# CHAPTER 7

# R645-301-700 HYDROLOGY

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# R645-301-700 Hydrology

# R645-301-710 Introduction

This chapter discusses existing hydrologic resources and potential impacts resulting from existing and proposed mining and reclamation operations. Hydrologic performance standards, design criteria, plans along with methods and calculations and reclamation requirements are discussed.

Cross sections, maps and plans required to be certified under these regulation have been prepared by or under the direction of a qualified, registered, professional engineer whose stamp and signature can be found on the individual documents in question.

Impoundments requiring periodic inspections are discussed in Chapter 5 Engineering under R645-301-514.300.

## R645-301-720 Environmental Description

## R645-301-721 General Requirements

Existing, premining hydrologic resources within the permit and adjacent areas that may be affected or impacted by proposed coal mining and reclamation operations are defined and discussed in the following outline.

## R645-301-722 Cross Sections and Maps

### 722.100 Sub-Surface Water

Exhibits 7-5 and 7-6 give geologic cross sections showing potential water bearing formations within the permit and adjacent areas.

A surface drilling project was conducted in 1976 and 77 to evaluate coal reserves south of the permit area. These holes were rotary drilled down to the Blackhawk formation then core drilled through the Blackhawk to the top of the Star Point sandstone formation. Little if any geologic or hydrologic information is available for the rotary drilled portions of the holes, except that many of the holes are said to have lost circulation in a zone approximately 300 feet below the collar. The core samples were retained and their lithologic information closely examined and documented. Since these holes give information over a greater vertical extent than the holes drilled from within the mines (small drill unit with 400 ft. maximum capability) they were utilized to construct the cross sections on Exhibits 7-5 and 7-6.

Aquifers above the coal seams are discussed under R645-301-728 on page 7-58 ~~724.600 "Survey of Renewable Resource Lands".~~

An accessible source of groundwater flow in the King 4 mine is identified as UG-1 on Exhibit6-3. This source is discussed under 731.200 Water Monitoring, Ground Water Monitoring Plan.

**722.200 Surface Water**

Exhibits 7-1, 7-2 and 7-4 show the location of surface water bodies such as streams, lakes ponds and springs within the permit and adjacent areas.

**722.300 Water Monitoring Stations**

Exhibit 7-1 gives elevations and locations of monitoring stations used to gather baseline data on water quality and quantity.

**722.400 Location of Water Wells**

There are no water wells in the permit or adjacent area.

**722.500 Slope Measurements or Contour Maps**

Numerous contour maps of various scales are included in this and other chapters which adequately represent the existing land surface configuration of disturbed areas.

## R645-301-723 Sampling and Analysis

All water quality analyses performed to meet the requirements of this chapter will be conducted according to the methodology in the current edition of *Standard Methods for the Examination of Water and Wastewater* or the methodology in 40 CFR Parts 136 and 434. Currently, surface and groundwater samples are analyzed by ~~Inter-Mountain Laboratories, Inc., 2506 W. Main Street, Farmington, New Mexico. Mine water discharge samples are analyzed by Commercial Testing & Engineering Co., P.O. Box 1020, Huntington, Utah.~~ certified water labs.

# R645-301-724 Baseline Information

### 724.100 Ground Water Information

Geology is the principal factor controlling the occurrence and availability of groundwater. Unconsolidated deposits of Quaternary age are the most permeable water-bearing formations in parts of this region; sandstone strata of Jurassic, Cretaceous, and Tertiary age contain the most extensive bedrock aquifers (Price, and Arnow, 1974).

The region is not very complex structurally, but hydrologically it is "divided into three regions based on structural and erosional features." "The region boundaries are based on fault zones and cliff outcrops." "Region 1 is the northeastern portion of the Wasatch Plateau." "Region 2 is located in the middle of the eastern edge of the Wasatch Plateau." "Region 3 is located south and west of Region 2." (Bills, 2000 page 51) There is little groundwater flow since the Mancos Shale acts as a barrier. Figure 13b on page 63 of Appendix 7-21 shows the typical offset created by faults. ~~units by structural elements such as the Book Cliffs, the San Rafael Swell, and the Wasatch Plateau. These units are modified by numerous subsidiary folds, faults, and intrusions; and in the upper formations by deeply cut drainage systems. The deep drainage system in some areas drains the exposed bedrock.~~ The upper water-bearing beds are discontinuous and partially void of water near cliff faces (Final EIS, 1979). The upper formations of the Wasatch Plateau as shown on Exhibit 6-1 (General Geology Map) have been reported as the water-bearing formations. Field investigations have shown that most of the springs and seeps outcrop in the Price River, Star Point, and Castlegate Sandstone formations. The Flagstaff limestone and North Horn formation are conglomerates composed of limestone yielding water to wells for municipal use at Price, Utah. Price and Waddell note that wells in consolidated rocks underlying most of this region generally yield less than 50 gallons per minute.

Quaternary alluvial deposits are the most permeable deposits in the area. They can be expected to yield from 10 to 100 gallons per minute to wells in the vicinity of perennial streams.

The lower valley area of the drainage is underlain with a formation called the Mancos shale. The shales have very low permeability, the little water that originates from this formation has little value due to its bicarbonate, sodium and sulfate content. The Ferron Sandstone formation in the southern parts of the Wasatch Plateau has yielded potable water to the Emery municipal well and water to underground mine workings.

Water table conditions commonly prevail in shallow alluvium along larger streams, and in relatively flat-lying sedimentary rocks. The deeply cut drainages that are common to the Wasatch Plateau and the Hiawatha area in particular are recharged into the larger streams by the water table found in the canyon's alluvium. Quaternary alluvial deposits can be expected to yield from 10 to 100 gallons per minute to wells in the vicinity of perennial streams. The groundwater is recharged principally in the higher plateaus which receive the most precipitation and produce most of the runoff. Springs, stream courses, and patches of preatophytes discharge the groundwater into the creeks. The direction of movement of water through the bedrock formations has not been determined accurately for the regional area, although a few local areas have been examined.

Precise knowledge of ground water depths and aquifers in the Miller and Cedar Creek drainage areas is ~~quite~~ limited to water encountered during the drilling of gas wells ~~as no wells or borings have been drilled into the alluvial fill~~ in the vicinity of the mine property. ~~No description~~

~~of the depth to water table is available~~. It is questionable whether a reliable water table in the Quaternary valley fill exists. No wells have been dug in town or the surrounding areas which could provide documentation of alluvial ground water. Piezometric maps of ground water levels do not exist nor is there available data.

Seepage, at the elevation of the streams, contributes to small tributary streams from localized seeps along the channel banks. Water appears to percolate down through permeable layers and alluvium until it intercepts the level of the stream flow. Seeps can be observed at various points along the canyons down from the top of the plateau to the alluvium and weathered Mancos Shale below.

Extensive drilling for gas wells in the area has shown that there are no water bearing aquifers between the Starpoint and Ferron Sandstone members. In areas disassociated with direct seepage from perennial streams and based on principal geologic units in the area, a six inch diameter well drilled up to 1,000 ft. deep in the vicinity of Hiawatha should only produce one to five gallons per minute[1].

The ground water is recharged primarily by direct infiltration of precipitation (probably much less than 5% of the annual precipitation) in the upper elevations of the plateaus and by infiltration from perennial streams that flow into the Mancos shale lowlands. Although the surficial material may be relatively less permeable than the underlying saturated beds,

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[1] United States Department of the Interior, BLM, *Uinta Southwest Utah Coal Region, Round II Draft EIS.*

considerable amounts of water infiltrate to the saturated beds because of the large areas through which the infiltration occurs.

Groundwater recharge also takes place to a limited extent by infiltration in outcrops (exposures at the land surface) of some of the more permeable and stratigraphically lower formations. The areas of outcrops are small, and thus limit the amount of recharge (Final EIS, 1979).

Depths to ground water range from less than 50 feet to more than 1,000 feet. Ground water levels are generally less than 50 feet beneath the land surface along alluvial plains in the larger perennial streams (Green, Price and San Rafael Rivers) and 500 feet to more than 1,000 feet beneath the land surface on higher plateaus (Price and Waddell, 1973). Local perched ground water bodies are only a few feet below the land surface in much of the region. The high elevation aquifers can best be described as perched aquifers, these are generally the springs that recharge the perennial streams.

Gentry Mountain is hydraulically isolated from other areas of the Wasatch Plateau. There are two types of groundwater systems in the Gentry Mountains, perched groundwater systems, and Star Point Sandstone fracture-flow groundwater systems. Groundwater flow is predominantly horizontal with very little vertical movement.[2] (Mayo 2001, page 98)

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[2] Mayo and Associates, LC, Investigation of Groundwater and Surface-Water Systems in the C. W. Mining Company Federal Coal Leases and Fee Lands, Southern Gentry Mountain, Emery and Carbon Counties, Utah: Probable Hydrologic Consequences of Coal Mining in the Bear Canyon Mine Permit Area and Recommendations for Surface Water and Groundwater Monitoring, June 25, 2001.

A perched system occurs where rocks of low permeability impede the downward percolation of water and cause the groundwater to accumulate above the permeability horizon leaving and unsaturated zone beneath the system.[2] (Mayo 2001, page 100)

~~Directions and rates of ground water movement from the recharge to the discharge areas are controlled largely by geologic structures and variations in rock permeability. Because of faults and the dip of the rock strata, some ground water passes from one surface drainage basin to another. Considering the locations of faults, the gentle dip of rock strata and overall rock permeability it is generally believed that most of the ground water that originates in a given drainage basin is also discharged somewhere within that basin. However, on a local level, the springs in Tie Fork Canyon and Bear Canyon which are tributary to Huntington Creek appear to be fault related and could be fed by sources that would otherwise be tributary to the Price River.~~[1]

~~It is believed that most water enters the rocks above the coal seam principally from the higher plateaus where the most show falls. This water has the potential of eventually finding its way to the coal seams.~~[1]

"Perched groundwater systems occur in the Flagstaff Limestone, North Horn Formation, Price River Formation, and Blackhawk Formation". Active systems extend into the cliff 500 to 1,000 feet where they encounter discontinuous fractured channels preventing active groundwater flow. The vertical movement of groundwater is limited to 100 to 200 feet. The inactive systems do not have good hydraulic communication with recharge and discharge and drain quickly when encountered. These systems are small and localized.[2] (Mayo, 2001, pages 100-102) ~~Ground water in the Castle Valley Ridge area occurs in perched aquifers. The Blackhawk Formation and Star Point Sandstone form a regional aquifer in the southern Wasatch Plateau coal field;~~

~~however, this aquifer is a localized aquifer in the Castle Valley Ridge area.~~ The principal source of recharge to the aquifers is snowmelt on outcrops. Faults or aquacludes may be major conduits and control the movement of ground water. Ground water discharges at formation contacts, between zones of differing permeability within a formation, near faults and into mines.[3]

Fracture-flow groundwater systems exist both above and in the Star Point Sandstone, but these fractures are of limited lateral extent and do not convey large quantities of water over long distances and there is no significant hydraulic communication between sandstone members.

~~"Flow in the Blackhawk-Star Point aquifer in the Castle Valley Ridge coal-lease tract probably is controlled by the Bear Canyon fault on the east side of the ridge and by local topography on the west side".[3]~~

~~U. S. Fuel~~ Hiawatha Coal Company's permit area is located on the southern end of Castle Valley Ridge and east of the Bear Canyon Fault. It includes ~~part of the localized Blackhawk-Star Point aquifer and possibly~~ higher perched aquifers all of which are bounded by outcrops on the north, east and south and by the Bear Canyon Fault on the west. See Exhibit 6-1 in Chapter 6 for outcrop locations. As noted above, the principal source of recharge to the aquifers is snowmelt and rainfall on outcrops. An examination of flow rate data from 14 springs monitored by U. S. Fuel since 1978 ~~(Tables 1 through 19 in Appendix 7-12)~~ indicate significant changes in seasonal flow rates which tend to substantiate this conclusion.

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[3] Seiler, R.L. and R.L. Baskin, Hydrology of Alkali Creek and Castle Valley Ridge Coal-Lease Tracts, Central Utah, and Potential Effects of Coal Mining, U.S.G.S. Report 87-4186, 1988, P. 30.

Ground water is encountered from time to time in the course of underground mining, possibly existing in perched aquifers. Usually, it occurs in the form of drippers or small steady trickles from the roof and floor. These generally tend to decrease and dry up as development advances. Large water flows have been encountered in the past, mainly due to contact with the Bear Canyon Fault, this water is likely associated with a large sandstone channel due to the fact that the age is more then 9,000 years. ~~which is a major water bearing structure~~. Old mine workings have contacted the fault at several points and this probably accounts for most of the mine water presently being discharged from the old Mohrland portal. Since the dip of the beds in this area is toward the southwest, all water encountered in mining tends to flow to the most southerly opening, the old Mohrland portal. The direction of the subsurface water flow is demonstrated by potentiometric surface of the perched aquifers, indicated by both the spring elevations and the dip of the formations in the southerly direction. A western development heading, which is now inaccessible in the King 4 mine, contacted the Bear Canyon fault at an elevation of about 8180 feet and exposed a water flow from the B seam floor averaging approximately 100 gallons per minute. A minor north trending fault zone with an offset of from 6 inches to 4 feet in the north western part of the King 4 mine (shown on Exhibit 6-1) contains numerous small water trickles where it was followed in the B seam at elevation 8400 for a distance of over 600 feet. The combined flow from these trickles amounts to less than 10 gallons per minute.

At the King 4 mine portal, water has been observed draining from the coal-roof interface of a rider seam above the B seam during years of high spring runoff.

During surface drilling programs conducted in 1976 and 1977, water was encountered in most of the 11 drill holes drilled at the elevation of about the base of the Flagstaff Limestone or top of the North Horn Formation. This particular horizon is usually a peril in surface drilling programs and was in this case also. The holes lost circulation at this level (about 300 ft. below the drill collar). No measurements of ground water flow or records of depth or quality were made at that time. No surface holes have been drilled since the eleven that were drilled prior to the Surface Mining and Reclamation Act.

No significant amount of information from mine workings concerning depths to ground water has been collected but some observations have been made. Mine workings in an east section of the King 4 mine intersected the lower portion of drill hole No. 13 which was drilled 950 ft. vertically from the surface on Gentry Mountain. A small trickle of water amounting to less than 1 gallon per minute is flowing from this hole. Numerous small diameter exploratory holes have been drilled from underground workings throughout the area. Most of these holes are now inaccessible and drill records show little or no data relating to ground water. Of the underground drill holes drilled since 1970, only two encountered appreciable water zones. Drill hole 72-8, approximately 1,500 ft. east of the Bear Canyon fault, was drilled vertically up for a distance of 93 ft. It is producing a water flow of 3 gallons per minute. Drill hole 77-1, approximately 1,000 ft. east of the Bear Canyon fault, was drilled vertically down for a distance of 118 ft. It is said to have produced a very small artesian flow, but is no longer accessible for observation. These drill holes are shown on Exhibit6-3, "Mine Workings and Drill Hole Map".

No prominent water bearing joint or fracture systems have been observed in the coal seams or overlying roof rock. Seepage occurs in the mine workings to a certain extent. This indicates that water does percolate down through the strata to some unknown degree. Joints and fractures within the coal and roof allow some water contained in the rock above to drain into the open workings. A sandstone roof would be the most permeable type of roof lending to moist conditions until the supply of water is exhausted, while shale and mudstone don't allow the percolation of water as easily. Joint and fracture patterns are most commonly observed in sympathetic orientation usually directly responding to extraneous elements imposed upon the coal seam (e.g. faults, horizontal off-set, channelization). The cleat orientation for the Gentry Mountain region appears to be N 73EW and from N 25EE to N 25E W. Jointing, where it can be observed, is approximately east-west and in some places inclined from 60E-70E to the south. This feature or its orientation has not been found to have any particular significance in relation to water infiltration of mine workings.

Mine water, ~~besides that used in King 4 for fire prevention and dust suppression,~~ flows southerly ~~away from active mining~~ and is presently discharged by gravity flow at the old Mohrland portal. A quantity of this water enters a 12 inch metal pipe and is diverted to a water tank on Miller Creek for culinary and industrial purposes at Hiawatha. The remainder of mine water flows into Cedar Creek. This mine water discharge (EPA Id. No. D001) along with in-mine monitoring at location UG-1 (shown on Exhibit6-3) will closely reflect the character of water encountered during mining operations. ~~Table 1 in Appendix 7-13 gives a summary of water quality data for point D001 for past years.~~

During the period of October 26 through October 28, 1983, hydrologists with Ford, Bacon and Davis Inc. conducted a spring inventory of the permit area and the surrounding region extending at least two ~~mines~~ miles from the boundary of the permit area. The purpose of this survey was to identify all seeps and springs within the study area and to determine selected characteristics of the seeps and springs (discharge, specific conductance, geologic conditions and signs of usage). Results of the inventory are tabulated in Table 7-1. Locations are shown on Exhibit 7-2. Due to the steep, often inaccessible and sometimes heavily overgrown nature of the study area, it is possible that a limited number of seeps and springs were not found during the survey. However, the data presented in Table 7-1 and Exhibit 7-2 are felt to be generally representative of local conditions.

Table 7-2 summarizes the data contained in Table 7-1 by geologic formation. More than 75 percent of the seeps and springs found during the survey issue from formations located stratigraphically above the coal bearing Blackhawk Formation. More than half of the seeps and springs were found issuing from the North Horn Formation occupying the ridges in the western portion of the permit area. Flow rates from springs issuing from these upper formations tend to vary between about 2 and 8 gallons per minute, with light to heavy usage by deer and cattle where accessible.

Approximately one-fifth of the seepage points found during the survey are located in the Blackhawk Formation. Flow rates at these points tend to be minimal, with seepage issuing predominately at the interface between sandstone and shale lenses. Usage is also minimal, due to the low flow rate and the general inaccessibility of the seeps. Below the Blackhawk

Formation, significant discharge rates are often encountered in springs issuing from the Star Point Sandstone. The larger springs are usually associated with fracturing and are probably related to the Bear Canyon fault zone.

Tables 7-3 and 7-4 list ground water rights and ownership for sources on and adjacent to the permit area. Their locations are shown on Exhibit 7-3. There are no wells in this area. U.S. Fuel's Hiawatha's approved groundwater monitoring plan is discussed under R645-301-731.200 later in this chapter. Springs selected for monitoring are shown on Exhibit 7-1 (General Surface and Groundwater Hydrology Map). Monitoring data is summarized in Appendix 7-12. Mine water discharge points are also identified on Exhibit 7-1. These points are covered by EPA NPDES Permit No. 0023094. Monitoring data for mine water discharges is given in Appendix 7-13.

On November 18, 2002 Robert Eccli, an engineer for U.S. Fuel Company from 1972 until it closed, was interviewed in order to determine the source of the flows from the Mohrland portal. According to Eccli in 1972 they encountered the Bear Canyon Fault in Area A shown on Exhibit 7-22 while mining the B-seam. When they hit the fault water started flowing up from the floor at a rate of 300 gpm. After a short while the flow decreased to approximately 100 gpm where it remained until monitoring discontinued due to the sealing of the portals. Once they hit the fault they started mining north and only encountered minor roof drippers and seeps producing less then 1 gpm of flow each. Although Area B on Exhibit 7-22, also located in the B-seam, was inaccessible at the time he started working he was told us that water had been flowing there when it was accessible. He also stated that in 1972 water was flowing south-west into the mine in Area C on Exhibit 7-22, located in the Hiawatha seam. This water was being pumped from this point down to the town of Hiawatha for use in the town. He stated that while there was no record of major sources of water flow encountered in the old mine workings they knew there was some minor sources and that the combination of these minor sources was responsible for the flows out of the Mohrland portal and that they did not expect this flow to decrease. As noted in R645-301-728 springs above these old workings have not changed since monitoring began.

Hiawatha Coal Company also feels that the source of the Mohrland flow is the combination of all the in mine flows since all mines have been connected and the coal seams slope down to the Mohrland area. The flows out of Mohrland represent the sum of all flows coming into the mine. The average flow of 400 gpm that has been reporting to the Mohrland portals is a minor amount when compared to the size of the mine. A comparison with the Co-Op Mine shows that while the Bear Canyon #1 Mine is less then 1/8$^{th}$ the size of the Hiawatha Mines it is producing more then 1/8$^{th}$ the amount of the flow coming out of the Mohrland portal. When looking at the fact that the water in the Bear Canyon #1 Mine comes from two major sources, both less then 50 gpm, and then several minor drippers and seeps it is easy to see that a flow of 400 gpm could be easily produced when feed by a major flow of 100 gpm and then multiply minor sources flowing from location throughout the entire mine. When compared to it's size the Hiawatha Mine Complex is in fact a very dry mine.

References


Bills, Tamara, 2000. Groundwater Flow Systems In The Star Point Sandstone Wasatch Plateau, Utah. Brigham Young University, Department of Geology. Orem, Utah.

Danielson, T.W., M.D. ReMillard, and R.H. Fuller, 1981. Hydrology of the Coal Resource Areas in the Upper Drainages of Huntington and Cottonwood Creeks, Central Utah. Water Resources Investigations 81-539. U. S. Geological Survey, Salt Lake City, Utah.

Geological Survey Water Supply Paper 2068, United States BLM and EPA, "Hydrologic Reconnaissance of the Wasatch Plateau-Book Cliffs Coal Fields Area, Utah"

Mayo and Associates, LC, Investigation of Groundwater and Surface-Water Systems in the C. W. Mining Company Federal Coal Leases and Fee Lands, Southern Gentry Mountain, Emery and Carbon Counties, Utah: Probable Hydrologic Consequences of Coal Mining in the Bear Canyon Mine Permit Area and Recommendations for Surface Water and Groundwater Monitoring, June 25, 2001.

Price, Don and K.M. Waddell, 1973, Selected Hydrologic Data in the Upper Colorado River Basin. Hydrologic Investigation Atlas HA-477. U.S. Geological Survey.

Seiler, R.L. and R.L. Baskin, 1988. Hydrology of Alkali Creek and Castle Valley Ridge Coal-Lease Tracts, Central Utah, and Potential effects of Coal Mining. Water Resources Investigations Report 87-4186. U. S. Geological Survey, Salt Lake City, Utah.

Stokes, W.L. and R.E. Cohenour, 1956. Geologic Atlas of Utah-Emery County. Bulletin 52. Utah Geological and Mineral Survey. Salt Lake City, Utah.

United States Department of the Interior, BLM, Uinta-Southwest Utah Coal Region, Round II Draft EIS.

Waddell, K.M., Pl Kay Contratto, C.T. Sumsion, and J.R. Butler, 1981, Hydrologic Reconnaissance of the Wasatch Plateau-Book Cliffs Coal-Fields Area, Utah. U.S. Geological Survey Water-Supply Paper 2068. Washington, D.C.

## Table 7-1

### Results of Spring Inventory Conducted On and Adjacent To U.S. Fuel's Permit In October, 1983

| LOCATION NUMBER | FLOW (gpm) | SPECIFIC CONDUCTANCE (umhos/cm @ 25° C) | GEOLOGIC CONDITIONS | SIGNS OF USAGE | COMMENTS |
|---|---|---|---|---|---|
| 15-7-11-1 | 1 | 260 | Steep slopes (base of Castlegate Sandstone) | Deer tracks | Chem date in WRI 81-539 |
| 11-2 | Seep | | At sandstone - Shale interface (base of Castlegate ss) | None | Dry |
| 11-3 | Seep | | At sandstone - Shale interface (in Blackhawk Formation) | None | |
| 11-4 | Seep | | In limestone (North Horn FM.) | None | |
| 15-7-12-1 | <1 | 260 | Base of limestone (North Horn FM.) | Deer tracks | Chem data in BDR 31 |
| 15-7-13-1 | 1 | 320 | Fractured sandstone within limestone (North Horn FM) | Developed with trough | |
| 13-2 | Seep | | In limestone (North Horn FM.) | None | |
| 13-3 | 4 | 320 | Fractured sandstone within limestone (North Horn FM) | Wildlife | |
| 13-4 | Seep | | In limestone (North Horn FM.) | Developed as pond. Cattle\deer tracks | |
| 13-5 | Seep | | In limestone (North Horn FM.) | Deer & cattle tracks | |
| 13-6 | | | In limestone (North Horn FM.) | Developed as pond. Cattle & deer tracks | |
| 14-7-14-1 | | | In limestone (North Horn FM.) | Deer & cattle tracks | |
| 15-7-14-2 | Seep | | In limestone (North Horn FM.) | Developed as pond. Cattle & deer tracks | No outflow |
| 14-3 | 7 | 380 | In limestone (North Horn FM.) | Deer & cattle tracks | Chem. data in WRI 81-539 |
| 14-4 | Seep | | In limestone (North Horn FM.) | Deer & cattle tracks | |
| 14-5 | Seep | | In limestone (North Horn FM.) | Deer tracks | |
| 14-6 | 8 | 320 | At base of resistance unit (North Horn FM.) | Fenced, developed | U.S.Fuel monitor- ing station SP-3 |
| 15-7-15-1 | 2 | 400 | In limestone (North Horn FM.) | Fenced, developed | Chem. data in BRD 31 & WRI 81-539 |
| 15-2 | Seep | | In limestone (North Horn FM.) | Deer & cattle tracks | |
| 15-3 | Seep | | In limestone (North Horn FM.) | Deer tracks | |
| 15-4 | Seep | | In limestone (North Horn FM.) | Deer tracks | |
| 15-5 | 2 | 540 | Base of limestone (North Horn FM.) | | Chem. data in |
| 15-6 | 4 | 480 | From fractured sandstone (Price River Fm) | Deer & cattle tracks | WRI 81-539 |
| 15-7 | 2 | 370 | At base of limestone (North Horn FM.) | Deer tracks | Chem. data in WRI 81-539 |

*** The spring names are based on the township, range, and section where the are located.**
**Example: The 3rd spring found in Township 15 S, Range 7 East, Section 15 is named 15-7-15-3.**

## Table 7-1 (Continued)

## Results of Spring Inventory Conducted On and Adjacent To U.S. Fuel's Permit In October, 1983

| LOCATION NUMBER | FLOW (gpm) | SPECIFIC CONDUCTANCE (umhos/cm @ 25° C) | GEOLOGIC CONDITIONS | SIGNS OF USAGE | COMMENTS |
|---|---|---|---|---|---|
| 15-7-22-1 | 1 | 430 | At sandstone-shale interface (Price River Fm.) | None | Chem. data in WRI 81-539 |
| 22-2 | 10 | 430 | Near base of sandstone (Price River Formation) | Deer & cattle tracks | |
| 22-3 | 12 | 390 | Near base of sandstone (Price River Formation) | Deer & cattle tracks | |
| 22-4 | Seep | | Fractured Sandstone (Castlegate sandstone) | Deer & cattle tracks | |
| 15-7-23-1 | Seep | | At sandstone - Shale interface (in Price River Fm.) | Deer & cattle tracks | Possible past development |
| 23-2 | Seep | | Near base of limestone (in North Horn Fm.) | None | |
| 23-3 | 5 | | Base of fractured sandstone (in Price River Fm.) | Deer & cattle tracks | Not sampled |
| 23-4 | Seep | | Near base of limestone (North Horn Formation) | Deer tracks | |
| 15-7-24-1 | Seep | | Fractured sandstone within limestone (North Horn Fm.) | Wildlife | Diffuse seepage |
| 24-2 | 8 | 340 | At base of steep slope (in North Horn Fm.) | Deer & cattle tracks | |
| 24-3 | 5 | 360 | In fractured limestone (North Horn FM.) | Deer & cattle tracks | |
| 24-4 | Seep | | Limestone slope (North Horn Fm.) | Deer tracks | Diffuse seepage |
| 15-7-25-1 | Seep | | Base of limestone (North Horn Fm.) | Deer tracks | |
| 25-2 | 8 | 540 | Near base of limestone (North Horn Fm.) | Deer & cattle tracks | Chem data in WRI 81-539 |
| 25-3 | 2 | | Near base of limestone (North Horn Fm.) | Deer tracks | Not sample |
| 25-4 | Seep | | Base of limestone (North Horn Fm.) | Deer tracks | |
| 15-7-26-1 | Seep | | Near base of limestone (North Horn Fm.) | None | |
| 26-~~1~~2 | 2 | 480 | Near base of limestone (North Horn Fm.) | Deer & cattle tracks | Chem data in WRI 81-539 |
| 26-3 | 5 | 500 | Near base of limestone (North Horn Fm.) | Deer tracks | Field data in WRI 81-539 |
| 26-4 | 15 | 460 | Near base of limestone (North Horn Fm.) | Deer & cattle tracks | Field data in WRI 81-539 |
| 15-7-27-1 | 29 | 440 | Base of limestone (North Horn Fm.) | Deer tracks | Chem data in WRI 81-539 |
| 27-2 | 11 | 310 | Base of limestone (North Horn Fm.) | Deer tracks | Field data in WRI 81-539 |
| 15-7-34-1 | Seep | | At sandstone-shale interface (Price River Fm.) | None | Diffuse seepage |
| 34-2 | Seep | | At sandstone-shale interface (Price River Fm.) | None | |

*** The spring names are based on the township, range, and section where the are located.**
**Example: The 3rd spring found in Township 15 S, Range 7 East, Section 15 is named 15-7-15-3.**

## Table 7-1 (Continued)

## Results of Spring Inventory Conducted On and Adjacent To U.S. Fuel's Permit In October, 1983

| LOCATION NUMBER | FLOW (gpm) | SPECIFIC CONDUCTANCE (umhos/cm @ 25° C) | GEOLOGIC CONDITIONS | SIGNS OF USAGE | COMMENTS |
|---|---|---|---|---|---|
| 15-7-34-3 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | Deer tracks | Diffuse seepage |
| 34-4 | 1 | 500 | At sandstone-shale interface (Blackhawk Fm.) | Deer & cattle tracks | |
| 34-5 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | In road cut |
| 34-6 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | In road cut |
| 15-7-35-1 | 5 | 410 | Fracture sandstone (Castlegate sandstone) | Cattle tracks | Chem data in WRI 81-539 |
| 35-2 | Un-known | 580 | Fractured sandstone (Blackhawk Fm.) | Developed, manhole & valve | Chem data in WRI 81-539 |
| 36-3 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | Deer tracks | |
| 15-7-36-1 | 1 | 340 | At sandstone lense in limestone (North Horn Fm.) | Deer tracks | |
| 36-2 | 5 | 410 | At sandstone lense in limestone(North Horn Fm.) | Deer & cattle tracks | |
| 36-3 | 5 | 320 | In limestone (North Horn Fm.) | Cattle tracks | |
| 15-8-7-1 | Seep | | Near Base of limestone (North Horn Fm.) | Deer & cattle tracks | |
| 7-2 | Seep | | Near Base of limestone (North Horn Fm.) | Deer tracks | |
| 15-8-7-3 | 5 | 350 | At base of limestone (North Horn Fm.) | Deer tracks | U.S.Fuel monitor ing station SP-14 |
| 7-4 | 2 | 330 | In limestone (North Horn Fm.) | Deer & cattle tracks | |
| 7-5 | Seep | | At sandstone-shale interface | None | |
| 15-8-17-1 | Seep | | At base of limestone (North Horn Fm.) | None | |
| 17-2 | 1 | 320 | Near base of limestone (North Horn Fm.) | Deer tracks | |
| 15-8-18-1 | 2 | 300 | At base of limestone (North Horn fm.) | Deer & cattle tracks | U.S.Fuel monitor ing station SP-1 |
| 18-2 | Seep | | At sandstone-shale interface (Price River Fm.) | Deer tracks | |
| 18-3 | Seep | | At sandstone-shale interface (Price River Fm.) | Deer tracks | |
| 18-4 | 2 | 350 | At base of limestone (North Horn Fm.) | Deer & cattle tracks | U.S.Fuel monitor ing station SP-2 |
| 18-5 | 5 | | Base of sandstone ledge (Castlegate sandstone) | None | Diffuse seepage |
| 15-8-19-1 | Seep | | At sandstone-shale interface (Price River Fm.) | None | |
| 19-2 | 4 | 480 | Fractured sandstone (Castlegate sandstone) | Some deer tracks | U.S.Fuel monitor ing station SP-11 |
| 15-8-19-3 | Seep | | At base of limestone (North horn Fm.) | None (inaccessible) | Not sampled |

*** The spring names are based on the township, range, and section where the are located.**
**Example: The 3rd spring found in Township 15 S, Range 7 East, Section 15 is named 15-7-15-3.**

## Table 7-1 (continued)

## Results of Spring Inventory Conducted On and Adjacent To U.S. Fuel's Permit In October, 1983

| LOCATION NUMBER | FLOW (gpm) | SPECIFIC CONDUCTANCE (umhos/cm @ 25° C) | GEOLOGIC CONDITIONS | SIGNS OF USAGE | COMMENTS |
|---|---|---|---|---|---|
| 19-4 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | | |
| 19-5 | 4 | 480 | At sandstone-shale interface (Castlegate sandstone) | Deer tracks | |
| 19-6 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 19-7 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 19-8 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | Some deer tracks | |
| 15-8-30-1 | 3 | 460 | In limestone above resistant layer (North Horn Fm.) | Developed | sampled at spring box |
| 30-2 | 2 | 490 | Base of sandstone ledge (Castlegate sandstone) | Deer tracks | |
| 30-3 | 1 | 520 | Base of sandstone ledge (Castlegate sandstone) | Deer tracks | |
| 30-4 | 8 | 530 | At base of sandstone (Castlegate sandstone) | Deer tracks | U.S.Fuel monitor ing station SP-12 |
| 30-5 | 5 | 470 | At base of sandstone, above claystone (Castlegate ss) | Deer tracks | |
| 30-6 | Seep | | Sandstone-shale interface (Blackhawk Fm.) | None | |
| 15-8-31-1 | <1 | 350 | In limestone below resistant layer (North Horn Fm.) | Developed with pond & trough | U.S.Fuel monitor ing station SP-4 |
| 3~~2~~1-2 | Seep | | In limestone (North Horn Fm.) | None | In roadway |
| 31-3 | <1 | 280 | In limestone (North Horn Fm.) | None | In roadway |
| 31-4 | 4 | 460 | Base of fractured sandstone (Castlegate sandstone) | Deer tracks | U.S.Fuel monitor ing station SP-13 |
| 31-5 | 2 | 640 | Base of fractured sandstone (Castlegate sandstone) | Developed | |
| 15-8-32-1 | <1 | 1030 | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 32-2 | 10 | 580 | From fractured sandstone (Star Point sandstone) | Deer tracks | |
| 16-7-1-1 | 5 | 400 | In limestone (North Horn Fm.) | Deer & cattle tracks | Chem data in WRI 81-539 |
| 1-2 | 5 | 380 | In limestone (North Horn Fm.) | Flows into stock pond | U.S.Fuel monitor ing station SP-7 |
| 1-3 | Seep | | In limestone (North Horn Fm.) | Livestock | fenced |
| 1-4 | Seep | | At base of resistant layer (North Horn Fm.) | Livestock | |
| 1-5 | 3 | 400 | At base of resistant layers (North Horn Fm.) | Deer tracks | Diffuse seepage |
| 16-7-2-1 | Seep | | In limestone (North Horn Fm.) | Deer & Cattle tracks | |

*** The spring names are based on the township, range, and section where the are located.**
**Example: The 3rd spring found in Township 15 S, Range 7 East, Section 15 is named 15-7-15-3.**

## Table 7-1 (Continued)

## Results Of Spring Inventory Conducted On And Adjacent To U.S. Fuel's Permit In October, 1983

| LOCATION NUMBER | FLOW (gpm) | SPECIFIC CONDUCTANCE (umhos/cm @ 25° C) | GEOLOGIC CONDITIONS | SIGNS OF USAGE | COMMENTS |
|---|---|---|---|---|---|
| 16-7-11-1 | <1 | 500 | At sandstone-shale interface (Price River Fm.) | Deer tracks | Diffuse seepage |
| 16-7-11-2 | 5 | 390 | From fractured sandstone in limestone (North Horn Fm.) | Deer tracks | Chem. data in WRI 81-539 |
| 11-3 | 3 | 390 | From fractured sandstone in limestone (North Horn Fm.) | Deer & cattle tracks | |
| 11-14 | 1 | 540 | Near base of limestone (North Horn Fm.) | Deer tracks | Field data in WRI 81-539 |
| 16-7-12-1 | Seep | | From sandstone (North Horn Fm.) | None | |
| 12-2 | 2 | 450 | From fractured sandstone (North Horn Fm.) | Deer tracks | |
| 12-3 | 1 | 420 | Base of resistant layers (North Horn Fm.) | Deer tracks, trails | Near surface displacement |
| 12-4 | Seep | | In limestone (North Horn fm.) | Deer tracks, trails | Diffuse seepage |
| 12-5 | 5 | 520 | In limestone (North Horn Fm.) | Deer tracks | Chem data in WARI 81-539 |
| 16-7-13-1 | 3 | 330 | Base of fractured limestone (North Horn Fm.) | Deer & cattle tracks | U.S.Fuel monitor ing station SP-9 |
| 13-2 | 2 | | At sandstone-shale interface (Price River Fm.) | None | Not sampled |
| 167-13-3 | 5 | 390 | From fractured sandstone above shale (Price River Fm.) | None | |
| 13-4 | Seep | | At sandstone-shale interface (Price River Fm.) | None | |
| 16-7-13-5 | Seep | | At sandstone-shale interface (Price River Fm.) | None | Diffuse seepage |
| 13-6 | Seep | | At sandstone-shale interface (Price River Fm.) | Deer tracks | Diffuse seepage |
| 13-7 | 10 | 360 | At sandstone-shale interface (Price River Fm.) | None | Sampled at bottom of main canyon |
| 13-8 | 8 | 310 | At sandstone-shale interface (Price River Fm.) | None | Sampled at bottom of main canyon |
| 13-9 | Seep | | At sandstone-shale interface (Price River Fm.) | None | |
| 13-10 | Seep | | At sandstone-shale interface (Price River Fm.) | None | |
| 13-11 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 13-12 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 13-13 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 13-14 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 16-7-13-15 | 3 | 490 | Base of limestone (North Horn Fm.) | Deer & cattle tracks | |

*** The spring names are based on the township, range, and section where the are located.**
**Example: The 3rd spring found in Township 15 S, Range 7 East, Section 15 is named 15-7-15-3.**

## Table 7-1 (continued)

## Results of Spring Inventory Conducted On and Adjacent To U.S. Fuel's Permit In October, 1983

| LOCATION NUMBER | FLOW (gpm) | SPECIFIC CONDUCTANCE (umhos/cm @ 25° C) | GEOLOGIC CONDITIONS | SIGNS OF USAGE | COMMENTS |
|---|---|---|---|---|---|
| 16-7-23-1 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 16-7-24-1 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 24-2 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 24-3 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | Diffuse seepage |
| 16-7-25-1 | Seep | | From fractured sandstone (Star point sandstone) | None | |
| 25-2 | Seep | | From fractured sandstone (Star point sandstone) | None | |
| 25-3 | <1 | 5470 | From bottom of channel (Mancos shale) | Deer tracks | Shale outcrops in channel downstream |
| 16-7-26-1 | >100 | 470 | From fractured sandstone (Star point sandstone) | Developed City water supply | Bear Canyon spring Data in WRI 81-539 |
| 26-2 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 26-3 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 26-4 | 8 | 730 | From fractured sandstone (Star point sandstone) | Deer tracks | Birch spring Data in WRI 81-539 |
| 16-7-26-5 | >50 | 750 | From fractured sandstone (Star point sandstone) | Deer tracks | Chem. data in WRI 81-539 |
| 16-8-5-1 | 3 | 450 | In limestone (North Horn Fm.) | Developed, with trough | U.S.Fuel monitor ing station SP-5 |
| 16-8-6-1 | 3 | 450 | Base of fractured sandstone (North Horn Fm.) | Deer & cattle tracks | U.S.Fuel monitor ing station SP-6 |
| 6-2 | Seep | | Base of resistant layer (North Horn Fm.) | None | |
| 6-3 | Seep | | From road cut (north Horn Fm.) | None | |
| 6-4 | Seep | | From road cut (north Horn Fm.) | None | |
| 6-5 | Seep | | From road cut (north Horn Fm.) | None | |
| 16-8-7-1 | Seep | | From road cut (Price River Fm.) | None | |
| 7-2 | 10 | 440 | From fractured sandstone (North Horn Fm.) | Deer & cattle tracks | |
| 16-8-8-1 | 5 | 560 | Fractured sandstone (Castlegate sandstone) | Deer tracks | |
| 8-2 | 7 | 640 | Fractured sandstone (Castlegate sandstone) | Deer tracks | Diffuse seepage in road cut |
| 8-3 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | In road cut |
| 16-8-8-4 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | In road cut |

*** The spring names are based on the township, range, and section where the are located.**
**Example: The 3rd spring found in Township 15 S, Range 7 East, Section 15 is named 15-7-15-3.**

## Table 7-1 (continued)

## Results of Spring Inventory Conducted on and Adjacent To U.S. Fuel's Permit In October, 1983

| LOCATION NUMBER | FLOW (gpm) | SPECIFIC CONDUCTANCE (umhos/cm @ 25° C) | GEOLOGIC CONDITIONS | SIGNS OF USAGE | COMMENTS |
|---|---|---|---|---|---|
| 8-5 | 6 | 730 | Colluvium overlying sandstone (Blackhawk Fm.) | Developed | U.S.Fuel monitor ing station SP-8 |
| 16-8-8-6 | Seep | | At sandstone-shale interface (Blackhawk Fm.) | None | In road cut |
| 16-8-9-1 | Seep | | Sandstone in road cut (Star Point Fm.) | None | |
| 16-8-17-1 | 5 | 500 | Near base of limestone (North Horn Fm.) | Deer & Cattle tracks | |
| 17-2 | 5 | 490 | Near base of limestone (North Horn Fm.) | Deer & Cattle tracks | |
| 16-8-18-1 | 3 | | Fractured limestone (North Horn Fm.) | Deer & Cattle tracks | Not sampled |
| 18-2 | 3 | 600 | Fractured limestone (North Horn Fm.) | Deer & Cattle tracks | Field data in WRI 81-539 |
| 18-3 | 9 | 520 | In limestone (North Horn Fm.) | Deer & Cattle tracks | Chem. data in WRI 81-539 |
| 16-8-19-1 | <1 | 570 | Base of fractured sandstone (Castlegate sandstone) | Deer tracks | Chem. data in WRI 81-539 |
| 16-8-20-1 | 3 | 700 | Base of limestone (North Horn Fm.) | Cattle tracks | U.S.Fuel monitor ing station SP-10 |
| 20-2 | Seep | | Near base of limestone (North Horn Fm.) | Deer tracks | |
| 16-8-21-1 | <1 | 2820 | At sandstone-shale interface (Blackhawk Fm.) | None | |
| 21-2 | 4 | 2630 | Fractured sandstone (Star Point sandstone) | Deer tracks | Field data in WRI 81-539 |
| 16-8-28-1 | 9 | 2230 | Base of sandstone (Star Point sandstone) | Developed, with trough | |
| | | | | | |

*** The spring names are based on the township, range, and section where the are located.**
**Example: The 3rd spring found in Township 15 S, Range 7 East, Section 15 is named 15-7-15-3.**

**Table 7-2**

**Summary of Spring Inventory Data**
**By Geologic Formation**

| Formation | Number Found | Percent of Total | Predominant Flow Rate |
|---|---|---|---|
| North Horn Fm. | 82 | 52 | 2-8 |
| Price River Fm. | 23 | 14 | 2-8 |
| Castlegate SS | 16 | 10 | 2-5 |
| Blackhawk Fm. | 28 | 18 | Seep |
| Star Point SS | 9 | 6 | 10-100 |
| Mancos Shale | 1 | <1 | Seep |

Table 7-3
Ground Water Rights in the Price River Basin Located on
and Adjacent To the Hiawatha Complex Permit Area

| W.U. Claim No. | Owner | Flow (CFS) | Use | Period of use | Source and Geologic Formation |
|---|---|---|---|---|---|
| 91-57 | Plateau Mining Company | 0.0055 | Domestic | Jan. 1 to Dec. 31 | Spring - Km |
| 91-59 | Plateau Mining Company | 0.0134 | Domestic | Jan. 1 to Dec. 31 | Spring - Ksp |
| 91-61 | Plateau Mining Company | 0.0042 | Domestic | Jan. 1 to Dec. 31 | Spring - Km |
| 91-103 | U.S Fuel Company | 0.3868 | Domestic | Jan. 1 to Dec. 31 | 6 Springs - Tw |
| 91-104 | U.S Fuel Company | 0.0877 | Domestic | Jan. 1 to Dec. 31 | 3 Springs - Tw |
| 91-174 | ~~U.S. Fuel Company~~ ANR Co. Inc | 3.3000 | Industrial | Jan. 1 to Dec. 31 | Tunnel - Kb |
| 91-251 | ~~U.S. Fuel Company~~ ANR Co. Inc | 0.9420 | Industrial | Jan. 1 to Dec. 31 | Tunnel - Kb |
| 91-316 | ~~U.S. Fuel Company~~ ANR Co. Inc | 0.0580 | Industrial | Jan. 1 to Dec. 31 | Tunnel - Kb |
| 91-837 | John Petitti | 0.0220 | Stockwater | May 1 to Oct. 31 | Spring - Kb |
| 91-839 | Victor Pierucci | 0.0150 | ~~Stockwater~~ Domestic | Jan. 1 to Dec. 31 | Well - Km |
| 91-840 | ~~Victor Pierucci~~ Carl & Amy Dees | 0.0150 | ~~Stockwater~~ Domestic | Jan. 1 to Dec. 31 | Well - Km |
| 91-841 | ~~Victor Pierucci~~ Carl & Amy Dees | 0.0110 | ~~Stockwater~~ Domestic | Jan. 1 to Dec. 31 | Spring - Km |
| 91-972 | U.S. Forest Service | 0.0150 | Stockwater | Jun. 15 to Oct 15 | Spring - Tw |
| 91-973 | U.S. Forest Service | 0.0150 | Stockwater | Jun. 15 to Oct 15 | Spring - Tw |
| 91-974 | U.S. Forest Service | 0.0150 | Stockwater | Jun. 15 to Oct 15 | Spring - Tw |
| 97-975 | U.S. Forest Service | 0.0150 | Stockwater | Jun. 15 to Oct 15 | Spring - Tw |
| 97-977 | U.S. Forest Service | 0.0150 | Stockwater | Jun. 15 to Oct 15 | Spring - Tw |
| 91-978 | U.S. Forest Service | 0.0150 | Stockwater | Jun. 15 to Oct 15 | Spring - Tw |
| 91-979 | U.S. Forest Service | 0.0150 | Stockwater | Jun. 15 to Oct 15 | Spring - Tw |
| 91-980 | U.S. Forest Service | 0.0150 | Stockwater | Jun. 15 to Oct 15 | Spring - Tw |
| 91-1067 | ~~Charles Kingston~~ U.S. Forest Service | ~~0.2500~~ 0.0150 | ~~Mining~~ Stockwater | Jan. 1 to Dec. 31 | Tunnel - Kb |
| 91-1633 | U.S. Forest Service | 0.0110 | Stockwater | Jun. 15 to Oct.15 | Spring - Tw |
| 91-1651 | Clifford & Hazel Smith | 0.0110 | Stockwater | Jan. 1 to Dec. 31 | Spring Qg & Km |
| 91-3231 | James Potter | 0.0150 | Stockwater | Jan. 1 to Dec. 31 | Well - Km |
| 91-3232 | James Potter | 0.0150 | Stockwater | Jan. 1 to Dec. 31 | Well - Km |
| 91-3233 | George Diamenti | 0.0150 | Stockwater | Jan. 1 to Dec. 31 | Well - Km |
| 91-3555 | Cyprus Plateau Mining Corporation | 0.91 | Unknown | Jan. 1 to Dec. 31 | Mine Workings |

Tw - North Horn Formation
Kp - Price River Formation
Kc - Castlegate Sandstone
Kb - Blackhawk Formaktion
Ksp - Starpoint Sandstone
Km - Masuk Shale
Qg - Gravel Deposits

## Table 7-4
## Ground Water Rights In the San Raphael Drainage Basin Located On and Adjacent To the Hiawatha Complex Permit Area

| W.U. Claim No. | Owner | Flow (CFS) | Use | Period of use | Source and Geologic Formation |
|---|---|---|---|---|---|
| 93-143 | ~~Peabody Coal Company~~ Nevada Power Co. | 0.011 | Stockwater | Jan. 1 to Dec. 31 | Spring - Ksp |
| 93-161 | ~~U.S. BLM~~ C.O.P. Development Co. | 0.011 | Stockwater | Jan. 1 to Dec. 31 | Spring - TW |
| 93-219 | Hutington-Cleveland Irrigation Company | 150 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 92-253 | Hutington-Cleveland Irrigation Company | 150 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-303 | Hutington-Cleveland Irrigation Company | 150 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-309 | Hutington-Cleveland Irrigation Company | 150 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-508 | ~~U.S. Fuel Company~~ ANR Co. Inc | 0.011 | Stockwater | Jan. 1 to Dec. 31 | Spring - TW |
| 93-509 | ~~U.S. Fuel Co.~~ C.O.P. Development Co. | 0.011 | Stockwater | Jan. 1 to Dec. 31 | Spring - TW |
| 93-510 | ~~U.S. Fuel Co.~~ C.O.P. Development Co. | 0.011 | Stockwater | Jan. 1 to Dec. 31 | Spring - TW |
| 93-511 | ~~U.S. Fuel Co.~~ C.O.P. Development Co. | 0.011 | Stockwater | Jan. 1 to Dec. 31 | Spring - TW |
| 93-1089 | ~~U.S. Fuel Company~~ ANR Co. Inc | ~~0.447~~ 0.3902 | Industrial | Jan. 1 to Dec. 31 | Mine Water |
| 93-1129 | ~~U.S. BLM~~ Utah State Lands | 0.007 | Stockwater | Jan. 1 to Dec. 31 | Spring - Ksp |
| 93-1425 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Ksp |
| 93-1426 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Kb |
| 93-1427 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1428 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Kc |
| 93-1429 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1430 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1431 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1432 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1433 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1434 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1435 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1436 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1437 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1438 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |

Tw - North Horn Formation
Kp - Price River Formation
Kc - Castlegate Sandstone
Kb - Blackhawk Formaktion
Ksp - Starpoint Sandstone
Km - Masuk Shale
Qg - Gravel Deposits

## Table 7-4 (Continued)
## Ground Water Rights In the San Raphael Drainage Basin Located On and Adjacent To the Hiawatha Complex Permit Area

| W.U. Claim No. | Owner | Flow (CFS) | Use | Period of use | Source and Geologic Formation |
|---|---|---|---|---|---|
| 93-1439 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1440 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1441 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1442 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1446 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1447 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1448 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1449 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1450 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1453 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1454 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1455 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1456 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1458 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1459 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1460 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1461 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1462 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1463 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1464 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| ~~6~~93-1465 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1466 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1467 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1468 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1469 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1470 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1471 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1472 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |

Tw - North Horn Formation
Kp - Price River Formation
Kc - Castlegate Sandstone
Kb - Blackhawk Formaktion
Ksp - Starpoint Sandstone
Km - Masuk Shale
Qg - Gravel Deposits

**Table 7-4 (Continued)**
**Ground Water Rights In the San Raphael Drainage Basin Located On and Adjacent To the Hiawatha Complex Permit Area**

| W.U. Claim No. | Owner | Flow (CFS) | Use | Period of use | Source and Geologic Formation |
|---|---|---|---|---|---|
| 93-1473 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1474 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1475 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1476 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1477 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1478 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1479 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Tw |
| 93-1491 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Kb |
| 93-1492 | U.S. Forest Service | 0.011 | Stockwater | Jun. 21 to Sep. 30 | Spring - Kb |
| 93-2190 | Hutington-Cleveland Irrigation Company | 45.00 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-2191 | Hutington-Cleveland Irrigation Company | 77.25 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-2192 | Hutington-Cleveland Irrigation Company | 80.00 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-2199 | Hutington-Cleveland Irrigation Company | 45.00 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-2200 | Hutington-Cleveland Irrigation Company | 77.25 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-2201 | Hutington-Cleveland Irrigation Company | 80.00 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-2202 | Hutington-Cleveland Irrigation Company | 45.00 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-2203 | Hutington-Cleveland Irrigation Company | 77.25 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-2204 | Hutington-Cleveland Irrigation Company | 80.00 | Irrigation | Mar. 2 to Nov. 14 | Spring - Ksp |
| 93-3047 | ~~U.S. BLM~~ Utah State Lands | 0.011 | Stockwater | Jan. 1 to Dec. 1 | Spring Km |

Tw - North Horn Formation
Kp - Price River Formation
Kc - Castlegate Sandstone
Kb - Blackhawk Formaktion
Ksp - Starpoint Sandstone
Km - Masuk Shale
Qg - Gravel Deposits

## 724.200 Surface Water Information

The eastern part of the Wasatch Plateau is part of the Colorado River Basin and is drained by small streams tributary to the Price, San Rafael, and Fremont Rivers, branches of the Green and Colorado Rivers. The west slope of the plateau, a smaller part of the total area, is drained by tributaries of the Sevier River, which flows into Sevier Lake, one of the numerous sinks of the Great Basin. The crest of the plateau is thus part of the divide between the Colorado Rover and The Great Basin (Spieker, 1931).

The Price River is the largest stream in the plateau and drains about 500 square miles in the northeastern part, rising in the general vicinity of Soldier Summit and Pleasant Valley, and flowing eastward through a narrow canyon in the plateau, across the northern part of Castle Valley and north of the Beckwith Plateau to its confluence with the Green River, about 14 miles north of the town of Green River. The Price River is normally a moderate sized stream, having a mean flow of about 200 second-ft. at Helper, where it emerges from its canyon in the plateau. In the early summer the flow usually reaches a maximum of 800 to 1,200 second-ft., but it varies from year to year, having an extreme recorded maximum of more than 8,000 second-ft. (Spieker, 1931). These conditions are due to the fact that the tributaries of Price River are snow fed, therefore, seasonal fluctuation of flow rates is great. Stream flows are greatest during late spring and early summer, decreasing to a minimum flow in early autumn through mid-winter.

Huntington Canyon is the next large stream south of the Price River. These two waterways are the immediate recipients of surface and groundwater discharge from the ~~U.S. Fuel~~ Hiawatha Coal Company property. Huntington Creek rises on the well-watered plateau surface, flows through a narrow, deep canyon toward the desert, and joins Cottonwood and Ferron Creeks to form the San Rafael River which eventually drains into the Green River. Its mean flow, measured near the mouth of the Huntington Canyon is normally about 100 second-ft., its maximum about 600, and its minimum about 30. It drains an area in the plateau of about 160 square miles. The Left Fork of Huntington Creek has been impounded at two places, and the reservoirs are used to equalize the seasonal flow of water for irrigation of Castle Valley in the vicinity of Huntington and Cleveland (Spieker, 1931). The Right Fork has been impounded at one location, to insure water supplies for irrigation and a steam-electric power plant. The main course of Huntington Creek in the plateau is about 30 miles long.

There are several small drainages discharging surface water from ~~U.S. Fuel~~ Hiawatha Coal Company's property. Miller Creek in the northern part of the property (Exhibit 7-1) is part of the Price River drainage system. It's main tributaries include North Fork (Right Fork on U.S.G.S. maps), Middle Fork and South Fork (left Fork on U.S.G.S. maps). The main artery of Miller Creek is a perennial stream and the tributaries, except the Left and Right Forks of North Fork are intermittent. Miller Creek flows just north of the town of Hiawatha into the bottom lands. Miller Creek is used for municipal, industrial and irrigation purposes.

Cedar Creek, with it's Left and Right Fork tributaries, is part of the San Rafael River system. Cedar Creek is a perennial stream. The remaining streams draining surface water from the ~~U.S. Fuel~~ Hiawatha Coal Company property are small and in the southern part of the property, thus they are all part of the San Rafael River drainage system. Ben Johnson, Chris Ottison Canyon and the Left and Right Forks of Fish Creek are ephemeral. Bear Creek Canyon and McCadden Hollow are intermittent. Gentry Hollow Creek is a tributary to Tie Fork and Huntington Creek which are also part of the San Rafael River system. Mine water generated in ~~U.S. Fuel's~~ Hiawatha's King mines is discharged from the King 2 mine portal in Cedar Creek Canyon. Part of this water is conveyed by pipeline to the town of Hiawatha and Hiawatha's ~~U.S. Fuel's~~ coal preparation plant and part is discharged into Cedar Creek. This discharge is covered by EPA discharge permit No. 0023094.

The mine plan areas are located in both Cedar and Miller Creek Canyons. ~~U.S. Fuel~~ Hiawatha Coal Company holds numerous water rights to surface water in these two canyons. A summary of surface water rights is presented in Table 7-5 (Price River basin) and Table 7-6 (San Raphael drainage basin).

A diversion dam in the left fork of the north fork of Miller Creek (Cert. No. 5294), as shown on Exhibit 7-1, is being used to divert water to an underground storage reservoir in the old Hiawatha NO. 2 mine. Water from this reservoir is pumped to a tank in the Middle Fork mine yard where it is used for culinary and mining purposes at the King 4 and 5 mines. Water leaving the mine plan area via Miller and Cedar Creeks is used for irrigation and stock watering purposes at the Millerton and Cedar Creek Ranches, ~~both of which are owned by U.S. Fuel Company~~.

Surface water quality and quantity are monitored at several sites throughout the permit area. These sites are identified on Exhibit 7-1 and discussed in the surface water monitoring section of this chapter. Monitoring data collected ~~over the past 10 years is given in Appendix 7-14~~ can be found on the Divisions database.

**Table 7-5**

**Surface Water Rights In the Price River Basin Located On and Adjacent To the Hiawatha Complex Permit Area**

| W.U. Claim No. | Owner | Flow (CFS) | Use | Period of use | Source |
|---|---|---|---|---|---|
| 91-174 | ~~U.S. Fuel Company~~ ANR Co. Inc | 3.3 | Industrial | Jan. 1 to Dec. 31 | Right Fork of Miller Creek |
| 91-347 | George S. Diamenti | - | Stockwater | Jan. 1 to Dec. 31 | Stream |
| 91-838 | John J. Petitti | - | Stockwater | Jan. 1 to Dec. 31 | Mud Water Cyn. Creek |
| 91-981 | U.S. Forest Service | - | Stockwater | Jan. 1 to Dec. 31 | Right Fork of Miller Creek |
| 91-982 | U.S. Forest Service | - | Stockwater | June 15 to Oct. 15 | Right Fork of Miller Creek |
| 91-983 | U.S. Forest Service | - | Stockwater | Jan. 1 to Dec. 31 | Seeley Canyon Creek |
| 91-984 | U.S. Forest Service | - | Stockwater | June 1 to Oct. 15 | South Fork of Corner Canyon |
| 91-1156 | ~~Victor Pierucci~~ Carl & Amy Dees | - | Stockwater | Jan. 1 to Dec. 31 | Miller Creek |
| 91-1157 | Victor Pierucci | - | Stockwater | Jan. 1 to Dec. 31 | Miller Creek |
| 91-1634 | ~~U.S. Fuel Company~~ Phillips Petroleum Co. | - | Stockwater | Jan. 1 to Dec. 31 | Miller Creek |
| 91-2402 | ~~U.S. BLM~~ Utah State Lands | - | Stockwater | Jan. 1 to Dec. 31 | Miller Creek |
| 91-3079 | Utah State Lands | - | Stockwater | Jan. 1 to Dec. 31 | Mud Water Creek |
| 91-3162 | Utah State Lands | - | Stockwater | Jan. 1 to Dec. 31 | Washboard Wash |
| 91-3229 | James Potter | - | Stockwater | Jan. 1 to Dec. 31 | Washboard Wash |
| 91-3230 | James Potter | - | Stockwater | Jan. 1 to Dec. 31 | Washboard Wash |
| 91-3333 | ~~U.S. Fuel Company~~ ANR Co. Inc | - | Stockwater | Jan. 1 to Dec. 31 | Left Fork of Miller Creek |
| 91-3763 | ~~U.S. Fuel Company~~ ANR Co. Inc | - | Stockwater | Jan. 1 to Dec. 31 | Miller Creek |

# Table 7-6

## Surface Water Rights In the San Rafael Drainage Basin Located On and Adjacent To the Hiawatha Complex Permit Area

| W.U. Claim No. | Owner | Flow (CFS) | Use | Period of use | Source |
|---|---|---|---|---|---|
| 93-119 | U.S. Forest Service | - | Stockwater | June 21 to Sept. 30 | Little Park Canyon Creek |
| 93-120 | U.S. Forest Service | - | Stockwater | June 21 to Sept. 30 | Little Park Canyon Creek |
| 93-134 | U.S. Forest Service | - | Stockwater | June 21 to Sept. 30 | Tie Fork Canyon Creek |
| 93-135 | U.S. Forest Service | - | Stockwater | June 21 to Sept. 30 | Wild Cattle Hollow |
| 93-136 | U.S. Forest Service | - | Stockwater | June 21 to Sept. 30 | Gentry Hollow |
| 93-137 | U.S. Forest Service | - | Stockwater | June 21 to Sept. 30 | Jack's Hole Creek |
| 93-138 | ~~Peabody Coal Co.~~ Nevada Power Co. | - | Stockwater | Jan. 1 to Dec. 31 | Trail Canyon Creek |
| 93-139 | U.S. Forest Service | - | Stockwater | June 21 to Sept. 30 | Trail Canyon Creek |
| 93-140 | Utah State Lands | - | Stockwater | Jan. 1 to Dec. 31 | Trail Canyon Creek |
| 93-141 | ~~Peabody Coal Co.~~ Nevada Power Co. | - | Stockwater | Jan. 1 to Dec. 31 | McCadden Hollow |
| 93-142 | U.S. Forest Service | - | Stockwater | June 21 to Sept. 30 | McCadden Hollow |
| 93-148 | U.S. BLM | - | Stockwater | Jan. 1 to Dec. 31 | Bear Creek |
| 93-149 | ~~Peabody Coal Co.~~ Nevada Power Co. | - | Stockwater | Jan. 1 to Dec. 31 | Bear Creek |
| 93-150 | Nevada Power Co. | - | Stockwater | Jan. 1 to Dec. 31 | Bear Creek |
| 93-157 | AU Mines Inc. | - | Stockwater | May 16 to Oct. 15 | Right Fork of Fish Creek |
| 93-158 | ~~U.S. Fuel Co.~~ C.O.P. Development Co. | - | Stockwater | Jan. 1 to Dec. 31 | Right Fork of Fish Creek |
| 93-160 | ~~U.S. Fuel Co.~~ C.O.P. Development Co. | - | Stockwater | Jan. 1 to Dec. 31 | Right Fork of Fish Creek |
| 93-163~~*~~ | ~~U.S. Fuel Co.~~ C.O.P. Development Co. | - | Stockwater | Jan. 1 to Dec. 31 | Left Fork of Cedar Creek |
| 93-164 | ~~U.S. Fuel Co.~~ ANR Co. Inc. | - | Stockwater | May 16 to Oct. 15 | Right Fork of Cedar Creek |
| 93-166 | U.S. Forest Service | - | Stockwater | June 21 to Sept. 30 | Left Fork of Fish Creek |
| 93-167 | ~~U.S. Fuel Co.~~ C.O.P. Development Co. | - | Stockwater | Jan. 1 to Dec. 31 | Left Fork of Fish Creek |
| 93-512 | ~~U.S. Fuel Co.~~ ANR Co. Inc. | - | Stockwater | Jan. 1 to Dec. 31 | Ben Johnson Creek |
| 93-513 | ~~U.S. BLM~~ Utah State Lands | - | Stockwater | Jan. 1 to Dec. 31 | Ben Johnson Creek |
| 93-514 | ~~U.S. Fuel Co.~~ C.O.P. Development Co. | - | Stockwater | Jan. 1 to Dec. 31 | Ben Johnson Creek |
| 93-516 | ~~U.S. Fuel Co.~~ ANR Co. Inc. | - | Stockwater | Jan. 1 to Dec. 31 | Cedar Creek |
| 93-517 | Keith & Joyce Larsen | - | Stockwater | Jan. 1 to Dec. 31 | Cedar Creek |
| 93-519 | Triole Salvatore | - | Stockwater | Jan. 1 to Dec. 31 | Cedar Creek |
| 93-522~~*~~ | ~~U.S. Fuel Co.~~ Intermountain Power | 0.5 | Industrial | Jan. 1 to Dec. 31 | Left Fork of Cedar Creek |
| 93-1128 | ~~U.S. BLM~~ Utah State Lands | - | Stockwater | Jan. 1 to Dec. 31 | Cedar Creek |
| 93-1182 | Peabody Coal Company | - | Stockwater | Jan. 1 to Dec. 31 | Bear Creek |

~~* Right Conveyed To Intermountain Power in 1986~~

**724.300 Geologic Information**

Geologic information for use in determining the probable hydrologic consequences of mining operations upon the quality and quantity of surface and ground water, whether reclamation can be accomplished, and whether the proposed operations have been designed to prevent material damage to the hydrologic balance outside the permit area is discussed in detail in Chapter 6 Geology (R645-301-624) and under numerous headings in this chapter.

**724.400 Climatologic Information**

The climate ~~of U.S. Fuel's permit area~~ at Hiawatha is typical of other canyon regions of Central Utah. A historical review of the relatively large mountainous region suggests that climatic averages will be influenced by the variations of topography. Consequently, the variability within the region is defined as adequately as possible.

Temperature patterns change along with the seasonal transitions. The shorter summers result in a temperature range of 85 degrees F maximum to 40 degrees F minimum. Winter months usually encounter more severe temperature ranges with an average around 25 degrees F and extremes as low as -15 degrees F, depending on severity of conditions.

Average precipitation readings are usually 12 inches annually with the maximum precipitation totals rarely occurring in the same month throughout the years. Precipitation averages will occasionally fluctuate heavily due to the occurrence of a drought in the area, however, this usually only happens once every five years. Effects of evapo-transpiration are in a range of 18 to 22 inches annually, depending on the relative location.

Relative humidity data for the area is limited to an environmental statement from the Emery Power Plant. Overall analysis shows the winter maximums at 75 percent, with the summer minimums approximately 40 percent, which makes the yearly average around 55 percent.

Air circulation in the canyon regions varies with local slope winds which occur because of pressure and temperature differentiation along the mountain sides. General wind directions over a broader region are from the north-northeast in the winter months and south-southwest in the summer. Conditions throughout the mining region are directly affected by the orographic barriers in the canyons. Consequently, local and regional conditions will be determined by the diverse topography.

**Precipitation**

The principal inflow of moisture into the Western United States that produces the noticeable amounts of precipitation may vary with summer and winter months. During the warm summer months precipitation is generally associated with an influx of air masses that originate in the Gulf of Mexico and flow in from the south-southwest. The overall climate is arid with precipitation ranging 12 to 15 inches annually.

Warm, moist air and higher temperatures generate a potential for convective rain shower activity. Storms of this nature are usually short in duration and release a varied amount of precipitation, depending on the potential of evapotranspiration. These conditions generally peak in the months of July and August.

Winter precipitation originates from moisture inflow of Polar air masses that move from the Pacific northwest. Moist air ascends and cools along the mountains windward side and releases the majority of the moisture. On the leeward side of the mountain the air descends, becoming warmer and will result in less precipitation due to the lack of available moisture.

Snowfall may occur from November to April, with a range of 20 to 30 inches annually. Depth will vary from year to year, depending on the available amount of moisture in the air.

**Temperature**

The temperature pattern in the area is directly related to the diverse topography. The average annual temperature is usually around 45 degrees F with annual temperatures varying in any given year. A weather station has been located at Hiawatha since 1915 in which monthly precipitation and temperature readings have been recorded by ~~U.S. Fuel~~ Hiawatha Coal Company and relayed to the U.S. National oceanic and Atmospheric Administration (NOAA) in Asheville, North Carolina. Manual recording was discontinued in 1985 when the National Weather Service installed an automated system near Hiawatha which samples and radio transmits data via satellite.

High temperatures for the summer range from 70 to 75 degrees F, while the winter temperatures experience lows ranging from 15 to 20 degrees F. These temperatures vary depending on location above or inside the canyons.

Temperature extremes occur in both summer and winter months. Temperatures as low as -15 degrees F could be encountered between the months of November through March. Record high temperatures of as much as 95 degrees F have been recorded in the months of May through September.

**Evaporation**

Water loss through means of evaporation and transpiration ranges from 20 to 24 inches annually, depending on location. Annual amounts of evapotranspiration are determined by the amount of evaporation and transpiration that could take place, provided plants, water bodies, and soils never experience water shortages. The amount of evapotranspiration indicates that more moisture is lost through vaporization than gained by precipitation within one year.

**Relative Humidity**

Information about relative humidity within the area is limited. A study made by Utah Power & Light Company during a 16 month period provides ample data for an estimation of an average humidity reading. The summer minimum is about 40 percent, with winter maximums approximately 75 percent. Annually the relative humidity averages about 55 percent. Seasonal variations of "dew point" temperatures range from around 10 degrees F in the winter to 35 degrees F in late summer, with a yearly average of 25 degrees F. Rapid loss of heat by radiation cooling causes humidity readings to be greater at night than during the day. Due to low amounts of rainfall in the area, the amount of water vapor added by evapo-transpiration is also limited.

**Wind**

Patterns of air movements in the area are difficult to describe due to the absence of wind records. General observations, however, can adequately describe the characteristics of air flow. Local winds or slope winds associated with the mountainous terrain constitute the immediate air flow. On calm, clear nights, rapid loss of heat by ground radiation produces a layer of dense, cold air near the ground. A combination of differences and gravity causes a drainage of cold air downslope into the canyons (katabatiac winds) with a slight return of air circulation aloft.

Depending on conditions, these winds can occur both day and night. Shaded upper slopes during the day can produce the same air flow. Upper slopes heated by insulation causes the winds to reverse direction and move upslope (anabatic winds). This flow pattern is most common during the dry summer months because of the lack of snow cover.

Wind data compiled by Utah Power & Light Company present a general analysis of the area airflow. Winds tend to move predominantly from the north to northwest at about 3 to 5 miles per hour in the fall, winter and early spring. However, in late spring and summer they move from the south to southwest with speeds of 8 to 12 miles per hour. Wind speeds overall have reached maximum proportion at 30 miles per hour. Surface winds are usually moderate most of the year, with stronger winds occurring during the spring. When local thunderstorms take place, a much stronger (plow wind) is likely to occur. Blizzard conditions commonly produce strong winds in the area that are also of the katabatic nature.

### 724.500 Supplemental Information

Rule R645-301-728 later in this chapter discusses the probable hydrologic consequences of existing and proposed mining operations.

### ~~724.600 Survey of Renewable Resource Lands~~

~~During the period of October 26 through October 28, 1983, hydrologists and geotechnical personnel with Ford, Bacon and Davis Inc. conducted a spring inventory and survey of renewable resource lands for the purpose of identifying aquifers and potential damage to aquifers which may result from subsidence. The results of their findings are given below.~~

~~**Potential Water Bearing Zones**~~

~~Lithologic logs obtained during exploratory drilling on the permit and adjacent areas are restricted to the lower Blackhawk Formation, within the coal measures. Hence, subsurface information from stratigraphically higher zones is lacking. Nonetheless, data obtained from field investigations and derived from analyses and interpretations of the available drill hole logs indicate that approximately four potential water bearing units exist beneath the uppermost coal seams in the general area of the Hiawatha Mine Complex. Cross sections containing selected drill hole logs are contained in Exhibits 7-5 and 7-6. Refer to Exhibit 7-1 for the locations of the cross sections. Cross sections were constructed at the identified locations so as to utilize surface drill hole information which give the greatest vertical range of available lithologic information. Unfortunately, no ground water information was recorded during the surface drilling operations. It should be noted, however, that many of the holes are said to have lost circulation in a zone approximately 300 feet below the drill collar.~~

~~In examining cross sections A-A and B-B it is apparent that the stratigraphic units of the Blackhawk Formation, within the boundaries formed by the overlying Castlegate Sandstone (Price River Formation) and underlying Star Point Sandstone (Mesa Verde Group), are discontinuous in their thickness, lithology and spatial extent. In cross section B-B, three sandstones identified as units A, B and C appear to be relatively consistent. However, in cross section A-A, the profile of the stratigraphic units have altered dramatically in their thickness, stratigraphy, lithology and spatial extent. Between the sandstone units of the Blackhawk Formation identified in Exhibits 7-5 and 7-6 are thick shale units and thin, discontinuous sandstone and coal units. The fourth potential water-bearing zone is the Star Point Sandstone that underlies the Blackhawk Formation.~~

~~A significant factor affecting the ability of any of the sandstone units of the Blackhawk Formation to transmit appreciable amounts of water is the presence of intercalated clay-stone and siltstone layers within the~~

massive sandstones. These claystones and siltstones are very thin bedded and were encountered in the core of each drill hole.

The Blackhawk Formation was deposited in a sedimentary environment associated with coastal lagoons, floodplains, and swamps. Therefore, the physical and chemical characteristics of the deposits were readily influenced by climatic conditions and changing landforms. The effects of seasonal changes and storm events can easily be noted in the present stratiagraphy. As such, lithologies, bedding features, and the spatial extent of the units tend to change very rapidly. In a coastal lagoon environment containing large rivers and swamps, a single storm event could spread sand over the floodplain, extending partially into the lagoon. Further out into the lagoon, the slower flows could be expected to deposit silt-sized materials. Only the higher slow moving floodwater containing suspended clays would enter swamps. Such a storm event may have left several feet of sediments. Similar occurrences apparently formed the Blackhawk Formation.

Based on a study of the drill hole logs and the cross sections, the three sandstone units in the Blackhawk formation which have characteristics normally associated with good aquifers have spatial characteristics that are so limited and discontinuous as to preclude them from significance as aquifers. Field investigations associated with the spring inventory confirm this, as only limited seepage was found issuing from the Blackhawk Formation. This seepage was confined to sandstone units immediately overlying a shale or claystone unit. The low seepage rates suggest only limited recharge.

Beneath the Blackhawk Formation, the Star Point Sandstone is regionally extensive. This formation has the characteristics of a good aquifer and yields relatively large quantities of water (50 to 100 gpm or greater) to springs in the area associated with fractures.

Above the Blackhawk Formation, the Castlegate Sandstone and North Horn Formation appear to be relatively good aquifers. Where fractured, the Castlegate Sandstone yields up to about 5 gpm to individual springs. Yields up to about 10 gpm are encountered in the North Horn Formation, although fracturing does not appear to be a dominant factor in flow rates and points of issuance.

As with the Blackhawk Formation, surface exposures of the Price River Formation suggest that the latter consists of interbedded sandstone, claystones, and shales. Yields from springs in the Price River Range up to 10 gpm, mostly from the upper portions of the formation near the contact with the overlying North Horn Formation.

Information collected during the spring inventory suggests that fracturing plays an important role in the occurrence of springs in the Castlegate and Star Point Sandstones and a minor role in the North Horn and Price River Formations. In most cases, springs from the Castlegate and Star Point Sandstones issue near the base of the formations, where fractured sandstones overlie a claystone or shale. The fracture, therefore, serves as a conduit, with the underlying claystone or shale inhibiting a significant amount of downward movement from the fracture to lower rock units.

Fracturing was also noted as a control for some springs issuing from the North Horn and Price River Formations. Again, claystone or shale units were often found underlying the fracture and acting as the lower limit of the fracture conduit along which water was flowing.

No fracture controlled seeps or springs were found issuing from the coal-bearing Blackhawk Formation. Instead, seeps and springs within this formation were found issuing from the base of sandstone units overlying shale layers. Hence, fracturing of the Blackhawk Formation does not appear to convey groundwater to the surface.

Major fracturing in the area trends primarily north-south, paralleling the Bear Canyon Fault. A geologic map prepared by Waddell et al. (1981) indicates that the Bear Canyon fault is near the eastern edge of the Fault Zone, which a fault zone that extends from the southern half of T.17 S., R.7 E. northward through Pleasant Valley to Scofield Reservoir. Hence, all fracturing noted in relation to the springs is assumed to be part of the Bear Canyon Fault Zone or one of the companion fault zones.

A survey was conducted in the King 4 mine to determine the extent of inflow to the mine along the Bear Canyon Fault and other sources. Surveys could not be conducted in older mine workings since they are permanently sealed. The King 5 Mine is essentially dry (containing only a few low-yield roof drippers) and, hence, was not surveyed. In addition, roof stability problems in the King 6 mine makes access hazardous. Thus, the in-mine seepage survey was confined to the King 4 mine.

Five points of inflow greater than 1 gpm were found in the mine. Three of these originated from the floor of the mine through fractures or the Bear Canyon Fault, one originates from the roof through a fracture near the northern-most portion of the mine and one originates behind a seal in a fully extracted section of the mine. Prior to placing the seal on the fully extracted section, inflow to this section issued primarily from the floor.

Except for the fracture in the northern portion of the mine, inflow appears to come primarily through fractures in the floor. This suggests that recharge to the fault zone is not from directly above the mine but probably from the area located north and up dip from the mine workings.

Within the mine, approximately 35 gpm of the water discharging from the Bear Canyon Fault and associated fractures is consumed by in-mine water supply uses. Flows in excess of the in-mine requirements and the ventilation evaporation losses (Given in Appendix 7-1) eventually discharge at the old Mohrland portal to Cedar Creek or are used by U.S. Fuel Company as an industrial and domestic supply in the town of Hiawatha.

An accessible in-mine flow, identified as UG-1 and shown on Exhibit 6-3, will be monitored for quality, quantity and seasonal variation (see 731.200, "Ground Water Monitoring Plan"). Due to the dip of the beds, monitoring the flow at this location will reflect the cumulative result of all sources originating in U. S. Fuel's mine workings north of the 10 West and 10 East sections. Currently (June, 1992) this flow amounts to approximately 22 gpm.

Beneath the mine workings, groundwater traveling along the Bear Canyon Fault within the Star Point Sandstone discharges at Bear Canyon Spring and other nearby springs. In addition, due to the outcropping of the Mancos Shale in the bottom of Huntington Creek immediately upstream from Bear Canyon, fracture-related groundwater in the Star Point Sandstone that does not discharge at springs is assumed to discharge directly into Huntington Creek. Data provided by Danielson et al. (1981) suggest that the discharge from the Star Point Sandstone to springs average approximately 210 gpm.

It is uncertain whether Additionally that portion of the Bear Canyon Fault encountered in the Blackhawk Formation (i.e., within the mines) is not hydraulically connected to that portion which exists in the Star Point Sandstone. However, the shales of the Blackhawk Formation that underlie the coal seams and overlie the Star Point Sandstone should minimize the extent of the hydraulic connection. As was noted previously, water in the area that issues from fractured sandstones does not appear to percolate significantly into underlying claystones or shales. Instead, all water appears to issue above the impermeable layers. Hence, fracture-controlled groundwater flow probably does not migrate significantly into surrounding claystones and shales, suggesting that water encountered in fractures within the mines is at least partially isolated from that contained in the Star Point Sandstone.

Preliminary data collected from cores of the Blackhawk Formation obtained from section 27, T.17 S., R.6 E. (Greg Lines, U.S. Geological Survey, personal communications, October 31, 1983) indicate that horizontal and vertical laboratory hydraulic conductivities of the shale layers within the Blackhawk vary from $1 \times 10^{-8}$ ft./day to impermeable (even at a pressure of 5,000 pounds per square inch). Sandstone layers within the Blackhawk Formation, however, had average horizontal and vertical laboratory hydraulic conductivities of $1.3 \times 10^{-2}$ ft./day and $3.8 \times 10^{-3}$ ft./day respectively. The laboratory hydraulic conductivity of the Star Point Sandstone was found to be similar to that of the sandstone units in the Blackhawk Formation. These data confirm the impermeable nature of the shales compared to the sandstones of the Blackhawk Formation. In addition to the relative impermeability of the unfractured shales, the bentonitic nature of the Blackhawk Formation shales (Stokes and Cohenour, 1956) tends to result in a sealing of the fractures within the shales. Hence, to some degree, groundwater traveling along the Bear Canyon Fault within the Blackhawk Formation is probably hydraulically isolated from sandstone.

Ground water quality in this area is generally good. Appendix 7-12 gives U.S. Fuel Company's quantity and quality data for 14 springs in and near the mine plan area. The locations of these springs are shown on Exhibit 7-1. They were selected as hydrologic monitoring points because of their representative location with respect to mine workings. Most of them had some flow during the drought year of 1977. Some springs have been developed with troughs and small impoundments to facilitate livestock and wildlife watering.

References


Danielson, T.W., M.D. ReMillard, and R.H. Fuller, 1981, Hydrology of the CoalResource Areas in the Upper Drainages of Huntington and Cottonwood Creeks, Central Utah. Water Resources Investigations 81-539. U.S. Geological Survey Salt Lake City, Utah.

Stokes, W.L. and R.E. Cohenour, 1956. Geologic Atlas of Utah-Emery County. Bulletin 52. Utah Geological and Mineral Survey. Salt Lake City, Utah.

Waddell, K.M., P. Kay Contratto, C.T. Sumsion, and J.R. Butler, 1981. Hydrologic Reconnaissance of the Wasatch Plateau-Book Cliffs Coal Fields Area, Utah. U.S. Geological Survey Water Supply Paper 2068. Washington, D.C.

Wardell, K.M., H.L. Vickers, R.T. Upton, and P.K. Contratto, 1978. Selected Hydrologic Data, 1931-77, Wasatch Plateau-Book Cliffs Coal Fields Area, Utah. Utah Basic Data Release No. 31. Utah Department of Natural Resources, Division of Water Rights, Salt Lake City, Utah.


**Areas of Potential Subsidence**

To estimate the effects of subsidence on the hydrologic regime of the permit and adjacent areas, a limit angle of 70 degrees from horizontal was assumed. The selection of this limit angle is from geologically similar areas in the Book Cliffs Mining District, Utah and the Somerset Mining District, Colorado. Limit angles in these districts varied from 69 degrees in weak overburden to 75 degrees or more in moderately strong overburden relative to the position of the room-and-pillar retreat line. Using the assumed limit angle of 70 degrees, the relationship presented in Figure 7-1 was developed.

Unless pillars are pulled and a section of the mine is fully extracted, conventional room-and-pillar coal mining methods do not generally result in surface subsidence if the pillars are adequately stable. Mining within that portion of the King 5 Mine that overlies the old Hiawatha No. 1 Mine has shown that subsidence should not occur above old room-and-pillar workings within the lease area where the pillars have been left in place. The King 5 Mine is separated from the underlying Hiawatha Mine by approximately 120 feet of innerburden. Most pillars were left in place in the Hiawatha Mine at the completion of mining. Subsequent mining in the overlying King 5 Mine has shown none of the compression or tension effects that cause subsidence.

As a result, it is assumed that subsidence effects in the lease area will be confined to those areas within the limit angles overlying the fully-extracted sections of the mines. Exhibit 7-7 shows the vertical projections of those areas that have been fully extracted within the past ten years and that may be fully extracted during the remaining life of the mines. Also included on this exhibit are areas surrounding the vertical projections that include the limit angle (using the relation given in Figure 7-1). It is emphasized that these are zones where subsidence may potentially occur. Hence, an examination of these broad areas should give a conservative estimate of impacts.

When the term "fully extracted" is used herein, it should be noted that barrier pillars will be left in the King Mines between extracted panels. On the average, panels will be approximately 500 feet wide, with barrier pillars averaging 150 feet in width.

At the Belina Mines (located about 15 miles northwest of Hiawatha), visible subsidence effects (primarily cracks and sinkholes) are limited to areas within the Blackhawk Formation where overburden thicknesses are 400 feet or less (Valley Camp of Utah, Inc., 1983). At the Star Point Mines, located immediately northeast of the U.S.

Fuel Company lease area, visible subsidence effects have been noted in overburden ranging in thickness up to 500 feet (Plateau Mining Company, 1981). These effects are limited to linear cracks.

Noticeable subsidence effects attributed to mining at the Gordon Creek Mines (located approximately 11 mines northwest of Hiawatha) have been limited to overburden thicknesses of 200 feet or less (Dan Guy, Beaver Creek Coal Company, Price, Utah, personal communication, 1983). Where mining extended below the perennial Beaver Creek in 1976, no inflow of surface water to the mine has been noted even though pillars were pulled. Overburden in this location averages approximately 800 feet thick.

A detailed subsidence investigation conducted above the Utah Power and Light Company mines (13 miles southwest of Hiawatha) where the longwall mining method is used has indicated that the visible effects of subsidence are limited to cracks that form within and below the cliff-forming Castlegate Sandstone and Price River Formation (Utah Power and Light Company, 1982). Overburden in these areas reaches thicknesses of 800 to 1200 feet. No hydrologic impacts have been discovered within this zone. Above the Castlegate Sandstone and Price River Formation, (i.e., in the North Horn Formation) no visual subsidence effects have been noticed. However, survey data indicate that subsidence troughs have developed (Utah Power and Light Company, 1981, 1982). These troughs are elliptical and broad, sometimes covering tens of acres. Maximum subsidence within these troughs normally ranges from 2 to 4 feet. Slopes along the edges of the troughs are shallow, with maximums of 0.5 feet per 100 feet (Utah Power and Light Company, 1983). No hydrologic impacts due to subsidence have been discovered in the North Horn Formation.

An examination of subsidence effects near the Deer Creek Fault by Utah Power and Light Company (1981) shown that subsidence effects do not migrate across this fault. Instead, the fault acts as a pressure and stress relief point, precluding subsidence on the side of the fault opposite the mine.

The foregoing information obtained from mines surrounding Hiawatha indicate that visible subsidence effects (mostly cracking) should be limited at the King Mines to fully extracted areas underlying outcrops of the Blackhawk Formation, Castlegate Sandstone, and the Price River Formation. Cracks that form have the potential of intercepting stream flow if located in the bottom of a channel and spring flow if located downstream from the spring but upstream from the point where the spring flow is naturally consumed (by seepage, evapotranspiration, etc.).

Above the Price River Formation (i.e., within outcrops of the North Horn Formation), subsidence effects should be limited to broad troughs that are undetectable except by surveying. No surface fracturing should occur. No diversions of spring flow and stream flowto subsurface strata are expected within this trough subsidence zone due to the lack of cracking.

Subsidence effects at the Bear Canyon Fault are expected to be similar to those measured by Utah Power and Light Company (1981) at the Deer Creek Fault and those measured by C.W. Mining on the Bear Canyon Fault. This conclusion is based on the similarity of the two faults. Both faults are clean, with little drag, each has common offsets of 100 to 200 feet, and each is commonly associated with sympathetic faulting (Roger Fry, Utah Power and Light Company, personal communication, 1984). Hence, subsidence should not occur on the west side of the Bear Canyon Fault due to mining by U.S. Fuel Company.

**Subsidence Effects on Geomorphic Stability**

As noted on Exhibit 7-7, areas of potential subsidence are confined predominantly to Gentry Mountain,the upper west-facing slopes of Gentry Hollow, and the upper portions of the Miller Creek watershed. Except for a small area near the King 4 portal, most of the area of potential subsidence is underlain by bedrock of the North Horn Formation, Price River Formation, and Castlegate Sandstone, with overburden thicknesses often in excess of 1000 feet.

Along the ridge of Gentry Mountain, slopes are gentle (normally 0.80 to 2 degrees) with overburden thicknesses in excess of 1500 feet. This area is entirely underlain by the North Horn Formation. As a result, subsidence effects that do reach the surface along the ridge should be limited to the creation of broad troughs. Changes in slope along the ridge due to subsidence should, as noted by Utah Power and Light Company (1983), be gradual and less than 0.5 percent (0.3 degrees). No abrupt changes are expected. This condition, plus the fact that no well-defined stream channels exist along the ridge, indicates that subsidence along the ridge will not alter the erosional stability of the area.

The west facing slopes of Gentry Hollow within the area of potential subsidence are moderately steep (up to about 11 degrees) and are underlain by sandstones and limestones of the North Horn Formation. Overburden thicknesses are mostly greater than 1500 feet. Small, natural benches and cliffs are present where resistance sandstones underlie less resistant limestones. Stream channels that cross the area of potential subsidence are small and ephemeral, flowing only in response to snow melt or excess precipitation. The fact that these slopes are underlain by the North Horn Formation indicates, again, that subsidence effects will be gradual and gentle, with no surface cracks developing. Maximum changes in slope should be less than 0.3 degrees. The lack of abrupt changes in slope and configuration will preclude adverse impacts to natural stream gradients and erosional stability.

The topography of the Miller Creek watershed in the area of potential subsidence is generally steep (often in excess of 25 degrees) with numerous vertical cliffs on both the sideslopes and within the stream channels. These cliffs have formed in sandstones of the Price River Formation, Castlegate Sandstone, and Blackhawk Formation. Vertical rise at the cliff faces varies from about 5 feet within the Blackhawk Formation to over 100 feet in the overlying formations. Vegetation on the sideslopes is dense, consisting of conifer and aspen forest on north and east facing aspects, and sagebrush on south facing aspects. Overburden thicknesses vary from less than 300 feet to about 1500 feet. Within the Miller Creek watershed, the effects of subsidence on natural geomorphic stability will be minimal where underlain by the North Horn Formation. Reasons for this have been stated previously, including gradual slope changes, probable lack of surface cracks, etc.

To determine the effects of subsidence on the geomorphic stability of areas below the North Horn Formation outcrop, the relationship shown in Figure 7-2 was used. This figure gives the relations between subsidence ratios (maximum surface subsidence ($S_{max}$) relative to the thickness (t) of the coal bed for various ratios of mine panel width (W) to mean overburden depth (D). Data points bounded by the circles are from Wardell (1971) for coal fields in the United Kingdom. The data point bounded by the square is from Dunrud (1976) for the Somerset Mine, Colorado, 3 to 5 months after mining was completed.

Because it is uncertain whether subsidence over the Somerset Mine was complete at the time of data collection, the upper (more conservative) curve will be used for estimating maximum subsidence above the King Mines.

Within the King 4 Mine, the coal seam in those sections to be fully extracted averages about 8 feet in thickness. As has been stated previously, the panel width of the fully extracted areas averages about 500 feet. Using these two values and Figure 7-2, the relationship provided in Figure 7-3 was developed. This figure gives the comparison between overburden depth and maximum subsidence, showing approximate overburden depths at formation contacts.

According to Figure 7-3, maximum subsidence within the Price River Formation should be approximately 2.5 to 3.3 feet. Within the Castlegate Sandstone, maximum subsidence may reach depths of 3.3 to 4.3 feet. Subsidence in these two formations should occur predominately as abrupt slope changes and cracks. In an area within the Miller Creek Watershed characterized by vertical cliffs over 50 to 100 feet in height and competent sandstone bedrock, these relatively small subsidence offsets should not affect natural stream gradients and erosional stability.

Subsidence within the Blackhawk Formation above fully extracted areas may reach a maximum of 4.3 to 7.2 feet in the Miller Creek watershed. A comparison of Exhibits 7-7 and 6-1 indicates that bedrock outcrops over the entire area of potential subsidence (i.e., alluvium is too thin and discontinuous to be mapped, even at a larger scale). In bedrock typified by interlayered sandstone and shale, where natural vertical drops of 5 feet are not unusual, it is doubtful that long term changes in geomorphic stability will result from subsidence. Local and temporary increases in stream gradients and erosion may occur if the zone of subsidence intersects a stream channel. However, the lack of continuous alluvial deposits, the thick vegetative growth, and the overall natural geomorphic stability of the upper Miller Creek watershed (i.e. no signs of excessive erosion or slope failure were found during the spring inventory even though precipitation during the preceding year was much above normal) suggest that unstable areas will quickly return to stable condition.

In 1979 a subsidence monitoring agreement was signed between U.S. Fuel Company and the U.S. Forest Service. Aerial photogrammetric monitoring had been done on a yearly basis, however, the Forest Service continued to experienced difficulty establishing point readings and announced its intent to discontinue monitoring in 1987. In October 1988 U.S. Fuel began its own subsidence monitoring program. This program is discussed in detail under R645-301-525 in Chapter 5 (Engineering). Exhibit 5-3 shows the location of monitoring points

An examination of subsidence monitoring data collected above the King 4 mine in 1990 and compared with baseline monitoring data established in 1988 substantiates the foregoing discussion. A fully extracted area (except for barrier pillars) in the King 4 mine averaging 800 ft. wide by 2,000 ft. long was mined in late 1988 and 1989. Overburden above this area is approximately 1,300 feet and the surface formation is the North Horn. Monitoring data show that the surface has subsided from 0.5 ft. to a maximum of 2.17 ft. over a broad area. No visible subsidence effects have been detected.

Exhibit 7-7 shows two springs (91-974 & 91-978) located just north of U.S. Fuel's permit boundary in Section 13, T.15S., R.8E. These springs are within the zone of potential subsidence projected from U.S. Fuel's most northerly mine workings. Based on the previous discussion, recent field investigations and the following considerations, no material damage should occur to these springs from subsidence effects of U.S. Fuel's mine workings:

Mining was last conducted in the near vicinity of the springs in 1982. There are no longer any recoverable coal reserves in U.S. Fuel's property in this area and there is no access to mine workings closer than 3,000 feet from the springs. The King 4. is being phased out and will be shut down in the near future, thus, precluding any potential for affecting the springs

The land surface in the vicinity of the springs is easily accessible, relatively gently sloping and mostly open brushland. No material damage to the surface of this area has been observed. The springs were examined during the spring and fall of 1992 and except for drought influences, show no diminution of normal flows.

**References**

Dunrud, C. Richard, 1976. Some Engineering Geologic Factors Controlling Coal Mine Subsidence in Utah and Colorado, U.S. Geological Survey Professional Paper 696, Washington, D.C.

Plateau Mining Company, 1981. Star Point Mines Mining and Reclamation Plan. Submitted to the Utah Division of Oil, Gas, and Mining, Salt Lake City, Utah.

Stokes, W.L. and R.E. Cohenour, 1956. Geologic Atlas of Utah Emery County. Bulletin 52. Utah Geological and Mineral Survey. Salt Lake City, Utah.

Utah Power and Light Company, 1981. Subsidence Report. Submitted to the Utah Division of Oil, Gas and Mining. Salt Lake City, Utah.

Utah Power and Light Company, 1982. Subsidence Control Report. Submitted to the Utah Division of Oil, Gas and Mining. Salt Lake City, Utah.

Utah Power and Light Company, 1983. Update of Deer Creek Coal Mine Permit Application. Submitted to the Utah Division of Oil, Gas and Mining, Salt Lake City, Utah.

Wardell, K., 1971. The Effects of Mineral and Other Underground Excavations on the Overlying Ground Surface. Symposium, Geological and Geographical Problems of Areas of High Population Density. Association of Engineering Geologists, Sacramento, California.

**724.700 Alluvial Valley Floor**

The geologic map of the area (Exhibit 6-1) shows the extent of alluvial materials which hold streams in and adjacent to the permit area. Miller Creek, with it's tributaries, is the major drainage in the area. Miller Creek provides the only perennial stream flow within the permit and adjacent areas underlain by alluvial deposits. However, no mining or reclamation activities are proposed which would affect these areas.

Cedar Creek borders on the southern part of the permit area, however, only the upper section of Cedar Creek is in the permit area, and in that area Cedar Creek is very steep and narrow, precluding the development of an alluvial valley floor.

The land immediately associated with Miller Creek near Hiawatha is unimproved, undeveloped rangeland and has primarily been used for wildlife habitat. There is no evidence to indicate that the area has been used for agricultural practices other than grazing on the undeveloped rangeland. Within a thirty mile radius of the Miller Creek area, there are no alluvial valley floors at similar elevations with the same general characteristics as Miller Creek that are used for crop production. Because of their remoteness to the general agricultural community and their very narrow nature (50 to 100 feet wide) and moderate slopes (10 to 15 percent), the flood plain terraces associated with Miller Creek have very little potential for development as pasture land or other more intensive agricultural uses. Cropland type farming does exist further downstream along Miller Creek (about 4 miles); however, the terraces in these areas are much larger in size and they have more gentle slopes and fewer cobbly soils than the flood plains adjacent to Hiawatha.

Field examinations conducted by U.S. Fuel Company, a literature search and field studies by the U.S. Soil Conservation Service, and examinations of aerial photographs from the general vicinity did not indicate any evidence of the prior existence of flood irrigation in the permit or adjacent areas along Miller Creek. It is apparent from vegetation growth (large sagebrush), from mottling in soil test pits (B(Haverdad) and C (Ustic Torrifluvent) see Exhibit 2-1) that some of the terraces associated with Miller Creek are subirrigated. However, because of the physical characteristics of the area, including small terrace size (10 acres or less), moderately steep slopes (10 to 15 percent), excessive amounts of cobbles in the soils (20 to 40 percent), marginal soil characteristics (shallow and very coarse grained or clayey), and a seasonally high water table, the land use and soils' capabilities are very limited (see Appended SCS letter dated December 28, 1983). These limitations have precluded this area of Miller Creek and other similar areas within a thirty-mile radius from agricultural development and use. Therefore, they are not significant to the regional agricultural community.

The dominant vegetation present on these areas are species which are non-agriculturally useful. Additionally, the areas where mottling occurs are only seasonally subirrigated. This was substantiated from data obtained from the test pits excavated in borrow areas B and C in October 1983. The soils were dry to slightly moist, with insufficient moisture at the 5 to 6 foot depth to form a cohesive ball of the clayey soil.

The soils associated with Miller Creek are the Haverdad series, Shingle-Ildefonso-Badland Complex, and Ustic Torrifluvents. Detailed physical and chemical data are available for the Haverdad series and the Ustic Torrifluvent based on samples collected from test pits B and C in October 1983 (see Table 7-7). Detailed pedon descriptions from unpublished SCS data are also available for each of the above soils.

Above the 7400 foot elevation along Miller Creek the canyons become so narrow that their base (less than 20 feet, see Exhibit 2-1) and slopes so steep (16 to 30 percent) as to limit the deposition of fine grained alluvial and colluvial materials in sufficient quantities to support agricultural practices. Colluvial soils from the steep mountainside butt directly against the stream or against very narrow, 5 foot wide stream terraces. In addition, the amount of boulders and cobbles in the alluvial soils above the elevation of 7400 feet exceeds 20 percent, precluding intensive agricultural activities.

From elevation 7,400 to 7,120 feet, the slope decreases (10 to 16 percent slopes) and the floodplain widens (50 to 100 feet average). However, the slope, percentage of boulders, cobbles and gravels in the alluvial soils, and available area (areas less than 10 acres in size) continue to limit the land use primarily to wildlife habitat.

From elevation 7120 to 6900 feet, the floodplain continues to widen (100 to 255 feet), the slopes become more gentle (6 to 10 percent), and the cobbly soils are generally limited to the lower stream terraces. The Haverdad soil located on the north side of Miller Creek has limited potential for flood irrigation or for sub-irrigation. However, due to it's small acreage (generally 10 acres or less) and lack of continuity, plus the prevalence of nonagricultural plant species, it is not economically feasible to develop these soils for intensive agricultural uses.

Therefore, based on the facts that the current land use is undeveloped rangeland and wildlife habitat, and that the predominant vegetative cover is a non-agriculturally useful plant species, this area is not considered to be an alluvial valley floor. This negative determination has accounted for the local, regional, historical and current land-use practices and the physical characteristics of the area under consideration.

## Table 7-7

## Physical and Chemical
## Characteristics of the Haverdad and Ustic Torrifluvent Alluvial Soils

| SOIL | HORIZON | DEPTH | TEXTURE | SAND | SILT | CLAY | ECe | SAR | Na | Ca | Mg | HCO3 | SLOPE | >2mm | MOTTLING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ustic Torrifluvent | A1 | 0-6 | Loam | 47 | 36 | 17 | 0.4 | 0.3 | 0.5 | 3.8 | 0.6 | 2.9 | 5% | 0 | |
| | C1 | 6-14 | Loam | 51 | 34 | 15 | 0.2 | 0.3 | 0.4 | 2.4 | 0.5 | 2.1 | | 0 | |
| | C2 | 14-20 | Sandy Loam | 53 | 32 | 15 | 0.2 | 0.4 | 0.5 | 2.1 | 0.6 | 2.1 | | 0 | |
| | C3 | 20-34 | Loam | 48 | 37 | 15 | 0.3 | 0.5 | 0.6 | 2.1 | 1 | 2.1 | | 0 | |
| | C4 | 34-60 | Cobbly Loam | | | | | | | | | | | 75 | Yes |
| Haverdad | A1 | 0-6 | Loam | 37 | 44 | 19 | 1.2 | 0.3 | 0.6 | 7.5 | 2.1 | 2.0 | 3-6% | 0 | |
| | C1 | 6-18 | Loam | 43 | 42 | 15 | 0.4 | 0.4 | 0.6 | 3.6 | 0.9 | 2.1 | | 0 | |
| | C2 | 18-38 | Silty Clay Loam | 12 | 59 | 29 | 0.3 | 0.5 | 0.7 | 3.4 | 1.0 | 1.8 | | 0 | |
| | C3 | 38-48 | Silty Clay Loam | 14 | 54 | 32 | 3.9 | 106 | 8.0 | 30.6 | 19.3 | 1.8 | | 0 | |
| | C4 | 48-90 | Clay Loam | 26 | 44 | 50 | 2.6 | 1.0 | 4.0 | 12.4 | 18.8 | 1.2 | | 0 | Yes |

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## R645-301-725 Baseline Cumulative Impact Area Information

Information provided in this and other chapters along with information available from appropriate federal and state agencies should be adequate to allow the Division to assess the probable cumulative hydrologic impacts of the existing and proposed mining and reclamation operations at ~~U.S. Fuel~~ Hiawatha Coal Company's permit area.

## R645-301-726 Modeling

Some modeling, interpolation and statistical techniques are utilized in this chapter, however, actual surface and ground-water information is predominately provided.

## R645-301-727 Alternative Water Source Information

As noted in the section on Probable Hydrologic Consequences, subsidence from mining operations may potentially deplete flows from springs by 28 gallons per minute. Most of these springs show some signs of stock and wildlife usage. A portion of this flow rate (approximately 19 gpm) contributes to the base flow in a stream that crosses an area of potential subsidence near the King 4 mine portal.

An inaccessible in-mine flow, identified as UG-1 and shown on Exhibit 6-3 exists near the intersection of the 10 East and 10 West sections in the King 4 mine. This flow, measured at 22 gpm on June 26, 1992, represents the total of all water sources intercepted by mine workings north of this point.  Flow from the old Mohrland portal (EPA Mine Water Discharge Point D001) represents the total of all water intercepted by U. S. Fuel's mining operations.

It has been noted in the response to R645-301-724.600 that ~~the degree of~~ hydraulic interconnection along the Bear Canyon Fault between the Blackhawk Formation and the Star Point Sandstone is thought to be nonexistent ~~uncertain~~.  ~~Whether dewatering of the mines will impact downgradient springs issuing from the Star Point Sandstone is, therefore, unknown. However, and~~ An examination of discharge rates of springs issuing from the Star Point Sandstone in and near the mouth of Bear Canyon (Danielson et al., 1981: ~~David~~ Darrel Leemaster, Castle Valley Special Services District, personal communication 1984) indicates no general decline in flow during the period of record (1978-1983). Additional monitoring of the flows in Big Bear Spring has shown no decline in flow through 1987.   Since mining near the fault by U.S. Fuel occurred in the late 1950's and then again from January of 1973 to June of 1977 and no drop in flows was noticed for 10 years after mining in the area had ceased ~~As a result,~~ dewatering of the mine workings is not expected to impact discharge rates of springs issuing from the Bear Canyon Fault in the Star Point Sandstone.  Thus, no alternate water supply should be required for these springs.  Because of drought conditions in the period between 1988 to 2001 a decline was observed in Big Bear Spring hitting a low approximately 50% of pre 1988 in 1993 and then recovering to approximately 70% of pre 1988 flows by 2001.  Once the drought conditions end and the palmer drought index returns to pre 1988 levels the flows in Big Bear Spring should return to pre 1988 levels.

Several options are available for providing an alternative water supply if mining impacts result in contamination, diminution, or interruption of an important source of water within the mine plan or adjacent areas that is used for wildlife or stock watering or other legitimate uses. The exact course of action will depend on site-specific hydrologic conditions, use patterns associated with the water source, whether a right has been filed for use of the water, etc.

The selection of a course of action for development of an alternative water supply will be done in consultation with the Utah Division of Oil, Gas, and Mining. It is understood that the Division may give an opinion on the availability and suitability of alternative water supplies but the settlement of any disputes will be between Hiawatha Coal ~~U. S. Fuel~~ Company, the user of the affected water, and the Division of Water Rights.

One option for developing an alternative water supply is for ~~U.S. Fuel~~ Hiawatha Coal Company to obtain water rights on an un-appropriated source near (as defined by DOGM) the source that is affected by mining activities. This would be accomplished by filing with the Utah Division of Water Rights for a change in point of diversion of water rights currently owned by ~~U.S. Fuel~~ Hiawatha Coal Company. Should this be acceptable ~~U.S. Fuel~~ Hiawatha Coal Company proposes to use rights it holds in the Miller Creek and Cedar Creek drainages. Some of these rights, selected to show that sufficient water is available, are listed in Table 7-8.

Other options for development of an alternative water supply include a collector entrenched in the ground, construction of a spring box at a remote location with a delivery pipe to the impact area, a guzzler (with the option of water being trucked to the site), or a pond located to retain snow melt runoff. Development of an alternative water supply will be done in consultation DOGM, with the development method depending on site-specific conditions.

**Table 7-8**

**Hiawatha ~~U.S. Fuel~~ Water Rights That Could Be Used For Alternative Water Supply**

| W.U.C. No. | Certificate No. | Amount | Source |
|---|---|---|---|
| 91-103 | 2155 | 0.387 cfs | Springs on South Fork of Miller Creek |
| 91-104 | 2156 | 0.087 cfs | Springs on Middle Fork of Miller Creek |
| 91-105 | 2159 | 0.700 cfs | Miller Creek |
| 91-174 | 5294 | 3.3 cfs | Miller Creek |
| ~~93-522~~ | ~~2195~~ | ~~0.13 cfs~~ | ~~Cedar Creek~~ |
| 93-904 | 107B | 2.5 cfs | Cedar Creek |
| 93-964 | 2158 | 0.02 cfs | Spring on Right Fork of Cedar Creek |
| 93-3524 | 2195 | 0.37 cfs | Cedar Creek |
| 93-3525 | 2195 | 1.00 cfs | Cedar Creek |

## R645-301-728 Probable Hydrologic Consequences Determination

Underground mining operations could affect surface and groundwater sources. Depending on coal extraction methods used, subsidence could more or less result in fractures through the strata above the Star Point sandstone formation. Fractures resulting from subsidence, as well as natural fractures encountered in mining could contribute to changes in existing water patterns. Springs, seeps, and stream flows could possibly be affected, and changes in drainage patterns could result. Since no mining is proposed to be done below the Hiawatha coal seam which lies immediately on top of the Star Point sandstone, strata below that elevation should not be affected. In order to prevent any anticipated affects, barriers can be left around the permit boundary or under a spring or a seep preventing any subsidence from occurring in those areas.

The effects of past mining on water sources is not known, except that significant flows have resulted from contact with major fractures such as the Bear Canyon fault. Large areas of the King 1 and King 2 mines were mined out from 15 to 80 years ago by room and pillar methods, yet numerous springs and seeps overlying these mines are still flowing. Whether or not they have diminished as a result of mining is not known.

Since the general dip of the strata in the mine plan area is toward the south west and since all existing mine workings are more or less interconnected, all water encountered in mining tends to flow to the most southerly mine opening which at this time is the old Mohrland Portal (King 2 portal) in Cedar Creek Canyon.

Diminution of existing surface and ground water sources could possibly affect some livestock and wildlife watering sites at higher elevations. Water presently being used for municipal, domestic, industrial, and irrigation purposes should not be diminished to any great extent since water diverted into the ground would most likely return to mine openings, springs and streams near the Star Point sandstone which is well above municipal, domestic, industrial and irrigation points of use. Water quality should not be significantly affected by mining as evidenced by the consistent high quality of mine water presently being discharged. ~~See Appendix 7-13.~~

**Potential Water Bearing Zones**

During the period of October 26 through October 28, 1983, hydrologists and geotechnical personnel with Ford, Bacon and Davis Inc. conducted a spring inventory and survey of renewable resource lands for the purpose of identifying aquifers and potential damage to aquifers which may result from subsidence. The results of their findings are given below.

Lithologic logs obtained during exploratory drilling on the permit and adjacent areas are restricted to the lower Blackhawk Formation, within the coal measures. Hence, subsurface information from stratigraphically higher zones is lacking. Nonetheless, data obtained from field investigations and derived from analyses and interpretations of the available drill-hole logs indicate that approximately four potential water bearing units exist beneath the uppermost coal seams in the general area of the Hiawatha Mine Complex. Cross sections containing selected drill hole logs are contained in Exhibits 7-5 and 7-6. Refer to Exhibit 7-1 for the locations of the cross sections. Cross sections were constructed at the identified locations so as to utilize surface drill hole information which give the greatest vertical range of available lithologic information. Unfortunately, no ground water information was recorded during the surface drilling operations. It should be noted, however, that many of the holes are said to have lost circulation in a zone approximately 300 feet below the drill collar.

In examining cross sections A-A and B-B it is apparent that the stratigraphic units of the Blackhawk Formation, within the boundaries formed by the overlying Castlegate Sandstone (Price River Formation) and underlying Star Point Sandstone (Mesa Verde Group), are discontinuous in their thickness, lithology and spatial extent. In cross section B-B, three sandstones identified as units A, B and C appear to be relatively consistent. However, in cross section A-A, the profile of the stratigraphic units have altered dramatically in their thickness, stratigraphy, lithology and spatial extent. Between the sandstone units of the Blackhawk Formation identified in Exhibits 7-5 and 7-6 are thick shale units and thin, discontinuous sandstone and coal units. The fourth potential water-bearing zone is the Star Point Sandstone that underlies the Blackhawk Formation.

A significant factor affecting the ability of any of the sandstone units of the Blackhawk Formation to transmit appreciable amounts of water is the presence of intercalated clay-stone and siltstone layers within the massive sandstones. These claystones and siltstones are very thin bedded and were encountered in the core of each drill hole.

The Blackhawk Formation was deposited in a sedimentary environment associated with coastal lagoons, floodplains, and swamps. Therefore, the physical and chemical characteristics of the deposits were readily influenced by climatic conditions and changing landforms. The effects of seasonal changes and storm events can easily be noted in the present stratiagraphy. As such, lithologies, bedding features, and the spatial extent of the units tend to change very rapidly. In a coastal-lagoon environment containing large rivers and swamps, a single storm event could spread sand over the floodplain, extending partially into the lagoon. Further out into the lagoon, the slower flows could be expected to deposit silt-sized materials. Only the higher slow moving floodwater containing suspended clays would enter swamps. Such a storm event may have left several feet of sediments. Similar occurrences apparently formed the Blackhawk Formation.

Based on a study of the drill hole logs and the cross sections, the three sandstone units in the Blackhawk formation which have characteristics normally associated with good aquifers have spatial characteristics that are so limited and discontinuous as to preclude them from significance as aquifers. Field investigations associated with the spring inventory confirm this, as only limited seepage was found issuing from the Blackhawk Formation. This seepage was confined to sandstone units immediately overlying a shale or claystone unit. The low seepage rates suggest only limited recharge.

Beneath the Blackhawk Formation, the Star Point Sandstone is regionally extensive. This formation has the characteristics of a good aquifer and yields relatively large quantities of water (50 to 100 gpm or greater) to springs in the area associated with fractures.

Above the Blackhawk Formation, the Castlegate Sandstone and North Horn Formation appear to be relatively good aquifers. Where fractured, the Castlegate Sandstone yields up to about 5 gpm to individual springs. Yields up to about 10 gpm are encountered in the North Horn Formation, although fracturing does not appear to be a dominant factor in flow rates and points of issuance.

As with the Blackhawk Formation, surface exposures of the Price River Formation suggest that the latter consists of interbedded sandstone, claystones, and shales. Yields from springs in the Price River Range up to 10 gpm, mostly from the upper portions of the formation near the contact with the overlying North Horn Formation.

Information collected during the spring inventory suggests that fracturing plays an important role in the occurrence of springs in the Castlegate and Star Point Sandstones and a minor role in the North Horn and Price River Formations. In most cases, springs from the Castlegate and Star Point Sandstones issue near the base of the formations, where fractured sandstones overlie a claystone or shale. The fracture, therefore, serves as a conduit, with the underlying claystone or shale inhibiting a significant amount of downward movement from the fracture to lower rock units.

Fracturing was also noted as a control for some springs issuing from the North Horn and Price River Formations. Again, claystone or shale units were often found underlying the fracture and acting as the lower limit of the fracture conduit along which water was flowing.

No fracture-controlled seeps or springs were found issuing from the coal-bearing Blackhawk Formation. Instead, seeps and springs within this formation were found issuing from the base of sandstone units overlying shale layers. Hence, fracturing of the Blackhawk Formation does not appear to convey groundwater to the surface.

Major fracturing in the area trends primarily north-south, paralleling the Bear Canyon Fault. A geologic map prepared by Waddell et al. (1981) indicates that the Bear Canyon fault is near the eastern edge of the Pleasant Valley Fault Zone, which a fault zone that extends from the southern half of T.17 S., R.7 E. northward through Pleasant Valley to Scofield Reservoir. Hence, all fracturing noted in relation to the springs is assumed to be part of the Bear Canyon Fault Zone or one of the companion fault zones.

A survey was conducted in the King 4 mine to determine the extent of inflow to the mine along the Bear Canyon Fault and other sources. Surveys could not be conducted in older mine workings since they are permanently sealed. The King 5 Mine is essentially dry (containing only a few low-yield roof drippers) and, hence, was not surveyed. In addition, roof stability problems in the King 6 mine makes access hazardous. Thus, the in-mine seepage survey was confined to the King 4 mine.

Five points of inflow greater than 1 gpm were found in the mine. Three of these originated from the floor of the mine through fractures or the Bear Canyon Fault, one originates from the roof through a fracture near the northern-most portion of the mine and one originates behind a seal in a fully extracted section of the mine. Prior to placing the seal on the fully extracted section, inflow to this section issued primarily from the floor.

Except for the fracture in the northern portion of the mine, inflow appears to come primarily through fractures in the floor. This suggests that recharge to the fault zone is not from directly above the mine but probably from the area located north and up dip from the mine workings.

Currently all portals are sealed and no water is used for in-mine water supply. Flows in excess of the in-mine requirements and the ventilation evaporation losses (Given in Appendix 7-1) eventually discharge at the old Mohrland portal to Cedar Creek or are used by Hiawatha Coal Company as an industrial and domestic supply in the town of Hiawatha.

Once mining is resumed an in mine flow, located in the B-seam, identified as UG-1 and shown on Exhibit 6-3, will be monitored if accessible for quality, quantity and seasonal variation (see 731.200, "Ground Water Monitoring Plan"). Due to the dip of the beds, monitoring the flow at this location will reflect the cumulative result of all sources originating in U. S. Fuel's mine workings north of the 10 West and 10 East sections. The most current measurements showed this flow amounts to approximately 22 gpm. Hiawatha Coal Company also commits to monitor all in mine flow encountered that are greater then 5 gpm and last for more then 30 days once the portal seals are breached and mining resumes.

Although it was originally speculated that water below the mine working may travel along the Bear Canyon Fault to Big Bear Spring additional research has proven this wrong and has shown that they are not hydraulically connected. Radioactive dating has shown that the water suppling Big Bear Spring was modern while the water flowing out of the Mohrland portal is older then 9,000 years. Additionally it has been demonstrated that groundwater chemistry is significantly degraded by passing through the Mancos Shale and the chemistry of water in Big Bear Spring is not degraded relative to the groundwater encountered in the mine. (Mayo, 2001, pages 87 and 89) Hiawatha Coal Company believes there is a confining layer below the Hiawatha Seam throughout Gentry Mountain that would prevent any water from flowing past it down to the elevation of Big Bear Spring or Birch Spring. This conclusion was reached based on the fact that both U.S. Fuel and the Co-Op Mining Company reported water as flowing up out of the floor when the Bear Canyon Fault was encountered. And also because the groundwater age and lack of tritium from monitoring wells, DH1-A, DH-2, DH-3, DH-4, SDH-1, SDH-2, and SDH-3, that are located in the same formations as Birch Spring and Big Bear Spring indicate that these wells are part of a groundwater flow system that is isolated from the surface. (Bills, 2000, page 81)

Beneath the mine workings, groundwater traveling along the Bear Canyon Fault within the Star Point Sandstone discharges at Bear Canyon Spring and other nearby springs. In addition, due to the outcropping of the Mancos Shale in the bottom of Huntington Creek immediately upstream from Bear Canyon, fracture-related groundwater in the Star Point Sandstone that does not discharge at springs is assumed to discharge directly into Huntington Creek. Data provided by Danielson et al. (1981) suggest that the discharge from the Star Point Sandstone to springs average approximately 210 gpm.

Large faults in the area are almost always filled with relatively impermeable fault gouge and where the Bear Canyon Fault is exposed and also where it was encountered in the Bear

Canyon Mine extensive fault gouge is visible. (Mayo, 2001, pg. 130) As was noted previously, water in the area that issues from fractured sandstones does not appear to percolate significantly into underlying claystones or shales. Instead, all water appears to issue above the impermeable layers. Hence, fracture-controlled groundwater flow probably does not migrate significantly into surrounding claystones and shales, suggesting that water encountered in fractures within the mines is isolated from that contained in the Star Point Sandstone.

Preliminary data collected from cores of the Blackhawk Formation obtained from section 27, T.17 S., R.6 E. (Greg Lines, U.S. Geological Survey, personal communications, October 31, 1983) indicate that horizontal and vertical laboratory hydraulic conductivities of the shale layers within the Blackhawk vary from 1 X $10^{-8}$ ft./day to impermeable (even at a pressure of 5,000 pounds per square inch). Sandstone layers within the Blackhawk Formation, however, had average horizontal and vertical laboratory hydraulic conductivities of 1.3 X $10^{-2}$ ft./day and 3.8 X $10^{-3}$ ft./day respectively. The laboratory hydraulic conductivity of the Star Point Sandstone was found to be similar to that of the sandstone units in the Blackhawk Formation. These data confirm the impermeable nature of the shales compared to the sandstones of the Blackhawk Formation. In addition to the relative impermeability of the unfractured shales, the bentonitic nature of the Blackhawk Formation shales (Stokes and Cohenour, 1956) tends to result in a sealing of the fractures within the shales. Hence, to some degree, groundwater traveling along the Bear Canyon Fault within the Blackhawk Formation is probably hydraulically isolated from sandstone.

Ground water quality in this area is generally good. Appendix 7-12 gives quantity and quality data for 14 springs in and near the mine plan area. The locations of these springs are shown on Exhibit 7-1. They were selected as hydrologic monitoring points because of their representative location with respect to mine workings. Most of them had some flow during the drought year of 1977. Some springs have been developed with troughs and small impoundments to facilitate livestock and wildlife watering.

References

Danielson, T.W., M.D. ReMillard, and R.H. Fuller, 1981, Hydrology of the CoalResource Areas in the Upper Drainages of Huntington and Cottonwood Creeks, Central Utah. Water Resources Investigations 81-539. U.S. Geological Survey Salt Lake City, Utah.

Mayo and Associates, LC, 2001. Investigation of Groundwater and Surface-Water Systems in the C.W. Mining Company Federal Coal Leases and Fee Lands, Southern Gentry Mountains, Emery and Carbon Counties, Utah. Bear Canyon Mining and Recovery Plan Appendix 7-K. Huntington, Utah.

Stokes, W.L. and R.E. Cohenour, 1956. Geologic Atlas of Utah-Emery County. Bulletin 52. Utah Geological and Mineral Survey. Salt Lake City, Utah.

Waddell, K.M., P. Kay Contratto, C.T. Sumsion, and J.R. Butler, 1981. Hydrologic Reconnaissance of the Wasatch Plateau-Book Cliffs Coal Fields Area, Utah. U.S. Geological Survey Water Supply Paper 2068. Washington, D.C.

Wardell, K.M., H.L. Vickers, R.T. Upton, and P.K. Contratto, 1978. Selected Hydrologic Data, 1931-77, Wasatch Plateau-Book Cliffs Coal Fields Area, Utah. Utah Basic Data Release No. 31. Utah Department of Natural Resources, Division of Water Rights, Salt Lake City, Utah.

**Effects of Mining on Streamflow**

Data obtained from mines in the region, as outlined in section 724.600, suggest that subsidence will affect streamflow quantity only in those areas where surface cracks develop. In areas experiencing trough subsidence, no streamflow impacts have been documented to date. As a result, those areas on the ridge of Gentry Mountain and within Gentry Hollow that are subjected to subsidence should not experience any changes in streamflow attributable to mining. As noted previously, well-defined streamflow does not exist along Gentry Mountain. Stream channels that cross the upper west-facing slopes of Gentry Hollow are ephemeral. That stream flow that is generated in these areas originates within and flows in the area of potential subsidence only across outcrops of the North Horn Formation (presumably subject only to trough subsidence). Hence, without the development of subsidence fractures, no impacts are expected to occur to streamflow crossing the ridges of Gentry Mountain and the upper slopes of Gentry Hollow.

Potential impacts to streamflow resulting from subsidence should be limited to the Miller Creek watershed where streams cross formations that are stratigraphically lower than the North Horn Formation. The results of the spring inventory conducted in the permit and adjacent areas in October 1983 indicate that base-flow within the zone of potential subsidence in the Miller Creek watershed is about 7 gallons per minute in the north branch of North Fork of Miller Creek, 12 gpm in the south branch of North Fork, 16 gpm in Middle Fork, and 6 gpm in South Fork. This base-flow all originates as springs issuing from the North Horn Formation and the Castle-gate Sandstone (compare Exhibits 7-2 and 7-7). Only minor seepage issues from the Price River Formation within the potential subsidence zone of the Miller Creek watershed. Snowmelt and other surface runoff are also generated within the zone of potential subsidence, however, data are not available to determine the quantity of this runoff.

Losses of streamflow may result either from interception of source springs by a subsidence crack (which is not expected within the North Horn Formation) or by interception of the stream channel by a subsidence crack (which may occur downstream from source springs issuing either from the North Horn Formation or the Castle-gate Sandstone). ~~U.S. Fuel~~ Hiawatha Coal Company maintains a streamflow monitoring program in upper Miller Creek watershed below the zones of potential subsidence and above the mine yards that will provide information regarding streamflow reductions due to subsidence (compare Exhibits 7-1 and 7-7).

Data collected from the ~~U.S. Fuel~~ Hiawatha Coal Company stream monitoring network can be found on the Division website ~~are summarized in Appendix 7-14~~ and are compared with potential losses to base-flow due to subsidence in table 7-9 on page 7-70. According to this table, potential losses to baseflow due to subsidence will occur only in the North Fork of Miller Creek. Available data indicate that natural seepage into the stream channels depletes the spring flow above the upper monitoring stations in the other forks of Miller Creek. Hence, the maximum potential impact to streamflow above the mines will be a depletion of 19 gpm in the North Fork of Miller Creek. It should be noted that water rights for streamflow in both branches of North Fork of Miller Creek below the North Horn Formation are owned by ~~U.S. Fuel~~ Hiawatha Coal Company (see Exhibit 7-4).

It is emphasized that these flow reductions are expected to occur only if a subsidence crack intercepts the stream channel or a source area. Because of the location of the monitoring network high in the Miller Creek watershed, data collected by ~~U.S. Fuel~~ Hiawatha Coal Company should be sufficient to determine if subsidence is affecting streamflow.

Because of the lack of data, potential losses of snowmelt runoff and other ephemeral flow cannot be quantified. However, such losses may occur through interception of a stream channel by a subsidence fracture.

The effects of planned subsidence and unexpected subsidence on ground water occurrence, discharge and quality are discussed under R645-301-724.

If it is determined that subsidence has measurably affected streamflow in the area (as noted by reductions in streamflow at the monitoring stations or sustained increases in flow into the mine workings from the roof), appropriate mitigating measures will be installed by ~~U.S. Fuel~~ Hiawatha Coal Company. These measures may include culverts or lined channels over loss zones within the stream channels.

**Table 7-9**

**Comparison of Baseflow at Stream Monitoring Station and Flows of Source Springs Measured During 1983 Spring Inventory**

| Monitoring Station (a) | Stream | Average Baseflow (b) (gpm) | Baseflow from Potential Subsidence Zone(gpm) | Col. 4/Col3 (100) |
|---|---|---|---|---|
| ST-1 | North Branch of North Fork of Miller Creek | 68 | 7 | 10.3 |
| ST-2A | South Branch of North Fork of Miller Creek | 44 (c) | 12 | 27.3 |
| ST-3A | Middle Fork of Miller Creek | 0 | 16 | (d) |
| ST-4A | South Fork of Miller Creek | 0 | 6 | (d) |

(a) See Exhibit 7-1

(b) From available records for the period of March through September

(c) Accounts for average upstream discharge of 8 gpm from the King 4 Mine ventilation tunnel

(d) All flow from source springs normally lost to natural seepage into The stream channel upstream from the station during the baseflow period

~~As explained in the response to R645-301-724.600, the degree of interconnection between that portion of the Bear Canyon Fault encountered in the mine workings and that portion existing within the Star Point Sandstone below the mine workings is unknown. However, assuming that all water encountered within the mines would have eventually discharged into Huntington Creek (a conservative assumption that does not take other consumptive uses into account), the total reduction in the streamflow of Huntington Creek would amount to 955 gpm (see the response to R645-301-724.600), or 2.1 cubic feet per second (cfs). With an average annual discharge of Huntington Creek of 30 cfs (Danielson et al., 1981) this maximum potential depletion amounts to 7 percent of the flow of Huntington Creek. An examination of available records of spring flow from three springs issuing from the fractured Star Point Sandstone about 7.5 miles southwest of Hiawatha in section 26,T.16 S., R.7 E. (Danielson, 1981) indicates no general decline in discharge during the period of record (1978-1979). The Castle Valley Special Services District (the agency that controls the major spring issuing from the north of Bear Canyon for use by Huntington City) has noted no decrease in flows since they began keeping records in 1980 (Darrel Leemaster, Castle Valley Special Services District, personal communication, 1984). Although the period of record is short, the data suggest that dewatering rates from downgradient springs have not been reduced. Hence, future impacts are not expected.~~

~~It is emphasized that this depletion estimate is a maximum potential quantity. As noted by Danielson et al. (1981), much of the mine discharge is probably a depletion of groundwater storage and\or an interruption of groundwater naturally moving out of the basin. Danielson et al. (1981) further indicates that the maximum potential streamflow depletion of Huntington Creek resulting from the combination of King Mines, the Wilberg Mine, and the Deer Creek Mine (both located about 13 miles southwest of Hiawatha) is 10 percent of the average annual flow. Hence, the 7 percent value for the King Mines is considered conservative.~~

**Impacts to Springs**

Within the area of potential subsidence, water rights have been filed on nine springs or sets of springs (see Exhibit 7-3). Ground and surface water rights for the ~~U.S. Fuel~~ Hiawatha Coal Company permit and adjacent areas are presented in Tables 7-3, 7-4, 7-5, 7-6 and 7-8. Tables are separate for ground water rights in the Price River and San Raphael drainages. The surface water claims are located in Tables 7-5 and 7-6, and the groundwater claims are located in Tables 7-3, and 7-4. As noted in Table 7-10, these rights total 250 gpm, 215 gpm of which belong to ~~U.S. Fuel~~ Hiawatha Coal Company. All of these springs issue from the North Horn

Formation. With the exception of the ~~U.S. Fuel~~ Hiawatha Coal Company rights, each spring is used for stock watering. All springs issue above an elevation of 9600 feet, indicating that overburden thicknesses exceed 1500 feet. All issue from the North Horn Formation and should, therefore, show no measurable impacts due to subsidence.

As has been noted in several of the preceding sections, subsidence within the North Horn formation is expected to occur as broad troughs without the development of surface cracks. Since none of the springs issuing from the North Horn Formation within the zone of potential subsidence appear to be fault related, these springs are recharged from the shallow surface near the point of discharge. Hence, trough subsidence, with its gradual slope changes and lack of fracturing, should have no adverse impacts on the flow of springs for which water rights have been filed.

In addition to those springs with water rights, 21 other seeps and springs were found during the spring inventory within the areas of potential subsidence. Most of these seeps and springs are used by livestock and wildlife for watering and had a cumulative discharge in October 1983 of 41 gpm. All of these flow or seep into the Miller Creek watershed. Seven of these were seeps and eight were springs issuing from formations stratigraphically below the North Horn Formation. The combined flow of the 8 springs with measurable flow was 28 gpm during the 1983 spring inventory.

Although water flowing from springs issuing from the North Horn Formation may be intercepted downstream by subsidence fractures that intercept stream channels, no impacts to

North Horn springs proper are expected (see previous discussions). Impacts downstream from the point of issue have been discussed in a previous section. Hence, potential impacts to springs due to subsidence are assumed to be limited to those springs that issue from the Price River Formation or the Castle-gate Sandstone.

Assuming that all springs issuing below the North Horn Formation dry up as a result of subsidence, the maximum depletion in spring flow will be 28 gpm. It is emphasized that the subsidence fracture would have to directly intercept the spring or its immediate recharge area to cause a depletion in flow. If the cracks pass downstream from the spring, water would still be available at the source for livestock and wildlife use.

Some concern has been raised by OSM regarding an apparent decrease in flow rates measured at spring monitoring station SP-3 since 1980. The flow data collected from this station are given in Tables 1 and 4 of Appendix 7-12. According to this table, flows at SP-3 normally vary from about 4.5 to 6.0 gpm. The data is insufficient to determine long-term trends.

Stream monitoring, ongoing since 1978, at monitoring points downstream from disturbed areas, serve to identify contaminating materials. Stream monitoring data ~~are given in Appendix 7-14~~ can be found on the Divisions website.

**Table 7-10**

**Spring For Which Water Rights Have Been Filed and Which Exist Within the Zone of Potential Subsidence**

| WUC No. | Owner | Source | Right (Gpm) | Use | Period Of Use |
|---|---|---|---|---|---|
| 93-1471 | U.S. Forest Service | Gentry Flat Spring | 5 | Stockwater | June 21 - Sept. 30 |
| 91-103 | ~~U.S. Fuel Company~~ Hiawatha Coal Company | Springs 4,5,6,7,8,& | 175 | Domestic | Jan. 1 - Dec. 31 |
| 91-104 | ~~U.S. Fuel Company~~ Hiawatha Coal Company | Springs 1,2,&3 | 40 | Domestic | Jan. 1 - Dec. 31 |
| 91-972 | U.S. Forest Service | Unnamed | 5 | Stockwater | June 15 - Oct. 15 |
| 91-973 | U.S. Forest Service | Unnamed | 5 | Stockwater | June 15 - Oct. 15 |
| 91-974 | U.S. Forest Service | Unnamed | 5 | Stockwater | June 15 - Oct. 15 |
| 91-978 | U.S. Forest Service | Unnamed | 5 | Stockwater | June 15 - Oct. 15 |
| 91-979 | U.S. Forest Service | Unnamed | 5 | Stockwater | June 15 - Oct. 15 |
| 91-1633 | U.S. Forest Service | Unnamed | 5 | Stockwater | June 15 - Oct. 15 |

**Impacts to Water Quality**

An assessment of post-mining groundwater quality was performed using existing data for waters being discharged from the mine workings. This assessment is presented in Table 7-11. Values given represent arithmetic means due to the lack of some discharge data (precluding the computation of flow-weighted means). Also included in Table 7-11 is a comparison of the mine-water discharge quality with that quality of receiving streams. No mine water is discharged into springs. As noted, mine water tends to have lower concentrations of the examined constituents than the receiving streams with respect to suspended solids, total manganese, total and dissolved iron, and PH. Concentrations of total dissolved solids and oil and grease are present in the mine water in greater concentrations than in the receiving streams.

On October 21, 1983, a sample of water standing in Slurry Impoundment No. 4 was collected for chemical analyses. This water was discharged from the coal processing plant and is representative of that which might be lost as seepage from ponds. The sample was analyzed for selected gross and trace constituents. Appendix 7-2 presents the results of the analysis.

A comparison of the slurry pond sample analysis with analyses of Miller Creek water, taken adjacent to the slurry ponds at Station ST-5 in October and November 1983, shows that water from the slurry ponds will not have significant impact on waters in Miller Creek (see Appendix 7-2). Analyses show the pond water to be slightly higher in concentrations of iron and sulfate, but PH and TDS concentration are approximately the same.

Mancos shale is the geologic formation with which pond waters could be contact. This formation has a high salt content and is susceptible to leaching. As water seeps from the pond, it could contact the Mancos shale and naturally degrade due to increased salt load. All waters flowing through the surface and ground water system which come in contact with the Mancos shale will naturally degrade. Therefore, little impact will result from water loss from the slurry sites.

**Acid-Forming or Toxic-Forming Materials**

No acid or toxic-forming materials are present that could contaminate surface or ground-water supplies. Current methods of generation, handling, storage and disposal of excess spoil, overburden, coal mine waste, non-coal waste and underground development waste are described in Chapter 5 under R645-301-528. All previously existing underground storage tanks were excavated and disposed of in 1989 in accordance with State and Federal requirements. Coal refuse material is discussed in detail in Chapter 2 under R645-301-231.200. Six representative samples of coal refuse material were collected from the embankments of slurry ponds 1,3,4 and 5 in 1983 and 1984. The results of these tests, presented in Table 2-8 in Chapter 2, show no significant toxic effects to plants or wildlife.

**Table 7-11**

**Comparison of Water Quality Between Mine-Water Discharge Points and Surface Water Immediately Upstream**

| Parameter (A) | Concentration | | | | | |
|---|---|---|---|---|---|---|
| | Mohrland Portal Discharge | | Town Tanks Discharge | | Vent. Tunnel Discharge | |
| | Mine Water | Cedar Creek | Mine Water | Miller Creek | Mine Water | North Fork Miller Creek |
| Total Suspended Solids | 11.8 | 198 | 2 | 75.5 | 2.9 | 3.3 |
| Total Dissolved Solids | 684 | 470 | 641 | 871 | 351 | 283 |
| Total Manganese | 0.042 | 0.074 | 0.041 | 0.085 | 0.005 | 0.004 |
| Total Iron | 0.19 | 1.02 | 0.07 | 1.18 | 0.05 | 0.05 |
| Dissolved Iron | 0.08 | 0.22 | 0.06 | 0.36 | 0.03 | 0.02 |
| Ph | 7.4 | 7.9 | 7.6 | 8 | 8 | 8.2 |
| Oil And Grease | 5.9 | 0.9 | 0.9 | 0.9 | 1.3 | 1.2 |

) All units in milligrams per liter except pH (which is in standard units.

## Areas of Potential Subsidence

A discussion on the amount of potential subsidence is given in Section R645-301-620 under Geologic Effects of Mining.

To estimate the effects of subsidence on the hydrologic regime of the permit and adjacent areas, a limit angle of 70 degrees from horizontal was assumed. The selection of this limit angle is from geologically similar areas in the Book Cliffs Mining District, Utah and the Somerset Mining District, Colorado. Limit angles in these districts varied from 69 degrees in weak overburden to 75 degrees or more in moderately strong overburden relative to the position of the room-and-pillar retreat line. Using the assumed limit angle of 70 degrees, the relationship presented in Figure 7-1 was developed.

Unless pillars are pulled and a section of the mine is fully extracted, conventional room-and-pillar coal mining methods do not generally result in surface subsidence if the pillars are adequately stable. Mining within that portion of the King 5 Mine that overlies the old Hiawatha No. 1 Mine has shown that subsidence should not occur above old room-and-pillar workings within the lease area where the pillars have been left in place. The King 5 Mine is separated from the underlying Hiawatha Mine by approximately 120 feet of interburden. Most pillars were left in place in the Hiawatha Mine at the completion of mining. Subsequent mining in the overlying King 5 Mine has shown none of the compression or tension effects that cause subsidence.

As a result, it is assumed that subsidence effects in the lease area will be confined to those areas within the limit angles overlying the fully-extracted sections of the mines. Exhibit 7-7 shows the vertical projections of those areas that have been fully extracted within the past ten years and that may be fully extracted during the remaining life of the mines. This includes areas where multiple seam mining may include full extraction in one or more seams. A detailed discussion of multiple seam mining is given in Chapter 6 Section R645-301-620 under Geologic Effects of Mining. Also included on this exhibit are areas surrounding the vertical projections that include the limit angle (using the relation given in Figure 7-1). It is emphasized that these are zones where subsidence may potentially occur. Hence, an examination of these broad areas should give a conservative estimate of impacts.

When the term "fully extracted" is used herein, it should be noted that barrier pillars will be left in the King Mines between extracted panels. On the average, panels will be approximately 500 feet wide, with barrier pillars averaging 150 feet in width.

At the Belina Mines (located about 15 miles northwest of Hiawatha), visible subsidence effects (primarily cracks and sinkholes) are limited to areas within the Blackhawk Formation where overburden thicknesses are 400 feet or less (Valley Camp of Utah, Inc., 1983). At the Star Point Mines, located immediately northeast of the U.S. Fuel Company lease area, visible subsidence effects have been noted in overburden ranging in thickness up to 500 feet (Plateau Mining Company, 1981). These effects are limited to linear cracks.

Noticeable subsidence effects attributed to mining at the Gordon Creek Mines (located approximately 11 mines northwest of Hiawatha) have been limited to overburden thicknesses of 200 feet or less (Dan Guy, Beaver Creek Coal Company, Price, Utah, personal communication, 1983). Where mining extended below the perennial Beaver Creek in 1976, no inflow of surface water to the mine has been noted even though pillars were pulled. Overburden in this location averages approximately 800 feet thick.

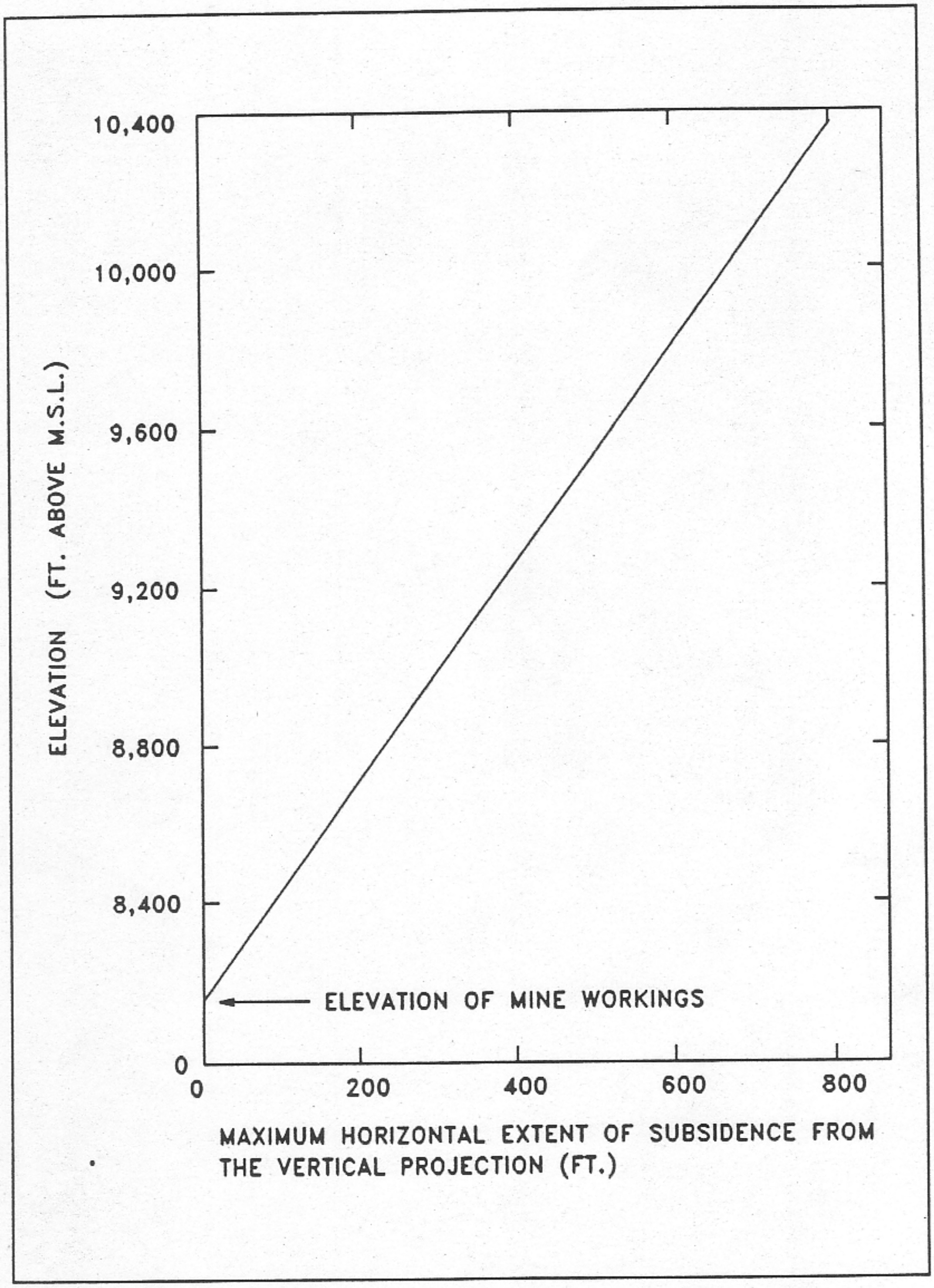


Figure 7-1 Relation Between Elevation and Horizontal Extent of Subsidence Effects Assuming a Limit Angle of 70 Degrees.

A detailed subsidence investigation conducted above the Utah Power and Light Company mines (13 miles southwest of Hiawatha) where the longwall mining method is used has indicated that the visible effects of subsidence are limited to cracks that form within and below the cliff-forming Castlegate Sandstone and Price River Formation (Utah Power and Light Company, 1982). Overburden in these areas reaches thicknesses of 800 to 1200 feet. No hydrologic impacts have been discovered within this zone. Above the Castlegate Sandstone and Price River Formation, (i.e., in the North Horn Formation) no visual subsidence effects have been noticed. However, survey data indicate that subsidence troughs have developed (Utah Power and Light Company, 1981, 1982). These troughs are elliptical and broad, sometimes covering tens of acres. Maximum subsidence within these troughs normally ranges from 2 to 4 feet. Slopes along the edges of the troughs are shallow, with maximums of 0.5 feet per 100 feet (Utah Power and Light Company, 1983). No hydrologic impacts due to subsidence have been discovered in the North Horn Formation.

An examination of subsidence effects near the Deer Creek Fault by Utah Power and Light Company (1981) and the Bear Canyon Fault by Co-Op Mining Company has shown that subsidence effects do not migrate across this fault. Instead, the fault acts as a pressure and stress relief point, precluding subsidence on the side of the fault opposite the mine.

The foregoing information obtained from mines surrounding Hiawatha indicate that visible subsidence effects (mostly cracking) should be limited at the King Mines to fully extracted areas underlying outcrops of the Blackhawk Formation, Castlegate Sandstone, and the Price River Formation. Cracks that form have the potential of intercepting stream flow if located in the bottom of a channel and spring flow if located downstream from the spring but upstream from the point where the spring flow is naturally consumed (by seepage, evapotranspiration, etc.).

Above the Price River Formation (i.e., within outcrops of the North Horn Formation), subsidence effects should be limited to broad troughs that are undetectable except by surveying. No surface fracturing should occur. No diversions of spring flow and stream flowto subsurface strata are expected within this trough-subsidence zone due to the lack of cracking.

Subsidence effects at the Bear Canyon Fault are expected to be similar to those measured by Utah Power and Light Company (1981) at the Deer Creek Fault and those measured by C.W. Mining on the Bear Canyon Fault. This conclusion is based on the similarity of the two faults. Both faults are clean, with little drag, each has common offsets of 100 to 200 feet, and each is commonly associated with sympathetic faulting (Roger Fry, Utah Power and Light Company, personal communication, 1984). Hence, subsidence should not occur on the west side of the Bear Canyon Fault due to mining by U.S. Fuel Company. Additionally C.W. Mining Company observed that the Bear Canyon Fault was sealed by a gouge as discussed earlier, and that although this gouge may be disrupted due to subsidence it will quickly fill in due to the abundance of clay and mudstone in the North Horn Formation.

## Subsidence Effects on Geomorphic Stability

As noted on Exhibit 7-7, areas of potential subsidence are confined predominantly to Gentry Mountain,the upper west-facing slopes of Gentry Hollow, and the upper portions of the Miller Creek watershed. Except for a small area near the King 4 portal, most of the area of potential subsidence is underlain by bedrock of the North Horn Formation, Price River Formation, and Castlegate Sandstone, with overburden thicknesses often in excess of 1000 feet.

Along the ridge of Gentry Mountain, slopes are gentle (normally 0.80 to 2 degrees) with overburden thicknesses in excess of 1500 feet. This area is entirely underlain by the North Horn Formation. As a result, subsidence effects that do reach the surface along the ridge should be limited to the creation of broad troughs. Changes in slope along the ridge due to subsidence should, as noted by Utah Power and Light Company (1983), be gradual and less than 0.5 percent (0.3 degrees). No abrupt changes are expected. This condition, plus the fact that no well defined stream channels exist along the ridge, indicates that subsidence along the ridge will not alter the erosional stability of the area.

The west-facing slopes of Gentry Hollow within the area of potential subsidence are moderately steep (up to about 11 degrees) and are underlain by sandstones and limestones of the North Horn Formation. Overburden thicknesses are mostly greater than 1500 feet. Small, natural benches and cliffs are present where resistance sandstones underlie less resistant limestones. Stream channels that cross the area of potential subsidence are small and ephemeral, flowing only in response to snow melt or excess precipitation. The fact that these slopes are underlain by the North Horn Formation indicates, again, that subsidence effects will be gradual and gentle, with no surface cracks developing. Maximum changes in slope should be less than 0.3 degrees. The lack of abrupt changes in slope and configuration will preclude adverse impacts to natural stream gradients and erosional stability.

The topography of the Miller Creek watershed in the area of potential subsidence is generally steep (often in excess of 25 degrees) with numerous vertical cliffs on both the sideslopes and within the stream channels. These cliffs have formed in sandstones of the Price River Formation, Castlegate Sandstone, and Blackhawk Formation. Vertical rise at the cliff faces varies from about 5 feet within the Blackhawk Formation to over 100 feet in the overlying formations. Vegetation on the sideslopes is dense, consisting of conifer and aspen forest on north and east facing aspects, and sagebrush on south facing aspects. Overburden thicknesses vary from less than 300 feet to about 1500 feet. Within the Miller Creek watershed, the effects of subsidence on natural geomorphic stability will be minimal where underlain by the North Horn Formation. Reasons for this have been stated previously, including gradual slope changes, probable lack of surface cracks, etc.

To determine the effects of subsidence on the geomorphic stability of areas below the North Horn Formation outcrop, the relationship shown in Figure 7-2 was used. This figure gives the relations between subsidence ratios (maximum surface subsidence ($S_{max}$) relative to the thickness (t) of the coal bed for various ratios of mine panel width (W) to mean overburden depth (D). Data points bounded by the circles are from Wardell (1971) for coal fields in the United Kingdom. The data point bounded by the square is from Dunrud (1976) for the Somerset Mine, Colorado, 3 to 5 months after mining was completed.

Because it is uncertain whether subsidence over the Somerset Mine was complete at the time of data collection, the upper (more conservative) curve will be used for estimating maximum subsidence above the King Mines.

Within the King 4 Mine, the coal seam in those sections to be fully extracted averages about 8 feet in thickness. As has been stated previously, the panel width of the fully extracted areas averages about 500 feet. Using these two values and Figure 7-2, the relationship provided in Figure 7-3 was developed. This figure gives the comparison between overburden depth and maximum subsidence, showing approximate overburden depths at formation contacts.

According to Figure 7-3, maximum subsidence within the Price River Formation should be approximately 2.5 to 3.3 feet. Within the Castlegate Sandstone, maximum subsidence may reach depths of 3.3 to 4.3 feet. Subsidence in these two formations should occur predominately as abrupt slope changes and cracks. In an area within the Miller Creek Watershed characterized by vertical cliffs over 50 to 100 feet in height and competent sandstone bedrock, these relatively small subsidence offsets should not affect natural stream gradients and erosional stability.

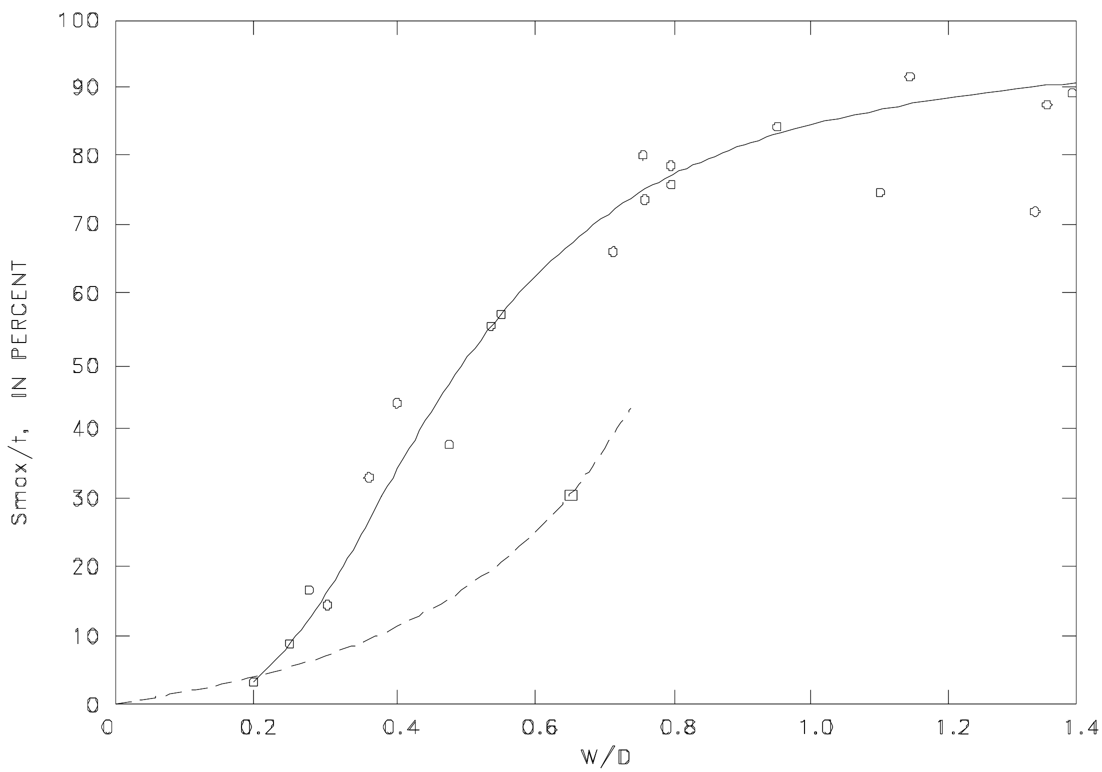


Figure 7-2 Subsidence Ratios For Various Ratios of Mine Panel width to Mean Overburden Depth (From Dunrud, 1976).

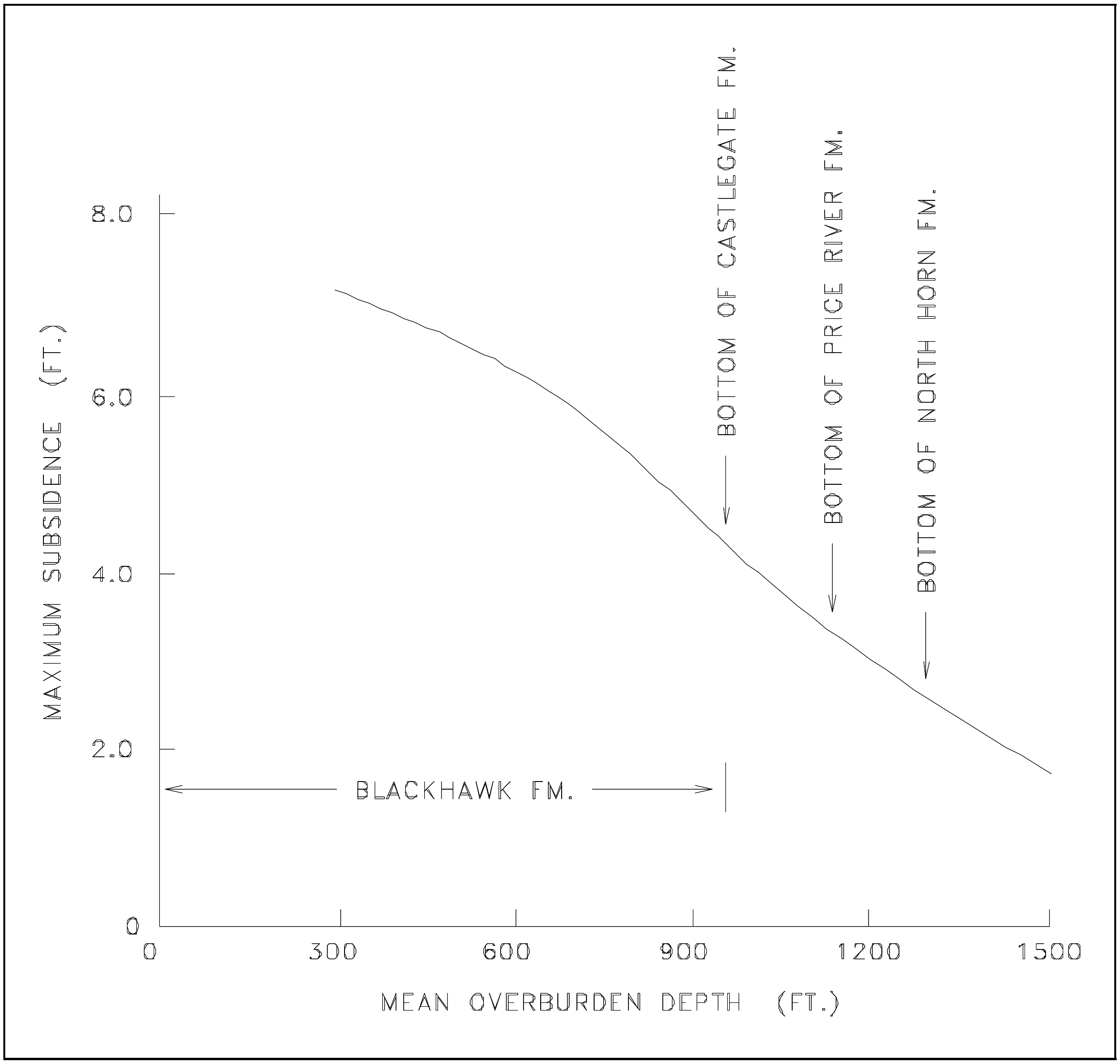


Figure 7-3 Potential Maximum Subsidence Above The King Mines.

Subsidence within the Blackhawk Formation above fully extracted areas may reach a maximum of 4.3 to 7.2 feet in the Miller Creek watershed. A comparison of Exhibits 7-7 and 6-1 indicates that bedrock outcrops over the entire area of potential subsidence (i.e., alluvium is too thin and discontinuous to be mapped, even at a larger scale). In bedrock typified by interlayered sandstone and shale, where natural vertical drops of 5 feet are not unusual, it is doubtful that long term changes in geomorphic stability will result from subsidence. Local and temporary increases in stream gradients and erosion may occur if the zone of subsidence intersects a stream channel. However, the lack of continuous alluvial deposits, the thick vegetative growth, and the overall natural geomorphic stability of the upper Miller Creek watershed (i.e. no signs of excessive erosion or slope failure were found during the spring inventory even though precipitation during the preceding year was much above normal) suggest that unstable areas will quickly return to stable condition.

In 1979 a subsidence monitoring agreement was signed between U.S. Fuel Company and the U.S. Forest Service. Aerial photogrammetric monitoring had been done on a yearly basis, however, the Forest Service continued to experienced difficulty establishing point readings and announced its intent to discontinue monitoring in 1987. In October 1988 U.S. Fuel began its own subsidence monitoring program. This program is discussed in detail under R645-301-525 in Chapter 5 (Engineering). Exhibit 5-3 shows the location of monitoring points. Hiawatha Coal Company has continued this program, with no evidence of any significant subsidence in recent years.

An examination of subsidence monitoring data collected above the King 4 mine in 1990 and compared with baseline monitoring data established in 1988 substantiates the foregoing discussion. A fully extracted area (except for barrier pillars) in the King 4 mine averaging 800 ft. wide by 2,000 ft. long was mined in late 1988 and 1989. Overburden above this area is approximately 1,300 feet and the surface formation is the North Horn. Monitoring data show that the surface has subsided from 0.5 ft. to a maximum of 2.17 ft. over a broad area. No visible subsidence effects have been detected.

Exhibit 7-7 shows two springs (91-974 & 91-978) located just north of Hiawatha Coal Companies permit boundary in Section 13, T.15S., R.8E. These springs are within the zone of potential subsidence projected from Hiawatha's most northerly mine workings. Based on the previous discussion, recent field investigations and the following considerations, no material damage should occur to these springs from subsidence effects of Hiawatha coal Companies mine workings:

Mining was last conducted in the near vicinity of the springs in 1982. There are no longer any recoverable coal reserves in Hiawatha's property in this area and there is no access to mine workings closer than 3,000 feet from the springs. The reservoirs in the King 4 mine have been exhausted and the mine has been sealed. No future mining is projected. If any form of mining occurs in the area, adequate barriers along the proposed borders will be left to protect these springs.

The land surface in the vicinity of the springs is easily accessible, relatively gently sloping and mostly open brushland. No material damage to the surface of this area has been observed. The springs were examined during the spring and fall of 1992 and except for drought influences, show no diminution of normal flows.

**References**


Dunrud, C. Richard, 1976. Some Engineering Geologic Factors Controlling Coal Mine Subsidence in Utah and Colorado, U.S. Geological Survey Professional Paper 696, Washington, D.C.

Plateau Mining Company, 1981. Star Point Mines Mining and Reclamation Plan. Submitted to the Utah Division of Oil, Gas, and Mining, Salt Lake City, Utah.

Stokes, W.L. and R.E. Cohenour, 1956. Geologic Atlas of Utah Emery County. Bulletin 52. Utah Geological and Mineral Survey. Salt Lake City, Utah.

Utah Power and Light Company, 1981. Subsidence Report. Submitted to the Utah Division of Oil, Gas and Mining. Salt Lake City, Utah.

Utah Power and Light Company, 1982. Subsidence Control Report. Submitted to the Utah Division of Oil, Gas and Mining. Salt Lake City, Utah.

Utah Power and Light Company, 1983. Update of Deer Creek Coal Mine Permit Application. Submitted to the Utah Division of Oil, Gas and Mining, Salt Lake City, Utah.

Wardell, K., 1971. The Effects of Mineral and Other Underground Excavations on the Overlying Ground Surface. Symposium, Geological and Geographical Problems of Areas of High Population Density. Association of Engineering Geologists, Sacramento, California.

## **Runoff and Sediment Control Structures**

All disturbed areas associated with Hiawatha Coal ~~U.S. Fuel~~ Company's mining operations are protected by runoff and sediment control structures. Sediment ponds on the property have been designed and placed such that all disturbed area drainage will flow into and be contained in them. The ponds are designed with spillways, decant systems and oil skimmers in order to treat and control the water in the event of discharge from the ponds. The ponds, all constructed during the period of 1979 through 1981, have been assigned EPA identification numbers and are included in Hiawatha Coal's ~~U.S. Fuel's~~ NPDES Permit. To date (July, 1992) none of these ponds have discharged any water.

The King 4 and King 5 mine surface facilities are served by sediment pond No. D008. It's location along with diversion ditches are shown on the Middle Fork Surface Facilities map (Exhibit 5-5).

The King 6 mine, with surface facilities in South Fork is protected by two sediment ponds. Pond No. D009 contains runoff from the mine yard while pond No. D011 contains runoff from the truck loading facility. Undisturbed drainage from the surrounding canyons is diverted away from the disturbed areas by ditches and culverts. These structures are detailed on Exhibit 5-7. Interim revegetation operations have also been established in the South Fork area, see Exhibit 3-5.

The coal processing plant, along with slurry ponds, refuse piles, coal stockpile sites and maintenance facilities near Hiawatha are protected by sediment ponds D004, D005, D006 and

D007. These ponds, shown on Exhibit 5-9, have been strategically located to contain runoff from slurry pond embankments as well as other disturbed area runoff not contained in the slurry ponds themselves.

Sediment Pond D003, shown on Exhibit 7-18A serves to contain runoff from the upper coal storage yard (upper end of the railroad spur serving the processing plant).

In addition to sediment ponds designed to protect the larger disturbed areas, seven catch basins associated with smaller areas near the preparation plant have been constructed. These can also be seen on Exhibit 5-9.

A small disturbed site of approximately one acre containing a ventilation portal for the King 4 mine is located in the Left Fork of North Fork. This site, shown on Exhibit 5-4, is protected by a catch basin, silt fence structures and interim revegetation.

## R645-301-729 Cumulative Hydrologic Impact Assessment

This rule to be addressed by the Division with input provided by the Permit Application.

# R645-301-730 Operation Plan

# R645-301-731 General Requirements

### 731.100 Hydrologic Balance Protection

Surface-water and ground-water quality is protected by handling earth materials and runoff in a manner that minimizes acidic, toxic or other harmful infiltration to ground-water systems. The removal, handling, storage and transportation of overburden, excess spoil, coal mine waste, non-coal waste and underground development waste are discussed under R645-301-528 in Chapter 5. The handling of coal processing waste is also discussed under R645-301-528. The characteristics, concentrations of trace elements and suitability of refuse material for reclamation is covered in detail in R645-301-231.200 (Chapter 2, Soils). The nature and properties of overburden and excess spoil material existing in mine pads and their suitability for use in reclamation is described in R645-301-231.200. Tables 2-13, 2-14 and 2-15 give soil lab analysis for these materials.

Sedimentation ponds, catch basins, disturbed and undisturbed drainage ditches, culverts, down-spouts, check dams and interim revegetation have been employed at various sites throughout the permit area to protect the hydrologic balance. Sediment pond designs, proposals and as-built drawings are covered in this chapter under R645-301-732. Catch basin implementations are discussed under Small Area Exemptions in Appendix 5-8. Road drainage erosion control, culvert spacing, culvert down spouts and check dams are addressed under R645-

301-527 and R645-301-732. Interim Reclamation is given in R645-301-331 and in Appendix 5-7. Topsoil storage and protection is covered in R645-301-231.

To ensure compliance of all effluent parameters within the UPDES permit, Hiawatha Coal ~~U.S. Fuel~~ will implement the following steps:

1. Monitor according to the UPDES Permit.
2. Report monitoring results according to the UPDES Permit.
3. When exceedances occur, report the exceedances according to the UPDES Permit.
4. Implement changes required when the Division of Water Quality approves changes to the UPDES Permit.

## 731.200 Water Monitoring

**Ground-Water Monitoring Plan**

~~United States Fuel~~ Hiawatha Coal Company currently monitors springs included in its monitoring program twice each year (normally in July and October, depending on accessibility). Data collected during each visit includes; flow, PH, water temperature, and specific conductance. ~~Prior to 1986, spring samples were analyzed according to Table 7-12. In order to bring the monitoring program into line with the Division's "Guidelines For Establishment of Surface and Ground-water Monitoring Programs" (January, 1986)~~, ~~s~~Samples are ~~now~~ analyzed according to either Table 7-12~~13~~ or 7-15~~19~~. ~~The type of analyses to be done will depend on the year in which the samples are taken. Refer to the monitoring schedule given in Table 7-22.~~

## ~~TABLE 7-12~~

## ~~SPRING MONITORING PARAMETERS PRIOR TO 1986~~

~~Flow Rate~~
~~PH~~
~~Air and Water Temperature~~
~~Acidity*~~
~~Specific Conductance~~
~~Total Suspended Solids*~~
~~Total Dissolved Solids~~
~~Total Manganese*~~
~~Total Iron~~
~~Nitrate (as N)~~
~~Sulfate~~
~~Chloride~~
~~Oil and Grease*~~

~~* Surface and Mine Water Only~~

Collection of samples during July and October of each year corresponds to high and low flow periods. The area is largely inaccessible during those months of the year before July and after October. Hence, the frequency of sampling (twice each year during high and low flow periods) complies with the letter and intent of both the regulations and the "Guidelines for Establishment of Surface and Groundwater Monitoring Programs" prepared by the Division. Monitoring data is submitted to the Division on a quarterly basis.

Flow measurements are made with a V-notch weir on open springs and by the time-volume method where springs discharge from installed pipes.

Exhibit 7-1 shows the location of 14 numbered springs which ~~U.S. Fuel~~ haves been monitoreding ~~data for (see Appendix 7-12)~~. Several of these locations have been deleted due to changes in the Mine Plan or changes made by OSM and are noted as discontinued on the map and in the tables. Most of these springs were selected because of their location with respect to the mine workings and because they each had some flow during the drought year of 1977. Several others were selected to reflect a geologic variability of spring sources.

**TABLE 7-1~~3~~ 2**

**OPERATIONAL GROUND WATER ~~SPRING MONITORING~~ PARAMETER LIST**

**Field Measurements:**

- Flow
- PH
- Specific Conductance
- Temperature

**Laboratory Analyses:**

- Total Dissolved Solids
- Total Hardness ($CaCO_3$)
- Total Cations and Anions
- Carbonate
- Cation-Anion Balance
- Bicarbonate
- Calcium (Dissolved)
- Chloride
- Iron ~~(Diss.)~~ (Total and Dissolved)
- Magnesium (Dissolved)
- Manganese (Total and Dissolved)
- Potassium (Dissolved)
- Sodium
- Sulfate

During the period between 1977 and 1984 U.S. Fuel monitored springs SP-1 through SP-10. In 1984, based on a request from OSM to monitor "a representative number of springs that reflect variability of springs issuing from the geologic source and local groundwater systems that may be affected by the King Mines", U.S. Fuel added SP-11, 12, 13 and 14. Each of these, with the exception of SP-14 which issues from the Castle Gate sandstone, was within a zone of potential subsidence and shows signs of wildlife use.

In order to vary geologic sources and help gauge impacts resulting from subsidence U.S. Fuel added SP-11, SP-12 SP-13 and SP-14 and dropped SP-3, SP-7 and SP-10. SP-3 is located on the opposite side of the Bear Canyon Fault from the mine workings and should, therefore, not be affected by subsidence or other mining activities (see 728 ~~724.600~~ Areas of Potential Subsidence). In addition, as noted on Exhibit 7-7, no full extraction is planned in the future at the fault. SP-7 and SP-10 are now located out of the permit area far from current operations.

In December of 1985, U.S. Fuel Company leased the northern portion of Section 18, T.15S., R.8E. to Plateau Mining Company. Plateau assumed responsibility for the hydrologic monitoring in the upper portion of the right fork of Miller Creek (north of the middle of Section 18). In September 1988 DOGM allowed U.S. Fuel to delete monitoring stations SP-1 and SP-14 from their water monitoring program.

In March, 1986 U.S. Fuel sold a large coal block in the Mohrland (left fork of Cedar Creek) area. It was determined that monitoring stations SP-6, SP-8, SP-9 and ST-7 could be deleted because these sites would not be necessary in view of the fact U.S. Fuel no longer intended to mine in this area.

With the current spring monitoring program there is wide coverage of geologic formations (North Horn, Castle-gate and Blackhawk), wide geographic coverage of springs utilized by wildlife and livestock, monitoring of springs with water rights and monitoring of springs within the zone of potential subsidence. It should be noted that the new springs included in this program (SP-11, SP-12 and SP-13) issue from the base of the cliff-forming Castle-gate Sandstone and are not easily accessible. However, it was felt that monitoring would be desirable to gauge potential impacts due to subsidence. Spring monitoring data for past years is given in Appendix 7-12.

Exhibit 7-1 shows the locations of mine water discharge points monitored by U.S. Fuel Hiawatha Coal Company. These points have been assigned EPA identification numbers D001 D002, D010, D012 and D013. and are included in NPDES Permit No. UT-0023094. Discharge points D010, D012, and D013 are not included in the current discharge permit, but will be added to it again the next time it is renewed. Monitoring requirements for these points as required by the Permit issued Feb. 14, 1990 are given in Table 7-13 7-14.

Once mining resumes the sources for the water discharging at the Mohrland will be tested for age according to the method used in the Mayo report (Appendix 7-21).

## TABLE 7-143

## ~~EPA MONITORING REQUIREMENTS FOR~~ MINE WATER DISCHARGE PARAMETER LIST ~~POINTS~~ ~~(AS OF FEB. 14, 1990)~~

**Field**
Flow
PH
Conductivity
Temperature
**Operational***
Total Suspended Solids
Total Dissolved Solids
Total Iron
PH
Oil And Grease (if visible)

*Field parameters will also be sampled when an operational sample is taken

Point D001 is located at the Mohrland Portal (King No. 2 Mine) in Cedar Creek Canyon. This discharge is monitored twice a month from April through September and once a month during the rest of the year. D002 is overflow from the Hiawatha Town water tanks. This water originates from the Mohrland portal via the Mohrland Pipeline. Sampling is done ~~twice a month from April through September and~~ once a month ~~during the rest of the year~~. Point D010 is a discharge from the King 4 mine ventilation portal in North Fork Canyon and is currently inactive. ~~Sampling is done once a month when accessible~~. Point D012 is at a valve on the Mohrland Pipeline. Water is monitored at this point whenever the pipeline must be drained for major repairs. Point D013 is from an overflow pipe from the King 6 water tank in South Fork

Canyon. The King 6 mine is currently inactive and the water tank is not being used.~~ Mine water discharge sample analyses for past years is given in Appendix 7-13.~~

During the 2002 ~~1992~~ permit review the Division requested that persistent and measurable in-mine flows be monitored for quality quantity and seasonal variations. Currently all portals are sealed so no in-mine monitoring can be done. Once the seals are breached and mining is resumed Hiawatha will develop an underground water monitoring plan. The Division will be consulted during the development of this plan. ~~Towards this end U. S. Fuel will monitor the flow at point UG-1 (Exhibit 6-3). No mine workings are currently accessible south of this point and only a very limited area is accessible to the north and east. Due to the dip of the beds, monitoring the flow at this location will reflect the cumulative result of all sources originating in the King 4 mine north of the 10 West and 10 East sections. UG-1 will be monitored once in the spring (May or June) and once in the fall (Sept. or Oct.).~~ Monitoring parameters will be the same as those required by the EPA NPDES permit listed in Table 7-13 ~~7-14~~.

## SURFACE WATER MONITORING PLAN

~~United States Fuel~~ Hiawatha Coal Company currently monitors streams described in this program on a monthly basis when accessible. The location of each monitoring point is shown on Exhibit 7-1 and described in Table 7-15. Sample analyses are done semi-annually. ~~Table 7-16 presents the initial comprehensive parameter schedule used in September of 1979. Table 7-17 presents the routine analytical parameter schedule that has been followed from September 1979 to May 1986. From May 1986 to August 1988 Table 7-18 was used.~~ Samples collected ~~after~~

~~1988~~ will be analyzed according to either Table 7-15~~19~~ or 7-16~~20~~. ~~The type of analyses to be done will depend on the year in which the samples are taken. Refer to the monitoring schedule given in Table 7-21~~. ~~During the period from April to October, when no samples are collected, field parameters and flow will be measured.~~ The Water Monitoring Schedule is shown in Table 7-17.

~~Data collected for surface water has been ongoing since 1978. Refer to Table 7-21 for stream station monitoring history. From 1978 to September, 1986, U.S. Fuel monitored water on a monthly basis (depending on accessibility). For 1986, 1987 and 1988 stream locations were monitored April through October. Water samples collected were analyzed for the parameters in Table 7-18.~~ In late 1988 the groundwater and surface water programs were reviewed and revised. Samples will now be collected twice during the annual monitoring interval. Once during high flow, (April or May), and once during low flow, (September or October). Parameters listed in Table 7-15 ~~7-19~~ were ~~will be~~ run for all stations having flow in April or May and September or October during 1989 and 1990. ~~In 1991 and 1992~~ Currently the same monitoring schedule shown in Table 7-17 is used ~~will apply but~~ and analyses is ~~will be~~ done according to Table 7-16 ~~7-20~~.

U.S. Fuel ~~has been allowed to~~ discontinued certain monitoring points in the water program due to revised permit boundaries. In their September 21, 1988 letter, DOGM allowed U.S. Fuel to discontinue surface water monitoring point ST-7. On November 30, 1988, DOGM approved the cessation of monitoring for ST-2A, ST-6 and ST-6A. These locations have been marked as discontinued on Exhibit 7-1.

~~Surface water monitoring data collected over past years is given in Appendix 7-14.~~

**<u>Water Monitoring, General</u>**

Water monitoring stations have been established throughout the permit area to determine the impacts of the operation on the hydrologic balance (see Exhibit 7-1). Some examples of how this data can be used to assess impacts are presented under R645-301-728 "Effects of Mining on Streamflow" and "Impacts to Water Quality". However, since the Division has over the years carefully defined and revised the analysis parameters to be evaluated, it is felt that the Division is better suited to make determinations regarding this data. Hiawatha Coal ~~United States~~ Fuel Company commits to notify the Division or other agencies if a sample indicates noncompliance with applicable Federal and State water quality laws and regulations.

~~United States~~ Hiawatha Coal Fuel Company commits to remove all equipment, structures, and other devices used in conjunction with monitoring when they are no longer needed.

Water monitoring results are submitted to the Division at the end of the quarter following the quarter the samples were collected. All water monitoring data collected since 1978 can be obtained from the Division of Oil Gas and Mining Water Database.

**Table 7-145**
**Description of Surface Water Monitoring Points**

| Station | Description |
|---|---|
| **Surface Stations** | |
| ST-1 | Right Fork of North Fork of Miller Creek. This perennial tributary to Miller Creek is monitored with a Cipolletti weir installed just above the junction with Left Fork. This station is presently analyzed according to Tables 7-19, 7-20 and 7-21. |
| ST-2 | Left Fork of North Fork of Miller Creek. Three stations were monitored on this perennial tributary. One above the King 4 ventilation portal (ST-2), one above the Hiawatha No. 2 mine diversion point (ST-2A) and one between the diversion point and the junction with Right Fork (ST-2B). Location ST-2A was discontinued 11/20/88. Stations ST-2 and ST-2B will be monitored according to Table 7-16, 7-19, 7-20 and 7-21. |
| ST-3 | Middle Fork of Miller Creek. Three stations will be monitored on this tributary. One above the Middle Fork portals (ST-3A), one below the Middle Fork sediment pond (ST-3B) and one near the confluence with the North Fork of Miller Creek (ST-3). These stations are monitored according to table 7-16, 7-19, 7-20 and 7-21. |
| ST-4 | South Fork of Miller Creek. Three stations will be monitored on this tributary. One above the South Fork portal (ST-4A), one below the South Fork sediment pond (ST-4B) and one near the confluence with North Fork (ST-4). Water will be monitored according to Table 7-6 similarly to Middle Fork. |
| ST-5 | Miller Creek. This perennial stream will be monitored with a three foot Cipolletti weir at a point below the confluence of South Fork. Water will be monitored according to Table 7-16, 7-19, 7-20 and 7-21. |
| ST-6 | Cedar Creek. Two stations were monitored on this perennial stream. One above the old Mohrland mine portal (ST-6A), and one below the railroad yard (ST-6). Monitoring was done from 1978 until October, 1988 on these stations. They were discontinued on 11/30/88. |
| ST-7 | Gentry Hollow Creek. A recording station for this perennial stream was installed just above the junction with Wild Cattle Hollow. Due to the remote location of this point it was monitored on a semi-annual basis between 1978 and June, 1988. This station was discontinued on 11/30/88. |
| **Ground Water Stations** | |
| SP-2 | North Fork Spring. This station is located on top of Gentry Mountain above North Fork. Water will be monitored according to Table 7-6. |
| SP-4 | South Fork Spring. This station is located above South Fork near a hunting cabin. Water will be monitored according to Table 7-6. |
| SP-5 | Bald Ridge Spring. This station is on Bald Ridge. Water will be monitored according to Table 7-6. |
| SP-11 | North Fork Canyon Spring. This station is located approximately ½ mile above the North Fork mine portals. Water will be monitored according to Table 7-6. |

SP-12 Middle Fork Spring. This station is located on Gentry Mountain above Middle Fork. Water will be monitored according to Table 7-6.

SP-13 South Fork Canyon Spring. This station is located approximately ½ mile above the South Fork mine portals. Water will be monitored according to Table 7-6.

D001 Mohrland Mine Portal. Water will be monitored according to Table 7-6.

D002 This water comes through a pipeline from D001 to the Town of Hiawatha where it Discharges to Miller Creek. Water will be monitored according to Table 7-6.

**~~TABLE 7-16~~**

**~~STREAM MONITORING~~**

**~~INITIAL COMPREHENSIVE ANALYTICAL SCHEDULE (1979)~~**

~~Flow Rate~~
~~PH~~
~~Air and Water Temperature~~
~~Specific Conductance~~
~~Acidity (as $CACO_3$)~~
~~Total Suspended Solids~~
~~Total Dissolved Solids~~
~~Total Organic Carbon~~
~~Calcium~~
~~Manganese~~
~~Magnesium~~
~~Sodium~~
~~Potassium~~
~~Total Iron~~
~~Dissolved Iron~~
~~Iron~~
~~Carbonate~~
~~Fluoride~~
~~Bicarbonate~~
~~Chloride~~
~~Sulfate~~
~~Nitrate Plus Nitrite (as N)~~
~~Kjeldahl N~~
~~Dissolved Phosphorus~~
~~Silica~~
~~Trace Elements~~
~~Arsenic~~
~~Cadmium~~
~~Zinc~~
~~Selenium~~
~~Radioactivity~~
~~Gross Alpha~~
~~Gross Beta~~
~~Oil and Grease~~

## TABLE 7-17

## STREAM MONITORING
## ROUTINE SAMPLING ANALYTICAL SCHEDULE (1979-1986)

Flow Rate
PH
Air and Water Temperature
Acidity
Specific Conductance
Total Suspended Solids
Total Dissolved Solids
Total Manganese
Total Iron
Dissolved Iron
Nitrate (as N)
Sulfate
Chloride

## TABLE 7-18

## STREAM MONITORING
## ABBREVIATED SAMPLING ANALYTICAL SCHEDULE (1986- 1988)

Flow Rate
PH
Air and Water Temperature
Specific Conductance
Total Suspended Solids
Total Dissolved Solids
Alkalinity
Iron (Dissolved)
Oil and Grease
Sodium
Calcium
Magnesium
Potassium
Sulfate
Bicarbonate
Carbonate
Chloride

**Table 7-15~~19~~**

**Spring and Stream Monitoring**
**Baseline Sampling List ~~(After 1988)~~**

| | |
|---|---|
| Flow Rate | Sulfate ($SO_4^{-2}$) |
| PH | Sulfide ($SO_2^{-1}$) |
| Air and Water Temperature | Magnesium (Mg) |
| Conductivity | Manganese (Mn) |
| Dissolved Oxygen* | Mercury (Hg) |
| Total Suspended Solids ** | Molybdenum (Mo) |
| Total Dissolved Solids | Nickel (Ni) |
| Total Settleable Solids ** | Nitrogen: Ammonia ($NH_3$) |
| Total Hardness ($CaCO_3$) | Nitrate ($NO_3^{-1}$) |
| Total Cation Anion Balance | Recover Space |
| Acidity ** | Nitrite ($NO_2$) |
| Aluminum (Al) | Potassium (K) |
| Arsenic (As) | Phosphate Total ($PO_4^{-3}$) |
| Barium (Ba) | Selenium (Se) |
| Boron (B) | Sodium (Na) |
| Carbonate ($CO_3^{-2}$) | Zinc (Zn) |
| Bicarbonate ($HCO_3^{-1}$) | Oil and Grease** |
| Cadmium (Cd) | Cation-Anion Balance ** |
| Calcium (Ca) | |
| Chloride ($Cl^{-1}$) | |
| Chromium (Cr) | |
| Copper (Cu) | |
| Fluoride (Fl) | |
| Iron (Fe) Total | |
| Lead (Pb) | |

* Perennial Streams Only        ** Streams Only

For stream monitoring - major, minor ions and trace elements are to be analyzed in total and dissolved forms.

For spring monitoring - major, minor ions and trace elements are to be analyzed in dissolved form only.

**Table 7-1620**

**Stream Monitoring**
**Operational Sampling List (After 1988)**

**Field Measurements:**

- Flow Rate
- PH
- Air and Water Temperature
- Specific Conductance
- Dissolved Oxygen*

**Laboratory Analysis:**

- Total Suspended Solids
- Total Dissolved Solids
- Total Settleable Solids
- Total Cation and Anion
- Cation-Anion Balance
- Iron (Dissolved)
- Oil and Grease (If Observed)
- Sodium (Dissolved)
- Calcium (Dissolved)
- Magnesium (Dissolved)
- Potassium (Dissolved)
- Sulfate
- Bicarbonate
- Carbonate
- Chloride
- Total Hardness
- Acidity
- Manganese

* Perennial Steams Only

** Field parameters will also be sampled when an operational sample is taken.

## Table 7-17

## Water Monitoring Matrix

| STATION | JAN | FEB | MAR | ARP | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-2 | | | | Operational | Field | Field | Field | Field | Operational | Field | | |
| ST-2B | | | | Operational | Field | Field | Field | Field | Operational | Field | | |
| ST-3 | | | | Operational | Field | Field | Field | Field | Operational | Field | | |
| ST-3A | | | | Operational | Field | Field | Field | Field | Operational | Field | | |
| ST-3B | | | | Operational | Field | Field | Field | Field | Operational | Field | | |
| ST-4 | | | | Operational | Field | Field | Field | Field | Operational | Field | | |
| ST-4A | | | | Operational | Field | Field | Field | Field | Operational | Field | | |
| ST-4B | | | | Operational | Field | Field | Field | Field | Operational | Field | | |
| ST-5 | | | | Operational | Field | Field | Field | Field | Operational | Field | | |
| SP-2 | | | | | | Operational | | | | Operational | | |
| SP-4 | | | | | | Operational | | | | Operational | | |
| SP-5 | | | | | | Operational | | | | Operational | | |
| SP-11 | | | | | | Operational | | | | Operational | | |
| SP-12 | | | | | | Operational | | | | Operational | | |
| SP-13 | | | | | | Operational | | | | Operational | | |
| D001* | Field | Operational | Field | Field | Operational | Field | Field | Operational | Field | Operational | Field | Field |
| D002* | Field | Operational | Field | Field | Operational | Field | Field | Operational | Field | Operational | Field | Field |

*D001 and D002 Operational samples will be tested for the parameters in Table 7-13. All others will be tested according to Table 7-16.

## TABLE 7-21

## STREAM STATION MONITORING HISTORY

Monitoring of the stations listed below is indicated by a number or letter. The number refers to the parameter list the sample was analyzed for. The letter F means only field parameters were taken. A blank exists if either the station was inaccessible that month or there was no flow.

F = Field Parameters 16 = 7-16 17 = 7-17 18 = 7-18 19 = 7-19

20 = 7-20

1978

| STATION | JAN | FEB | MAR | ARP | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | | 16 | | | | | 17 | | |
| ST-2A | | | | | F | | F | | F | 17 | | |
| ST-2B | | | | | 16 | | F | | F | 17 | | |
| ST-3 | | | | | | 16 | | | | | | |
| ST-4 | | | | | | 16 | | | | | | |
| ST-5 | | | | | 16 | | F | | F | 17 | | |
| ST-6 | | | | | 16 | | F | | F | 17 | | |
| ST-7 | | | | | | | | | | 16 | | |

1979

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | | 17 | | | | 17 | 16 | 17 | 17 |
| ST-2A | | | | | F | | F | | F | F | | |
| ST-2B | | | | | 17 | | | | 17 | 16 | 17 | 17 |
| ST-3 | | | | | 17 | | | | 17 | 16 | | F |
| ST-4 | | | | | 17 | | | | | | | |
| ST-5 | | | | | 17 | | | | 17 | 16 | 17 | 17 |
| ST-6 | | | | | | 17 | | | 17 | 16 | 17 | |

1980

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| ST-2A | | | | | | F | | F | | F | | |
| ST-2B | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| ST-3 | | | | | | 17 | | | | 17 | | |
| ST-3A | | | | | | | 17 | 17 | | | | |
| ST-3B | | | | | | | 17 | 17 | | | | |
| ST-4 | | | | | | 17 | | 17 | | 17 | | |
| ST-4A | | | | | | | 17 | 17 | | | | |
| ST-4B | | | | | | | 17 | | | | | |
| ST-5 | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| ST-6 | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-7 | | | | | | 17 | | | | 17 | | |

1981

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | 17 | 17 | | 17 | 17 | 17 | 17 | 17 | 17 | | 17 | 17 |
| ST-2 | | | | | | 17 | 17 | 17 | 17 | | 17 | 17 |
| ST-2A | | | | F | | 17 | 17 | 17 | 17 | | 17 | 17 |
| ST-2B | 17 | | | 17 | 17 | 17 | 17 | 17 | 17 | | 17 | 17 |
| ST-3 | | | | F | | 17 | | 17 | 17 | | 17 | 17 |
| ST-3A | | | | | | 17 | | | | | | |
| ST-3B | | | | | | | | | | | | |
| ST-4 | | | | | | | | | | | | |
| ST-4A | | | | | | 17 | | | 17 | 17 | 17 | 17 |
| ST-4B | | | | | 17 | 17 | | | | | | |
| ST-5 | 17 | 17 | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| ST-6 | 17 | 17 | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| ST-6A | | | | | | | | | | 17 | 17 | |
| ST-7 | | | | | | 17 | | | | 17 | | |

TABLE 7-21 (Continued)
STREAM STATION MONITORING HISTORY

1982

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | | 17 | 17 | 17 | 17 | | 17 | 17 | |
| ST-2 | | | | | 17 | 17 | 17 | 17 | | 17 | | |
| ST-2A | | | | | 17 | 17 | 17 | 17 | | 17 | | |
| ST-2B | | | | | 17 | 17 | 17 | 17 | | 17 | 17 | |
| ST-3 | | | | 17 | 17 | 17 | 17 | 17 | | 17 | 17 | |
| ST-3A | | | | | 17 | 17 | 17 | | 17 | | | |
| ST-3B | | | | | 17 | 17 | 17 | | 17 | | | |
| ST-4 | | | | | 17 | 17 | 17 | 17 | | 17 | | |
| ST-4A | | | | | 17 | 17 | 17 | 17 | | 17 | | |
| ST-4B | | | | | 17 | 17 | 17 | 17 | | 17 | | |
| ST-5 | | | | 17 | 17 | 17 | 17 | 17 | | 17 | 17 | |
| ST-6 | | | | 17 | 17 | 17 | 17 | | 17 | 17 | 17 | 17 |
| ST-6A | | | | 17 | 17 | 17 | 17 | | 17 | 17 | 17 | |
| ST-7 | | | | | | | 17 | | | 17 | | |

1983

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-2 | | | | | | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-2A | | | | | | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-2B | | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-3 | 17 | 17 | 17 | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-3A | | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-3B | | | 17 | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-4 | | 17 | 17 | | 17 | | 17 | 17 | 17 | 17 | 17 | |
| ST-4A | | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-4B | | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-5 | 17 | 17 | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-6 | 17 | 17 | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-6A | | 17 | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-7 | | | | | | | 17 | | | | 17 | |

1984

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-2 | | | | | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-2A | | | | | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-2B | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-3 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-3A | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-3B | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-4 | | F | F | F | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-4A | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-4B | | | | | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-5 | | 17 | F | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-6 | 17 | 17 | F | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| ST-6A | 17 | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-7 | | | | | | | 17 | | | | | |

1985

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | 17 | 17 | 17 | | 17 | 17 | 17 | 17 | | |
| ST-2 | | | | 17 | 17 | | 17 | 17 | 17 | 17 | | |
| ST-2A | | | | 17 | 17 | | 17 | 17 | 17 | 17 | | |
| ST-2B | | | 17 | 17 | 17 | | 17 | 17 | 17 | 17 | | |
| ST-3 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| ST-3A | | | | 17 | 17 | 17 | 17 | | | | | |
| ST-3B | | | | 17 | 17 | 17 | 17 | 17 | | 17 | 17 | 17 |
| ST-4 | | | 17 | | 17 | 17 | 17 | 17 | 17 | 17 | | |
| ST-4A | | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| ST-4B | | | | 17 | 17 | 17 | 17 | | | | | |
| ST-5 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| ST-6 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| ST-6A | | | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| STY-7 | | | | | | 17 | | | 17 | | | |

## TABLE 7-21 (Continued)
## STREAM STATION MONITORING HISTORY

1986

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | 17 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-2 | | | | 17 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-2A | | | | 17 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-2B | | | | 17 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-3 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-3A | | | | 17 | 18 | 18 | 18 | 18 | 18 | | | |
| ST-3B | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-4 | | | 17 | | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-4A | | | | 17 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-4B | | | | | 18 | 18 | | | 18 | 18 | | |
| ST-5 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-6 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-6A | | | 17 | 17 | 18 | 18 | 18 | | 18 | 18 | | |
| ST-7 | | | | | 18 | | | | 18 | | | |

1987

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-2 | | | | | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-2A | | | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-2B | | | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-3 | | | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-3A | | | | | | | | | | | | |
| ST-3B | | | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-4 | | | | | 18 | 18 | 18 | 18 | | | | |
| ST-4A | | | | | 18 | 18 | 18 | | | | | |
| ST-4B | | | | | 18 | 18 | | | | | | |
| ST-5 | | | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-6 | | | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-6A | | | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | | |
| ST-7 | | | | | 18 | | | | | 18 | | |

1988

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | | 18 | 18 | 18 | 18 | 19 | F | | |
| ST-2 | | | | | 18 | 18 | 18 | 18 | 19 | F | | |
| ST-2A | | | | | 18 | 18 | 18 | 18 | 19 | F | | |
| ST-2B | | | | | 18 | 18 | 18 | 18 | 19 | F | | |
| ST-3 | | | | 18 | 18 | 18 | | 18 | 19 | F | | |
| ST-3A | | | | | | | | | | | | |
| ST-3B | | | | 18 | 18 | 18 | | | 19 | F | | |
| ST-4 | | | | | | | | | | | | |
| ST-4A | | | | | 18 | 18 | | | | | | |
| ST-4B | | | | | | 18 | | | | | | |
| ST-5 | | | | 18 | 18 | 18 | 18 | 18 | 19 | F | | |
| ST-6 | | | | 18 | 18 | 18 | 18 | 18 | 19 | F | | |
| ST-6A | | | | 18 | 18 | 18 | 18 | 18 | 19 | F | | |
| ST-7 | | | | | 18 | | | | | | | |

1989

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | 19 | F | F | F | F | 19 | F | | |
| ST-2 | | | | 19 | F | F | F | F | 19 | F | | |
| ST-2A | | | | 19 | F | F | F | F | 19 | F | | |
| ST-3 | | | | 19 | F | F | F | F | 19 | F | | |
| ST-3A | | | | 19 | F | F | F | F | 19 | F | | |
| ST-3B | | | | 19 | F | F | F | F | 19 | F | | |
| ST-4 | | | | 19 | F | F | F | F | 19 | F | | |
| ST-4A | | | | 19 | F | F | F | F | 19 | F | | |
| ST-4B | | | | 19 | F | F | F | F | 19 | F | | |
| ST-5 | | | | 19 | F | F | F | F | 19 | F | | |

TABLE 7-21 (Continued)
STREAM STATION MONITORING HISTORY

19 = To be sampled according to Table 7-19, Baseline Schedule
20 = To be sampled according to Table 7-20, Operational Schedule
F = Field measurements, (Flow taken at weir locations only

**1990**

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | 19 | F | F | F | F | 19 | F | | |
| ST-2 | | | | 19 | F | F | F | F | 19 | F | | |
| ST-2A | | | | 19 | F | F | F | F | 19 | F | | |
| ST-3 | | | | 19 | F | F | F | F | 19 | F | | |
| ST-3A | | | | 19 | F | F | F | F | 19 | F | | |
| ST-3B | | | | 19 | F | F | F | F | 19 | F | | |
| ST-4 | | | | 19 | F | F | F | F | 19 | F | | |
| ST-4A | | | | 19 | F | F | F | F | 19 | F | | |
| ST-4B | | | | 19 | F | F | F | F | 19 | F | | |
| ST-5 | | | | 19 | F | F | F | F | 19 | F | | |

1991

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-2 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-2A | | | | 20 | F | F | F | F | 20 | F | | |
| ST-3 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-3A | | | | 20 | F | F | F | F | 20 | F | | |
| ST-3B | | | | 20 | F | F | F | F | 20 | F | | |
| ST-4 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-4A | | | | 20 | F | F | F | F | 20 | F | | |
| ST-4B | | | | 20 | F | F | F | F | 20 | F | | |
| ST-5 | | | | 20 | F | F | F | F | 20 | F | | |

1992

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-2 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-2A | | | | 20 | F | F | F | F | 20 | F | | |
| ST-3 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-3A | | | | 20 | F | F | F | F | 20 | F | | |
| ST-3B | | | | 20 | F | F | F | F | 20 | F | | |
| ST-4 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-4A | | | | 20 | F | F | F | F | 20 | F | | |
| ST-4B | | | | 20 | F | F | F | F | 20 | F | | |
| ST-5 | | | | 20 | F | F | F | F | 20 | F | | |

1993

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST-1 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-2 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-2A | | | | 20 | F | F | F | F | 20 | F | | |
| ST-3 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-3A | | | | 20 | F | F | F | F | 20 | F | | |
| ST-3B | | | | 20 | F | F | F | F | 20 | F | | |
| ST-4 | | | | 20 | F | F | F | F | 20 | F | | |
| ST-4A | | | | 20 | F | F | F | F | 20 | F | | |
| ST-4B | | | | 20 | F | F | F | F | 20 | F | | |
| ST-5 | | | | 20 | F | F | F | F | 20 | F | | |

TABLE 7-22
STREAM STATION MONITORING HISTORY

Monitoring of the stations listed below is indicated by a number or letter. The number refers to the parameter list the sample was analyzed for.
A blank exists if either the station was inaccessible that month or there was no

12 = 7-12    13 = 7-13    19 = 7-19

1980

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-1 | | | | | | | 12 | | 12 | | | |
| SP-2 | | | | | | | 12 | | | 12 | | |
| SP-3 | | | | | | | 12 | | | 12 | | |
| SP-4 | | | | | | | 12 | | | 12 | | |
| SP-5 | | | | | | | 12 | | | 12 | | |
| SP-6 | | | | | | | 12 | | | 12 | | |
| SP-7 | | | | | | | 12 | | | 12 | | |
| SP-8 | | | | | | | 12 | | | 12 | | |
| SP-9 | | | | | | | 12 | | | 12 | | |
| SP-10 | | | | | | | 12 | | | 12 | | |

1981

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-1 | | | | | | | | 12 | | | | |
| SP-2 | | | | | | | | 12 | | 12 | | |
| SP-3 | | | | | | | | 12 | | | 12 | |
| SP-4 | | | | | | | | 12 | | 12 | | |
| SP-5 | | | | | | | | 12 | | 12 | | |
| SP-6 | | | | | | | 12 | | | 12 | | |
| SP-7 | | | | | | | 12 | | | 12 | | |
| SP-8 | | | | | | | 12 | 12 | 12 | 12 | 12 | |
| SP-9 | | | | | | | 12 | | | 12 | | |
| SP-10 | | | | | | | 12 | | | 12 | | |

1982

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-1 | | | | | | | 12 | | | 12 | | |
| SP-2 | | | | | | | | 12 | | | 12 | |
| SP-3 | | | | | | | 12 | | | 12 | | |
| SP-4 | | | | | | | 12 | | | 12 | | |
| SP-5 | | | | | | | 12 | | | 12 | | |
| SP-6 | | | | | | | 12 | | | 12 | | |
| SP-7 | | | | | | | 12 | | | 12 | | |
| SP-8 | | | | | 12 | 12 | 12 | 12 | | 12 | 12 | |
| SP-9 | | | | | | | 12 | | | 12 | | |
| SP-10 | | | | | | | 12 | | | 12 | | |

1983

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-1 | | | | | | | 12 | | | 12 | | |
| SP-2 | | | | | | | | 12 | | | | |
| SP-3 | | | | | | | 12 | | | 12 | | |
| SP-4 | | | | | | | 12 | | | 12 | | |
| SP-5 | | | | | | | 12 | | | 12 | | |
| SP-6 | | | | | | | 12 | | | 12 | | |
| SP-7 | | | | | | | 12 | | | 12 | | |
| SP-8 | | | | | 12 | | 12 | | 12 | | 12 | |
| SP-9 | | | | | | | 12 | | | 12 | | |
| SP-10 | | | | | | | 12 | | | 12 | | |

TABLE 7-22 (Continued)
STREAM STATION MONITORING HISTORY

1984

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-1 | | | | | | | 12 | | | | | |
| SP-2 | | | | | | | 12 | | | | | |
| SP-3 | | | | | | | 12 | | | | | |
| SP-4 | | | | | | | 12 | | | | | |
| SP-5 | | | | | | | 12 | | | | | |
| SP-6 | | | | | | | 12 | | | 12 | | |
| SP-7 | | | | | | | 12 | | | 12 | | |
| SP-8 | | | | 12 | | 12 | | 12 | | 12 | | |
| SP-9 | | | | | | | 12 | | | 12 | | |
| SP-10 | | | | | | | 12 | | | 12 | | |

1985

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-1 | | | | | | 12 | | | | 12 | | |
| SP-2 | | | | | | 12 | | | | 12 | | |
| SP-3 | | | | | | 12 | | | | 12 | | |
| SP-4 | | | | | | 12 | | | | 12 | | |
| SP-5 | | | | | | 12 | | | | 12 | | |
| SP-6 | | | | | | 12 | | | | 12 | | |
| SP-7 | | | | | | 12 | | | | 12 | | |
| SP-8 | | | | | | 12 | 12 | | | 12 | | |
| SP-9 | | | | | | 12 | | | | 12 | | |
| SP-10 | | | | | | 12 | | | | 12 | | |

1986

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-1 | | | | | | 13 | | | | 13 | | |
| SP-2 | | | | | | 13 | | | | 13 | | |
| SP-4 | | | | | | 13 | | | | 13 | | |
| SP-5 | | | | | | 13 | | | | | | |
| SP-6 | | | | | | 13 | | | | 13 | | |
| SP-8 | | | | | | 13 | | | | 13 | | |
| SP-9 | | | | | | 13 | | | | 13 | | |
| SP-11 | | | | | | | 13 | | | 13 | | |
| SP-12 | | | | | | 13 | | | | 13 | | |
| SP-13 | | | | | | 13 | | | | 13 | | |
| SP-14 | | | | | | 13 | | | | 13 | | |

1987

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-1 | | | | | | 13 | | | | 13 | | |
| SP-2 | | | | | | 13 | | | | 13 | | |
| SP-4 | | | | | | 13 | | | | 13 | | |
| SP-5 | | | | | | 13 | | | | 13 | | |
| SP-6 | | | | | | 13 | | | | 13 | | |
| SP-8 | | | | | | 13 | | | | 13 | | |
| SP-9 | | | | | | 13 | | | | 13 | | |
| SP-11 | | | | | | 13 | | | | 13 | | |
| SP-12 | | | | | | 13 | | | | 13 | | |
| SP-13 | | | | 13 | | | | | | 13 | | |
| SP-14 | | | | | | 13 | | | | 13 | | |

TABLE 7-22 (Continued)
STREAM STATION MONITORING HISTORY

1988

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-1 | | | | | | | 13 | | | | | |
| SP-2 | | | | | | | 13 | | | 13 | | |
| SP-4 | | | | | | 13 | | | | 13 | | |
| SP-5 | | | | | | 13 | | | | 13 | | |
| SP-6 | | | | | | 13 | | | 13 | | | |
| SP-8 | | | | | | | 13 | | 13 | | | |
| SP-9 | | | | | | 13 | | | | | | |
| SP-11 | | | | | | 13 | | | 13 | | | |
| SP-12 | | | | | | 13 | | | | | | |
| SP-13 | | | | | 13 | | | | 13 | | | |
| SP-14 | | | | | | | 13 | | | | | |

1989

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-2 | | | | | 13 | | | | | 13 | | |
| SP-4 | | | | | 13 | | | | | 13 | | |
| SP-5 | | | | | 13 | | | | | 13 | | |
| SP-11 | | | | | 13 | | | | | 13 | | |
| SP-12 | | | | | 13 | | | | | | | |
| SP-13 | | | | | 13 | | | | | | | |

1990

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-2 | | | | | | | 13 | | | 13 | | |
| SP-4 | | | | | | | 13 | | | 13 | | |
| SP-5 | | | | | | | 13 | | | 13 | | |
| SP-11 | | | | | | | 13 | | | 13 | | |
| SP-12 | | | | | | | 13 | | | 13 | | |
| SP-13 | | | | | | | | | | | | |

1991

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-2 | | | | | | | 13 | | | 13 | | |
| SP-4 | | | | | | | 13 | | | 13 | | |
| SP-5 | | | | | | | 13 | | | 13 | | |
| SP-11 | | | | | | | 13 | | | 13 | | |
| SP-12 | | | | | | | 13 | | | 13 | | |
| SP-13 | | | | | | | | | | | | |

1992

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-2 | | | | | | | 13 | | | | | |
| SP-4 | | | | | | | 13 | | | | | |
| SP-5 | | | | | | | 13 | | | | | |
| SP-11 | | | | | | | 13 | | | | | |
| SP-12 | | | | | | | 13 | | | | | |
| SP-13 | | | | | | | 13 | | | | | |

1993

| STATION | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP-2 | | | | | | | 13 | | | 19 | | |
| SP-4 | | | | | | | 13 | | | 19 | | |
| SP-5 | | | | | | | 13 | | | 19 | | |
| SP-11 | | | | | | | 13 | | | 19 | | |
| SP-12 | | | | | | | 13 | | | 19 | | |
| SP-13 | | | | | | | 13 | | | 19 | | |

## 731.300 Acid And Toxic-Forming Materials

Current methods of generation, handling, storage and disposal of excess spoil, overburden, coal mine waste, non-coal waste and underground development waste are discussed in Chapter 5 under R645-301-528. All previously existing underground storage tanks were excavated and disposed of in 1989 in accordance with State and Federal requirements. Coal refuse material, its composition and characteristics, is described in detail in Chapter 2 under R645-301-231.200. Six representative samples of coal refuse material were collected from the embankments of slurry ponds 1,3,4 and 5 in 1983 and 1984. The results of these tests, presented in Table 2-8 in Chapter 2, show no significant toxic effects to plants or wildlife. Soil samples taken from excess spoil existing in the Middle Fork and South Fork mine yards are also described under R645-301-231.200.

## 731.400 Transfer of Wells

In the past, exploration bore holes have been sealed according to a plan recommended by the USGS whereby multiple coal beds are cemented from the bottom of the hole to a point 50 feet above the highest coal bed that is 4 feet or greater in thickness. The hole collar is plugged with 5 feet of concrete. This same method will be used for future boreholes unless they are approved for water monitoring. There are no water wells in the permit area and none are proposed to be transferred.

**731.500 Discharges**

The Hiawatha No. 2 mine, abandoned in 1926, is used as a water storage reservoir for culinary and mining purposes at the King 4, 5 and 6 mines. Water is diverted into this mine from a stream diversion in the North (Right) Fork of Miller Creek. This diversion is approved under Certificate of Appropriation No. 2159 on file with the Division of Water Rights. A structural analysis, hazard assessment and monitoring plan for the reservoir, as required by MSHA and OSM is included in Appendix 5-2. This diversion is currently inactive and the bulkheads over at the #2 Mine portal were removed and the reservoir was drained. Once mining resumes the diversion and the reservoir will be used.

**731.600 Stream Buffer Zones**

Coal mining and reclamation operations are conducted within 100 feet of perennial streams at several locations within the permit area. These are the North Fork ventilation portal and the North Fork diversion shown on Exhibit 7-18D, the upper coal storage yard shown on Exhibit 7-18A, the Hiawatha processing plant and waste disposal sites shown on Exhibit 7-18A, and the ~~proposed~~ topsoil borrow areas shown on Exhibit 2-4A. Runoff and sediment control structures exist to protect water quality. These areas are designated as stream buffer zones and are marked with signs stating "Stream Buffer Zone do not Disturb".

**731.700 Cross Sections And Maps**

Exhibit 7-1 shows the locations of water supply intakes for current users of surface waters flowing into, out of, and within the permit area and those surface waters which will receive discharges from affected areas in the permit area.

Exhibit 7-1 shows the locations of each water diversion, collection, conveyance, treatment, storage and discharge facility to be used.

Exhibit 7-1 shows the locations and elevations of each station used for water monitoring during coal mining and reclamation operations.

Exhibits 7-18A through 7-18D show the locations of each ~~existing and proposed~~ sedimentation pond, impoundment and coal processing waste embankment.

Plan views and cross sections for each ~~existing and proposed~~ sedimentation pond are shown on Exhibits 7-8 through 7-17. Cross sections for slurry ponds and refuse embankments are shown in Appendices 5-1 and 5-3.

General cross-sections of the coal seams, geologic formations, and potentiometric surfaces are shown Plates 7-5, 7-6, and 7-23.

## R645-301-732 Sediment Control Measures

All disturbed areas associated with mining and reclamation operations are protected by sediment control structures. Most of the larger areas are served by sediment ponds or slurry ponds. Other disturbed areas, classified as Alternate Sediment Control Areas (ASCA's), utilize alternative methods of sediment control such as catch basins, silt fences and interim revegetation.

To minimize disturbance to the hydrologic cycle, sediment ponds and slurry ponds have been placed such that disturbed area drainage will flow into and be contained in them. The sediment ponds are designed with spillways and oil skimmers in order to treat and control the water in the event of discharge from the ponds. Each pond has been assigned an EPA identification number and will be ~~is~~ included in ~~U.S. Fuel's~~ Hiawatha's UPDES Permit when it is renewed. To date none of the ponds have discharged any water. Table 7-18 lists each pond and the area it serves.

**Table 7-18~~22~~**

**Sediment Pond Locations**

| Pond No. | Location |
|---|---|
| D003 | Upper Coal Storage Yard |
| D004 | North of Slurry Pond No. 1 |
| D005 | East of Slurry Pond No. 4 |
| D006 | North East of Slurry Pond No. 5 |
| D007 | South East of Slurry Pond No. 5 |
| D008 | Middle Fork Mine Yard |
| D009 | South Fork Mine Yard |
| D011 | South Fork Truck Loading Facility |

Rainfall-runoff relationships have been determined for each pond. Because of different periods of development, several engineering staffs have been involved in the individual sediment pond designs. A report compiled by Vaughn Hansen Associates and supplemented by Rolling Brown and Gunnell, Incorporated is included in Appendix 7-3. This appendix relates to sediment ponds D003 through D009. Appendix 7-4 deals with sediment pond D011. Original design drawings submitted to and approved by the Division during the period of 1979 through 1981 have since been replaced with as-built drawings shown on Exhibits 7-8 through 7-15.

At the present time, and as reclamation of the site continues, a substantial amount of disturbed area runoff is being treated by total containment in Slurry Pond 5A. This area is large enough to contain all proposed runoff without discharge (see Appendix 7-20).

Each disturbed area and its associated sediment control structures is described in the following paragraphs.

**North Fork Operations**

The North Fork ventilation portal area consisted of an access road (jeep trail), a small pad area, an intake air portal for the King 4 mine and a stream diversion structure utilized to divert and store water in an underground reservoir in the Hiawatha No. 2 mine. These facilities are shown on Exhibit 5-4 and in Appendix 5-14. The North Fork portal and pad area have been reclaimed at this time. It is currently designated as an ASCA area, shown on Exhibit 7-18D.

The area is treated by silt fences. The remaining reclamation work is very minor (remove silt fencing, pick up exposed pipe, etc.).

The stream diversion, originally constructed in 1951, consists of a small earth impoundment with a 12 inch diameter steel pipe inlet to convey water to the Hiawatha No. 2 mine where it was stored for use at the King 4, 5 and 6 mines. Since the diversion is proposed to be a permanent structure, it was upgraded in 1984 by constructing a larger spillway to pass a 100 year storm and by reshaping and revegetating the embankment. Designs and approvals are given in Appendix 5-14.

The North Fork access road which is used very infrequently (once a month by company personnel to monitor water and inspect sediment control structures) was improved in 1981 to facilitate drainage control. This consisted of installing gravel fords at two locations where the road crosses Miller Creek and numerous water bars and riprapped ditch outslopes. The drainage control program along with approval letters is located in Appendix 7-19.

**Middle Fork Mining Operations**

Runoff from the Middle Fork mine yard, coal stockpile area and truck loadout facility is contained by sediment pond D008. Exhibit 5-5 shows the location of the sediment pond along with disturbed and undisturbed drainage ditches and culverts. Pond D008 is designed to contain runoff from the disturbed areas as well as undisturbed runoff from the hillsides north and south of the disturbed areas. Rainfall-runoff relationships are given in Appendix 7-3. Exhibit 7-13 shows as-built details of the pond and the drainage areas contributing to it. Runoff from the upper mine yard area is collected at drop inlets near the eastern end of the yard and channeled through culverts to the sediment pond. Runoff from the coal stockpile and truck loadout areas is directed to the pond by culverts and diversion ditches. An erosion control analysis was conducted for the two larger ditches in the truck loadout yard to determine their adequacy to reduce erosion. The results of this analysis is included in Appendix 7-6.

Runoff from the area containing the water tank, tank access corridor and main substation is not conveyed to the sediment pond. This area is designated as an ASCA and is discussed in Appendix 5-8.

Undisturbed canyon stream flows are collected near the north west and south west corners of the disturbed area, then channeled by culverts beneath the disturbed areas and the sediment pond. Upon final reclamation, the original stream channel will be re-established. Design calculations for the restored channel are given in Appendix 7-6.

Two timber yards are located east of the Middle Fork mine yard and adjacent to the Middle Fork haul road (see Exhibit 7-18C). Because of the nature of the material stored here and the small area of disturbance (1.3 acres), they are classified as Alternate Sediment Control Areas. Berms have been constructed to retain water within the disturbed area and channel it toward approved outflow locations. The outflow route passes through gabion filter baskets filled with gravel to filter any runoff leaving the disturbed area.

An extensive study of the road drainage and erosion related to the Middle Fork haul road was conducted in 1984. Results of this study and procedures implemented to control erosion are presented in Appendix 5-13. The haul road is shown on Exhibit 5-6 and 7-18C.

**Middle Fork Reclamation Hydrology**

Mining has been temporarily stopped in the Middle Fork area. The present site configuration and hydrologic controls are shown on Exhibit 7-18C.

The sediment pond will be left in place until vegetation has been established. The bypass culvert will then be removed and replaced with a permanent channel. As the culvert is removed, the flows of Middle Fork (if any) will be directed into the sediment pond. Where slopes exceed 2H:1V, additional erosion protection will be provided by the use of erosion control matting. When vegetation has been established on the reclaimed areas, the pond and bypass culvert beneath will be removed and the channel restored. After the pond is removed, sediment control treatment for the reclaimed site will be accomplished by extensive roughening of the reclaimed surface, mulching, and vegetation. Silt fences will be used to control runoff until vegetation has been established. If required, sediment traps may also be employed.

Reclaimed road hydrology is discussed in Appendix 7-17.

**South Fork Mining Operations**

Two sedimentation ponds have been constructed to serve operations in South Fork. Pond D009 contains runoff from the King 6 mine yard. Pond D011 receives runoff from the coal stockpile and truck loadout facility. These ponds and related diversion structures are shown on Exhibit 7-18B.

Pond D009 is designed to contain sediment and storm water runoff from the disturbed area of the King 6 mine yard north and west of the pond. Two disturbed drainage diversion ditches, one on the north side and one on the south side of the access road, convey runoff to the pond. The diversion ditch south of the access road (DD24) collects the majority of the runoff from the disturbed area. An erosion control analysis of this ditch is included in Appendix 7-5. An 8" culvert (57) originally carried the runoff from the mine yard across the road into this ditch. Due to maintenance problems and plugging of this culvert, the runoff was diverted into DD58 and culvert 57 was abandoned in place. This culvert will be removed during reclamation of the road. The mine yard has earth berms around its eastern perimeter to ensure that all runoff is directed to the diversion ditches. Storm runoff from the hillsides north and south of the yard is also contained in the sediment pond. As-built construction details and drainage areas contributing to pond D009 are presented on Exhibit 7-14. Rainfall-runoff relationships are presented in Appendix 7-3.

Undisturbed stream drainage is bypassed beneath the mine yard by a 96 inch diameter culvert (26). The stream drainage is also bypassed beneath the sediment pond by a 2 inch culvert (36). Design calculations for these culverts are included in Appendix 7-19.

The water tank and access corridor at the extreme west end of the mine yard is designated as an ASCA. Erosion and sediment control for this area is discussed in Appendix 5-8.

The coal stockpile and truck loadout area located at the termination of the overland conveyor east of the King 6 mine yard is protected by sediment pond D011. A discussion of this area along with hydrologic information and pond sizing calculations is given in Appendix 7-4. As built construction details and drainage areas contributing to the pond are shown on Exhibit 7-15.

**South Fork Reclamation Hydrology**

The South Fork area is temporarily idled, and some reclamation activities have been initiated at this site. The portals have been sealed and some major structures, including the overland conveyor have been removed. The present site configuration and hydrologic controls are shown on Exhibit 7-18B.

Once all facilities are removed, the site will be reshaped and reclaimed according to the approved plan. Where slopes exceed 2H:1V, additional erosion protection will be provided by the use of erosion control matting. The 96" diameter bypass culvert will be left in place as long as possible. At the appropriate time the bypass culvert will be removed and replaced with a reclaimed stream channel. The 48" cmp culvert which passes beneath the sediment pond D009 will remain in place to pass the reclaimed channel drainage. The reclaimed channel will be protected by silt fence installations. Runoff from the reclaimed mine yard and portal areas will be directed to sediment pond D009. When there is sufficient vegetation established on the reclaimed areas to act as a vegetative filter, the sediment pond and bypass culverts will be removed and those areas will be reclaimed.

Runoff from the coal stockpile and truck loadout areas will continue to go to sediment pond D011. Also, this area can be reclaimed without affecting the undisturbed drainage. After vegetation is established, the sediment pond and undisturbed drainage diversion can be easily removed. During the removal of each of the sediment ponds silt fencing, sediment traps, roughening and mulching may be utilized to treat the runoff.

The proposed reclaimed road hydrology is discussed in Appendix 7-17.

**Hiawatha Processing Plant And Waste Disposal Areas**

Disturbed areas associated with the coal processing plant, railroad and equipment yards and refuse disposal sites are shown on Exhibits 5-6, 5-9, and 7-18A. These areas, extending from the upper railroad yard in the west to slurry pond No. 5 in the east, are protected by five sedimentation ponds strategically located around the downslope perimeter of the disturbed area. As can be seen on Exhibit 7-18A the majority of runoff from the disturbed area is directed to and contained in slurry impoundments, therefore, the sediment ponds are sized and located to collect runoff mainly from the outside embankments of the slurry impoundments.

The sediment ponds, identified by EPA identification numbers D003, D004, D005, D006 and D007 were designed to contain sediment and storm water runoff from a ten year, twenty four hour storm event. All have decant systems with oil skimmer inlets and spillways designed to safely pass a 25-year 6-hour storm. Design criteria for these ponds is included in Appendix 7-3. Construction design drawings were approved by the Division in 1979 and 1980. Design drawings have since been replaced with certified as-built drawings given in Exhibits 7-8 through 7-12. These drawings depict the existing configuration of the ponds and show their design versus as-built capacities. Runoff areas contributing to each pond are also shown.

Storm runoff from major undisturbed drainages are bypassed beneath the disturbed area by culvert systems. Runoff from within the disturbed area, other than slurry impoundment surfaces, drains toward the Hiawatha spur railroad tracks. It then, more or less, follows the tracks to a point near their junction with the Utah Railroad track system. Here it is channeled by a 36 inch diameter culvert beneath the Utah Railroad tracks and conveyed to slurry pond No. 5, cell 5A.

A 1.2 acre storage yard south of the mine office in Hiawatha is included as part of the disturbed area. Surface drainage from this yard as well as from the town of Hiawatha is also conveyed via overland flow to slurry pond No. 5. The drainage water from the storage yard amounts to 0.10 acre ft. (see calculations in Appendix 7-8). Sedimentation from this small area is estimated at 0.001 acre ft. per year. This sediment will be held by slurry pond No. 5A. During and after reclamation, sediment control for this area will be included with sedimentation control for the Hiawatha facilities.

A haul truck maintenance yard located near the junction of the Middle Fork and South Fork haul roads (Exhibit 7-18A) and comprising 1.86 acres is included in the disturbed area. This yard has been classified as an Alternate Sediment Control Area. Sediment control is provided by full containment of storm water runoff within the disturbed area. See Appendix 7-11 for site maps and hydrologic calculations.

In 1979 the embankment of slurry pond No. 1 was reconstructed to comply with MSHA stability requirements. In order to reconstruct the embankment and establish room for a sedimentation pond near its toe (sediment pond D004), the Miller Creek stream channel was realigned. The channel realignment was approved along with the slurry pond reconstruction plans. In 1984 the Division required additional stability control measures for the realigned stream channel. These measures and their implementation are given in Appendix 7-7.

**Hiawatha Area Reclamation Hydrology**

Certain parts of the Hiawatha Area are being contemporaneously reclaimed. Approximately 40.29 acres have been reclaimed and reseeded at this time (Slurry Pond No. 2, No. 4 Refuse Pile, Preparation Plant Area and Borrow Area F). Another 22.73 acres of Slurry

Pond 5 have been topsoiled. The present site configuration and hydrologic controls are shown on Exhibit 7-18A.

All sediment ponds will remain in place until adequate vegetation has been established unless an ASCA treatment is approved for the site. ASCA sites will continue to be treated as they are at present. The majority of the reclaimed site drainage will be contained in Slurry Pond 5A, as described in Appendix 7-20. Adequacy of the existing drainage control structures is detailed in Appendices 7-3, 7-19 and 7-20.

**Slurry Pond #5 Main Cell**

The main cell of Slurry Pond #5 was so large that an initial regrading to final contour would have overwhelmed the existing sediment controls, especially pond D007. It would have also channeled significant amounts of surface runoff over a fairly long, unvegetated outslope which would have resulted in some significant erosion channels. Therefore, the main cell is being reclaimed in stages.

After recovering the pond fines from the main cell, the refuse outslopes were regraded to the interior of the pond. The outslopes were regraded to approximately a 5 to 1 slope to help control erosion. During the regrading, the interior of Slurry Pond #5 was constructed to drain into cell 5A. Cell 5A is more than adequate to handle the runoff from the main cell; see

Appendix 7-20. This design eliminated the certainty of serious erosion and possible sediment pond failure.

When slurry cell 5A is reclaimed, it will be contoured as shown on Exhibit 5-13. The slope will allow the runoff to gradually drain to the northwest, towards SR122. This will prevent the runoff from running over the steeper slopes, avoid possible excessive erosion.

**Slurry Pond #1**

Slurry Pond #1 currently acts as its own sedimentation control. During reclamation, this pond will be regraded so that it will not impound water. At that time, the small amount of additional water from the interior of Slurry Pond #1 will be treated by Sediment Pond D004. By ditching Refuse Pile #1 so that it reports to Slurry Pond 5A rather than D004, the capacity requirements of D004 will stay about the same.

**Slurry Pond #5 Cell 5A**

This cell will be the last slurry pond cell to be reclaimed. It will act as sediment control for much of the Hiawatha area during final reclamation. Once 5egetation is reestablished on the areas reporting to cell 5A, it will be regraded to the final contours as shown on Exhibits 5-13. The top of the pond will be maintained in a roughened condition, in conjunction with a positive but gradual slope to aid in sediment control. The runoff from this slurry pond will continue to report to sediment pond D006.

**Preparation Plant Area**

The runoff from the preparation plant area currently reports to cell 5A. Since the final contours will not change the basic drainage pattern, no changes in sediment control are anticipated.

**Upper Rail Yard**

Throughout the operating and reclamation phases, this area should continue to report to Sediment Pond D003.

**Savage Truck Yard, Gravel Storage Area, ASCA's in General**

Silt fencing, roughening and 5egetative filtering will be utilized for sediment control while reclaiming these areas.

**Substitute Topsoil Borrow Areas**

Exhibit 2-4A shows the location of three borrow areas proposed to be utilized for substitute topsoil material during final reclamation and 5 potential borrow sites to be used only if the 3 main sites cannot provide adequate material. Mitigation of water quality impacts is proposed for these sites. Borrow areas A, B, C, D and E are on tributaries of, or adjacent to Miller Creek, a perennial stream. Borrow Area A is located on an ephemeral tributary of Miller Creek with potential borrow areas B, C, D, and E located on alluvial terraces contiguous to Miller Creek.

Hydrologic controls are already in place for the three borrow areas which will be used. Borrow Area A is currently in use. Hydrologic controls for this area have been approved and implemented (see Appendix 7-18). Runoff is treated by a silt fence at the lower southeast corner of the site. The Lower Preparation Plant Borrow Area is located within the disturbed area. Runoff from this site is treated in Slurry Pond 5A, as shown on Exhibit 7-18A. The Upper Rail Storage Yard Borrow Area is also within the disturbed area. Runoff from this site is treated in Sediment Pond D003, also shown on Exhibit 7-18A.

Potential Borrow Areas will not be utilized unless insufficient material is obtained from the 3 proposed areas listed above. Of the 5 areas, the Ridge Borrow Area (Exhibit 2-4A) would be the first to be used, since it is within the disturbed area and runoff could be treated in Sediment Pond D004. Specific plans would be submitted to the Division for any other potential borrow areas prior to disturbance.

## R645-301-733 Impoundments

Two slurry impoundments, one underground reservoir and eight sedimentation ponds are currently maintained within the permit area. All are temporary impoundments. No permanent impoundments are proposed.

Plans, cross-sections and stability investigations for the slurry impoundments are given in Appendix 5-1. Certification is discussed under R645-301-513. Their location and configuration are shown on Exhibit 7-18A. Inspection requirements are given under R645-301-515 and 528.

The underground reservoir is discussed under R645-301-513.200, 513.600 and 514.300. Designs and stability information is given in Appendix 5-2. It's location and configuration is shown on Exhibits 5-15, 5-16 and 7-1.

Sedimentation ponds are discussed in this chapter under R645-301-732. Designs and calculations can be found in Appendices 7-3 and 7-4. Locations, plans and cross-sections are shown on Exhibits 7-8 through 7-15. Inspections and certifications are discussed in R645-301-514.300 and R645-301-732.

## R645-301-734 Discharge Structures

Due to the size and location of the two existing slurry impoundments, no discharge structures have been constructed. Slurry impoundment No. 1 is a side-hill type impoundment, isolated from runoff by embankments and natural drainage ditches. Slurry Pond No. 4 has been reclaimed. Slurry pond No. 5A is also a side-hill type impoundment, however, drainage from the processing plant area, railroad spur, part of the town and some hillside drainage is directed into it as a means of containing disturbed area runoff. The pond will provide sufficient freeboard to safely contain any additional storm runoff without any discharge, (see Appendix 7-20).

Discharge structures for sediment ponds are detailed on Exhibits 7-8 through 7-15. Sizing calculations are provided in Appendices 7-3 and 7-4.

Discharge structures for the North Fork stream diversion is given in Appendix 5-14. Erosion control structures for the Miller Creek diversion north of slurry pond No. 1 is given in Appendix 7-7.

## R645-301-735 Disposal of Excess Spoil

Excess spoil was removed from areas in the V~~5~~icinity of mine portals and used in the construction of pads for surface facilities, mostly prior to the Coal Mining and Reclamation Act. This material remains in place adjacent to the areas from which it was removed and will be utilized to reshape slopes during final reclamation. No spoil material has been deposited in areas other than adjacent to the location from which it was derived. No additional excess spoil is proposed to be generated during the term of this permit.

Adverse effects of surface runoff from these fills are controlled by diversion ditches and sediment ponds downslope from the fills. Numerous samples of this material have been collected and analyzed (see R645-301-230 in Chapter 2). They do not contain acid or toxic forming material and are suitable for final reclamation. No impoundments are located on the fills.

## R645-301-736 Coal Mine Waste

See R645-301-528.330 in Chapter 5 for a discussion of generation, storage and disposal of coal mine waste.

## R645-301-737 Noncoal Mine Waste

Generation, storage and disposal of non-coal mine waste is discussed under R645-301-528.330 in Chapter 5.

## R645-301-738 Temporary Casing and Sealing of Wells

No wells have been identified in the permit area to be used to monitor ground water conditions.

## R645-301-742 Sediment Control Measures

See R645-301-732 for a discussion of the sediment control measures. The primary sediment control for the minesite is through the use of sedimentation ponds. There are six ASCA areas, shown on Exhibits 7-18. Designs for the ASCA controls are given in Appendix 7-15. All of the sedimentation ponds and ASCA control structures will remain in place following reclamation activities until the 5egetation has been established on the reclaimed areas and the reclaimed areas have met the requirements for Phase 2 Bond Release. Then the sediment ponds, ASCA catch basins, and other ASCA control structures will be removed and reclaimed.

ASCA sediment control for these areas will be provided by a combination of surface roughening, mulching and 5egetation establishment. Where the disturbed area is small and flat, surface roughening will be used for treatment until 5egetation is established. When necessary, erosion on steep areas will be controlled by the placement of erosion control matting until 5egetation is established.

## R645-301-750 Performance Standards

The sampling frequency for all water monitoring sites is shown in Table 7-17. All water monitoring data is submitted to the Division of Oil Gas and Mining at the end of the quarter following the quarter the samples were collected. Information from mine water discharge sites is submitted to the Division of Water Quality at the end of the quarter the samples were taken.

## R645-301-760 Reclamation Hydrology

Designs for post-mining diversions are found in Appendix 7-19. Diversions are shown on Exhibits 5-11, 5-12, 5-13, 5-19 and 5-20.