illegible]	[illegible]				[illegible]	<0.001		[illegible]	18.0	[illegible]		
8-27-91			0.004	0.190			<0.001	38.40	2.52	<0.001		0.010		0.16			2.220	<0.001	16.88	0.210				1.24	0.003		<0.001	14.50	0.025		
10-27-91			0.003	0.080			<0.001	57.60	5.30	<0.001		0.014		0.22			2.850	<0.001	32.72	0.200				1.60	<0.001		<0.001	16.00	0.030		
12-3-91			<0.001	0.105			<0.001	60.00	12.84	<0.001		<0.001		0.22			0.330	<0.001	31.00	0.030				3.60	<0.001		<0.001	37.50	0.015		
2-16-92			<0.001	0.050		0.450	<0.001	63.00	15.53	<0.001		0.010		0.15			0.390	0.060	30.00	0.030				1.57	<0.001		<0.001	25.40	0.017		
4-14-92			0.038	0.400			<0.001	250	16.20	0.041		0.130		0.18			30.500	0.002	51.00	1.300				2.60	0.002		<0.001	30.5	0.025		
6-19-92			<0.001	0.090			<0.001	65.00	6.90	<0.001		0.020		0.11			1.010	0.005	18.10	0.020				1.16	<0.001		<0.001	8.0	0.030		
8-3-92			<0.001	0.083			<0.001	66.10	10.00	<0.001		0.030		0.13			0.460	0.003	18.00	0.040				1.16	<0.001		<0.001	8.1	0.020		
10-7-92			<0.001	0.090	<0.001		<0.001	60.80	16.10	<0.001		0.020		0.16			0.620	<0.001	26.80	0.040				1.50	<0.001		<0.001	20.0	0.020	<0.001	
12-11-92			<0.001	0.095			<0.001	64.80	17.80	<0.001		0.010		0.20			1.360	<0.001	32.48	0.030				1.23	<0.001		<0.001	30.5	0.015		
2-24-93			<0.001	0.120			<0.001	45.80	15.30	<0.001		0.030		0.12			1.120	<0.001	17.72	0.195				1.32	<0.001		<0.001	26.0	0.015		
4-20-93			0.004	0.260			0.012	56.00	19.60	0.007		1.140		0.17			5.400	0.012	34.00	0.450				2.10	0.002		<0.001	23.0	0.060		

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-5

Location: Price River below washing facility

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen Ammonia	Nitrogen Nitrate	Nitrogen Nitrite	Nitrogen Total Kjeldahl	Nitrogen Organic
6/28/83	16:20		26	18	8.2														
1/19/83			21	19	7.9								10.2	<0.001		<0.02			
													11.2	0.283		0.12			

Date	Phosphate Total	Phosphate Ortho	Sulfate	Chloride	Fluoride	Solids TSS	Solids Total Dissolved	Solids TDS	Solids Total	Solids Total Volatile	Hardness	Turbidity	Alkalinity	Alkalinity as $CaCO_3$	Total Alk.	Total	Acidity	Gross Alpha	Gross Beta
6/28/83																			
1/19/83	0.280		28.0			154		266			381			286.00	202		<0.01		
	0.26		40			1294		268			369			244	200		6.00		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis.	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide	Fluoride Dis.	Hg Total	Iron Dis.	Iron Total	Lead Total	Magnesium Total	Manganese Total
6/28/83			0.002	0.250			<0.001	54.40	14.00	0.016										
1/19/83			0.002	0.245			<0.001	52.00	18.0	0.033		0.020		0.12			4.900	0.010	15.36	0.115
												0.090		0.10			18.690	0.020	16.80	1.040

Date	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	Vanadium Total				Comments
6/28/83														
1/19/83				2.10	<0.001		<0.001	21.0	0.145					
				2.1	<0.001		<0.001	22.0	0.059					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-6
Location Price River above Coal processing area

DATE	TIME	FLOW	TEMPERATURE AIR	TEMPERATURE WATER	pH	COLIFORM TOTAL	COLIFORM FECAL	FECAL STREP	B.O.D.	C.O.D.																												
4-19-77	13:40	87	17	8	(8.6)				8.0		3.0	10.4	<1.0		0.02	0.03				0.140	0.025	60.0	<0.01		153		370			560	520	<0.01	279.6	198	192		<1	<2
5-9-77	11:35	178	20	10	8.2				10.0		8.6	9.2	<1.0		0.05	0.02				0.120	0.050	24.0	<0.01		257		321			480	14.0	<0.01	271.2	179	162			
6-7-77	11:20	64	25	13	8.4				6.0		4.0	9.4	<1.0		0.15	0.05				0.110	0.045	28.0	<0.01		62.0		330			500	180	<0.01	222	182	188			
7-6-77	11:00	28	23	16	8.1				4.0		2.6	9.2	<1.0	<0.001	0.12	0.04				0.150	0.060	35.0	<0.01	<0.01	74.0		298			460	25.0	<0.01	274.6	184	204			
8-3-77	12:00	20	28	19	8.1				6.0		26.0	7.8	<1.0		0.10	0.02				0.090	0.060	44.0	<0.01		61.0		210			335	1.39	<0.01	178.1	196	156			
9-9-77	09:35	21	24	14	(9.7)				18.0		22.0	7.6	4.9		0.30	0.05				0.045	0.020	38.0	<0.01		119		218			336	180	<0.01	192	158	182			
10-12-77	12:30	7	16	7	(8.7)				4.0		2.5		1.9		0.40	0.08				0.130	0.030	120	<0.01		15.0		375			577	2.10	<0.01	279.1	196	234			
11-9-77	11:10	5	-4	0.5	7.6				6.0		4.0	10.6	1.2		0.20	0.24				0.080	0.020	150	<0.01		16.0		465			722	4.30	<0.01	292.5	248	271			
12-19-77	10:40	19.6	6	0.5	8.4				4.0		5.0	11.0	5.5		0.10	0.32				0.080	0.040	66.0	<0.01		67.0		325			580	15.0	<0.01	275.0	224	248			
1-11-78	13:15	4	2	0.5	8.4				10.0		3.0	11.1	3.0		0.05	0.34				0.070	0.010	52.0	<0.01		14.0		307			470	7.5	<0.01	280.6	230	250			
2-8-78	10:20	5.7	6	1.25	8.1				2.0		12.0	11.2	5.6		<0.01	0.23				0.140	0.012	56.0	<0.01		4.0		315			484	22.0	<0.01	280.6	230	254			
3-9-78	17:10	17	6	3	8.1				12.0		5.0	9.9	6.8		0.20	0.49				0.032	0.014	(310)	<0.01		269		(701)			1080	130	2.40	268.4	224	264			
4-11-78	10:05	131	12	5.5	8.1				19.0		64.0	9.6	(27.0)	<0.001	0.20	0.88				0.150	0.018	78.0	<0.01		1556		595			590	290	14.4	280.0	254	256			
5-10-78	10:15	149	15	8	7.8				10.0		86.0	9.0	(10.8)		0.10	0.28				0.098	0.028	46.0	<0.01		363		320			490	170	<0.01	273	250	254			
6-14-78	12:20	255	29	15	7.6							9.0	<1.0									28.0			120		271			395								

DATE																															COMMENTS
4-19-77			<0.001	0.149		0.025	<0.001	41.9	4.0	<0.001				0.23			0.44	<0.001	16.80	0.066	<0.0007										
5-9-77	0.015		<0.001	0.122		0.024	<0.001	17.0	14.0	<0.001				0.27			0.137	<0.001	31.68	0.036	<0.0002			1.65	<0.001		<0.001	17.65	0.016		
6-7-77	0.017		<0.001	0.125		0.020	<0.001	41.4	8.0	<0.001				0.21			0.203	<0.001	19.68	0.036	<0.0002			1.99	<0.001		<0.001	26.90	0.017		
7-6-77	0.016		<0.001	0.025		0.025	<0.001	46.4	8.0	<0.001		0.002	<0.001	0.22			0.108	0.003	21.12	0.019	<0.0002			1.63	<0.001		<0.001	14.5	0.013		
8-3-77	0.009		<0.001	0.027		0.016	<0.001	56.8	6.0					0.19			0.130	<0.001	15.36	0.009	<0.0002			1.91	<0.001	2.80	<0.001	39.8	0.020		
9-9-77	0.310		<0.001	0.011		0.010	<0.001	42.4	8.0			<0.001		0.16			(0.340)	<0.001	19.24	0.037	<0.0002			1.72	<0.001			18.80	0.006		
10-12-77	0.032		<0.001	0.061		0.110	<0.001	52.0	10.0	<0.001				0.18			0.163	0.005	24.96	0.006	<0.0002			2.58	<0.001			12.3	0.017		
11-9-77	0.042		<0.001	0.025		0.09	<0.001	62.4	10.0			0.002		0.21			(0.368)	<0.001	23.80	0.008	<0.0002			12.61	<0.001	2.60	<0.001	37.90	0.006		
12-19-77	0.048		<0.001	0.019		0.07	<0.001	54.4	14.0					0.17			(0.987)	<0.001	26.8	0.010	<0.0002			1.92	<0.001			44.0	<0.001		
1-10-78	0.015		<0.001	0.220		0.020	<0.001	54.4	12.0	<0.001				0.20			0.160	<0.001	27.96	0.032	<0.0002			1.60	<0.001			26.4	0.038		
2-8-78	2.41		<0.001	0.09		0.15	<0.001	56.0	14.0					0.17			(0.960)	<0.001	29.36	0.022	<0.0002			2.09	<0.001	6.0		26.0	0.010		Estimate through Ice
3-9-78	1.260		0.005	0.190		0.15	<0.001	60.0	26.0			0.006		0.20			(0.998)	<0.001	27.3	(0.200)	<0.0002			1.625	<0.001			27.0	0.257		
4-12-78	0.080		0.002	0.120		0.12	<0.001	56.4	24.0	<0.001				0.29			0.015	<0.001	26.40	0.013	<0.0002			4.37	<0.001		0.003	198	0.092		SO_4 and TDS Results not Consistent – Probably lab error.
5-10-78	0.060		<0.001	0.10		0.15	<0.001	55.2	14.0			0.004		0.30			0.080	<0.001	28.32	0.005	<0.0002			1.65	<0.001	14.0		48.0	0.016		
6-14-78									14.0								(1.859)			0.022				1.436	<0.001	..	<0.001	24.0	0.006		

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-6
Location: Price river above washing facility

Date	Time	Flow (cfs)	Temperature Air (°C)	Temperature Water (°C)	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol
6-14-78	12:20	255	29	15	7.6							9.0	<1.0	
8-9-78	12:40	106	29	20	8.0							8.8	4.0	
10-11-78	12:37	75	19	8	7.53						3.0	9.1	<1.0	
11-13-78	12:20	22	2	1	7.6						5.0	10.6	<1.0	<0.001
1-[illegible]-79	11:25	42.5	2	1	8.5						1.0	10.3	<1.0	0.020
[illegible]-18-79	12:25	225	1	4	[illegible]						5.0	10.4	1.4	<0.001
[illegible]-18-79	11:50	255	29	16	8.7							7.7	<1.0	<0.001
[illegible]-1-79	15:10	133	28	20	8.0							7.4	<1.0	0.020
10-30-79	14:58	9.6	7	5.5	7.6							10.4	<1.0	<0.001
12-20-79	15:55	13.3	3	1	9.3							12.0	<1.0	<0.001

Date	Nitrogen Ammonia as N	Nitrate as N	Nitrite as N	Nitrogen Total Kjeldahl	Nitrogen Organic	Phosphate Total as PO_4	Phosphate Ortho as PO_4	Sulfate as SO_4	[illegible] as F	[illegible] as H_2S
6-14-78								32.0		
8-9-78								18.0		
10-11-78								4.0		
11-13-78		0.29	<0.01				0.025	26		
1-[illegible]-79		0.21					0.045	126		
[illegible]-18-79		0.15					1.17	80.0		
[illegible]-18-79		0.10					<0.010	24.0		
[illegible]-1-79		<0.01					0.260	14.0		
10-30-79		<0.01				0.080	0.040	140		
12-20-79		0.25				0.048	0.017	78.0		

Date	Solids TSS	Total Settleable Solids	TDS	Total Solids	Total Volatile Solids	Specific Cond.	Turbidity	Alk as CO_3	Alk as HCO_3	Total Alk as $CaCO_3$	Total Hardness as $CaCO_3$	Acidity as $CaCO_3$	Gross Alpha	Gross Beta
6-14-78	120		271			395								
8-9-78	43.0		210			340								
10-11-78	4.0		250			370								
11-13-78	15.0		460			710			353.9					
1-[illegible]-79	17.0		476			649			[illegible]					
[illegible]-18-79	1120		228			600			[illegible]					
[illegible]-18-79	51.0		260			400			253.76	208		10.0		
[illegible]-1-79	62.0		374			560			482.48	394		10.0		
10-30-79	25.0		450			650			270.81	222		30.0		
12-20-79	0.5		377			590			290.36	238		20.0		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Dis
6-14-78									14.0					
8-9-78			<0.001						4.0					
10-11-78				0.180			<0.001		8.0	<0.001		0.002		0.16
11-13-78			<0.001	0.092			<0.001	17.0	15.0	<0.001		[illegible]		0.17
1-[illegible]-79			<0.001	[illegible]			<0.001	15.6	[illegible]	<0.001		[illegible]		0.20
[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]
[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]
8-[illegible]-79			<0.001	0.078			<0.001	29.20	8.0	<0.001		0.001		0.14
10-30-79			<0.001	0.090			<0.001	54.00	13.0	<0.001		0.002		0.23
12-20-79			<0.001	0.070			<0.001	64.00	26.0	<0.001		0.005		0.14

Date	[illegible] Total	[illegible] Dis	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	[illegible] Total	Comments
6-14-78			4.859			0.022											
8-9-78			1.290			1.066					<0.001						
10-11-78			0.013	<0.001		0.008					<0.001		<0.001				
11-13-78			0.511	<0.001	[illegible]	[illegible]				1.952	<0.001	11.0	<0.001	57.2	0.005		
1-[illegible]-79			0.617	<0.001	17.88	0.045				1.754	<0.001	5.25	<0.001	29.7	0.017		
[illegible]			[illegible]	0.002	[illegible]	[illegible]				[illegible]	[illegible]	5.60	[illegible]	14.50	[illegible]		
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]				1.225	<0.001		<0.001	11.09	[illegible]		
8-[illegible]-79			1.040	<0.001	9.80	0.095				1.166	<0.001		<0.001	16.60	0.008		
10-30-79			0.27	<0.001	15.40	0.075	<0.0002			1.250	<0.001		<0.001	17.30	0.008		
12-20-79			0.180	<0.001	31.20	0.014	0.0002			1.51	<0.001		<0.001	26.20	0.002		

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-6
Location: Price River above washing facility

Date	Time	Flow (cfs)	Temp. Air (°C)	Temp. Water (°C)	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen (mg/l)	Oil & Grease (mg/l)	Phenol (mg/l)	Nitrogen: Ammonia	Nitrate as N (mg/l)	Nitrite	Organic Total	Kjeldahl	Phosphorus Total (mg/l)	Phosphorus Ortho (mg/l)	Sulfate (mg/l)	Chloride	Fluoride	Solids: TSS (mg/l)	Total Volatile SS	TDS (mg/l)	Total	Total Volatile	Cond. (umhos)	Turbidity	Alk. as $CaCO_3$	Hardness as $CaCO_3$ (mg/l)	Total Alk. (mg/l)	Total	Acidity as $CaCO_3$		
2-18-80	19:15		5	1	8.7							12.0	<1.0	<0.001		0.22				0.049	0.040	70.0			5.0		340			570			[illegible]	284		24.0		
11-17-80	19:00	240	15	2	8.25							10.6	28.40	0.022		0.29				0.170		43.0			247		265			480			[illegible]	194		2.0		
4-2-80	14:45	612	22	11	8.5							7.0	3.40	<0.013		0.19				0.100		18.0			273		250			250			[illegible]	198		16.0		
7-7-80	11:44	326	24	19	8.1							7.2	0.20	0.020		0.14				0.070		37.9			18.0		220			320			[illegible]	164		4.0		
[illegible]	[illegible]	25	7	2	7.1							11.1	0.40	<0.001		1.12				0.050		54.0			19.0		340			500			294.76	258		11.0		
[illegible]	13:30	10	11	4	7.6								0.60	0.056		0.22				0.110		145			16.0		370			320			[illegible]	242		<0.1		
2-4-81	10:20		-1	1	7.8								0.60	<0.002		0.14				1.080		48.0			10.0		350			335			[illegible]	260		<0.1		
[illegible]	10:58	24	9	6	8.2								1.40	0.380		<0.01				0.320		56.0			131		300			315			[illegible]	210		16.0		
7-22-81	10:20		30	17	8.6								19.20	<0.001		<0.01				0.290		21.0			110		194			270			[illegible]	162		<0.01		
9-22-81	19:45	136	23	16	8.5								13.40	<0.001		0.10				0.330		30.0			181		190			220			[illegible]	142		<0.00		
[illegible]	8:80		9	6	8.1								3.00	0.005		0.05				0.300		94.0			27.0		285			311			[illegible]	[illegible]		<0.01		
[illegible]	12:24		6	2	8.2								<0.01	0.048		0.63				0.730		75.0			23.0		358			310			[illegible]	[illegible]		6.00		
3-15-82	11:15		4	2	7.4								1.8	0.029		0.15				4.580		53.0			86.0		344			369			[illegible]	[illegible]		0.00		
[illegible]	9:40		18	5	8.0								1.0	0.008		0.33				1.030		460			1580		910			580			[illegible]	[illegible]		<0.01		
[illegible]	16:25		15	13	8.4								3.8	<0.001		0.16				0.080		46.0			101		277			368			[illegible]	[illegible]		<0.01		
[illegible]	11:06		24	17	8.3								<0.1	0.008		<0.01				0.080		40.5			44.0		268			353			[illegible]	[illegible]		<0.01		
[illegible]	11:10		13	8	8.0								<0.1	<0.001		0.05				0.220		17.0			153		280			379			[illegible]	[illegible]		<0.01		
[illegible]	10:10		0	1	7.8								<0.1	<0.001		0.15				0.110		27.0			85.0		365			517			[illegible]	[illegible]		1.50		
[illegible]	11:55		7	1	7.4								<0.2	<0.001		0.06				0.160		15.0			950		240			333			[illegible]	191.72		<0.01		
3-21-83													1.4	0.008		0.27				0.56		51.0			680		335						[illegible]	214		<0.01		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide	Fluoride Dis	[illegible] Total	Iron Dis	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	[illegible] Total	[illegible] Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	[illegible] Total				Comments
2-15-80			<0.001	0.080			<0.001	57.60	16.0	<0.001		<0.001		0.28			0.130	<0.001	23.10	0.020				1.35	<0.001		<0.001	22.20	0.010					
11-17-80			<0.001	0.118			<0.001	46.00	14.0	<0.001		0.010		0.16			0.162	<0.001	26.40	0.100				1.57	<0.001		<0.001	15.50	0.010					
[illegible]			<0.001	0.162			<0.001	56.00	8.0	<0.001		0.002		0.17			1.950	0.005	15.26	0.210				1.26	<0.001		<0.001	7.70	0.020					
[illegible]			<0.001	0.070		0.020	<0.001	56.10	6.0	[illegible]		0.052		0.12			1.410	<0.001	15.90	0.140				0.94	<0.001		<0.001	7.50	0.005					
[illegible]			<0.001	0.090		0.080	<0.001	42.00	12.0	<0.001		<0.001	<0.001	0.41		0.020	0.320	<0.002	27.44	0.020	<0.0002			1.42	<0.001		<0.001	29.10	0.022					
[illegible]			0.001	0.095			<0.001	49.00	4.95	<0.001		<0.001		0.12			0.210	<0.001	21.10	0.035				1.40	0.002		<0.001	24.50	0.020					
[illegible]			[illegible]	[illegible]		[illegible]	0.001	44.00	23.70	<0.001		<0.001		1.25		0.020	[illegible]	[illegible]	30.00	0.010	<0.0002			1.70	<0.001		<0.001	26.00	0.007					
[illegible]			0.001	[illegible]			<0.001	52.00	11.00	[illegible]		[illegible]		0.11			1.950	0.002	26.40	[illegible]				1.48	<0.001		<0.001	16.00	0.070					
[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		0.14			[illegible]	<0.001	[illegible]	[illegible]				[illegible]	[illegible]		<0.001	[illegible]	[illegible]					
[illegible]			0.006	0.105			<0.001	38.40	9.33	<0.001		0.010		0.16			5.400	<0.001	17.20	0.010				[illegible]	0.001		<0.001	7.00	[illegible]					
[illegible]			<0.001	0.086			<0.001	36.00	10.80	<0.001		0.011		0.20			4.000	<0.001	38.40	[illegible]				1.22	0.003		<0.001	5.50	0.025					
[illegible]			<0.001	0.110			0.010	40.00	10.89	<0.001		<0.001		0.22			0.600	<0.001	30.00	0.040				1.30	<0.001		<0.001	2.80	0.025					
[illegible]			<0.001	0.080		0.400	0.006	43.50	11.17	<0.001		0.010		0.15			0.610	<0.001	28.00	0.040				1.80	<0.001		<0.001	26.00	0.000					
[illegible]			0.026	0.090			<0.001	2.00	16.00	0.039		0.100		0.18			25.300	0.003	11.00	1.320				1.45	<0.001		<0.001	28.60	0.023					
[illegible]			<0.001	0.080			<0.001	47.00	7.30	<0.001		0.020		0.13			4.920	0.001	18.60	0.080				2.85	0.003		<0.001	22.6	0.140					
[illegible]			<0.001	0.088			<0.001	43.50	5.40	<0.001		0.050		0.13			1.500	0.003	17.30	0.060				1.15	<0.001		<0.001	8.1	0.025					
[illegible]			<0.001	0.100	<0.001		<0.001	52.80	17.20	<0.001		0.020		0.15			1.400	<0.001	26.40	0.090				1.16	<0.001		<0.001	8.1	0.040					
[illegible]			<0.001	0.095			<0.001	60.00	13.10	<0.001		0.010		0.21			0.290	<0.001	21.10	0.030				1.45	<0.001		<0.001	12.0	0.020	<0.001				
[illegible]			<0.001	0.120			<0.001	50.40	16.10	<0.001		0.030		0.12			1.520	<0.001	16.80	0.135				1.56	<0.001		<0.001	34.0	0.005					
3-21-83			0.007	0.210			<0.001	56.00	17.60	0.008		0.030		0.17			2.100	0.019	24.00	0.440				1.29	<0.001		<0.001	18.0	0.020					
																								1.31	<0.003		<0.001	24.0	0.050					[illegible]

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-6
Location: Price River above washing facility

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen Ammonia	Nitrogen Nitrate	Nitrogen Nitrite	Nitrogen Kjeldahl	Nitrogen Organic	Phosphorus Total	Phosphorus Ortho	Sulfate			TSS	Total Settleable Solids	TDS	Total Solids	Total Volatile Solids	Specific Cond	Turbidity	Alk. CO_3	Alk. HCO_3	Total Alk. as $CaCO_3$	Total Hardness as $CaCO_3$			
6-29-83	15:45		28	18	8.3								<0.2	<0.001		<0.02				0.220		22.0			176		258			829			286.2	194		12.01		
11-17-83	17:24		30	19	8.0								<0.2	0.175		0.02				0.20					1633		236			380			226.9	186		6.00		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis	Chromium Hexavalent	Chromium Total	Copper Total	Cyanide as CN	Fluoride Dis	Hardness Total	Iron Dis	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	Vanadium Total				Comments
6-29-83			0.005	0.220			<0.001	56.60	10.16	0.005		0.020		0.11			2.900	0.031	15.84	0.115				2.00	<0.001		<0.001	12.0	0.085					
11-17-83			<0.001	0.210			<0.001	63.60	10.0	0.027		0.860		0.10			18.400	0.026	15.84	0.960				2.2	<0.001		<0.001	16.0	0.010					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-9
Location Holding Pond below Bristol's mine #2

1-12-77	10:15		9	15	7.3	14.0	5.0	(1.0)	(12.0)		0.55	0.09	0.214	0.049	(330)	<0.01		70.0	(1160)	2650	72.0	<0.01	766	630	182	<1	<2
2-4-77	15:15		27	16	7.7	22.0	9.0	(1.5)	(14.0)		0.70	0.16	0.213	0.050	(58)	<0.01		51.0	(1620)	2450	60.0	<0.01	786	612	202		
6-1-77	12:30		31	17	7.9	66.0	45.0	(1.5)	(21.0)		0.40	0.05	0.310	0.050	136	<0.01		41.0	(1566)	2360	170	<0.01	810	669	106		
7-6-77	12:50		25	17	7.8	260	153	(3.1)	(39.9)	(0.008)	0.42	0.06	0.540	0.035	180	<0.01		119	(810)	1250	150	<0.01	978	592	700		
8-3-77	14:10		34	14	7.4	54.0	116	(1.5)	(33.0)		0.85	0.15	0.135	0.100	(160)	<0.01	<0.01	57.0	(1956)	2945	5.70	<0.01	1458	570	706		
9-9-77	10:00		29	16	8.1	45.0	123	(0.1)	(115.4)	(0.008)	0.45	0.16	0.210	0.100	(130)	<0.01		14.0	(2440)	3495	21.00	<0.01	1264	620	570		
10-17-77	15:00		6	14	7.1	46.0	32.0		(10.1)	(0.003)	0.45	0.10	0.060	0.020	(620)	<0.01		50.0	(1675)	2577	0.98	<0.01	1344	602	456		
11-9-77	8:40		1	15	(6.7)	86.0	55.0	(5.0)	(104)	(0.006)	0.30	0.02	0.015	0.010	150	<0.01		440	(1114)	1824	175	<0.01	1754	718	44.0		
12-14-77	11:00		3	5	7.4	26.0	30.0	(2.6)	(21.8)	<0.001	0.50	0.08	0.120	0.020	(400)	<0.01		18.0	(1180)	1830	28.0	<0.01	444	634	272		
1-11-78	12:50	-0-																									
3-8-78	11:30	-0-																									
3-8-78	11:10	-0-																									
4-11-78	12:05		19	4	7.2	22.0	72.0	(1.2)	(74.0)	<0.001	0.50	0.08	0.180	0.020	(720)	<0.01		29.0	(2000)	3100	70.0	<1.0	262.2	712	590		
5-10-78	12:50		21	14.5	8.0	46.0	129	(1.0)	(7.2)	0.005	0.70	0.10	0.098	0.020	(1400)	<0.01		59.0	(2152)	3300	145	<0.01	622	510	820		

4-4-77		<0.001	0.146	0.110	<0.001	32.8	34.0	<0.001			(1.16)	(1.423)	0.007	30.24	(0.072)	<0.0002	7.92	<0.001		<0.001	460	0.015
5-9-77	0.016	<0.001	0.110	1.150	<0.001	7.20	160	<0.001			(1.90)	(0.346)	<0.001	44.16	0.044	<0.0007	9.92	<0.001		<0.001	410	0.028
6-1-77	0.019	<0.001	0.086	1.670	0.001	14.4	162	<0.001			(1.80)	(0.970)	<0.001	16.80	0.077	<0.0002	7.65	<0.001		<0.001	421	0.020
7-6-77	0.017	0.001	0.062	0.910	<0.001	17.6	84.0	<0.001	0.001	<0.01	(1.80)	0.064	<0.001	6.24	1.041	<0.0002	5.44	<0.001	5.90		286	0.003
8-3-77	0.210	<0.001	0.061	0.800	<0.001	89.6	140				(1.63)	0.131	<0.001	115.60	(0.055)	<0.0002	12.26	<0.001			386	0.098
9-9-77	0.154	<0.001	0.035	1.10	<0.001	61.6	124		0.005		(1.62)	(5.280)	0.006	51.84	(0.159)	<0.0002	16.34	<0.001			590	0.082
10-6-77	0.060	<0.001	0.075	1.20	<0.001	52.6	136	<0.001			(1.92)	(0.374)	<0.001	77.28	(0.141)	<0.0002	7.55	0.001	11.50	0.002	425.8	0.015
11-9-77	0.120	<0.001	0.102	0.96	<0.001	56	146		0.001		(2.04)	(4.2)	0.007	7.20	(0.114)	<0.0002	6.37	<0.001			460	0.013
12-14-77	0.170	<0.001	0.097	1.05	<0.001	34.0	144				(1.49)	(0.140)	0.009	44.6	(0.202)	<0.0002	7.86	<0.001			328	0.015
1-11-78																						
2-8-78																						
3-8-78																						
4-12-78	0.040	0.002	0.050	1.20	<0.001	76.0	164	<0.001	0.008		(1.69)	0.280	<0.001	96.0	(0.376)	<0.0002	12.20	<0.001	6.20	0.001	442	0.015
5-10-78	0.190	<0.001	0.06	1.40	<0.001	100	152				(1.70)	0.171	0.018	156.80	0.460	<0.0002	18.20	(0.910)			445	0.019

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-11
Location: Hardscrabble Creek below Biezlah mine #3

Date	Time	Flow	Temp. Air	Temp. Water																																		
4-13-77	11:05	Pond	12	11	7.4				34.0		14.0	(1.2)	9.6		10.25	0.20				0.950	0.580	41.0	<0.01		46.0		(755)			1140	20.0	<0.01	458	400	144		<1	3
5-9-77	15:30	Pond	21	21	7.9				34.0		18.0	(2.5)	5.0		9.40	0.22				1.100	0.450	78.0	<0.01		57.0		(830)			1250	20.0	<0.01	4709	386	192			
6-1-77	17:45	Pond	21	22	(9.1)				68.0		48.0	(3.4)	(30.9)		5.20	0.75				0.650	0.140	84.0	<0.01		87.0		(1210)			1900	120	<0.01	705.7	518	104			
7-6-77	13:00	Dry																																				
8-5-77	14:25	Dry																																				
9-8-77	10:20	Dry																																				
10-12-77	11:30	Pond	9	12	7.04				76.0		64.0		(26.3)	(0.006)	9.80	0.15				0.240	0.110	28.0	<0.01		600		365			570	180	<0.01	417.2	342	190			
11-9-77	11:38	Dry																																				
12-14-77	15:55	Dry																																				
1-11-78	12:47	-0-																																				
2-8-78	11:35	-0-																																				
3-8-78	13:15	0.03	3	1	7.7				470		150	9.5	1.8	(0.004)	0.14	0.86				0.053	0.015	82.0	<0.01		2476		339			524	off scale	<0.01	1366	112	210			
4-18-78	11:26	0.02	12	19.5					4800		500	6.6	(35.4)	(0.143)	0.25	1.29				2.050	0.010	(420)	<0.01		22596		(1710)			1160	off scale	9.2	446.5	292	330			
5-10-78	12:10	0.1	19	21	7.1				89.0		90.0	(4.7)	(20.2)	(0.004)	6.50	0.11				0.950	0.250	26.0	<0.01		67.0		418			640	19.0	<0.01	390.4	320	184			
6-14-78	11:05	0.01	22	23	7.1							(3.6)	1.6	(0.008)								88.0					470			625	44.0							

Date			Lead																											Comments
4-13-77			<0.001	0.440		0.180	<0.001	82.3	74.0	<0.001				0.27			0.146	<0.001	14.88	(0.092)	<0.0002			5.80	<0.001		<0.001	15.50	0.036	
5-9-77	0.020		<0.001	0.180		0.14	<0.001	26.0	60.0	<0.001				0.50			0.200	<0.001	24.98	(0.150)	<0.0002			7.85	<0.001		<0.001	162.5	0.031	
6-1-77	0.016		<0.001	0.250		0.490	<0.001	20.6	120	<0.001				(1.60)			0.217	<0.001	12.48	(0.052)	<0.0002			9.29	<0.001		<0.001	350	0.084	
7-6-77																														
8-5-77																														
9-8-77																														
10-12-77	0.082		<0.001	1.277		0.230	<0.001	57.0	2.0	<0.001			<0.01	0.18			0.161	0.011	26.40	0.018	<0.0002			7.79	<0.001	9.0	<0.001	6.590	0.161	
11-9-77																														
12-14-77																														
1-11-78																														
2-8-78																														
3-8-78	0.15		0.004	0.370		0.60	<0.001	40.0	78.0	<0.001				0.41			0.174	<0.001	26.4	(0.911)	<0.0002			15.99	<0.001	56.0	<0.001	9.5	1.206	
4-18-78	0.020		<0.001	0.160		0.86	<0.001	52.0	134	<0.001		0.010		(0.05)			0.002	<0.001	60.0	(0.313)	0.0002			12.91	0.001			283	0.015	
5-10-78	0.150		<0.001	0.08		0.15	<0.001	38.4	94.0					0.22			0.026	<0.001	26.12	0.047	<0.0002			8.59	(0.022)	7.5	<0.001	96.0	0.054	
6-14-78									94.0					0.40			0.220			0.028										

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-11
Location: Hardscrabble Creek below mine #3

2-13-80	12:00	-0-												
4-17-80	11:35	0.01	20	22	9.4							6.1	10.40	0.019
6-5-80	13:33	-0-												
8-1-80	12:21	-0-												
4-21-80	11:40	0.01	9	12	2.1							6.2	36.00	<0.001
12-17-80	14:50	-0-												
2-4-81	12:20	-0-												
4-7-81	11:45	-0-												
6-25-81	12:40	-0-												
8-27-81	11:00	-0-												
11-29-81	12:09	-0-												
12-3-81	10:54	-0-												
2-4-82	12:46	-0-												
4-19-82	11:45	-0-												
6-19-82	12:51	-0-												
8-9-82	14:00	-0-												
10-7-82	13:47	-0-												
12-2-82	14:17	-0-												
2-24-83	12:26	-0-												
4-21-83	10:39	-0-												

2-13-80																								
4-17-80		0.25				0.130		244			79.0		648			1010			218.92	226		12.0		
6-5-80																								
8-1-80																								
4-21-80		0.02				0.620		11.6			12.0		360			550			373.07	214		41.0		
12-17-80																								
2-4-81																								
4-7-81																								
6-25-81																								
8-27-81																								
11-29-81																								
12-3-81																								
2-4-82																								
4-19-82																								
6-19-82																								
8-9-82																								
10-7-82																								
12-2-82																								
2-24-83																								
4-21-83																								

2-13-80															
4-17-80			2.004	0.150			<0.001	46.00	24.0	<0.001		0.010		0.70	
6-5-80															
8-1-80															
4-21-80			<0.001	0.050		0.070	<0.001	52.00	16.5	0.017		0.010	<0.001	0.19	
12-17-80															
2-4-81															
4-7-81															
6-25-81															
8-27-81															
11-29-81															
12-3-81															
2-4-82															
4-19-82															
6-19-82															
8-9-82															
10-7-82															
12-2-82															
2-24-83															
4-21-83															

2-13-80																			
4-17-80		0.250	0.002	55.20	0.030				7.00	0.019		<0.001	17.20	0.032					
6-5-80																			
8-1-80																			
4-21-80	0.950	1.100	0.010	16.70	0.050	<0.0002			3.85	<0.001		<0.001	17.30	0.040					
12-17-80																			
2-4-81																			
4-7-81																			
6-25-81																			
8-27-81																			
11-29-81																			
12-3-81																			
2-4-82																			
4-19-82																			
6-19-82																			
8-9-82																			
10-7-82																			
12-2-82																			
2-24-83																			
4-21-83																			

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station *B-11*
Location *Hackscrabble Creek below mine #3*

Date	Time	Flow
6-28-81	12:00	-0-
1-17-83	15:57	-0-

Date
6-28-81
1-17-83

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-11
Location Hardscrabble creek below mine #3

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen [illegible]	Nitrogen Total	Nitrogen [illegible]	Phosphorus Total	Phosphorus Ortho	[illegible]	[illegible]	[illegible]	Solids TSS	Solids Total [illegible]	Solids TDS	Solids Total [illegible]	Solids Total Volatile	Specific Cond.	Turbidity	[illegible]	[illegible]	Total [illegible]	Total [illegible]	[illegible]	Gross Alpha	Gross Beta
6-14-78	11:25	0.01	29	23	7.1							5.6	1.6	0.008								88.0					470			685	44.0							
8-9-78	11:50	0.005	27	25	7.8							4.2	10.6	0.026								18.0			16.0		410			620								
10-18-78	12:10	0.05	19	11	7.07							6.1	2.4	0.120								4.0			606		520			710								
12-13-78	11:35	-0-																																				
[illegible]	11:55	0.08	-1	12	8.2						30.0	7.2	12.4	0.090		1.18					1.980	29.0			634		414			688			[illegible]					
[illegible]	[illegible]	2.19	18	11.5	6.9						10.0	6.9	2.9	0.04		1.50					0.40	315			2220		608			[illegible]			2262					
5-15-79	[illegible]	-0-																																				
[illegible]	12:27	0.07	28	24	7.5							3.2	2.2	<0.001		<0.01					0.420	19.0			19.0		536			890			529.48	434		48.0		
[illegible]	13:43	0.04	6	8	7.6							6.9	1.6	<0.001		0.02				0.285	0.125	430			32.0		930			1080			3792	236		56.0		
12-26-79	5:30	-0-																																				

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride	Chromium	Cobalt Total	Copper Total	Cyanide	Fluoride	[illegible] Total	Iron	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	[illegible] Total	[illegible] Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	[illegible] Total				Comments
6-14-78									34.0					0.40			0.220			0.026					2.004									
8-9-78			<0.001						20.0					0.45			1.20			0.075					<0.001									
10-18-78			<0.001						45.0					0.80			1.22			0.054					<0.001									
12-13-78																																		
[illegible]			<0.001	[illegible]			<0.001	27.6	17.0	<0.001		0.016		0.26			7.180	0.010	34.96	0.144				17.90	<0.001	4.15	<0.001	76.90	0.116					
[illegible]			<0.001	[illegible]			[illegible]	[illegible]	20.0	[illegible]		[illegible]		[illegible]			[illegible]	<0.001	57.72	0.66				8.400	<0.005	2.20	<0.001	45.0	0.048					
[illegible]																																		
[illegible]			<0.001	0.011			<0.001	95.40	25.0	<0.001		0.015		0.15			1.210	<0.001	1.24	0.046				6.810	<0.001		<0.001	92.0	0.114					
[illegible]			<0.001	0.016			<0.001	104	52.0	<0.001		0.045		0.59			65.20	<0.001	44.40	0.225	<0.0002			6.390	<0.001		<0.001	79.40	0.132					
12-26-79																																		

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-12
Location Hardscrabble Creek above mine #3

DATE	TIME	FLOW
4-7-81	11:49	-0-
6-29-81	12:44	-0-
8-27-81	11:03	-0-
10-29-81	12:13	-0-
12-3-81	10:56	-0-
2-15-82	12:18	-0-
4-14-82	11:49	-0-
6-14-82	13:05	-0-
8-3-82	13:40	-0-
10-2-82	12:60	-0-
12-3-82	11:40	-0-
2-24-83	12:31	-0-
4-21-83	15:37	-0-
6-29-83	11:45	-0-
8-17-83	16:00	-0-

DATE	COMMENTS
4-7-81	
6-29-81	
8-27-81	
10-29-81	
12-3-81	
2-15-82	
4-14-82	
6-14-82	
8-3-82	
10-2-82	
12-3-82	
2-24-83	
4-21-83	
6-29-83	
8-17-83	

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-14
Location Holding pond below mine #6

7-6-77	12:20	Pond	29	25	7.1				12.0		7.0	(4.2)	3.0	(0.002)	0.50	0.16				0.350	0.025	101	<0.01	<0.01	62.0		214			380	31.0	<0.01	61.0	50.0	144			
8-3-77	14:05	Dry																																				
9-5-77	10:40	Dry																																				
10-12-77	11:20	Dry																																				
11-4-77	12:55	Dry																																				
12-14-77	16:30	Dry																																				
1-11-78	12:20	-0-																																				
2-3-78	11:50	-0-																																				
3-1-78	9:00	-0-																																				
4-12-78	12:50	-0-																																				
5-9-78	11:50	-0-																																				

																																		COMMENTS
7-6-77	1.80		<0.001	0.058		0.017	<0.001	21.0	17.0	<0.001		0.005	<0.01	0.16			1.142	<0.001	17.76	0.013	<0.001			4.64	<0.001	3.0	0.004	14.88	0.017					
8-3-77																																		
9-5-77																																		
10-12-77																																		
11-4-77																																		
12-14-77																																		
1-11-78																																		
2-3-78																																		
3-1-78																																		
4-12-78																																		
5-9-78																																		

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-17
Location Sow Belly Creek above Spring Canyon Creek

Date	Time	Flow	Temperature Air	Temperature Water	pH														
7-6-77	15:41	0.1	25	15	7.1				4.0		3.0	7.9	<1.0	<0.001	0.28	0.04			
8-8-77	14:40	Dry																	
9-8-77	15:40	Dry																	
10-8-77	15:25	Dry																	
11-9-77	11:00	Dry																	
12-9-77	14:30	Dry																	
1-11-78	12:25	-0-																	
2-6-78	09:35	-0-																	
3-8-78	11:55	-0-																	
4-12-78	12:25	-0-																	
5-10-78	11:45	-0-																	
6-14-78	11:50	0.1	24	14	7.7						8.0	9.2	<1.0			0.78	<0.01	0.25	

Date																			
7-6-77	0.060	0.020	(961)	<0.01	<0.01	4.0		(1240)			2410	0.25	<0.01	495.3	406	1180			
8-8-77																			
9-8-77																			
10-8-77																			
11-9-77																			
12-9-77																			
1-11-78																			
2-6-78																			
3-8-78																			
4-12-78																			
5-10-78																			
6-14-78		0.028	(466)			4.0		(467)			1950			337.7					

Date																
7-6-77	0.037		<0.001	0.060		0.425	<0.001	208	4.0	<0.001		0.004	<0.01	0.45		
8-8-77																
9-8-77																
10-8-77																
11-9-77																
12-9-77																
1-11-78																
2-6-78																
3-8-78																
4-12-78																
5-10-78																
6-14-78			<0.001				<0.001	192	42.0					0.47		

Date																		Comments
7-6-77	0.034	<0.001	158.40	0.009	<0.0001			12.92	<0.001	16.50	<0.001	66.0	0.015					
8-8-77																		
9-8-77																		
10-8-77																		
11-9-77																		
12-9-77																		
1-11-78																		
2-6-78																		
3-8-78																		
4-12-78																		
5-10-78																		
6-14-78	0.048	<0.001	88.9	0.010				8.93	<0.001	37.0		30.0	0.019					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-17
Location Sow Belly creek above Spring Canyon creek

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	N Ammonia	N Nitrate	N Nitrite	N Kjeldahl Total	N Organic	P Total	P Ortho
6-14-78	11:30	0.1	24	14	7.7						8.0	8.3	<1.0			0.78	<0.01	0.85			0.028
5-9-78	11:40	0.1	29	17	7.2							7.4	<1.0								
10-10-78	12:35	-0-																			
12-12-78	11:20	-0-																			
2-14-79	[illegible]:40	-0-																			
4-12-79	[illegible]:41	-0-																			
6-19-79	12:17	0.05	31	14	7.4							7.6	<1.0	0.028		0.02					<0.010
8-1-79	11:47	0.34	26	17	6.9							6.5	<1.0	<0.001		6.20					0.020
10-30-79	13:21	0.16	7	8	8.0							6.9	4.8	<0.001		4.90				0.089	0.050
12-4-79	15:50	0.009	0.5	5.5	9.1							9.0	1.8	<0.001		6.20				0.038	0.020

Date	Sulfate			Solids TSS	Total Settleable	TDS	Total	Total Volatile	Conductance	Turbidity	Alk CO3	Alk HCO3	Total Alk	Total Hardness	Acidity		
6-14-78	460			4.0		967			1830			326.2					
5-9-78	780			8.0		1810			1990								
10-10-78																	
12-12-78																	
2-14-79																	
4-12-79																	
6-19-79	889			8.0		1605			2450			594.84	122		20.0		
8-1-79	1060			4.0		1895			2800			295.64	242		22.0		
10-30-79	860			22.0		1655			2050			485.58	298		12.0		
12-4-79	750			<1.0		1510			2100			490.44	402		13.0		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide	Fluoride	Manganese Total	Iron Diss.	Iron Total	Lead Total
6-14-78			<0.001				<0.001	132	42.0									
5-9-78			<0.001											0.47			0.068	<0.001
10-10-78																	0.188	
12-12-78																		
2-14-79																		
4-12-79																		
6-19-79			<0.001				<0.001	19?	4.0					0.2?			[illegible]	[illegible]
8-1-79			<0.001	0.041			<0.001	430.4	51.0	<0.001		0.009		0.27			0.080	<0.001
10-30-79			<0.001	0.081			<0.001	340	46.0	<0.001		0.009		0.44			0.075	<0.001
12-4-79			<0.001	0.030			<0.001	64.0	46.0	<0.001		0.008		0.31			0.070	<0.001

Date	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO2	Silver Total	Sodium Total	Zinc Total	Vanadium Total				Comments
6-14-78																
5-9-78	112.9	0.010				2.95	<0.001	26.0		36.0	0.089					
10-10-78		0.016					<0.001									
12-12-78																
2-14-79																
4-12-79																
6-19-79	12.3?	[illegible]				15.40?	0.005			12.80	0.122					[illegible]
8-1-79	14.56	0.012				12.90	0.004		<0.001	70.30	0.071					
10-30-79	14.00	0.014	0.0002			12.88	0.005		0.002	71.60	0.092					
12-4-79	10.80?	0.011	<0.0002			12.40	0.006		<0.001	188	0.074					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-17
Location Sowbelly Creek above Spring Canyon Creek

Date	Time	Flow	Temperature Air	Temperature Water	pH											
5/28/80	14:45	-0-														
9-17-80	11:52	-0-														
-5-80	15:41	-0-														
12-7-80	13:44	-0-														
10-21-80	11:08	-0-														
11-21-80	15:02	-0-														
2-4-81	12:14	-0-														
4-7-81	12:04	-0-														
6-29-81	14:02	-0-														
8-27-81	11:14	-0-														
10-21-81	12:23	-0-														
12-3-81	10:40	-0-														
2-16-82	11:41	-0-														
4-14-82	12:00	-0-														
6-14-82	15:33	-0-														
8-3-82	11:34	-0-														
10-2-82	14:00	-0-														
12-8-82	12:44	-0-														
2-24-83	12:00	0.04	10	10	8.1	<0.2	0.012	0.31	0.200	680	28.0	1220	1510	366.60	300.17	2.00
4-21-83	15:50	0.13		13	8.3	0.6	0.744	2.04	1.06	860	7.0	1588	1770	394.92	320	<0.01

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total																							Comments
5-28-80																															
9-17-80																															
-5-80																															
12-7-80																															
10-21-80																															
11-21-80																															
2-4-81																															
4-7-81																															
6-29-81																															
8-27-81																															
10-21-81																															
12-3-81																															
2-16-82																															
4-14-82																															
6-14-82																															
8-3-82																															
10-2-82																															
12-8-82																															
2-24-83			<0.001	0.060			<0.001	158.90	18.60	0.010		0.010		0.27			0.250	<0.001	73.92	0.030				4.80	0.003		<0.001	66.0	0.010		
4-21-83			0.003	0.050			<0.001	199.70	54.90	0.002		0.070		0.29			0.200	0.002	72.08	0.008				17.80	<0.001		<0.001	85.0	0.035		Rain

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-17
Location: Sowbelly Creek above Spring Canyon Creek

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen Ammonia as N	Nitrogen Nitrate as N	Nitrogen Nitrite as N	Nitrogen Total Kjeldahl	Nitrogen Organic	Phosphate Total as P	Phosphate Ortho as P	Sulfate	Chloride	Fluoride	Solids TDS	Solids Total Volatile	Solids TSS	Solids Total	Solids Total Fixed	Specific Cond.	Turbidity	Alkalinity	Bicarbonate	Total Hardness	Total	Acidity		
6-27-83	12:45	1.03	27	20	7.7																																	
8-17-83	11:40	-0-											0.8	0.016		3.77				0.160		770			260		1310			1340			3666	290		<.001		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Diss.	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Diss.	Hydrogen Sulfide Total	Iron Diss.	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO2	Silver Total	Sodium Total	Zinc Total	Uranium Total				Comments
6-27-83			0.002	0.035			<.001	192.0	66.00	0.007																								
8-17-83												0.030		0.26			0.210	<.001	75.8	0.008				10.0	<.001		<.001	38.6	0.026					

R 1-78

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-19
Location Sulfur Canyon Creek

Date	Time	Flow (cfs)	Temperature Air (°C)	Temperature Water (°C)	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol
6-14-78	14:00	2	30	15	7.9						11.0	8.8	<1.0	0.006
8-9-78		0.09	32	20	8.1							8.2	<1.0	0.002
10-25-78	09:40	0.04	8	4	7.5						5.0	10.4	<1.0	<0.001
12-13-78	12:45	0.14	-1	0.8	7.4						5.0	[illegible]	<1.0	<0.001
2-15-79	16:55	0.07	2	2	8.1						5.0	9.6	2.6	<0.001
4-17-79	14:15	7.45	15	[illegible]	7.72						11.0	10.4	2.0	0.004
6-15-79	13:25	4	28	17	8.6							7.05	<1.0	<0.001
8-5-79	12:40	0.6	28	20	7.8							7.3	<1.0	<0.001
9-26-79	13:14	0.004	7	5.5	9.0							9.0	<1.0	<0.001
11-28-79	12:55	0.1	0.2	0.5	9.2							10.4	<1.0	0.220

Date	Nitrogen Ammonia as N	Nitrate as N	Nitrite as N	Kjeldahl Total	Organic N	Phosphate Total as PO4	Phosphate Ortho as PO4	Sulfate as SO4	Sulfide as S	Surfactant as MBAS	Solids TSS	Total Settleable Solids	TDS	Total Solids	Total Volatile Solids
6-14-78		0.34	0.04	0.12			0.025	46.0			32.0		326		
8-9-78								123			10.0		440		
10-25-78								112			8.0		423		
12-13-78		0.02	<0.01				0.025	115			5.0		560		
2-15-79		0.02					0.022	166			11.0		575		
4-17-79		0.14					0.020	46.0			207		420		
6-15-79		0.01					<0.010	40.0			28.0		315		
8-5-79		<0.01					0.040	125			7.0		410		
9-26-79		0.01				0.095	0.080	116			28.0		496		
11-28-79		0.02				0.180	0.080	160			<1.0		659		

Date	Specific Cond.	Turbidity	Alk as CO3	Alk as HCO3	Total Alk as CaCO3	Total Hardness as CaCO3	Acidity as CaCO3	Gross Alpha	Gross Beta
6-14-78	561		<0.01	779.6					
8-9-78	690								
10-25-78	865								
12-13-78	660			444					
2-15-79	840			335.20					
4-17-79	650			216.48					
6-15-79	480			300.12	246		6.0		
8-5-79	630			197.64	162		6.0		
9-26-79	800			339.16	278		38.0		
11-28-79	990			326.74	258		24.0		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Diss.	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Diss.
[illegible]			<0.001	[illegible]			<0.001	97.2	26.0	<0.001		0.005		0.26
8-9-78			<0.001											
10-25-78			<0.001						24.0					0.34
12-13-78			<0.001	0.170			<0.001	72.0	22.0	[illegible]		[illegible]		0.29
2-16-79			<0.001	0.14			<0.001	72.0	28.0	<0.001		0.012		0.26
4-17-79			<0.001	[illegible]			<0.001	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]
[illegible]			<0.001	0.11			<0.001	[illegible]	14.0	<0.001		[illegible]		[illegible]
8-5-79			<0.001	0.160			<0.001	98.90	25.0	<0.001		0.003		0.77
9-26-79			<0.001	0.190			<0.001	120	52.0	<0.001		0.004		0.36
11-28-79			<0.001	0.180			<0.001	84.00	46.0	<0.001		0.004		0.33

Date	[illegible] Total	Iron Diss.	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO2	Silver Total	Sodium Total	Zinc Total	[illegible] Total				Comments
[illegible]			1.240	<0.001	33.6	0.009				1.551	<0.001	23.0	<0.001	27.0	0.227					
8-9-78			0.160			0.014					<0.001									
10-25-78			0.095			0.122					<0.001									
12-13-78			[illegible]	<0.001	33.12	0.024				2.006	<0.001	9.6	<0.001	92.0	[illegible]					
2-16-79			0.416	0.001	51.36	0.012				1.525	<0.001	46.0	<0.001	43.90	0.004					
4-17-79			[illegible]	0.003	56.96	[illegible]				[illegible]	0.023	7.15	0.001	27.20	[illegible]					
[illegible]			[illegible]	0.003	[illegible]	[illegible]				[illegible]	0.001		<0.001	18.29	0.003					
8-5-79			0.027	<0.001	5.29	0.004				2.026	<0.001		<0.001	25.15	0.015					
9-26-79			0.210	<0.001	14.40	0.173	<0.0002			2.140	<0.001		<0.001	39.50	0.005					
11-28-79			0.110	<0.001	52.80	0.021	<0.0002			2.05	<0.001		<0.001	74.20	0.003					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-19
Location Sulfur Canyon Creek

Date	Time	Flow	Temp. Air	Temp. Water	pH	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen	Phosphate Total	Phosphate Ortho	Sulfate	TSS	TDS	Cond.			
2-9-80	14:35	0.12	0	5.5	8.4	10.8	1.60	<0.001	0.02	1.020	0.016	122	1.0	398	810	385.6	316	33.0
4-12-80	09:05	1.10	17	1.5	7.95	10.0	27.00	0.027	1.05	0.070		136	40.5	415	710	499.38	316	7.0
6-5-80	10:22	9	15	10	9.2	9.1	1.20	<0.012	<0.01	<0.001		660	45.0	251	550	212.33	260	24.0
7-1-80	11:00	0.9	30	14	9.5	7.8	<0.01	0.020	0.02	0.110		100	5.0	418	620	363.19	252	2.0
8-21-80	09:15	0.8	1	1	7.0		0.20	<0.001	<0.01	0.090		620	4.0	440	670	412.84	322	12.0
[illegible]	13:07	0.2	9	3	7.6		1.40	0.103	0.03	0.110		115	4.0	485	448	492.40	324	<0.1
2-4-81	10:03	1.5	-4	0	8.1		1.20	0.165	<0.01	<0.001		94.5	2.0	566	510	453.80	314	<0.1
[illegible]	10:15	1	4	5	9.4		0.80	0.202	<0.01	0.560		53.0	215	334	225	225.48	224	2.0
[illegible]	09:55	0.5	13	21	9.7		24.70	<0.001	<0.01	0.300		102	20.0	438	600	349.88	270	<0.01
[illegible]	09:20	0.2	19	13	8.4		0.20	<0.001	<0.01	0.190		124	7.0	595	695	385.32	320	<0.01
10-28-81	11:58	0.1	11	6	8.1		0.40	<0.001	0.01	0.100		112	8.0	495	625	374.40	321.70	<0.01
12-3-81	12:40	0.1	7	1	8.1		0.20	<0.001	0.51	0.720		244	12.0	610	498	420.00	419	4.00
2-15-82	11:05	-0-	Frozen															
4-14-82	10:15	1.2	15	4	8.1		9.0	0.009	0.13	0.300		65.0	72.0	398	678	356.20	292	<0.01
6-9-82	11:38	2	17	10	6.4		<0.1	<0.001	0.13	0.090		60.0	40.0	355	552	315.40	258.50	<0.01
8-5-82	10:40	0.4	17	15	8.1		<0.1	0.004	<0.01	0.095		38.0	16.0	365	487	393.30	174	<0.01
10-7-82	10:55	6.8	9	5	7.9		<0.1	<0.001	<0.01	0.070		96.0	6.0	422	554	365.40	298.30	<0.01
12-8-82	10:40	0.13	-3	1	6.6		<0.1	<0.001	<0.01	0.090		42.0	15.0	447	630	405.30	318.60	2.00
2-9-83	10:20	0.5	9	1	6.8		<0.2	<0.001	0.06	0.270		84.0	<0.1	445	547	391.70	321.06	<0.01
4-21-83	14:35	2.38		8	6.4		<0.2	<0.002	0.07	0.17		127	179	520	669	341.60	280	<0.01

Date	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride	Chromium	Copper Total	Cyanide	Fluoride	Iron Dis.	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Potassium Total	Selenium Total	Silver Total	Sodium Total	Zinc Total	Total	Comments
2-9-80	<0.001	0.200			<0.001	64.0	40.0	0.003	0.005		0.56		0.210	<0.001	46.08	0.010		2.20	<0.001	<0.001	65.40	0.050		
4-12-80	<0.001	0.190			<0.001	76.00	12.0	<0.001	<0.001		0.26		1.160	0.001	43.20	0.040		1.92	0.004	<0.001	36.40	<0.001		
6-5-80	<0.001	0.210			<0.001	60.00	10.0	<0.001	0.105		0.27		0.440	0.002	24.56	0.010		1.43	0.002	<0.001	20.30	<0.010		
7-1-80	<0.001	0.160		0.010	<0.001	52.00	28.0	<0.001	0.005		0.24		0.060	<0.003	45.20	0.011		1.82	<0.001	<0.001	22.20	[illegible]		
8-21-80	<0.001	0.460		1.190	<0.001	54.40	27.0	<0.001	0.010	<0.001	0.26	1.040	0.080	<0.002	45.12	0.020	<0.0002	1.78	<0.001	<0.001	45.70	0.010		
12-2-80	<0.001	0.155			<0.001	64.00	16.60	<0.001	0.011		0.21		0.056	<0.001	52.80	0.015		1.90	0.002	<0.001	43.00	0.004		
2-4-81	0.002	0.195		[illegible]	<0.001	64.00	49.30	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	<0.001	[illegible]	[illegible]	[illegible]	2.10	0.001	<0.001	75.30	[illegible]		
[illegible]	0.002	[illegible]			<0.001	60.90	24.00	[illegible]	[illegible]		[illegible]		1.250	0.002	41.97	[illegible]		2.50	0.001	<0.001	20.70	0.011		
[illegible]	0.025	[illegible]			<0.001	48.70	[illegible]	[illegible]	[illegible]		[illegible]		0.220	<0.001	42.65	[illegible]		2.26	<0.001	0.002	51.50	0.012		
[illegible]	0.004	0.225			<0.001	54.40	61.50	<0.001	<0.001		0.44		0.120	<0.001	48.41	1.020		2.95	0.005	<0.001	83.00	0.010		
[illegible]	0.002	0.180			<0.001	74.40	57.50	<0.001	0.003		0.37		0.150	<0.001	39.84	0.166		1.30	<0.001	<0.001	54.00	0.016		
12-3-81	<0.001	0.420			<0.001	64.00	18.21	<0.001	0.010		0.72		0.420	<0.001	56.00	0.030		4.40	0.012	<0.001	98.40	0.030		
2-15-82																								
4-14-82	0.003	0.200			<0.001	65.00	20.10	0.005	0.030		0.23		3.200	<0.001	38.00	0.090		2.58	<0.001	<0.001	32.0	0.020		
6-9-82	<0.001	0.190			<0.001	67.60	16.10	<0.001	0.020		0.21		0.470	0.004	36.00	0.035		1.64	<0.001	<0.001	23.0	0.026		
8-5-82	<0.001	0.145			<0.001	55.30	28.70	<0.001	<0.001		0.24		0.150	<0.001	33.80	0.012		2.04	<0.001	<0.001	35.0	0.010		
10-7-82	<0.001	1.160	<0.001		<0.001	57.60	2.60	<0.001	0.010		0.22		0.100	<0.001	42.72	0.020		1.99	<0.001	<0.001	38.5	0.013	<0.001	
12-8-82	<0.001	0.185			<0.001	68.20	28.70	<0.001	0.010		0.30		0.470	<0.001	37.36	0.015		1.75	<0.001	<0.001	60.0	0.010		
2-9-83	<0.001	0.200			<0.001	56.80	2.50	<0.001	0.012		0.29		1.140	<0.001	41.28	0.015		1.68	<0.001	<0.001	46.0	0.008		
4-21-83	<0.001	0.210			<0.001	64.00	37.70	0.004	0.050		0.27		1.150	0.006	50.40	0.180		2.13	<0.001	<0.001	41.0	0.025		Thorn Riault (signature)

JOHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-19
Location Sulfur Canyon Creek

Date	Time	Flow (cfs)	Temperature Air (°C)	Temperature Water (°C)	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen Ammonia as N	Nitrogen Nitrate as N	Nitrogen Nitrite as N	Nitrogen Kjeldahl Total	Nitrogen Organic	Phosphate Total as PO4-P	Phosphate Ortho as PO4-P	Sulfate as SO4	Hydroxide as OH	Carbonate as CO3	Solids TDS	Solids Total Settleable	Solids TSS	Total Solids	Total Volatile Solids	Specific Cond	Turbidity	Alkalinity as CaCO3	Bicarbonate as HCO3	Total Hardness	Total	Acidity as CaCO3	Gross Alpha	Gross Beta
6/[illegible]/83	13:50	11.4	21	14	8.0								<0.2	0.110		0.02				0.140		58.0			170		889			510			300	700		<1.4		
1-17-83	15:30	2.3	25	19	7.9								0.4	<0.001		0.08				0.16		75.0			170		448			1530			9240	240		300		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Dis	Hexavalent Total	Iron Dis	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO2	Silver Total	Sodium Total	Zinc Total	Vanadium Total				Comments
6/[illegible]/83			<0.001	0.190			<0.001	56.80	38.0	<0.001		<0.001		0.22			2.100	<0.001	26.46	0.076				2.50	<0.001		<0.001	82.5	0.024					
1-17-83			<0.001	0.300			<0.001	49.80	36.0	<0.001		0.010		0.17			0.210	<0.001	29.84	0.015				2.2	<0.001		<0.001	76.0	0.032					

8-1-79

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-20
Location Price River above Sulfur Canyon

DATE	TIME	FLOW	TEMPERATURE AIR	TEMPERATURE WATER	pH	COLIFORM TOTAL	COLIFORM FECAL	FECAL STREP	BOD	COD	TOC	DISSOLVED OXYGEN	OIL & GREASE	PHENOL
[illegible]-78	17:25	919	30	15	7.8						11.0	7.6	<1.0	0.002
9-9-78	13:45	127	30	21	8.0							8.6	<1.0	0.004
10-11-78	10:55	85	19	9	7.41						3.0	8.9	<1.0	0.002
[illegible]-79	[illegible]	45	-1	0.5	7.2						6.[illegible]	10.6	<1.0	<0.001
[illegible]-79	16:05	76.[illegible]	2	1	7.70						1.1	10.0	<1.0	0.044
[illegible]-79	[illegible]	202	11	3.5	7.55						[illegible]	10.8	1.6	0.010
[illegible]-79	9:45	166	28	17	8.7							7.4	1.0	0.004
[illegible]-79	17:45	255	28	23	7.6							7.2	<1.0	<0.001
10-30-79	15:19	20.4	7	5.5	8.0							8.9	<1.0	<0.001
12-4-79	12:45	23.8	2	1	8.9							12.2	<1.0	<0.001

DATE	NITROGEN [illegible]	NITROGEN [illegible]	NITROGEN [illegible]	NITROGEN [illegible]	NITROGEN [illegible]	PHOSPHATE TOTAL	PHOSPHATE [illegible]	[illegible]	[illegible]	[illegible]	SOLIDS [illegible]	SOLIDS TOTAL [illegible]	SOLIDS [illegible]	SOLIDS TOTAL [illegible]	SOLIDS TOTAL [illegible]	[illegible]	[illegible]	[illegible] CO3	[illegible] HCO3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]-78		0.16	<0.01	0.15			0.022	30.0			146		240			400		<0.01	277.2					
9-9-78								18.0			32.0		210			335								
10-11-78								6.0			12.0		240			365								
[illegible]-79		0.15	<0.01				0.020	71.0			17.0		452			660			366					
[illegible]-79		0.12					0.025	148			52.0		430						296.24					
[illegible]-79		[illegible]					0.17	95.0			1140		260			540			268.4					
[illegible]-79		0.16					<0.010	50.0			87.0		278			420			252.2	208		6.0		
[illegible]-79		<0.01					0.040	34.8			53.0		210			310			98.14	122		10.0		
10-30-79		<0.01				0.700	0.075	68.0			25.0		362			565			262.48	220		37.0		
12-4-79		0.21				0.125	0.060	144			2.0		415			555			280.40	230		20.0		

DATE	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible]	[illegible]	[illegible] TOTAL	[illegible] TOTAL	[illegible]	[illegible]	[illegible] TOTAL
[illegible]-78			<0.001	[illegible]			<0.001	41.7	16.0	<0.0[illegible]		0.006		0.16	
[illegible]-78			<0.001						6.0						
9-9-78			<0.001						8.0					0.16	
[illegible]-79			<0.001	0.10[illegible]			<0.001	45.8	12.0	[illegible]		[illegible]		0.17	
[illegible]-79			<0.001	[illegible]			<0.001	46.6	7.0	<0.001		0.004		0.20	
[illegible]-79			[illegible]	[illegible]			<0.001	56.6	8.0	[illegible]		0.005		[illegible]	
[illegible]-79			<0.005	0.[illegible]			<0.001	51.0	6.0	<0.001		[illegible]		[illegible]	
[illegible]-79			<0.001	0.060			<0.001	59.20	26.0	<0.001		0.003		0.15	
10-30-79			<0.001	0.050			<0.001	68.00	34.0	<0.001		0.004		0.23	
12-4-79			<0.001	0.100			0.001	64.00	10.0	<0.001		0.005		0.16	

DATE	[illegible] TOTAL	[illegible]	[illegible] TOTAL	LEAD TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible]	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL	[illegible] TOTAL
[illegible]-78			1.785	0.0[illegible]	11.[illegible]	0.005				1.11[illegible]	<0.001	3.16	<0.001	15.[illegible]	0.00[illegible]	
[illegible]-78			1.141			0.058					<0.001					
9-9-78			0.108			0.008					<0.001					
[illegible]-79			[illegible]	<0.001	22.20	0.050				1.22[illegible]	<0.001	10.0	<0.001	18.0	0.0[illegible]	
[illegible]-79			[illegible]	0.001	27.92	[illegible]				1.630	<0.00[illegible]	6.20	0.001	22.20	0.042	
[illegible]-79			[illegible]	<0.001	[illegible]	0.027				1.8[illegible]	<0.001	6.60	<0.001	22.90	0.0[illegible]	
[illegible]-79			[illegible]	0.012	[illegible]	0.09[illegible]				[illegible]	<0.001		<0.001	11.12	[illegible]	
[illegible]-79			1.180	<0.001	8.16	0.114				1.745	<0.001		<0.001	5.92	0.012	
10-30-79			0.710	<0.001	27.60	0.022	<0.002			1.500	<0.001		<0.001	24.00	0.004	
12-4-79			0.240	<0.001	31.30	0.018	<0.002			1.45	<0.001		<0.001	42.20	0.004	

COMMENTS

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-20
Location Price River above Sulfur Canyon Creek

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen Ammonia	Nitrogen Nitrate	Nitrogen Nitrite	Nitrogen Total Kjeldahl	Nitrogen Organic
6-28-83	15:30		24	18	8.4								0.4	<0.001		<0.02			
1-17-83	12:35		25	20	8.0								<0.2	<0.001		0.02			

Date	Phosphate Total	Phosphate Ortho	Sulfate	[illegible]	[illegible]	Solids TDS	Solids Total Settleable	Solids TSS	Solids Total	Solids Total Volatile	Specific Cond.	Turbidity	Alk as CO_3	Alk as HCO_3	Total Alk	Total Hardness	Acidity as $CaCO_3$	Gross Alpha	Gross Beta
6-28-83	0.280		32.0			145		246			331			229.8	188		<0.01		
1-17-83	0.28		36			1242		258			380			236.34	194		5.00		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chlorine Res.	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Ion	[illegible] Total	[illegible]
6-28-83			0.004	0.250			<0.001	58.40	10.00	0.006		0.020		0.11		
1-17-83			0.005	0.233			<0.001	54.40	10.0	0.031		1.060		0.10		

Date	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	[illegible] Total				Comments
6-28-83	8.450	0.013	12.78	0.410				1.90	<0.001		<0.001	10.0	0.116					
1-17-83	18.200	0.019	15.36	0.960				1.5	<0.001		<0.001	19.0	0.085					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-20
Location Price River above Sulfur Canyon Creek

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	B.O.D	C.O.D	TOC	Dissolved Oxygen	Oil & Grease	Phenol
2-13-80	14:40		0	0.5	8.6							12.0	<1.0	<0.001
11-13-80	13:40	425	12	2.0	8.5							10.4	57.00	0.002
5-5-80	11:30		17	11	7.6							8.9	25.06	0.012
11-?-80	[illegible]	165.8	30	18	8.4							7.2	<0.01	<0.001
11-?-80	9:35		5	1	7.0							11.5	0.20	<0.001
11-20-80	11:17		9	1	7.2								1.40	0.200
2-4-81	10:10		-8	0	8.2								0.40	<0.002
?-7-81	9:05		8	5	8.2								0.80	0.006
?-?-81	9:40		25	16	8.7								9.60	0.281
?-27-81	9:05		17	15	8.2								<0.01	<0.001
?-29-81	11:56		11	6	8.1								2.80	0.031
12-3-81	13:05		4	1	8.2								<0.01	<0.001
2-?-82	11:00		1	2									2.4	0.010
4-?-82	11:00		15	4	8.0								1.2	0.015
6-?-82	13:12		15	11	8.4								2.2	<0.001
1-3-82	10:55		22	17	8.4								<0.1	<0.001
9-?-82	11:50		9	5	8.1								<0.1	<0.001
11-?-82	11:60		-3	1	6.7								<0.1	<0.001
2-?-83	11:35		1	1	6.9								<0.2	0.010
4-21-83	14:10		6	5	8.5								<0.2	<0.012

Date	Ammonia as N	Nitrate as N	Nitrite as N	Total Kjeldahl	Organic N	Phosphate Total as P	Ortho as P	Sulfate	Sulfide	Chloride	TSS	Total Volatile	TDS	Total Settleable	Total Fixed	Cond	Turbidity	Alk. as $CaCO_3$	Hardness as $CaCO_3$	Total Alk.	Total	Acidity		
2-13-80		0.26				0.055	0.040	66.0			4.0		321			560			293.[illegible]	224		74.0		
11-13-80		0.40				0.160		71.0			210		294			460			284.6	194		2.0		
5-5-80		0.18				0.150		66.0			355		261			400			220.[illegible]	186		16.0		
11-?-80		<0.01				0.290		46.0			29.0		225			310			193.84	164		<0.1		
11-?-80		0.02				0.120		45.0			12.0		330			300			202.40	264		<1.0		
11-20-80		0.22				0.090		150			6.0		320			294			299.12	196		8.0		
2-4-81		0.07				0.095		48.0			9.0		332			318			305	266		<0.1		
?-7-81		<0.01				0.350		52.5			145		306			308			256.[illegible]	212		10.0		
?-?-81		<0.01				0.260		71.0			780		198			280			192.64	166		<0.01		
?-27-81		0.04				1.250		12.0			126		189			235			175.60	144		<0.00		
?-29-81		0.04				0.200		36.0			28.0		288			312			273	293.10		<0.01		
12-3-81		0.56				0.730		65.0			23.0		376			313			296.20	259		8.00		
2-?-82		0.10				1.550		55.0			24.0		335			356			300.[illegible]	246		6.00		
4-?-82		0.33				0.740		455			1278		380			575			292.70	244		<0.01		
6-?-82		0.05				0.070		31.0			88.0		265			389			248.[illegible]	216.20		<0.01		
1-3-82		<0.01				0.065		37.0			51.0		260			345			295.70	206.40		<0.01		
9-?-82		<0.01				0.110		10.0			48.0		266			414			270.[illegible]	231.80		<0.01		
11-?-82		0.14				0.150		276			36.0		448			527			40.80	41.10		2.00		
2-?-83		<0.02				0.900		15.0			83.0		270			291			292.50	228.09		<0.01		
4-21-83		0.22				0.38		40.0			704		382			448			361.10	214		<0.01		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride	Chromium	Cobalt Total	Copper Total	Cyanide	Fluoride Diss	Total	Iron Diss
2-13-80			<0.001	0.295			<0.001	56.80	18.0	<0.001		0.082		0.36		
11-13-80			0.003	0.060			<0.001	48.00	3.0	<0.001		<0.001		0.16		
5-5-80			<0.001	0.110			<0.001	52.70	4.0	<0.001		0.054		0.41		
11-?-80			<0.001	0.110		0.020	<0.001	52.00	4.0	<0.001		0.054		0.12		
11-?-80			<0.001	0.100		1.120	<0.001	50.40	11.7	<0.001		<0.001	<0.001	0.18		0.020
11-20-80			<0.001	0.070			<0.001	81.00	15.30	<0.001		<0.001		0.12		
2-4-81			0.002	0.090		0.055	<0.001	54.00	17.50	[illegible]		[illegible]		[illegible]		0.120
?-7-81			0.003	0.070			<0.001	52.20	20.00	1.001		[illegible]		0.19		
?-?-81			0.020	0.150			<0.001	45.60	18.80	[illegible]		1.020		0.15		
?-27-81			0.004	0.175			<0.001	42.20	10.10	<0.001		0.010		0.16		
?-29-81			0.003	0.085			<0.001	32.00	14.50	<0.001		0.012		0.26		
12-3-81			<0.001	0.115			<0.001	60.00	18.20	<0.001		<0.001		0.24		
2-?-82			<0.001	0.090		0.350	<0.001	42.00	14.73	<0.001		0.010		0.15		
4-?-82			0.029	0.350			<0.001	190	15.90	0.039		0.100		0.18		
6-?-82			<0.001	0.080			<0.001	65.50	4.00	<0.001		0.020		0.12		
1-3-82			<0.001	0.085			<0.001	64.0	1.80	<0.001		0.020		0.12		
9-?-82			<0.001	0.090	<0.001		<0.001	52.00	16.40	<0.001		0.030		0.14		
11-?-82			<0.001	0.105			<0.001	68.80	13.10	<0.001		0.010		0.21		
2-?-83			<0.001	0.070			<0.001	47.00	45.30	0.004		0.010		0.14		
4-21-83			0.004	0.260			0.003	56.80	15.70	0.011		0.050		0.17		

Date	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	Vanadium Total				Comments
2-13-80	0.224	<0.001	19.28	0.020				1.65	<0.001		<0.001	22.1	0.08					
11-13-80	5.270	0.003	31.20	0.460				1.55	<0.001		<0.001	15.40	0.010					
5-5-80	[illegible]	0.006	15.92	0.210	0.001			1.66	<0.001		<0.001	26.00	0.120					
11-?-80	0.490	<0.001	16.20	0.840				0.95	<0.001		<0.001	3.10	0.010					
11-?-80	0.440	0.012	24.56	0.030	<0.001			1.24	<0.001		<0.001	36.20	<0.001					
11-20-80	0.460	<0.001	16.80	<0.001				0.35	0.004		<0.001	9.30	0.012					
2-4-81	0.210	<0.001	21.65	0.020	0.0002			1.60	<0.001		<0.001	22.40	0.005					
?-7-81	14.5	0.011	26.41	0.091				1.55	<0.001		<0.001	24.70	0.020					
?-?-81	0.410	<0.001	8.55	0.080				0.99	<0.001		<0.001	6.00	0.005					
?-27-81	1.810	<0.001	10.56	0.190				1.18	0.002		<0.001	5.30	0.020					
?-29-81	1.130	<0.001	36.96	0.021				2.70	<0.001		<0.001	20.00	0.018					
12-3-81	0.250	<0.001	29.00	0.050				5.50	<0.001		<0.001	26.50	0.025					
2-?-82	0.880	<0.001	28.00	0.050				1.40	<0.001		<0.001	22.70	0.036					
4-?-82	25.800	0.002	17.20	1.150				2.45	0.002		<0.001	56.0	0.110					
6-?-82	6.060	0.005	18.20	0.080				1.16	<0.001		<0.001	7.9	0.025					
1-3-82	0.570	0.003	18.50	0.060				1.80	<0.001		<0.001	7.8	0.025					
9-?-82	4.380	<0.001	26.12	0.092				1.41	<0.001		<0.001	18.5	0.000	<0.001				
11-?-82	0.880	<0.001	28.32	0.045				1.55	<0.001		<0.001	22.0	0.010					
2-?-83	6.130	0.003	14.32	0.145				1.29	<0.001		<0.001	90.0	0.006					
4-21-83	9.800	0.019	23.62	0.470				1.80	<0.001		<0.001	26.6	0.080					Light Rain

8-1-78

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-21
Location Ford Creek
above US 50 & 6

Date	Time	Flow (cfs)	Temperature Air (°C)	Temperature Water (°C)	pH	Coliform Total	Coliform Fecal	Fecal Strep	COD	BOD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen Ammonia	Nitrogen Nitrate	Nitrogen Nitrite	Nitrogen Total Kjeldahl	Nitrogen Organic	Phosphate Total	Phosphate Ortho	Sulfate	[illegible]	[illegible]	Solids TSS	Solids Total Settleable	Solids TDS	Solids Total	Solids Total Volatile	Specific Cond.	Turbidity	Alk. as CO_3	Alk. as HCO_3	Total Alk.	Total Hardness	[illegible]	Gross Alpha	Gross Beta
[illegible]-19-78		3	26	14	8.0						11.0	8.5	<1.0	<0.001		0.05	<0.01	0.18			0.024	29.0			44.0		252			450		<0.01	242.5					
9-9-78	12:05	0.2	25	15	7.7							9.4	<1.0	<0.001								56.0			19.0		340			540								
10-10-78	11:40	0.07	18	8	7.62						18.0	8.9	<1.0									4.0			3.0		370			640								
1-13-79	12:30	-0-																																				
2-15-79	4:20	-0-																																				
5-18-79	9:45	0.15	11	2.5	7.51						6.0	10.2	1.0	0.009		<0.01					0.49	59.0			169		320			490			205					
6-19-79	14:40	2.6	20	15.5	8.16							8.22	<1.0	0.014		0.02					<0.010	36.0			26.0		257			400			224.2	210		7.0		
7-17-79	17:19	0.6	26	16.5	7.8							8.2	1.0	<0.001		<0.01					0.020	51.7			28.0		326			500			287.52	236		14.0		
10-31-79	15:38	0.2	5	1	8.0							9.5	<1.0	<0.001		0.02				0.210	0.080	19.0			26.0		355			520			317.32	256		44.0		
12-4-79	7:24	-0-																																				

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis.	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as Cn	Fluoride Dis.	[illegible] Total	Iron Dis.	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	[illegible] Total				Comments
[illegible]-19-78			<0.001	0.050			<0.001	44.0	10.0	<0.001		0.004		0.16			0.054	<0.001	26.7	0.012				0.962	<0.001	55.0	<0.001	7.4	0.006					
9-9-78			<0.001						8.0								0.022			0.004					<0.001									
10-10-78			<0.001						9.0					0.20			0.035			0.018					<0.001									
1-13-79																																		Frozen
2-15-79																																		Frozen
5-18-79			[illegible]	[illegible]			[illegible]	[illegible]	6.0	[illegible]		[illegible]		0.18			0.26	[illegible]	[illegible]	[illegible]				1.386	[illegible]	[illegible]	[illegible]	7.62	[illegible]					
6-19-79			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		0.15			0.150	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]		<0.001	[illegible]	[illegible]					
7-17-79			<0.001	0.040			<0.001	16.98	14.0	<0.001		0.002		0.17			0.420	<0.001	12.00	0.012				1.974	<0.001		<0.001	8.47	0.006					
10-31-79			<0.001	0.097			<0.001	66.00	6.0	<0.011		0.005		0.22			0.260	<0.001	27.20	0.011	<0.002			1.690	<0.001		<0.001	3.65	0.010					
12-4-79																																		

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-21
Location Ford Creek above US 50 & 6

Date	Time	Flow	Temp. Air	Temp. Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	N Ammonia as N	N Nitrate as N	N Nitrite as N	N Total Kjeldahl	N Organic	P Total as P	P Ortho as P	Sulfate	Sulfide	Cyanide	TSS	Total Settleable Solids	TDS	Total Solids	Total Volatile Solids	Spec. Cond.	Turbidity	Alk. as $CaCO_3$	Ca Hard. as $CaCO_3$	Total Alk. as $CaCO_3$	Total	Acidity as $CaCO_3$	Alpha Gross Activity	Beta Gross Activity
7-15-80	15:00	-0-																																				
4-17-80	11:28	0.8	3	2	8.75							10.6	11.20	0.002		0.11				0.070		60.0			64.5		310			475			277.92	236		2.0		
6-5-80	11:10	11.6	31	6	9.1							9.6	1.6	0.025		0.02				<0.001		62.0			54.0		326			510			277.92	244		16.0		
8-1-80	11:25	0.5	28	14	8.4							7.2	<0.01	<0.001		3.14				[illegible]		75.0			8.0		348			550			297.94	254		<0.1		
12-?-80	11:50	0.1	0	0	7.8							11.1	0.20	<0.001		<0.01				0.096		34.5			1.0		360			520			318.40	320		16.0		
12-27-80	7:57	-0-																																				
2-4-81	9:45	-0-																																				
?-?-81	09:50	0.3	2	1	8.2								2.40	0.021		<0.01				0.270		56.0			54.0		305			250			[illegible]	228		5.00		
?-22-81	11:15	0.5	15	11	9.6								18.10	0.005		<0.01				1.940		45.0			17.0		290			365			297.92	240		<0.01		
12-21-81	08:36	0.1	13	10	7.3								3.80	<0.001		0.04				0.120		25.5			215		285			360			295.20	246		<0.01		
?-?-81		1.2	2	2	6.8								1.20	<0.001		1.23				0.300		23.0			63.0		260			255			218.80	248.0		<0.01		
12-3-81	16:09	-0-	Frozen																																			
2-?-82	9:42	-0-	Frozen																																			
4-?-82	09:10	0.5	10	2	8.0								<1.0	0.008		0.16				1.520		500			1312		945			497			312.70	266.90		<0.01		
6-?-82	11:22	6.6	11	9	8.4								<0.1	0.003		0.10				0.030		53.0			61.0		320			452			312.80	260.00		<0.01		
8-?-82	10:00	2.8	22	15	7.8								<0.1	<0.001		0.06				0.035		35.0			89.0		310			532			338.00	278.60		<0.01		
10-?-82	10:06	3.0	9	9	7.0								<0.1	<0.001		<0.01				0.130		12.0			88.0		320			359			359	29?.30		<0.01		
12-?-82	09:27	-0-																																				
2-?-83	09:45	-0-																																				
4-21-83	15:33	2.0											<0.2	<0.003		0.23				0.72		119			1945		575			809			285.56	234		<0.01		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis.	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Dis.	Total	Iron Dis.	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	Chromium Total				Comments
7-15-80																																		
4-17-80			0.001	0.110			<0.001	48.00	5.0	<0.001		<0.001		0.18			0.990	0.002	45.20	0.020				1.10	0.001		<0.001	7.00	<0.001					
6-5-80			[illegible]	[illegible]			<0.001	45.20	6.0	<0.001		0.006		0.21			1.530	0.002	25.32	0.070				0.98	0.002		<0.001	16.00	0.020					
8-1-80			[illegible]	[illegible]		0.120	<0.001	52.00	11.0	<0.001		0.011		0.32			1.150	<0.001	33.40	0.002				1.09	0.011		<0.001	8.60	0.002					
12-?-80			0.001	0.170		0.050	<0.001	62.60	7.4	0.001		0.011	<0.001	1.17		0.011	0.180	0.002	42.24	0.010	0.0002			1.28	<0.001		<0.001	12.00	<0.001					
12-27-80																																		
2-4-81																																		
?-?-81			[illegible]				[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]			0.990	0.002	[illegible]	0.010				1.55	0.002		<0.001	5.70	0.010					
?-22-81			0.015	0.270			<0.001	44.00	10.00	<0.001		0.010		0.23			1.170	<0.001	41.55	0.010				1.55	0.001		<0.001	7.30	0.025					
12-21-81			0.007	0.115			<0.001	45.20	12.70	<0.001		0.010		1.20			3.710	<0.001	30.88	0.070				2.00	0.002		<0.001	8.50	0.025					
?-?-81			<0.001	0.070			<0.001	25.60	6.00	<0.001		0.012		0.17			4.100	<0.001	51.96	0.060				2.10	<0.001		<0.001	4.20	0.020					
12-3-81																																		
2-?-82																																		
4-?-82			0.027	0.200			<0.001	220	4.70	0.044		0.080		0.17			35.500	0.004	62.00	0.510				1.45	0.004		<0.001	8.0	0.175					
6-?-82			<0.001	0.090			<0.001	48.50	3.60	<0.001		0.020		0.13			5.740	0.006	36.10	0.090				1.15	<0.001		<0.001	6.6	0.025					
8-?-82			<0.001	0.092			<0.001	64.60	8.50	<0.001		0.050		0.15			2.050	0.005	37.40	0.070				1.61	<0.001		<0.001	8.2	0.035					
10-?-82			<0.001	0.090	<0.001		<0.001	56.80	10.80	<0.001		0.020		0.15			3.600	<0.001	41.76	0.040				1.81	<0.001		<0.001	7.7	0.025	<0.001				
12-?-82																																		
2-21-83																																		
4-21-83			0.013	1.320			0.002	64.00	10.770	0.058		0.270		0.23			21.000	0.099	42.24	0.490				2.00	<0.001		<0.001	81.0	0.175					Snowing

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-21
Location Ford Creek
above US 50 & 6

Date	Time	Flow (cfs)	Temp. Air (°C)	Temp. Water (°C)	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Ammonia as N	Nitrate as N	Nitrite as N	Nitrogen Total Kjeldahl	Nitrogen Organic	Phosphorus Total as P	Phosphorus Ortho as P	Sulfate as SO4	Chloride as Cl	Fluoride	TSS	Total Settleable Solids	TDS	Total Solids	Total Volatile Solids	Specific Cond	Turbidity	Alk as CO3	Alk as HCO3	Total Alk as CaCO3	Total Hardness as CaCO3	Acidity as CaCO3	Gross Alpha Activity	Gross Beta Activity
6-29-83	14:35	8.8	22	14	1.2								0.6	<0.001		0.04				0.800		44.0			168		280			379			218.00	284		1.01		
1-7-83	8:26	1.3	25	18	7.9								<0.2	<0.001		0.05				0.29		67			240		389			536			295.98	234		6.00		

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Dis	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Dis	Mercury Total	Iodide Dis	Iron Total	Lead Total	Magnesium Total	Manganese Total	Molybdenum Total	Nickel Total	Zinc? Total	Potassium Total	Selenium Total	Silica as SiO2	Silver Total	Sodium Total	Zinc Total	Uranium Total				Comments
6-29-83			0.014	0.350			<0.001	44.80	10.00	0.005		0.020		0.15			14.300	0.007	34.08	0.085				2.10	<0.001		<0.001	4.5	0.180					
1-7-83			0.015	1.360			<0.001	46.40	36.0	<0.001		0.010		0.13			0.110	<0.001	41.28	0.010				2.0	<0.001		<0.001	39.0	0.200					

8-1-78

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station B-25
Location Crandall Canyon above site

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen: Ammonia	Nitrogen: Nitrate	Nitrogen: Nitrite	Nitrogen: Kjeldahl Total	Nitrogen: Organic	Phosphate: Total	Phosphate: Ortho	Sulfate	Chloride	[illegible]	Solids: TDS	Solids: Total [illegible]	Solids: TSS	Solids: Total	Solids: Total Volatile	Cond	Turbidity	Alk as $CaCO_3$	[illegible]	Total [illegible]	Total Hardness	Acidity as $CaCO_3$	[illegible]	[illegible]
4-7-81	11:27	-0-																																				
6-27-81	11:10	-0-																																				
8-27-81	11:56	-0-																																				
10-23-81	10:26	-0-																																				
12-3-81	14:00	-0-																																				
2-16-82	13:50	-0-																																				
4-14-82	09:10	-0-																																				
6-14-82	8:22	-0-																																				
8-3-82	10:20	-0-																																				
10-7-82	11:25	-0-																																				
12-8-82	09:17	-0-																																				
2-24-83	10:00	-0-																																				
4-21-83	13:45	-0-																																				
6-27-83	11:55	1	23	18	8.2								0.8	<.0001		0.06				4.000		80.0			475		410			514			358.20	294		<.001		
8-17-83	11:43	-0-																																				

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride Diss	Chromium Hexavalent	Cobalt Total	Copper Total	Cyanide as CN	Fluoride Diss	[illegible] Total	Iron Diss	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	Vanadium Total				Comments
4-7-81																																		
6-27-81																																		
8-21-81																																		
10-23-81																																		
12-3-81																																		
2-16-82																																		
4-14-82																																		
6-14-82																																		
8-3-82																																		
10-7-82																																		
12-8-82																																		
2-24-83																																		
4-21-83																																		
6-28-83			0.006	0.220																														
8-17-83							<.0001	36.40	19.00	0.008		0.030		0.23			41.600	0.009	31.52	0.160				3.60	<.001		<.001	9.5	0.210					

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station: B-26
Location: Crandall Canyon below site

Date	Time	Flow	Temperature Air	Temperature Water	pH	Coliform Total	Coliform Fecal	Fecal Strep	BOD	COD	TOC	Dissolved Oxygen	Oil & Grease	Phenol	Nitrogen Ammonia	Nitrogen Nitrate	Nitrogen Nitrite	Nitrogen Total Kjeldahl	Nitrogen Organic	Phosphorus Total	Phosphorus Ortho	Sulfate	[illegible]	[illegible]	Solids TSS	Total Dissolved Solids	TDS	Total Solids	Total Volatile Solids	Cond.	Turbidity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1-7-81	11:25	-0-																																				
1-27-81	9:45	-0-																																				
[illegible]	11:53	-0-																																				
[illegible]	11:42	0.1	6	4	7.8								3.80	0.029		1.84				0.200		219			192		625			690			400.70	325.70		3.00		
12-3-81	14:00	-0-																																				
[illegible]	12:36	-0-																																				
4-14-82	11:45	0.13	11	7	7.7								<1.0	0.008		14.42				0.140		520			540		910			1140			81.70	630.0		4.00		
6-29-82	15:50	0.1	12	11	8.2								2.6	<0.001		0.08				0.040		730			736		1480			2040			252.50	1180		<0.01		
8-3-82	10:22	-0-																																				
10-27-82	10:32	-0-																																				
12-21-82	11:20	-0-																																				
2-24-83	11:36	-0-																																				
4-21-83	15:55	0.03	4	2	8.6								<0.2	<0.002		3.56				0.93		155			188		395			476			68.30	56.00		1.80		
6-29-83	15:15	1	23	8	8.3								0.6	<0.001		0.04				0.980		103			665		1168			559			348.10	372		<0.01		
9-17-83	11:40	-0-																																				

Date	Aluminum Total	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chloride	Chromium Total	Cobalt Total	Copper Total	Cyanide	Fluoride	[illegible]	Iron Dis	Iron Total	Lead Total	Magnesium Total	Manganese Total	Mercury Total	Molybdenum Total	Nickel Total	Potassium Total	Selenium Total	Silica as SiO_2	Silver Total	Sodium Total	Zinc Total	[illegible]				Comments
1-7-81																																		
2-11-81																																		
12-7-81																																		
10-23-81			<0.001	0.080			<0.001	52.80	29.10	<0.001		0.009		0.32			0.360	<0.001	104.44	0.005				5.40	<0.001		<0.001	14.00	0.010					
12-3-81																																		
2-4-82																																		
4-14-82			0.004	0.050			<0.001	125	65.50	0.042		0.030		0.37			0.453	<0.001	53.80	0.030				26.00	<0.001		<0.001	70.5	0.020					
6-29-82			0.007	0.090			<0.001	161	153	0.029		0.050		0.43			6.300	0.023	71.30	0.305				15.00	<0.001		0.011	220	0.180					
8-3-82																																		
10-27-82																																		
12-21-82																																		
2-24-83																																		
4-21-83			0.059	0.140			0.003	42.00	52.30	0.051		0.130		0.35			39.000	0.042	10.08	0.780				4.90	<0.001		<0.001	64.0	0.430					
6-29-83			0.050	0.150			0.005	32.00	14.00	0.016		0.030		0.24			12.500	0.039	74.88	0.165				5.20	<0.001		<0.001	140	0.450					
9-17-83																																		

8-1-78

VAUGHN HANSEN ASSOCIATES
Consultants / Engineers

WATER QUALITY DATA

Station Shaft
Location at Crandall Canyon Portal

12-3-81	1330	0.08			7.0								<0.01	0.003		0.42				0.450		860			35.0		1210			1880			580.46	778		36.0		

12-3-81			<0.001	0.020			<0.001	175	26.20	0.020		0.020		0.25			0.220	<0.001	95.00	0.220				5.20	<0.001		<0.001	120	0.025				