SOIL-WATER HYDROLOGY AND GEOCHEMISTRY OF A COAL SPOIL AT A RECLAIMED SURFACE MINE IN ROUTT COUNTY, COLORADO

By Robert S. Williams, Jr., and Stephen E. Hammond

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CONVERSION FACTORS

Inch-pound units used in this report may be converted to metric (International System) units by using the following conversion factors:

Multiply inch-pound unit	*By*	*To obtain SI unit*
atmosphere (atm)	6.895	kilopascal
cubic foot (ft^3)	0.028317	cubic meter
cubic foot per second (ft^3/s)	0.028317	cubic meter per second
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
gallon per minute (gal/min)	0.0630	liter per second
inch (in.)	25.40	millimeter
inch per year (in/yr)	25.40	millimeters per year
mile (mi)	1.609	kilometer
square foot (ft^2)	0.0929	square meter
square mile (mi^2)	2.590	square kilometer
British thermal unit (BTU)	1054.8	joule

Temperature in degree Celsius (°C) may be converted to degree Fahrenheit (°F) by using the following equation:

$$°F=9/5\ °C+32.$$

Temperature in degree Fahrenheit (°F) may be converted to degree Celsius (°C) by using the following equation:

$$°C=(°F-32)\times 5/9.$$

The following terms and abbreviations also are used in this report:

milligram per liter (mg/L)
microgram per liter (µg/L)
microsiemens per centimeter at 25° Celsius (µS/cm)

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level of 1929."

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ABSTRACT

Coal-spoil water quantity and quality were monitored, by five drainage-type lysimeters installed in a reclaimed coal spoil. Soil-water access tubes were used to monitor soil-water content at the coal spoil and at an adjacent undisturbed area.

Results of the monitoring indicate that the undisturbed soils are nearly saturated at 4.5 to 5 feet. Coal spoils are not near saturation at similar depths. Normal recharge in the nearby unmined area is estimated to be about 0.5 inch per year. At a depth of 8 feet, 2 to 6 inches of water per unit surface area is percolating through the coal spoil in the lysimeters. The water is potential recharge to a coal-spoil aquifer.

The coal-spoil leachate has an average dissolved-solids concentration of 3,600 milligrams per liter. Calcium (460 milligrams per liter), magnesium (370 milligrams per liter), and sulfate (2,540 milligrams per liter) are the dominant ions in the leachate; sodium (111 milligrams per liter) and bicarbonate (224 milligrams per liter) are present in lesser concentrations. Gypsum dissolution and carbonate dissolution by carbonic acid from carbon dioxide and by sulfuric acid from pyrite oxidation account for most of the dissolved-solids concentration. Saturation indices indicate that the water is saturated with many minerals and is composed of the aforementioned ions.

INTRODUCTION

Increasing energy demands throughout the United States have resulted in a renewed interest in using coal as a source of energy. In northwestern Colorado, as in other parts of the United States, surface mining is an economical way of mining the coal reserves.

During surface mining the overburden is broken up and removed from above the coal seams; this destroys the natural layering found in sedimentary deposits. The overburden material is placed in coal-spoil piles that are eventually recontoured to approximate the original land surface.

During spoil-pile placement and after the coal spoil is reclaimed, water from precipitation can enter the coal spoil. The ease of water movement, the quantity of water moving, and the quality of the water in a coal spoil may be different from a similar undisturbed area. The quantity and quality of water in the semiarid West is a prime concern to water users. Water from precipitation may percolate to ground water more easily or less easily through a coal spoil than through an undisturbed area. If water infiltrates into the coal spoil more easily than through the undisturbed area, then more water may be available for ground-water recharge; thus the volume of water in ground-water storage can increase. Evapotranspiration also can limit the quantity of ground-water recharge by removing the water from the subsurface. If the ground-water recharges a stream, then base flow can increase. However, if the coal-spoil recharge is less than the undisturbed area recharge, then the reverse of the condition mentioned before may exist, and ground-water and surface-water sources may decrease in areas of coal surface mining.

The quality of water that moves through a coal spoil is as important as the quantity. The water flowing through the coal spoil generally will have increased concentrations of dissolved solids. This increase in dissolved-solids concentrations can be detrimental, if the spoil water is a source of surface or ground water. For instance, crop production may be decreased or even unfeasible as a result of increased dissolved-solids concentrations. Use of the water by downstream municipalities also may be affected, because of the extra water purification required to make the water potable. Domestic use of ground water also may be limited by increased concentration of dissolved solids.

Some of the surface coal mines in northwestern Colorado are found throughout much of the area of recharge in their respective drainage basins. As a result, the mine may have a considerable effect on the hydrology of that basin. The water flowing from the basin then can affect adjacent larger basins. In locations where a number of separate surface coal mines affect small separate drainage basins, the cumulative effect on a larger drainage basin may be substantial. Therefore, surface coal mining has the potential to alter the natural hydrologic system. The alteration may result from changes in both the quantity of water and the quality of water.

In 1977, the U.S. Geological Survey, in cooperation with the U.S. Bureau of Land Management, began a study to determine and compare the quantity and quality of water in a coal spoil and in an adjacent undisturbed site in northwestern Colorado. The objectives were to define water movement, water chemistry, and chemical processes in the unsaturated part of the coal spoil and in the undisturbed area.

Purpose and Scope

This report describes:

1. Water movement through the unsaturated top 6 ft of a reclaimed coal spoil. The water percolating through the reclaimed coal spoil can evaporate, can be used for plant respiration and growth, or can percolate to the ground-water system. Soil-water movement also was monitored at a nearby undisturbed site. The undisturbed site was used to compare natural conditions with reclaimed coal-spoil disturbed conditions; and
2. Water chemistry and chemical processes in the unsaturated top 6 ft of a reclaimed coal spoil. The reclaimed coal spoil in this study is an area of recharge for the drainage basin. The relatively unpolluted precipitation that enters and flows through the reclaimed coal spoil may undergo a very different chemical evolution than precipitation that enters and flows through an undisturbed soil. The difference may determine if the reclaimed coal-spoil water continues to be suitable for its previous use or for any intended use.

The approach to monitoring the quantity and quality of water moving through the coal spoil and the unditurbed area was to use lysimeters and soil-water access tubes. The lysimeters at the coal spoil were used to collect water for measuring water quantity flowing out of the lysimeters and also to obtain water samples for chemical analysis. The soil-water access tubes were used to measure soil-water content, so that comparisons could be made between soil-water content in the coal spoil and a nearby undisturbed soil.

The report evaluates water-quantity and water-quality data collected at a coal spoil at the Seneca Mine, operated by Peabody Coal Company[1], in Routt County, Colo. Data collection began in 1978 and continued through 1980.

Acknowledgments

This study was funded in cooperation with the U.S. Bureau of Land Management. The study was done at the Seneca Mine, and the authors would like to thank the mine operators and employees of Peabody Coal Company for the use of their property and their cooperation throughout the study.

PREVIOUS WORK

The geology of northwestern Colorado has been described by many authors: Berman and others, 1980; Campbell, 1923; Pearl, 1974; Gaffke, 1979; Miller, 1975; Parsons and Liddell, 1903; Ryer, 1977. Maps of the area also are available (Dames and Moore, 1980a, 1980*b*; Tweto, 1976). The American Geological Institute (1976) published a bibliography and index of Colorado geology.

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[1] The use of trade, product, industry, or firm names in this report is for identification or location purposes only and does not constitute endorsement of products by the U.S. Geological Survey nor impute responsibility for any present or potential effects on the natural resources.

Both surface-water and ground-water chemical properties have been studied in northwestern Colorado. Basic data are available for water quality of surface water and ground water in northwestern Colorado (Giles and Brogden, 1978; Gaydos, 1980). Brogden and Giles (1977) discussed the availability of ground water, the quality of ground water, and ground-water circulation near the study area. Chemical and bacteriological data were collected by Covay and Tobin (1981) to describe the quality of water from selected geologic units in Routt County, Colo. Boettcher (1972) reported on the occurrence of ground water in the area.

The U.S. Geological Survey studied the effect of coal mining on regional water resources (Steele and others, 1979; Steele and Hillier, 1981). The Yampa River is the major river draining near the Seneca Mine. Changes in surface-water quantity and quality at the Seneca Mine and adjacent mines may affect the Yampa River. A general survey of the water quality of the Yampa River was conducted during 1972 by the Colorado Department of Health (Misbach, 1972). At that time it was determined that, "The Yampa River is meeting water-quality standards for the State of Colorado with the exception of pH violations exceeding the 8.5 maximum allowable limit in 17 of 28 river sampling points." Wentz and Steele (1980) analyzed the stream quality of the Yampa River and found a 14-percent increase in specific conductance since 1951. They attributed the change to increased agricultural and municipal use of water. Small streams near the study area were found to be saturated with respect to common carbonate minerals (calcium, magnesium, iron, manganese, and lead) (Turk and Parker, 1982).

Revegetating disturbed lands has been a prime concern in mine-land reclamation. "Reclamation of drastically disturbed lands" (Schaller and Sutton, 1978) encompasses a wide range of topics on reclamation. Techniques for vegetation analysis and measurement at mine sites are given by Cook and Bonham (1977). Revegetation and stabilization guidelines for mine sites are reported by Cook and others (1974). A series of workshop proceedings was published through Colorado State University (Berg and others, 1974; Zuck and Brown, 1976; Kenny, 1978; Jackson and Schuster, 1980). The topic of the workshops was revegetation of high-altitude disturbed lands, which includes reclamation of mined land as well as other disturbed lands.

The Piceance basin is about 70 mi southwest of Hayden, Colo. (fig. 1). The topography, vegetation, and precipitation are similar in the Piceance basin and in the study area for this report. Therefore, some of the results of work done in the Piceance basin will be used in this report to estimate conditions in the study area. Ficke and others (1974) and Weeks and Welder (1974) published basic data on the hydrology of the Piceance basin. A water balance for the Piceance basin was estimated by Wymore (1974). Weeks and others (1974) used a digital watershed model and a digital ground-water model to simulate the effects of oil-shale development on the hydrology of the Piceance basin. A digital model was used to simulate ground-water flow in the Piceance basin (Weeks, 1978). A detailed description of the model is in the report. A mathematical model was used to simulate the ground-water-quality changes that would occur as a result of mine activities in the Piceance basin (Robson and Saulnier, 1981).

Mine drainage can contaminate natural water resources, both during and after mining. A reconnaissance study of the effect of mine drainage on water quality in Colorado was designed to identify areas of surface-water degradation (Wentz, 1974). Subsequent to the study, 17 areas within Colorado were chosen for additional study (Moran and Wentz, 1974). The study concluded that significant quantities of trace elements are added to streams from metal-mine drainage, but that, with enough time and downstream distance, the streams can recover naturally. Turk (1982) investigated the thermodynamic controls on water quality from underground coal mines in Colorado. Turk determined that the water quality had developed by interaction of calcite-saturated ground water with sodium-rich marine shales.

The effects of soil-surface manipulation on water pollution at semiarid mined lands were investigated by Dollhopf and others (1977). The authors, in their interim report, stated that watersheds that contain topsoil produce less runoff than watersheds without topsoil. The authors also stated that unsaturated soil-water flow is an important component of the coal-spoil hydrologic cycle and actually may control the long-term success of vegetation reclamation procedures.

Hounslow and others (1978) used factor analysis to establish relations among rock and water variables. The predictive method was designed to be an efficient and economical means of predicting potential changes in ground-water quality that result from surface mining of coal.

McWhorter and others (1977) studied various aspects of coal spoil. Some of their conclusions follow and are of interest for this report. The coal spoil has no layers; thus, water percolates vertically through the coal spoil, until it reaches a water table or rock stratum. The deep percolation enables considerable dissolution of soluble minerals, and there is a resulting large dissolved-solids concentration in the ground water. The ions most commonly found are calcium, magnesium, sodium, bicarbonate, and sulfate. The large concentrations are not expected to decrease for many decades.

DESCRIPTION OF STUDY AREA

The coal-spoil study area is 6 mi southeast of Hayden, Colo., in secs. 34 and 35 of T. 6 N., R. 87 W., within the Grassy Creek drainage (fig. 1). Grassy Creek, the main drainage, flows to the north. The study area is at the Seneca Mine, which is operated by the Peabody Coal Company. Because coal mining began during 1968, a large part of the study area previously has been strip mined and subsequently reclaimed. The original southwesterly aspect still remains; however, the altitude and the surface contours have changed a little, and components of the hydrologic cycle associated with the coal spoil have changed. The part of the watershed surrounding the study area ranges in altitude from 6,600 to 7,300 ft and is approximately 7.5 mi^2 in area. Vegetation at the site consists primarily of grasses, sage, and oakbrush.

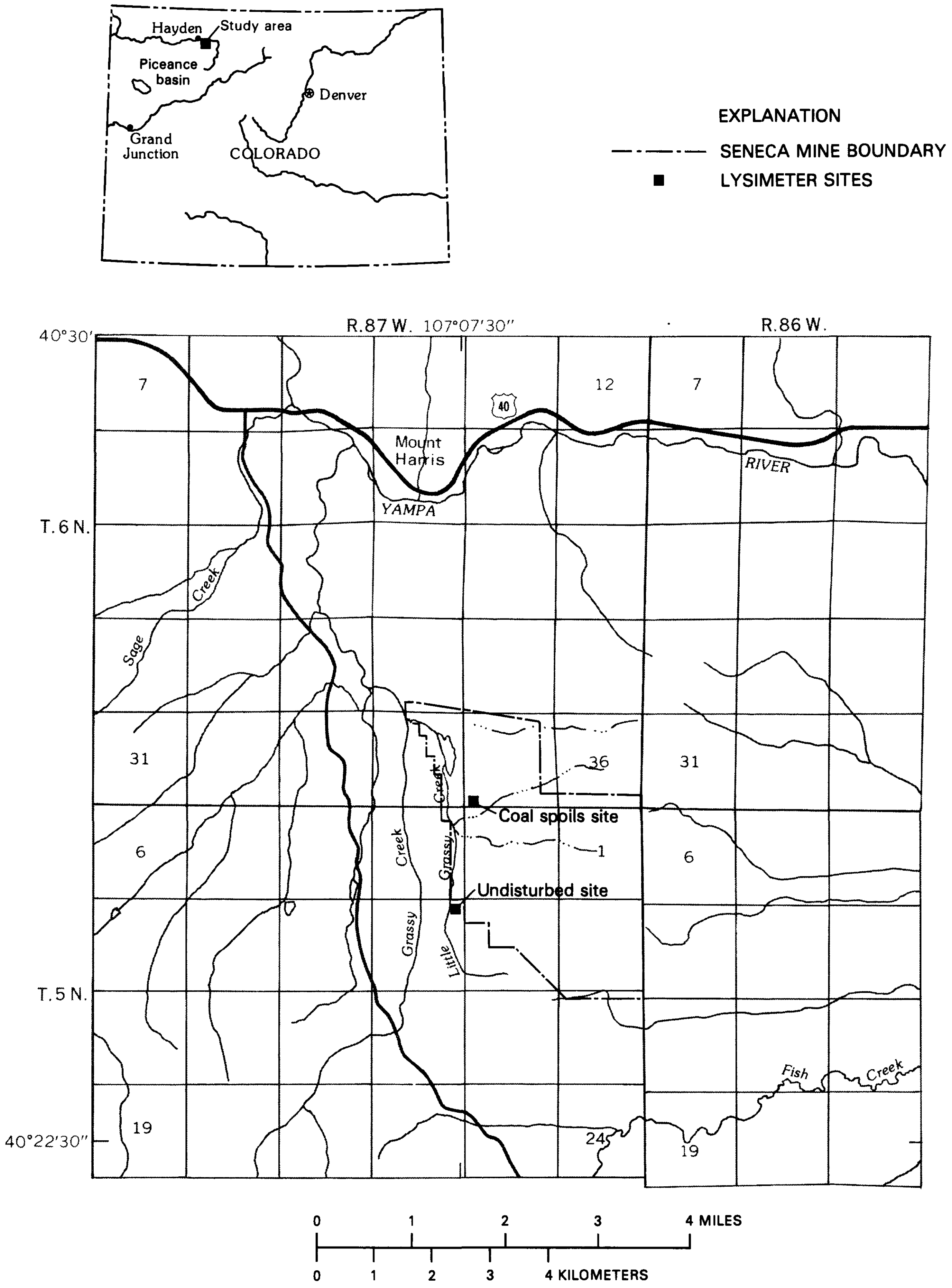


Figure 1.--Location of study area and the Piceance basin.

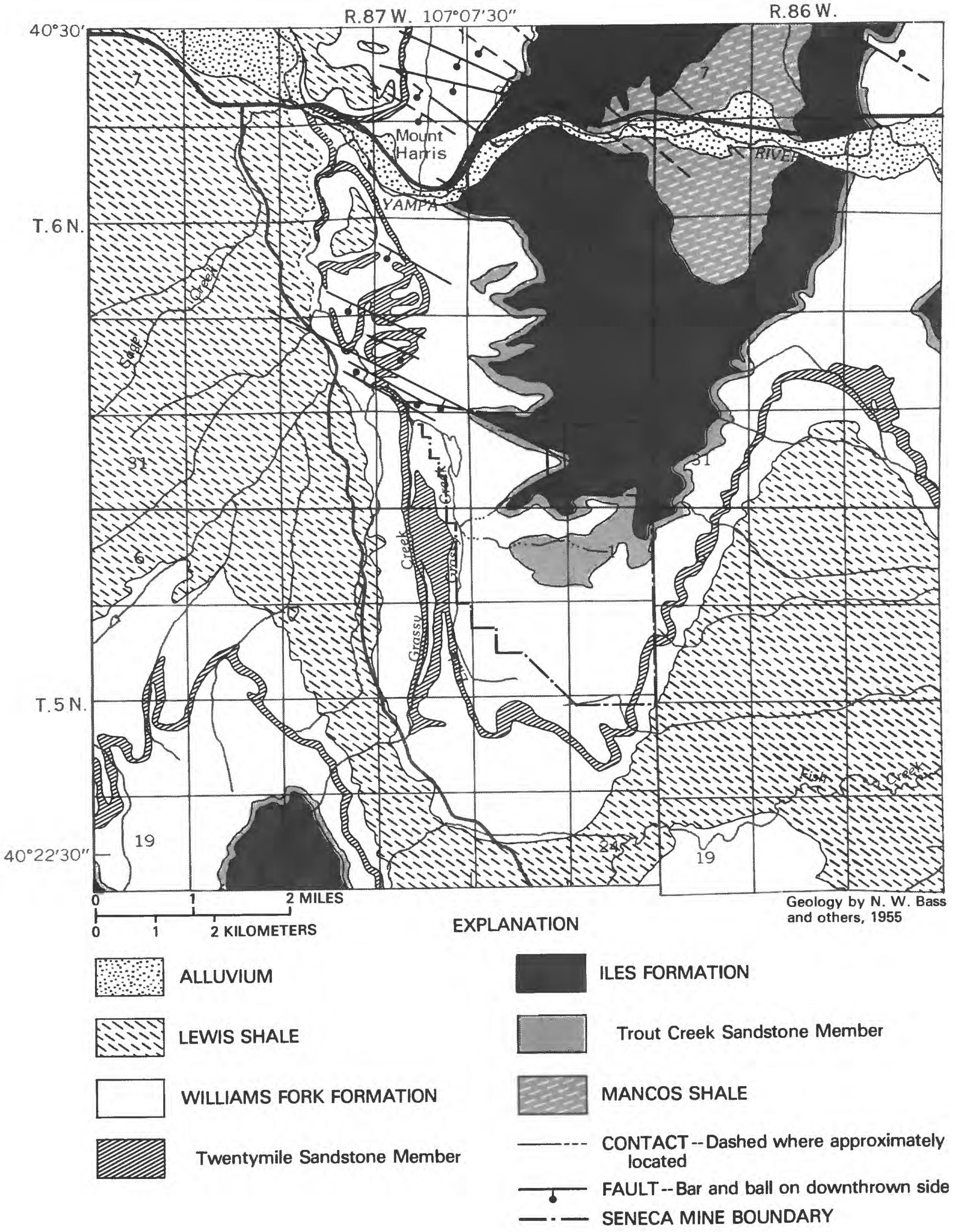
The premining surficial geology of the Seneca Mine and surrounding area is shown in figure 2. Even though numerous folds are found throughout northwestern Colorado, one of the largest of these is the Tow Creek anticline, which forms the ridge of the area being mined. Faults also are present throughout the area; however, their effect on local flow patterns at the mine site is unknown.

Upper Cretaceous rocks are present near the mine site (fig. 3) (Bass and others, 1955). The oldest formation cropping out in the area is the Mancos Shale, a dark-gray shale about 4,600 ft thick. The Williams Fork and the Iles Formations are part of the Mesaverde Group (about 3,000 ft thick) that overlies the Mancos Shale. Sandstone, sandy shale, shale, and coal can be found throughout the Mesaverde Group. Two major sandstone members are present: the Trout Creek Sandstone in the Iles Formation and the Twentymine Sandstone Member in the Williams Fork Formation. The Williams Fork Formation contains the Middle coal group, which is the coal being mined at the Seneca Mine. The coal beds dip to the west at about 8 degrees and are overlain by about 50 to 75 ft of shale. The subituminous coals (12,000 BTU's) being mined are the Lennox and the Wadge; the Wadge is deeper and more economically important. The sulfur content of the Wadge coal is about 0.5 percent; the sulfur content of the Lennox coal is about 1.7 percent. The Wadge coal generally is blended with the Lennox coal before combustion at the power plant to decrease the sulfur content. The Lennox coal seam is 4 ft or less thick, and the Wadge coal seam is as much as 10 ft thick. About 50 ft of sandstone and shaley sandstone separate the two coal seams.

The Lewis Shale is a dark-gray shale, about 1,700 ft thick, that overlies the Mesaverde Group and underlies the Lance Formation. The Lance Formation is about 1,400 ft thick and consists of sandstone, shale, and some coal.

The study site is in a semiarid region. Average monthly maximum temperatures reach almost 90 °F in the summer; average monthly minimum temperatures are about 0 °F in the winter (ENMAP Corp., 1981) (fig. 4). Average annual temperature is approximately 42 °F.

Precipitation in the area is approximately 16 in/yr and is fairly evenly distributed throughout the year (National Oceanic and Atmospheric Administration, 1982) (fig. 5). The precipitation is evenly distributed because the local altitude change is not significant enough to cause sufficient cooling of the moist Pacific air moving through the area in the winter to cause excess winter precipitation. Precipitation does increase during the winter to the east near Steamboat Springs, Colo., because of cooling of moist air, as the air mass rises and flows over the mountains. Total annual snowfall at Hayden, Colo., is 106 in.; 65 percent of the snow falls during December, January, and February (ENMAP Corp., 1981) (fig. 6). Snow accumulation is the primary source of streamflow in the area; summer precipitation contributes little to overall water availability.



Geology by N. W. Bass and others, 1955

Figure 2.--Geology near the Seneca Mine.

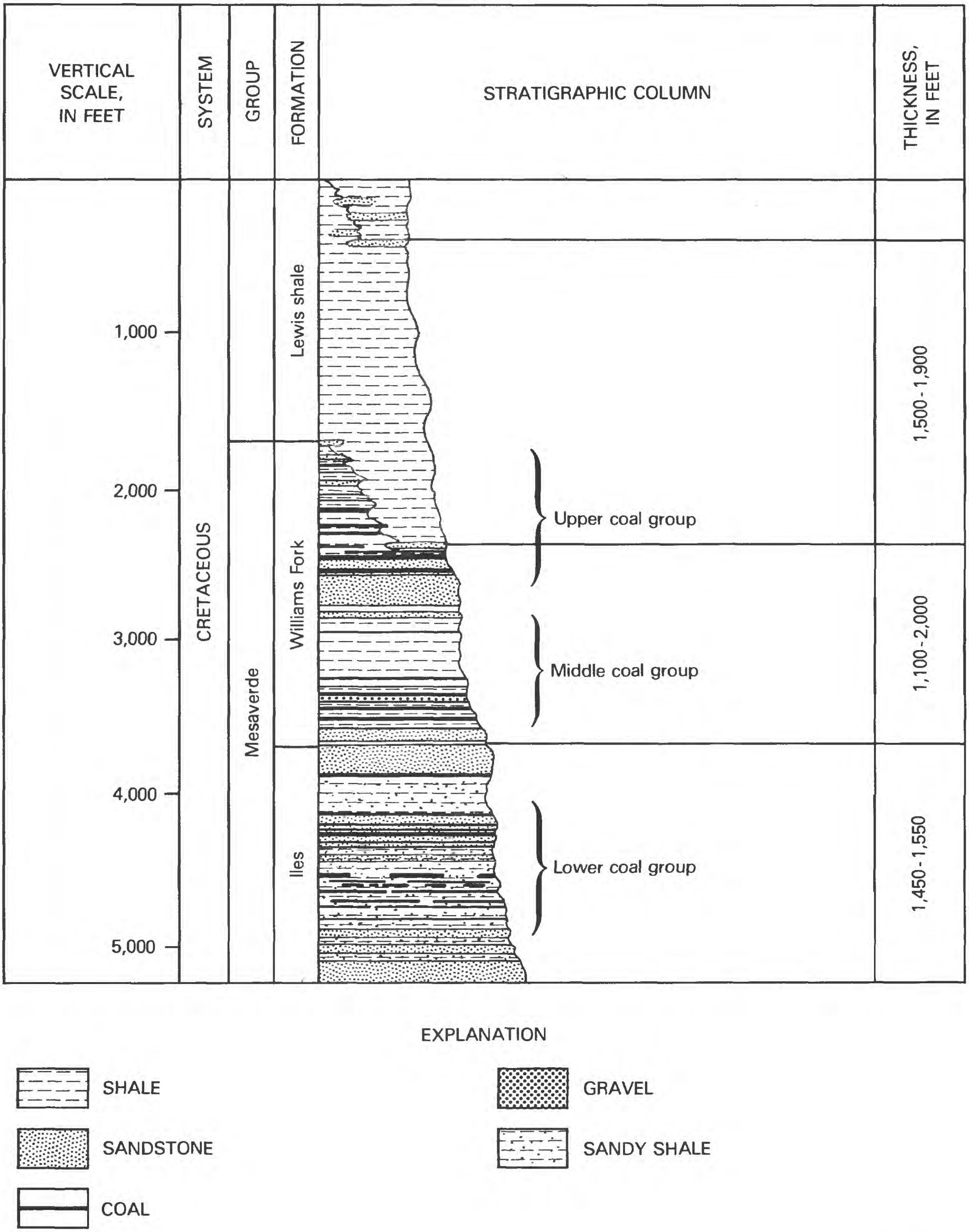


Figure 3.--Generalized columnar section of exposed rocks in parts of Routt and Moffat Counties (from Bass and others, 1955).

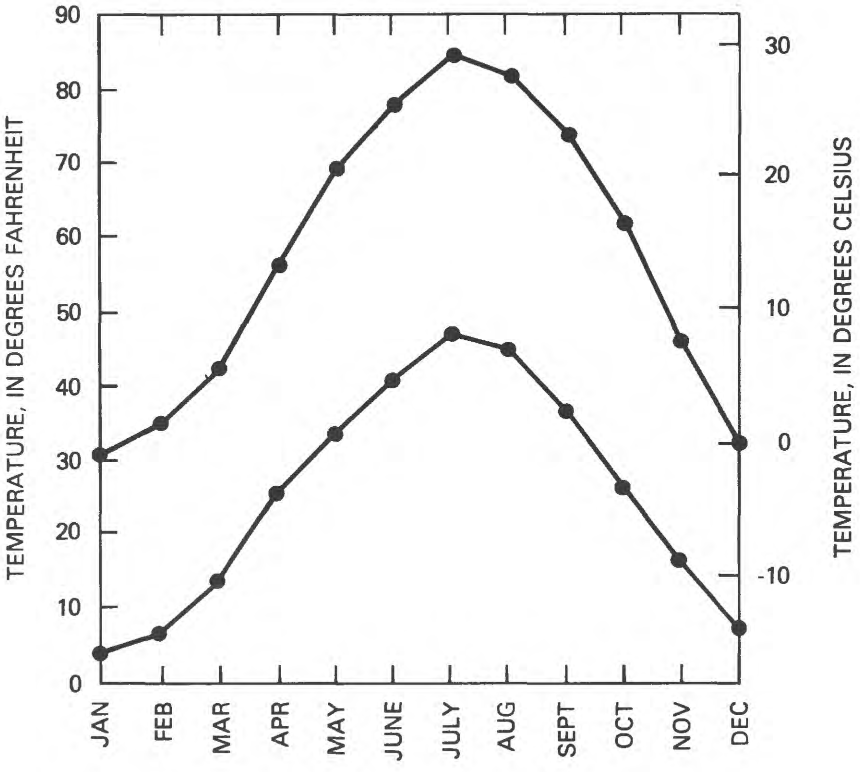


Figure 4.--Average monthly maximum and average monthly minimum temperatures at Hayden, Colo.

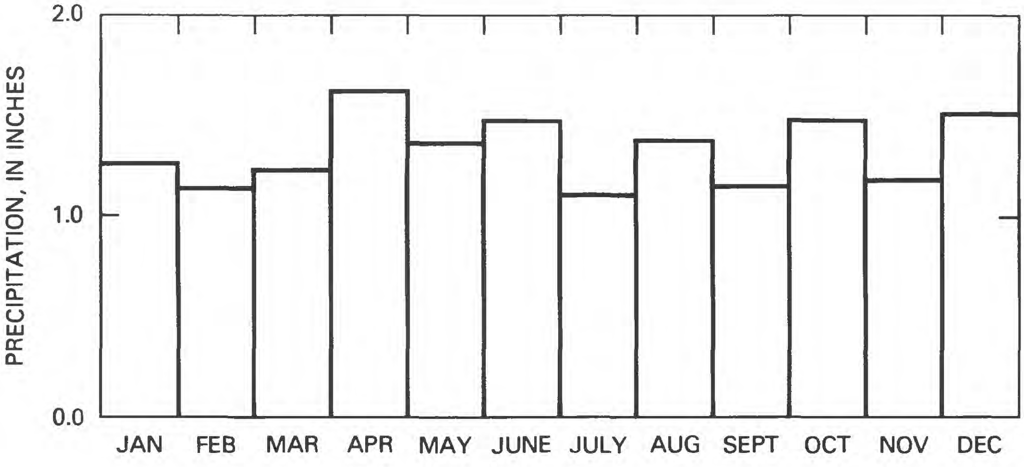


Figure 5.--Average monthly precipitation at Hayden, Colo.

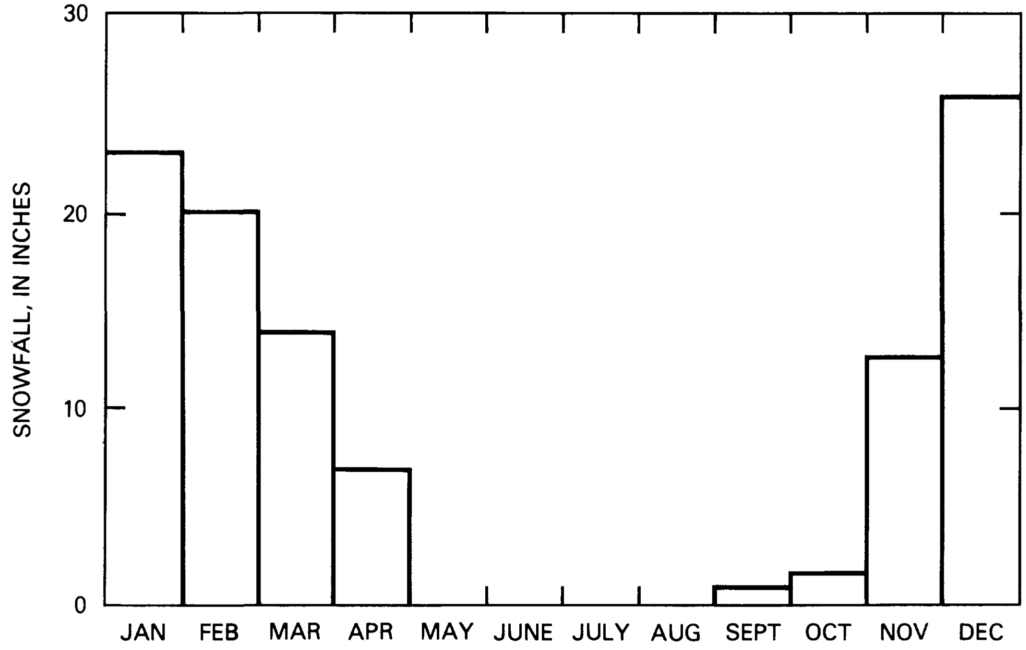


Figure 6.--Average monthly snowfall at Hayden, Colo.

Surface-water resources have been developed far more than the ground-water resources throughout the region. Surface-water flow rises rapidly in April, remains high in May, and recedes in June. The majority of streamflow occurs during these 3 months. This pattern of flow results primarily from snowmelt during the spring. Surface-water flow throughout the remainder of the year is sustained largely by ground-water discharge to the stream (Iorns and others, 1965). Streams near the study area are ephemeral or have discharges less than 0.1 ft^3/s for much of the year.

Ground water is used primarily for domestic and stock-watering purposes. Recharge occurs from stream loss and precipitation. The recharge quantity is not known; however, evapotranspiration, confining beds, and aquifers with small yields (less than 25 gal/min) probably limit the recharge. Ground-water quality varies in the area. Calcium, magnesium, and sodium are the dominant cations; bicarbonate and sulfate are the dominant anions.

DESCRIPTION OF INSTRUMENTATION

Three sites are discussed in this section: (1) The lysimeter site, which includes five drainage-type lysimeters, each containing a soil-water access tube; (2) the coal-spoil soil-water access-tube site, which includes the area outside the lysimeters; and (3) the undisturbed site, which includes 24 porous-cup lysimeters and 8 soil-water access tubes. Both the lysimeter site and the coal-spoil soil-water access-tube site are on reclaimed coal spoil; together, these sites will be referred to as the coal-spoil site. The undisturbed site is a site that has not been disturbed by surface mining.

Lysimeters

Tank or drainage-type lysimeters can be used to collect water that percolates through the material contained in the lysimeter. This water then can be analyzed to determine its chemical composition. The quantity and the timing of the water movement also can be recorded. The lysimeters used in this study collected water from the top 7 ft of a reclaimed and recontoured coal spoil. This top 7 ft is a dynamic zone, where evapotranspiration and aqueous chemical reactions occur.

Five tank or drainage-type lysimeters were installed in a reclaimed coal spoil at an altitude of approximately 7,000 ft. The lysimeter site has a southwesterly aspect and is on a fairly flat slope. A site where coal-spoil material had just been replaced and recontoured was chosen for the lysimeters.

Coal-spoil material excavated for the lysimeters was replaced in the lysimeters. The lysimeters were built so that their tops would be at ground level, which enables natural precipitation to recharge the lysimeters. This location also enables other abiotic and biotic factors such as temperature and vegetation to affect the spoil material, both inside and outside the lysimeters, in the same manner.

The lysimeters are 8-ft wide by 10-ft long by 8-ft deep (fig. 7). The walls are poured concrete, 8-in. thick. The outside of the walls is tarred to prevent acid decomposition of the concrete. The floor of the lysimeter is 10 in. of sulfate-resistant concrete that slopes to facilitate water movement out of the lysimeter. Footings 3-ft wide by 2-ft deep were placed under all walls.

After sandblasting, the inside walls of each lysimeter were painted with an epoxy paint that has excellent chemical, moisture, and abrasion resistance. The paint was chosen because it would be inert when it was in contact with the spoil material. As an added precaution, plastic sheeting reinforced with fiberglass was used to line the inside of the lysimeters before spoils were placed in the lysimeters.

Three 7-ft sections of slotted PVC pipe were placed in the bottom of each lysimeter to facilitate flow to the drain. Gravel was placed to a depth of 9 to 12 in. around and over the PVC pipe. A 7-ft, aluminum, soil-water access tube was placed at the center of each lysimeter before the spoil material was placed in the lysimeter.

A backhoe was used to place the spoil material in the lysimeters. Every attempt was made to replace the spoil material in the lysimeters so that the material within the lysimeters would be similar to the material outside. Rock fragments greater than 18 in. in diameter were not placed in the lysimeters.

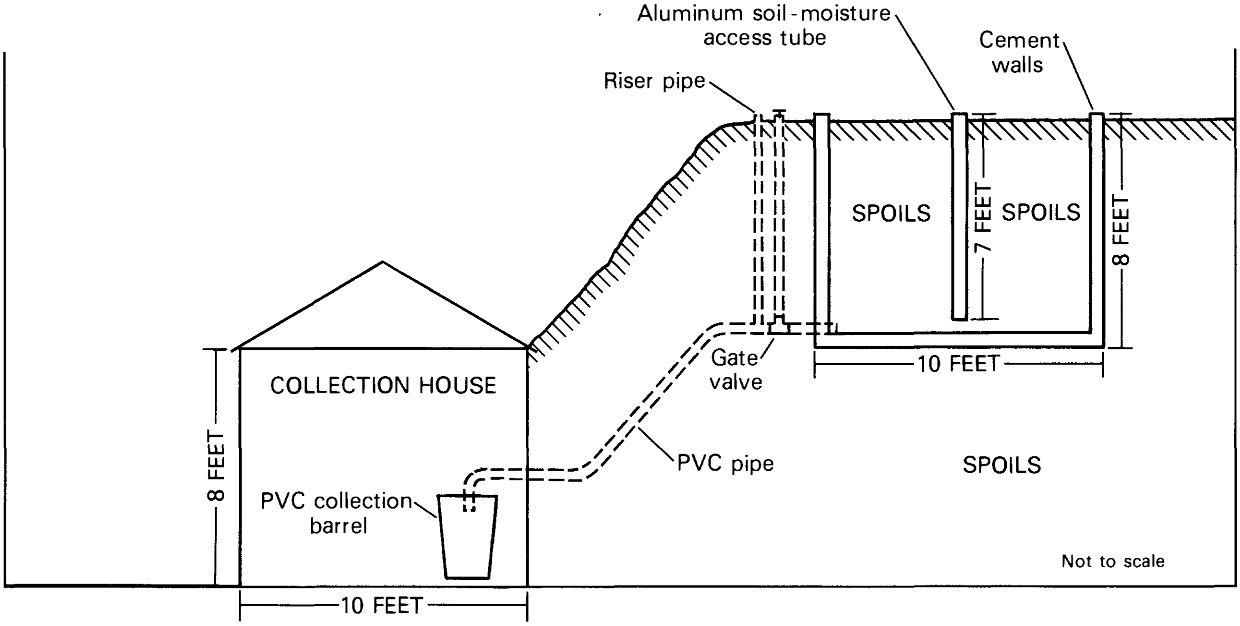


Figure 7.--Schematic of lysimeters at reclaimed coal spoil.

A 4-in. piece of PVC pipe was placed at the base and in the center of the west wall of each lysimeter; the lysimeter drains through the PVC pipe at this point. One ft from the wall, the PVC pipe enters a gate valve that is operated from land surface. One ft beyond the gate valve is a tee coupling that is connected to the surface by a 2-in. PVC pipe. The gate valve and 2-in. pipe were installed to enable cleaning of the pipe leading to the collection house. If water unexpectedly ceased flowing from a lysimeter, the gate valve could be closed, and water could be poured through the 2-in. riser pipe. By this approach, it could be determined if the problem is in the PVC leading to the collection house, or in the lysimeter itself.

Two-inch PVC pipe on a 4-percent slope connects each lysimeter independently to a series of separate PVC collection barrels in a collection house downslope. From these barrels, water samples were obtained for chemical analysis. The timing and quantity of water moving through the lysimeters was determined by continuously monitoring water levels with recorders in the PVC collection barrels.

Two sets of paired lysimeters and one single lysimeter were connected to the collection house (fig. 8). Lysimeter 1 contained the coarsest material, and the end pair of lysimeters (4 and 5) contained the least coarse material. The middle lysimeters, 2 and 3, were filled with material intermediate in texture. Lysimeters 2 and 4 were covered with about 12 in. of topsoil. The other three lysimeters (1, 3, and 5) had only raw spoil material at the surface. The topsoil was added to determine the difference in hydrologic response between spoil material covered with topsoil and raw spoil material. The lysimeters were seeded at the same time and in the same manner as the rest of the reclaimed coal spoil.

As stated earlier in this section of the report, the lysimeters were filled with the coal spoil excavated from the lysimeter site. The variation in texture coarseness was a result of the way the coal spoil was replaced and not the result of the experimental design of the study.

Approximately 2 mi south of the lysimeters is an undisturbed site. At this location, 24 porous-cup lysimeters and a shelter for collecting samples were installed. The following information, from a Soilmoisture Equipment Corp. brochure (1976), describes the porous cup lysimeters (also see fig. 9).

> "Pressure-vacuum soil-water samplers, Model 1920, are constructed of 1.9 inches diameter PVC tube with a porous ceramic cup bonded to one end. They are approximately 24 inches in overall length and are provided with two small diameter access tubes for evaluating the samples and removing the collected sample. A screw thread clamping ring, at the end of the sampler, seals the access tubes into the sampler by means of a large diameter neoprene plug. After the sample has been collected, it is forced out of the sampler by putting pressure on one end of the access tube to force the sample out of the other end of the access tube. The samplers are designed for installation up to 50 feet in depth."

The porous cups were placed at a depth of 5 ft because this depth was believed to be below the zone of dynamic soil-water change. Therefore, only water that was potentially percolating deeper to the ground water would be sampled, rather than water that was subject to evapotranspiration loss. Unfortunately, this zone proved to have very little available water that could be drawn into the porous cup. As a result, the porous-cup lysimeters did not yield sufficient water for chemical analysis.

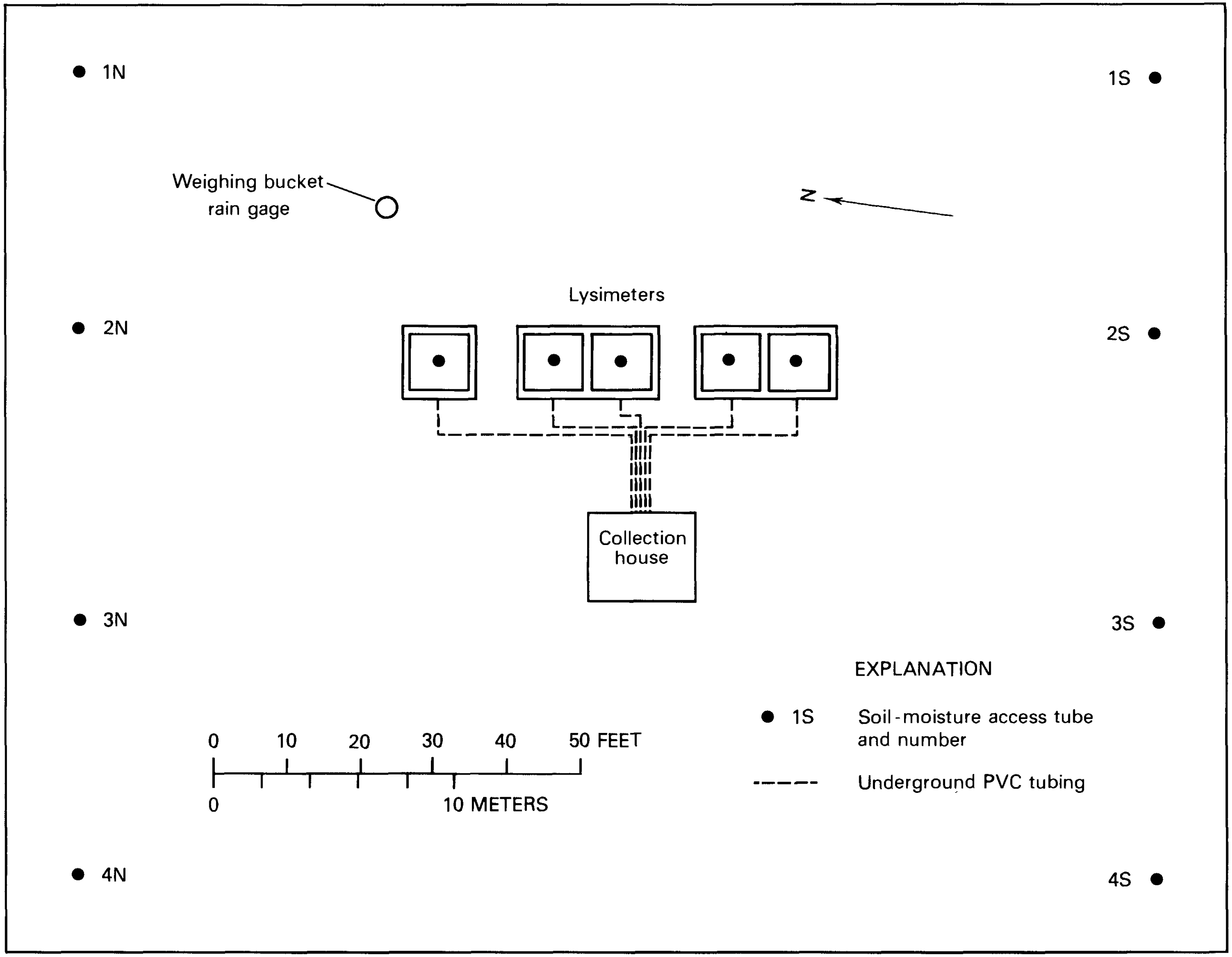


Figure 8.--Plan view of lysimeters and soil-water access tubes at reclaimed coal spoil.

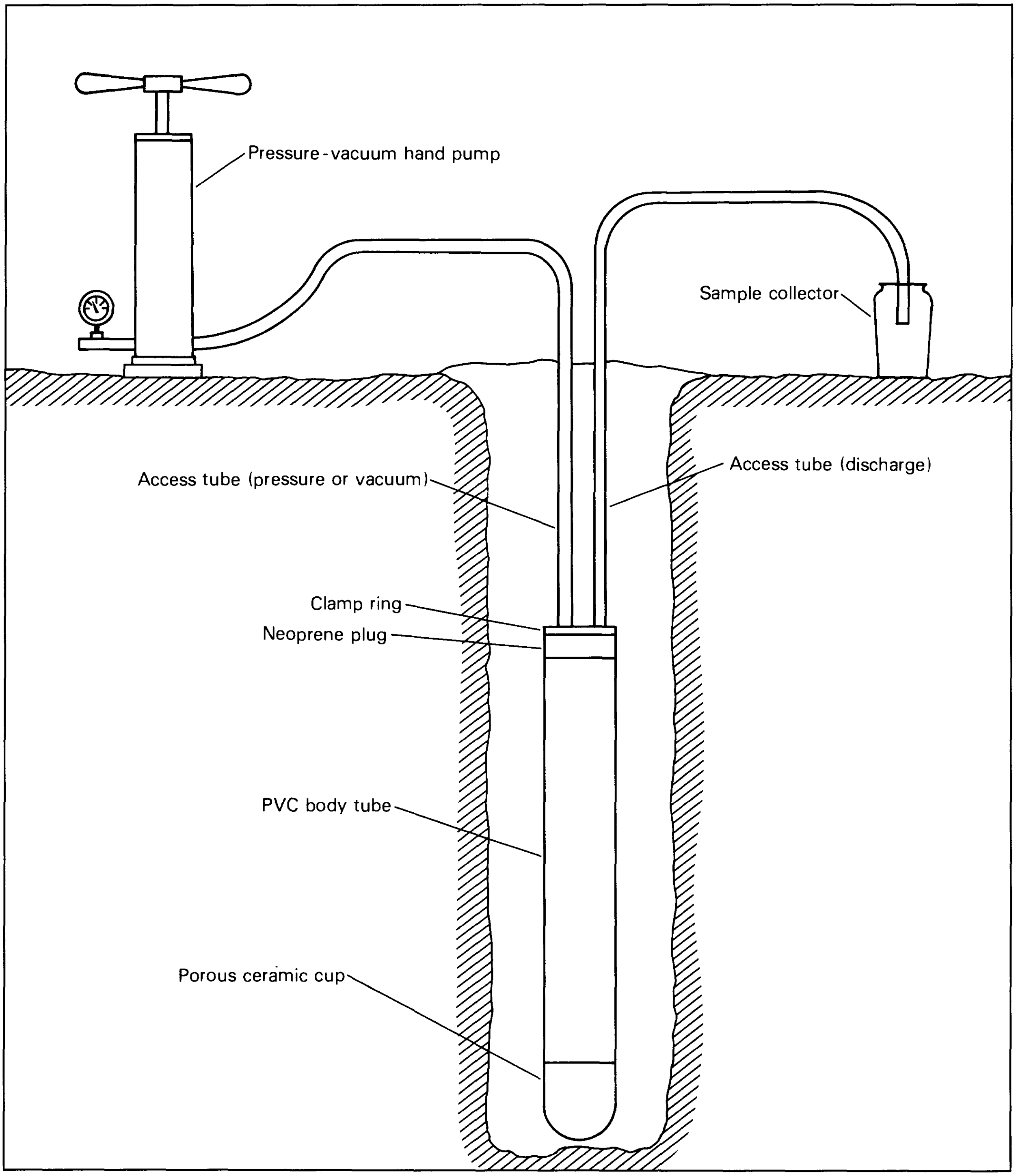


Figure 9.--Pressure-vacuum soil-water sampler.

Soil-Water Access Tubes

Soil-water access tubes were installed at three sites at the mine. Five drainage-type lysimeters were installed at the lysimeter site, each of which has a 7-ft-deep access tube at its center (fig. 8). Eight access tubes were installed at the coal-spoil soil-water access-tube site. These tubes were installed at depths ranging from 4.5 to 7 ft because it was difficult to drill through the spoil material. An additional eight access tubes were installed at the undisturbed site (fig. 10). Seven of the tubes were 7 ft deep, and one was 6.5 ft deep. More data were available at 6 ft than 7 ft, and the 6 ft depth is below the zone of dynamic soil-water change; therefore, 6 ft was the depth used for soil-water content calculations.

The soil-water access tubes were made of 2-in-diameter aluminum, through which a neutron probe was lowered to measure soil-water content. The theory of neutron moderation has been discussed by many authors (Gardner and Kirkham, 1952; Merriam, 1960; Buckman and Brady, 1969). The radius of influence of the neutron probe depends on the per-unit-volume wetness of the soil and the strength of the source (Van Bavel and others, 1956). Hydrocarbons (organic matter, coal) can introduce error if they are present in sufficient quantity. Although fragments of coal can be found in the coal spoil, and organic matter would be present in the undisturbed soil, they were assumed to introduce minimal error. Soil porosity was measured by lowering a density probe into the soil-water access tubes.

The density probe measures the subsurface wet density by using backscatter and absorption of nuclear radiation. The radius of influence for detection by the probe is about 5 in. The probe operates by emitting gamma radiation at a constant average rate. The degree of scattering is proportionate to the density of the surrounding medium. The degree of backscatter then is measured by a detector and recorded on a digital readout for user recording and later analysis.

Neutron-Probe Calibration

Gravimetric methods were used to determine the quantity of soil water in soil-core samples. Immediately after coring, an aluminum access tube was placed in the core hole. A neutron probe was positioned at points in the hole where each core was taken. Counts then were recorded. These counts were used later with the gravimetric water-content determinations to develop a calibration curve using linear-regression analysis. The coefficient of determination (r^2) was 0.89 with 94 samples. The water content ranged from about 5 percent to 35 percent.

Periods and Types of Data Collection

Soil-water measurements were made at the lysimeter sites during 1978, 1979, and 1980. The soil-water access tubes were installed at the undisturbed site in June 1978, and soil-water measurements were begun in July 1978.

Precipitation was measured using a weighing-bucket rain gage throughout the year and a float-type rain gage during the summer months. Lysimeter discharge was measured periodically for quantity and tested for quality.

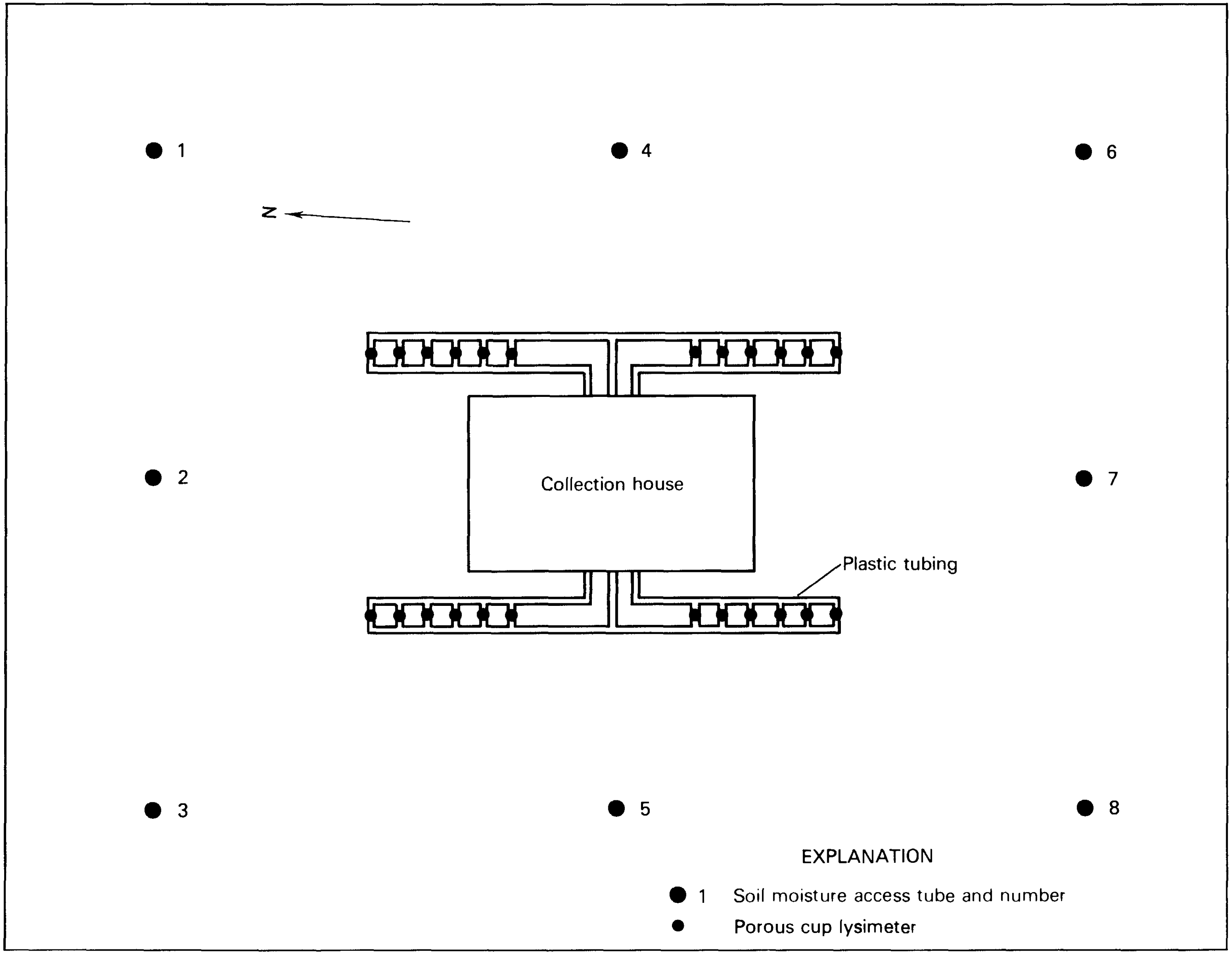


Figure 10.--Plan view of porous-cup lysimeters and soil-water access tubes at undisturbed site.

SOIL WATER

Once precipitation infiltrates into the soil matrix, it becomes soil water and "is subject to large fluctuations of quantity and quality in response to transpiration and evaporation" (Davis and DeWiest, 1966). Soil water in the top 3 to 5 ft of a coal spoil or an undisturbed soil can be lost to evapotranspiration, can be retained in the coal spoil or soil matrix, or can be lost to deep percolation and eventually become part of the ground-water system. (Hereafter, soil water will mean water from coal spoil, or water from the upper 3 to 5 ft of undisturbed soil, unless otherwise specified.)

Comparison of Sites

Because the lysimeters are isolated structurally from the rest of the coal spoil, it is necessary to compare the lysimeter water content with the surrounding coal-spoil water content to determine if the lysimeters water content is representative of the coal-spoil water content. The coal spoil may have different water-holding characteristics than the undisturbed soil, so the potential for this difference needs to be examined.

The soil-water content, in inches, within a site was fairly consistent among the tubes. The soil-water content for each depth, and the soil-water content through the total depth for each access tube within a site, was always within two standard deviations of the average for the site, assuming a normal distribution.

The average of the total soil-water content through the first 6 ft of depth was used to compare the sites. Soil-water content was summed at each access tube to determine the total soil-water content. The total soil-water contents for each access tube at a site then were added together, and the average soil-water content for the site was determined. These averages are reported as average total-maximum soil-water content and average total-minimum soil-water content. The average soil-water content for the lysimeter site, the coal-spoil soil-water access-tube site, and the undisturbed site are shown in figure 11. Graphically, it can be seen that the coal-spoil soil-water access-tube site generally contains slightly more water than the lysimeter site. The difference is probably the result of compaction differences. The coal-spoil sites do show similar changes in soil-water content with time; both sites will be considered as one population for this report.

The undisturbed site contains more water than the coal-spoil site (fig. 11). The greater water content of the undisturbed site possibly could result from differences in precipitation rather than soil structure and texture. However, because the sites are only a few miles apart and there is little difference in altitude, precipitation at both sites is assumed to be very similar.

Another way to evaluate the differences in water content between sites is to compare the difference between maximum and minimum water content for the sites. This difference shows the volume of water stored and depleted throughout the year. Analysis of variance shows all these differences to be nonsignificant. Therefore, the volume of water between the maximum and minimum soil-water content probably is the same at all sites. This means the quantity of water held between the maximum and minimum soil-water content for each year is about the same for both the reclaimed coal-spoil site and the undisturbed site. However, the rate at which water flows through these systems, and the quantity of water present at different depths at certain times during the year, may be quite different.

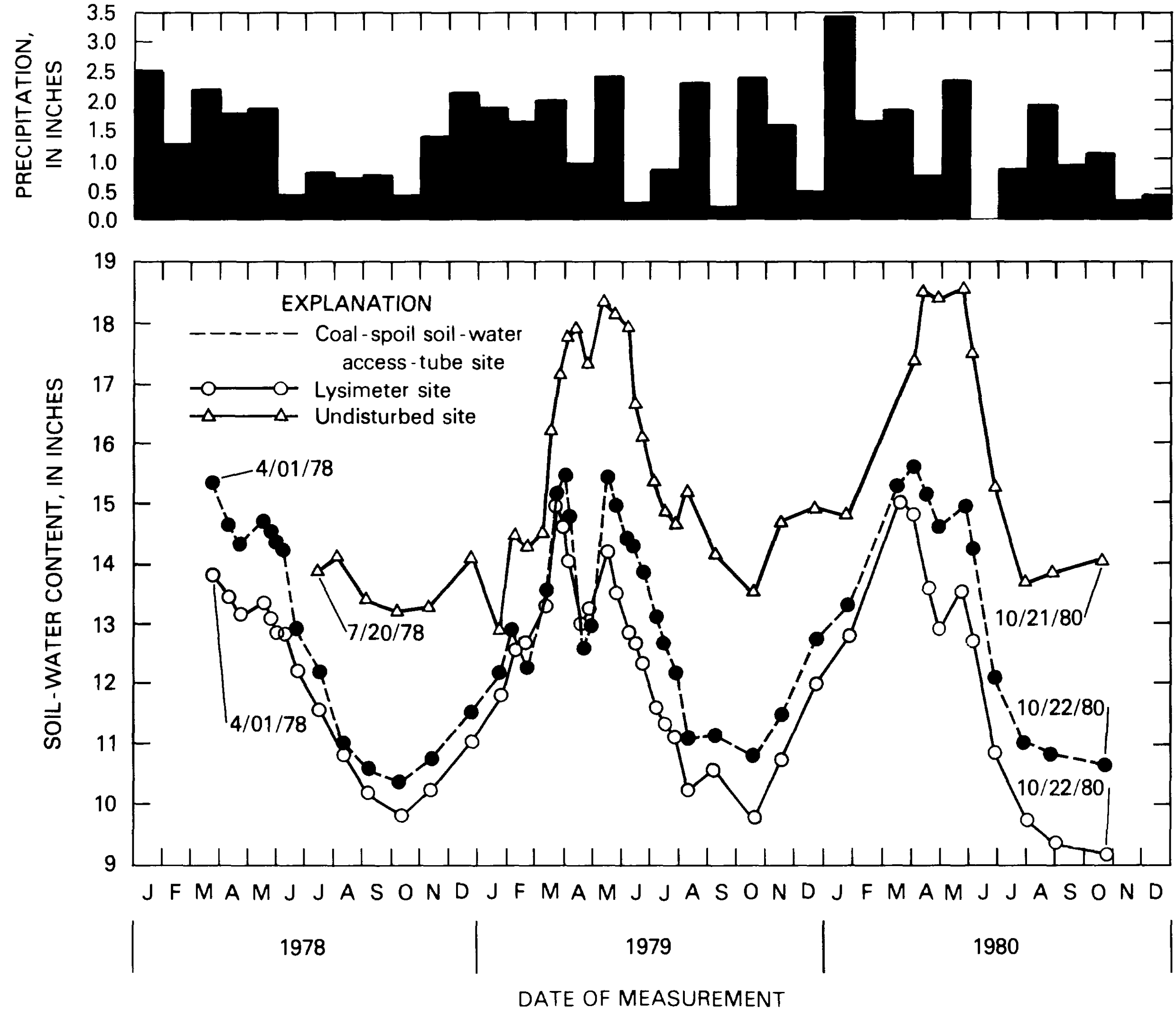


Figure 11.--Average soil-water content in the top 6 feet of soil for the lysimeter site, the coal-spoil soil-water access-tube site, and the undisturbed site, and monthly total precipitation.

Soil-Water Profiles

Random replacement of broken coal-spoil material results in a near-surface structure quite different from undisturbed soil layering and natural soil development. Water may flow differently through the two systems.

Evaluation and examination of soil-water profiles gives an indication of the soil-water content in the soil matrix. At each depth for the undisturbed site, the average total maximum and average total minimum soil-water content was calculated (fig. 12). The same calculations were made for the coal-spoil site (fig. 13).

The average maximum and the average minimum soil-water profiles of the undisturbed soil show that the largest variations in soil-water content are in the top 3 to 5 ft of the soil surface (fig. 12). This is a dynamic zone where water uptake by plant roots (transpiration) and evaporation are the predominate factors affecting losses. Consequently, a considerable change in soil-water content can be seen in this upper zone; whereas, below this zone, a minimal change in soil-water content can be seen throughout the year.

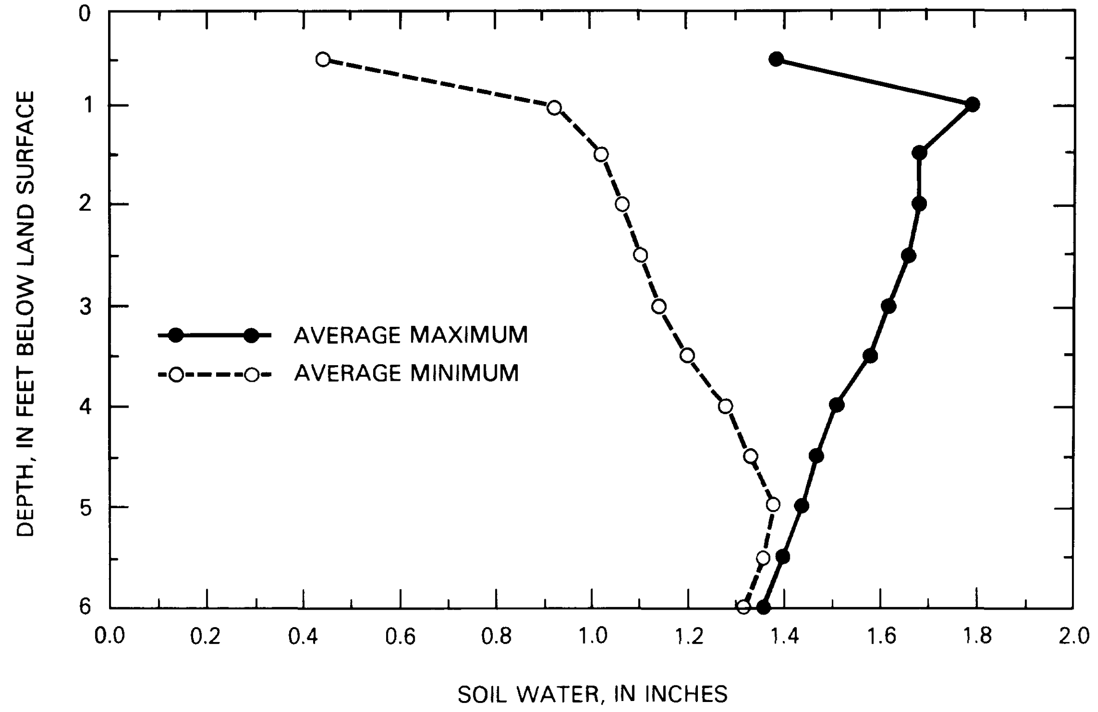


Figure 12.--Comparison of average maximum and average minimum soil-water content at the undisturbed site for 1979 and 1980.

By contrast, the coal-spoil profile (fig. 13) is different from the undisturbed soil-water profile. The coal spoil shows the same large variation in soil-water content in the upper 3 to 5 ft of the spoil profile, but this large variation also is present through the entire depth of measurement. Because large variations are seen throughout the profile, it is assumed that water is moving downward. This continued downward movement of water may result from different factors. The reclaimed coal spoil has much less dense and diverse vegetation than does the undisturbed soil. Therefore, transpiration demands are less. The reclaimed coal spoil does not have developed soil horizons as does the undisturbed area. The lack of soil structure and the often blocky nature of spoils enables water to move more freely downward and not be delayed or impeded by bedrock material such as the shale at the undisturbed site.

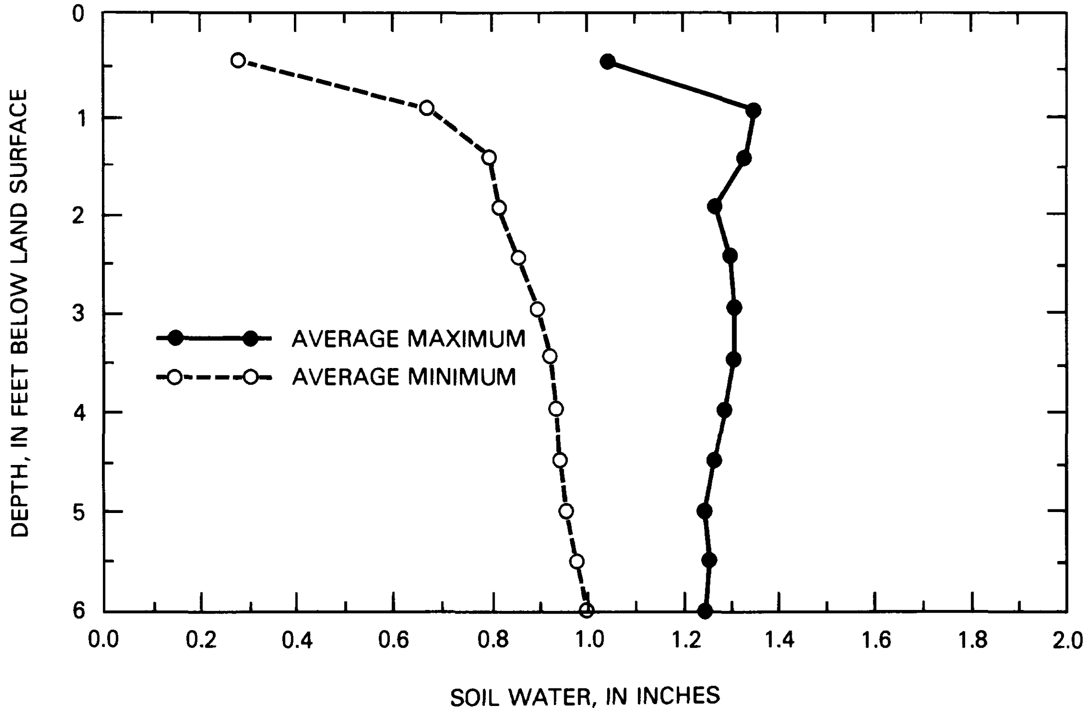


Figure 13.--Comparison of average maximum and average minimum soil-water content at the coal-spoil site for 1978, 1979, and 1980.

Increasing and decreasing soil-water contents through the water year at selected access tubes are shown in figures 14 through 19. Water began entering the soil in January and moved through the soil profile until a maximum soil-water content was reached about May. Just as the soil near the surface was wetted first, this soil also was the first zone to dry out as summer months passed. Successively deeper zones did not dry out until fall.

Comparison of the porosity curves and the maximum soil-water-content curves of the coal-spoil site and the undisturbed site gives an indication of how close the systems are to saturation. The undisturbed-site curves (fig. 14 and 15) show that the soil is nearly saturated at the 4.5- to 5-ft depth. Shale underlies the site. Because shale is relatively impermeable, deep percolation probably is restricted.

The coal-spoil curves (figs. 16-19) show that the coal-spoil site (lysimeter site and coal-spoil soil-water access-tube site) does not have the near-saturated conditions found at 5 ft in the undisturbed site. The shale layer is not present in the coal spoil as it is in the undisturbed soil; therefore, gravity drainage of water can continue to greater depths in the coal spoil

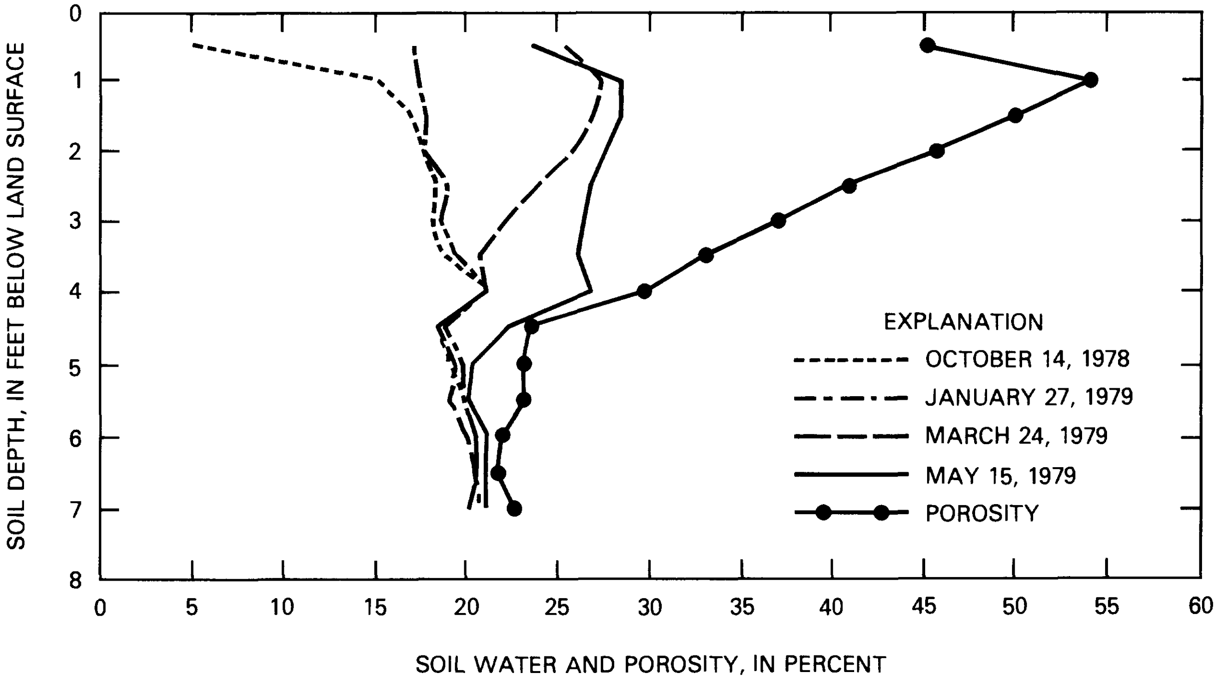


Figure 14.--Increase in soil-water content: Soil depth compared to water content and soil porosity at undisturbed site, October 14, 1978 to May 15, 1979.

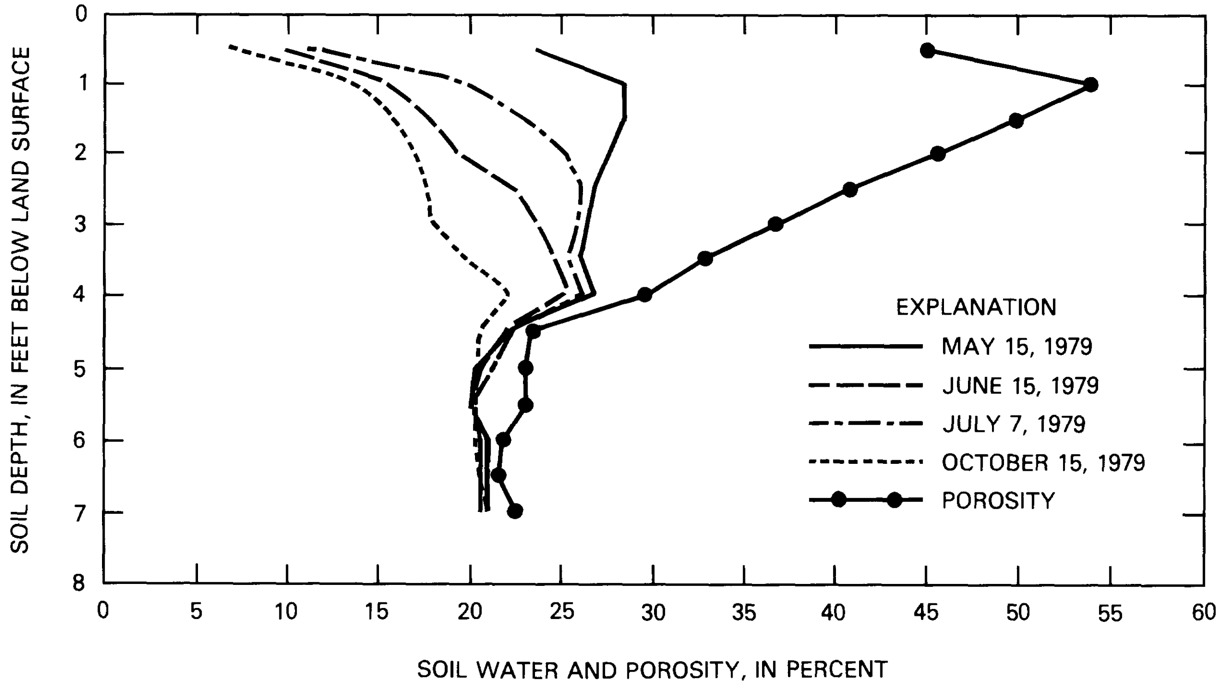


Figure 15.--Decrease in soil-water content: Soil depth compared to water content and soil porosity at undisturbed site, May 15, 1979 to October 15, 1979.

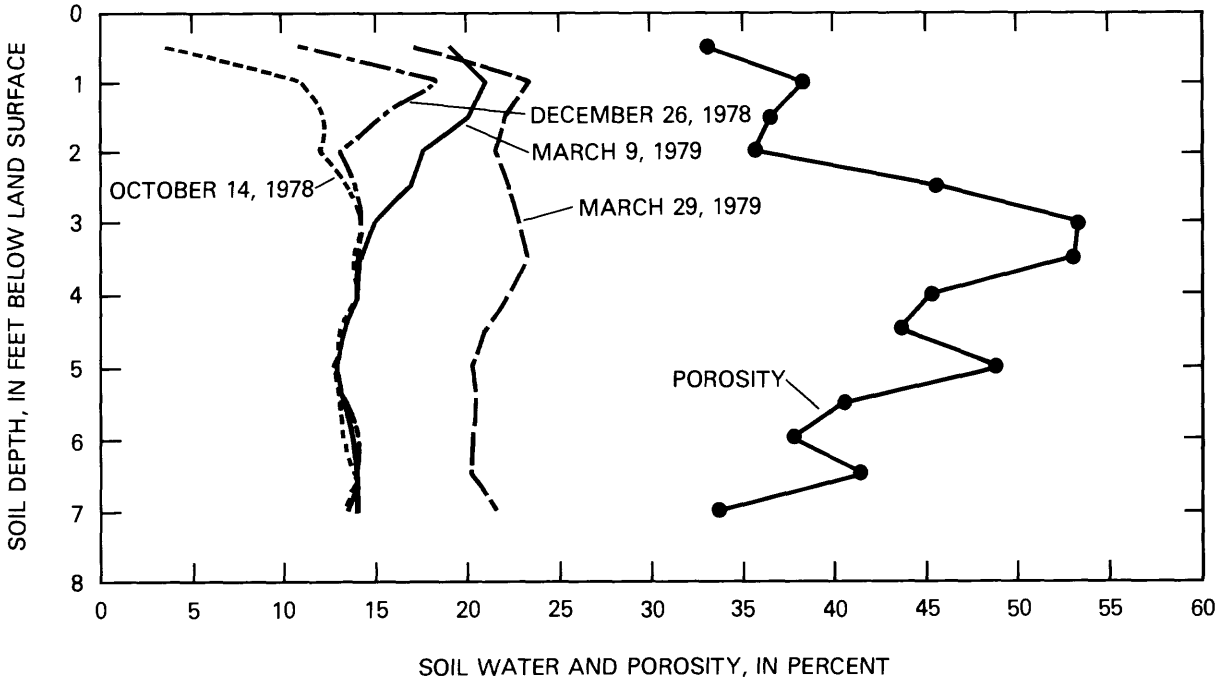


Figure 16.--Increase in soil-water content: Soil depth compared to water content and soil porosity at coal-spoil soil-water access-tube site, October 14, 1978 to March 29, 1979.

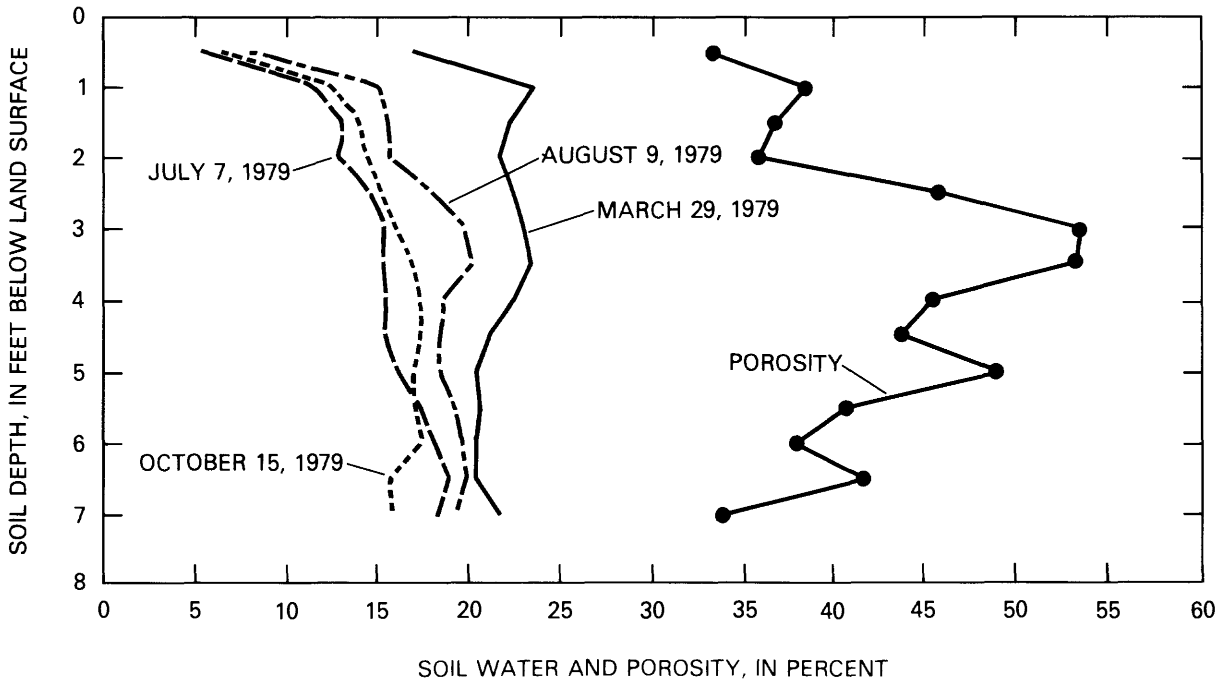


Figure 17.--Decrease in soil-water content: Soil depth compared to water content and soil porosity at coal-spoil soil-water access-tube site, March 29, 1979 to October 15, 1979.

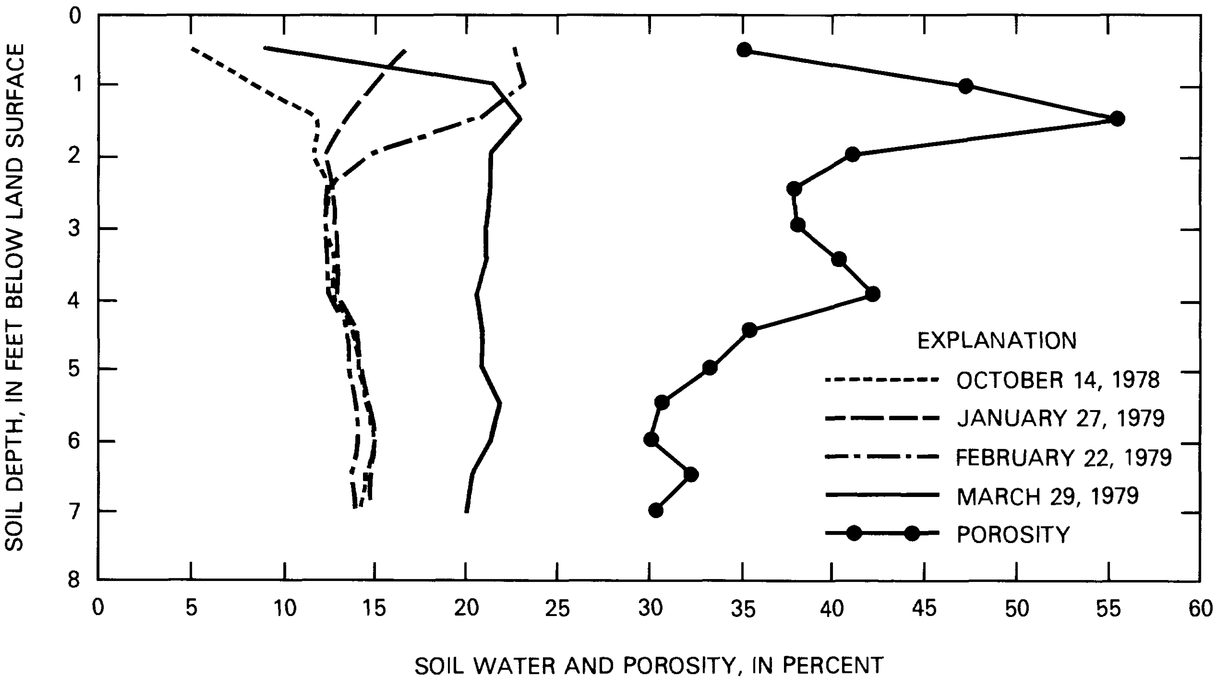


Figure 18.--Increase in soil-water content: Soil depth compared to water content and soil porosity at lysimeter site, October 14, 1978 to March 29, 1979.

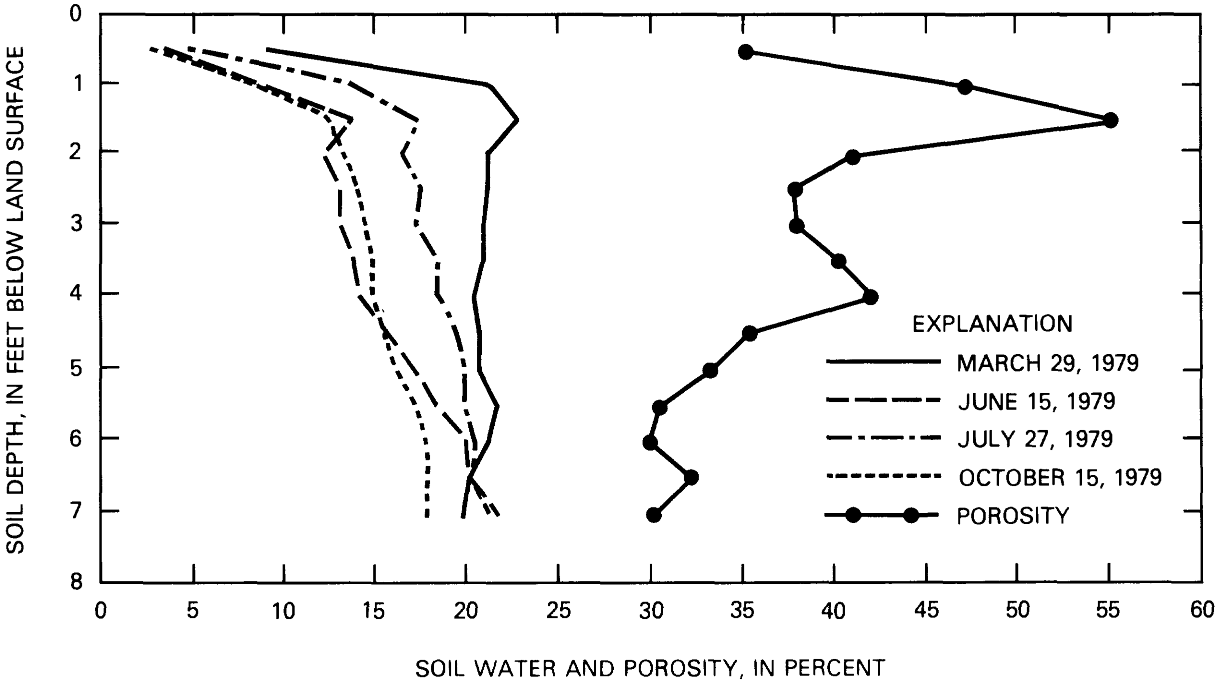


Figure 19.--Decrease in soil-water content: Soil depth compared to water content and soil porosity at lysimeter site, March 29, 1979 to October 15, 1979.

more easily than in the undisturbed soil (the assumption is made that the larger change in soil-water storage indicates a greater hydraulic conductivity in the coal spoil). Once the coal-spoil water is below the rooting zone, it no longer is subject to loss by evapotranspiration. Because water in the coal spoil may percolate to greater depths more easily than in the undisturbed soil, more recharge to ground water may occur in the coal spoil. Thus, the amount of water present at different depths at certain times of the year in the coal spoil is different from the undisturbed site. Also, coal-spoil water may directly recharge underlying deeper aquifers.

Soil-Water Content at the Undisturbed Site

The undisturbed site was near saturation at depths of about 4 or 5 ft throughout the year. Water at those depths could be part of the saturated zone (the aquifer), the tension-saturated zone (the capillary fringe), the unsaturated zone (the vadose zone), or the soil-water zone. These four zones will be considered in the following paragraphs.

No wells are drilled at the undisturbed site. However, wells are located approximately 0.5 mi from the site. Based on these wells and other wells in the area, it appears that the water table is 100 to 200 ft below land surface. Therefore, the water at 4- to 5-ft depths does not represent a main aquifer or saturated zone in the area. The water probably is not the tension-saturated zone (the capillary fringe) for the main aquifer in the area, because the capillary rise would have to be greater than 100 ft.

The unsaturated zone (or the vadose zone) is located between the tension-saturated zone and the soil-water zone. Davis and DeWiest (1966) state that the vadose zone "may be more than 1,000 feet thick in arid regions." They also note that the soil-water content in this zone can be near saturation. Based on the preceding explanation of the tension-saturated zone, the close-to-saturation conditions being measured at 4- or 5-ft depths could represent the unsaturated zone.

Davis and DeWiest (1966) also state that "...soil water is only distinguished from water in deeper unsaturated zones by the fact that it is subject to large fluctuations of quantity and quality in response to transpiration and evaporation." Clearly, the water at depths of 4 and 5 ft is not fluctuating during the year. Therefore, the layer also is not the soil-water zone.

Based on the preceding statements, the unsaturated zone is the zone that most likely describes the water found at depths of 4 and 5 ft. The material in this zone is clay, weathered shale, and weathered siltstone. Siltstone porosity has been measured to range from 0.14 to 0.49 (Morris and Johnson, 1967). This range encompasses the porosity shown in figures 14 and 15. Although the porosity shown in the figures is rather large for shale, it is small for clay. Whether the material is clay, shale, or siltstone, all these materials have small permeability values. Linsley and others (1975) report permeability values, in Meinzer units, for clay (0.01), shale (1), and sandstone (100). Differences in the values of permeability are one and two orders of magnitude. These permeability values may not be the same as at the undisturbed site, but they give an indication of how slowly water moves through the material at the site. So, the soil-water content being measured by the neutron probe at depths of 4 or 5 ft probably is part of the unsaturated zone.

Coal-Spoil Recharge

Water infiltrates the broken surface of a coal spoil more easily than the natural surface of an undisturbed soil. Replaced shales, clays, and topsoil on a coal spoil can decrease infiltration.

The mean annual volume of water flowing through the lysimeters for the first 3 years after coal-spoil reclamation ranges from about 100 to 300 gal/lysimeter. The volumes equal about 2 to 6 in. of water per unit surface area of spoil. Because the water is discharged from the base of the lysimeters, which are 8 ft deep, the water is assumed to represent ground-water recharge because evapotranspiration losses from a depth of 8 ft should be minimal.

The large quantity of water flowing through the coal spoil in the lysimeters indicates water is moving downwards easily through the coal spoil. When a soil is dominated by kaolinite and illite, the infiltration-percolation rate is relatively rapid (Dollhopf and others, 1977). X-ray diffraction for the lysimeter spoil material shows kaolinite and illite to be the major clay minerals (table 1). Hounslow and others (1978) found similar clay minerology at nearby mines. Greater percolation in coal spoils containing kaolinite and illite also was reported by McWhorter and others (1977). Therefore, the large quantity of water moving through the lysimeters is reasonable.

Table 1.--*Minerals or mineral groups detected by X-ray diffraction in coal-spoil material from locations throughout the Seneca Mine*

[Units are in percent mineral present]

Mineral or mineral group	Coal-spoil sample											
	1	2	3	4	5	6	7	8	9	10	11	12
Quartz (SiO_2)	42	35	46	43	36	34	42	38	38	25	59	45
Calcite ($CaCO_3$)	2	2	2	4	5	5	2	0	2	2	2	4
Dolomite ($CaMg(CO_3)_2$)	3	4	4	4	4	4	3	2	3	2	4	2
Gypsum ($CaSO_4 \cdot 2H_2O$)	0	3	0	0	0	0	0	0	0	0	0	0
Smectite	0	0	0	0	0	0	0	0	0	0	0	0
Muscovite/Illite	3	3	4	5	3	5	2	4	4	5	6	6
Chlorite	3	5	4	3	4	2	4	6	23	4	1	2
Kaolinite	37	36	32	24	38	36	34	38	15	50	21	34
Mixed layer clay	1	2	2	1	1	2	2	1	1	1	0	0
Plagioclase feldspar	8	5	4	8	3	4	7	9	6	3	5	3
Potassium feldspar	9	7	4	6	6	8	4	7	6	4	10	6
Total percent	98	102	102	98	100	100	100	105	98	96	108	102

Note: The detection limits approach 1 percent for most minerals. Thus, the absence of detectable smectite, for example, only indicates that it may have been present in concentrations of less than 1 percent.

The 2 to 6 in/yr of potential ground-water recharge is substantially larger than the natural recharge of nearby undisturbed areas. Based on a mean annual precipitation of 12.71 in., a mean annual recharge of 0.66 in. was predicted for the Piceance basin (Weeks and others, 1974). Because of the similarity of the Yampa River and Piceance basins, physiographically and climatically, Warner and Dale (1982) used 0.5 in. as recharge for a ground-water model simulation of the Yampa River area. Because the study area is within the Yampa River basin, this 0.5 in. of recharge can be applied.

Comparing the expected recharge of 0.5 in. with the measured lysimeter discharge of 2 to 6 in. shows that a potential exists for considerably more recharge through a coal spoil. The result may be decreased peak flows for surface water but increased base flows. The change in distribution of runoff may supply water on a more evenly distributed basis. However, increased recharge may increase the dissolved-solids concentration of the base flow. The chemistry of water from the coal spoils will be discussed in the "Geochemistry" section.

More water is flowing through the coal spoil than through the undisturbed site. As the coal-spoil weathers, settles, and vegetation is reestablished, the difference between the sites may be decreased or eliminated.

A very simple coal-spoil annual water balance was calculated to examine recharge, discharge, and changes in storage in the coal spoil, assuming only vertical movement of water (table 2):

$$ET = PCPN \pm \Delta SWC - DPR \quad (1)$$

where ET = calculated evapotranspiration;
$PCPN$ = precipitation;
ΔSWC = change in soil-water content; and
DPR = deep percolation recharge.

Table 2.--*Coal-spoil annual water balance*

[All values in inches]

Water year	Precipitation	Soil-water content		Change in soil-water content	Deep percolation recharge	Evapotranspiration, calculated
		Initial	Final			
1978	15.49	13.98	11.87	-2.11	5.93	11.67
1979	12.53	11.87	11.92	+.05	3.86	8.62
1980	17.92	11.92	10.99	-.93	3.21	15.64

Precipitation data were obtained from the rain gage at the coal-spoil site. Measurements of soil-water change were obtained using a neutron probe. Deep percolation was measured from flow out of the lysimeters, and evapotranspiration was calculated as a residual term. Runoff is not included in the water balance because the coal spoils have little or no runoff. Undisturbed basins in the area have approximately 1 in. of runoff per year (U.S. Geological Survey, 1983). If the water balance was extended to an entire basin, then the parts of disturbed and undisturbed areas and the associated runoff would have to be considered.

Wymore (1974) estimated actual evapotranspiration in the Piceance basin for sagebrush at 7,000 ft to be approximately 17.50 in/yr. If the deep percolation recharge for each of the 3 years was decreased to the estimated natural recharge of 0.5 in., then the coal-spoil evapotranspiration would be 17.1 in. for 1978, 11.98 in. for 1979, and 17.6 in. for 1980. These values of evapotranspiration are quite close to Wymore's estimated evapotranspirations.

Water flowing through the lysimeters decreased each year (table 3). Structural failure of the lysimeters, which enables leakage to occur, needs to be considered, but this failure is not believed to be the cause of decreased deep-percolation recharge. The decrease in deep-percolation recharge is probably the result of the effect of weathering on coal spoils. Weathering causes compaction and settling of coal spoil. Water moving through coal spoil will transport silt- and clay-sized soil and fill the available pore space. The result is that percolation rates will decrease, and soil water will have a longer coal-spoil residence time, thus enabling more evaporation near the coal-spoil surface and more transpiration by emergent vegetation.

Table 3.--*Lysimeter deep-percolation recharge*

[All values in inches]

	Lysimeter				
Year	1	2	3	4	5
1978	6.26	5.24	[1]2.52	6.34	5.89
1979	5.43	3.30	4.14	[1].30	2.58
1980	4.66	3.06	3.88	2.71	1.78

[1] Equipment malfunction.

The evidence is not conclusive from this data, but the maximum soil-water content at the coal spoil may occur as much as 30 to 45 days before the maximum soil-water content at the undisturbed site (see dates on figs. 11 and 14-17). The difference is probably the result of a combined effect of different infiltration rates and time of snowmelt. Whatever the cause of the change in timing of maximum soil-water content, the timing may affect the type of vegetation that will grow on the coal spoil.

GEOCHEMISTRY

Water in the Western United States is sometimes a scarce and frequently a greatly valued commodity. The quality of the water determines what use, if any, can be made of the water. The addition of dissolved solids or salts may result in water being unacceptable for its previous use or intended use. The concentration of dissolved solids "is ordinarily determined from the weight of the dry residue remaining after evaporation of the volatile portion of an aliquot of the water sample" (Hem, 1970). The recommended concentration limit for dissolved solids in drinking water is 500 mg/L (U.S. Environmental Protection Agency, 1976). A dissolved-solids concentration greater than 2,000 to 3,000 mg/L generally is considered too salty to drink, and is classified by the U.S. Geological Survey as slightly saline to moderately saline (Robinove and others, 1958). The recommended dissolved-solids concentration limit for small livestock animals is 3,000 mg/L, and the concentration limit for irrigation is 700 mg/L (National Academy of Sciences and National Academy of Engineering, 1972).

During surface mining and the subsequent reclaiming of coal spoil, many new rock surfaces are exposed. The new surfaces then are subject to additional weathering and chemical reactions with water. Weathering as explained later in this section, will result in larger dissolved-solids concentrations. Many authors have shown that surface mining increases dissolved-solids concentrations (Curtis, 1972; Caruccio, 1973; McWhorter and others, 1974; Caruccio and Geidel, 1978; McWhorter and others, 1977; Hounslow and others, 1978). The leachate from reclaimed coal spoil eventually will come into contact with water from surrounding undisturbed areas. Depending on natural conditions, addition of leachate to surface- or ground-water supplies can alter considerably the natural water quality.

Acceptance of Chemical Data

The first step in the evaluation of chemical data is to determine the acceptability of the data base. A plot of cations (calcium, magnesium, sodium, and potassium) compared to anions (bicarbonate, sulfate, chloride, and fluoride) is shown in figure 20. One sample point appears to be an outlier. The sample was taken from lysimeter 1 during 1978 and was found to have a cation-anion milliequivalent imbalance of 38 percent. This large error was deemed excessive, and the sample was not included in the data set for this study. Lysimeter leachate water chemistry is reported for 103 samples. All samples were collected by U.S. Geological Survey personnel using standard U.S. Geological Survey sampling procedures and laboratory techniques (Fishman and Friedman, 1985).

Lysimeter Leachate Quality

Because the lysimeters have different textural compositions, and because lysimeters 2 and 4 have topsoil, these differences need to be considered in determining the chemical composition of the water. Only two water-quality patterns in the lysimeters are evident. The quality of water in lysimeters 4 and 5 is similar to each other and differs from that in all other lysimeters with respect to mean sodium and mean chloride concentrations, as given below, in milligrams per liter. Individual values of the chemical constituents and properties sampled are given in the "Supplementary Water-Quality Data" section at the back of the report.

Ion (milligrams per liter)[1]	Lysimeter				
	1	2	3	4	5
Sodium	87	89	95	218	173
Chloride	7.7	7.5	6.0	103	89

[1] All values are average annual concentrations for 3 years (1978, 1979, and 1980).

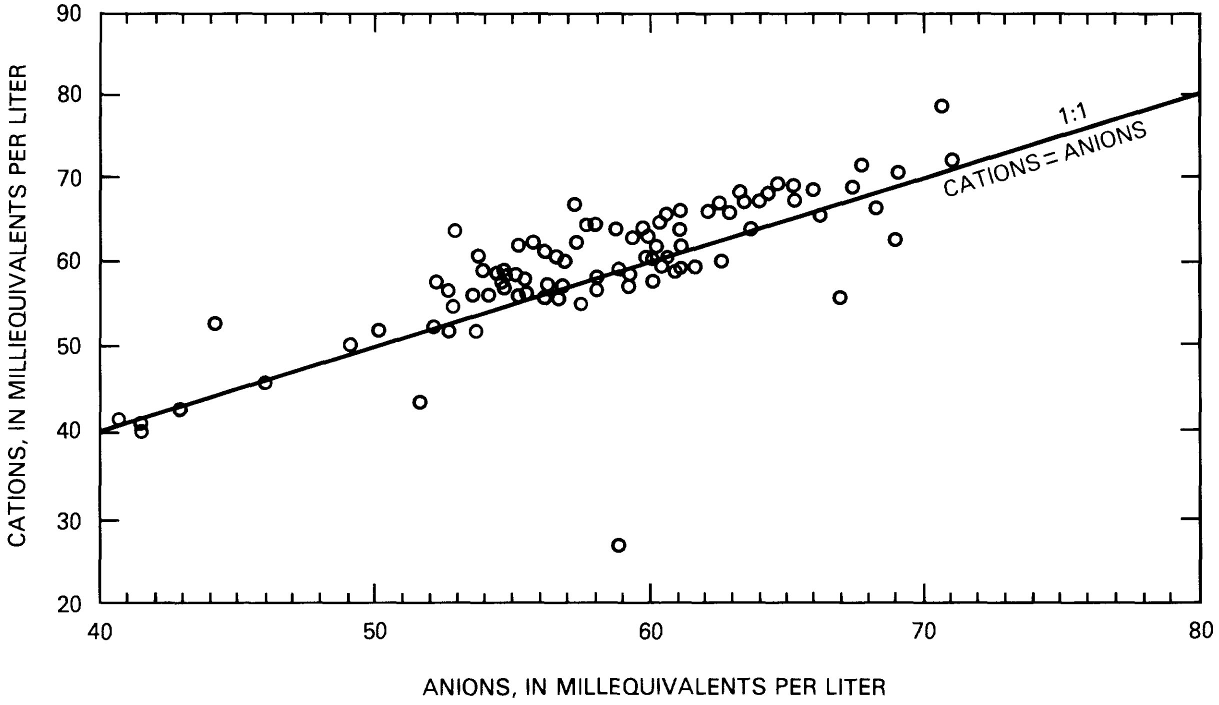


Figure 20.--Cations (calcium + magnesium + sodium + potassium) compared to anions (bicarbonate + sulfate + chloride + fluoride) in water from the lysimeters.

Sodium and chloride concentrations in water in lysimeters 4 and 5 are greater than those in lysimeters 1, 2, and 3. This fact indicates that the ions may originate from a similar mineral. The presence of sodium and chloride may indicate that dissolution of the evaporites, halite and natron, may be involved.

Available X-ray diffraction information does not indicate the presence of halite (table 1), and occurrence of this mineral probably is not an explanation for large concentrations in some lysimeters. However, fluid inclusions commonly occur in shales (J.E. Turk, U.S. Geological Survey, oral commun., 1984), and these inclusions could contain large concentrations of sodium and chloride ions. Rupturing of these inclusions and release of fluids in small quantities could explain why these ions occur in some water samples. It also is possible that halite is present in the spoil matrix, but that the crystals are so widely disseminated that they are not detectable by X-ray diffraction.

The water-quality data also indicate a difference between lysimeter 2 and the other lysimeters. An example of this difference is the concentration of dissolved solids. The concentration of dissolved solids in water from lysimeter 2 is smaller than that in the other lysimeters, while the water type is essentially the same as the other lysimeters (figs. 21 and 22). It is not known whether or not this difference is the result of natural variation. Thus, minor differences in chemical-constituent concentrations occur, and negligible differences in water type occur. Therefore, the effect of textural composition and topsoil appears to have little effect on water chemistry from one lysimeter to the next.

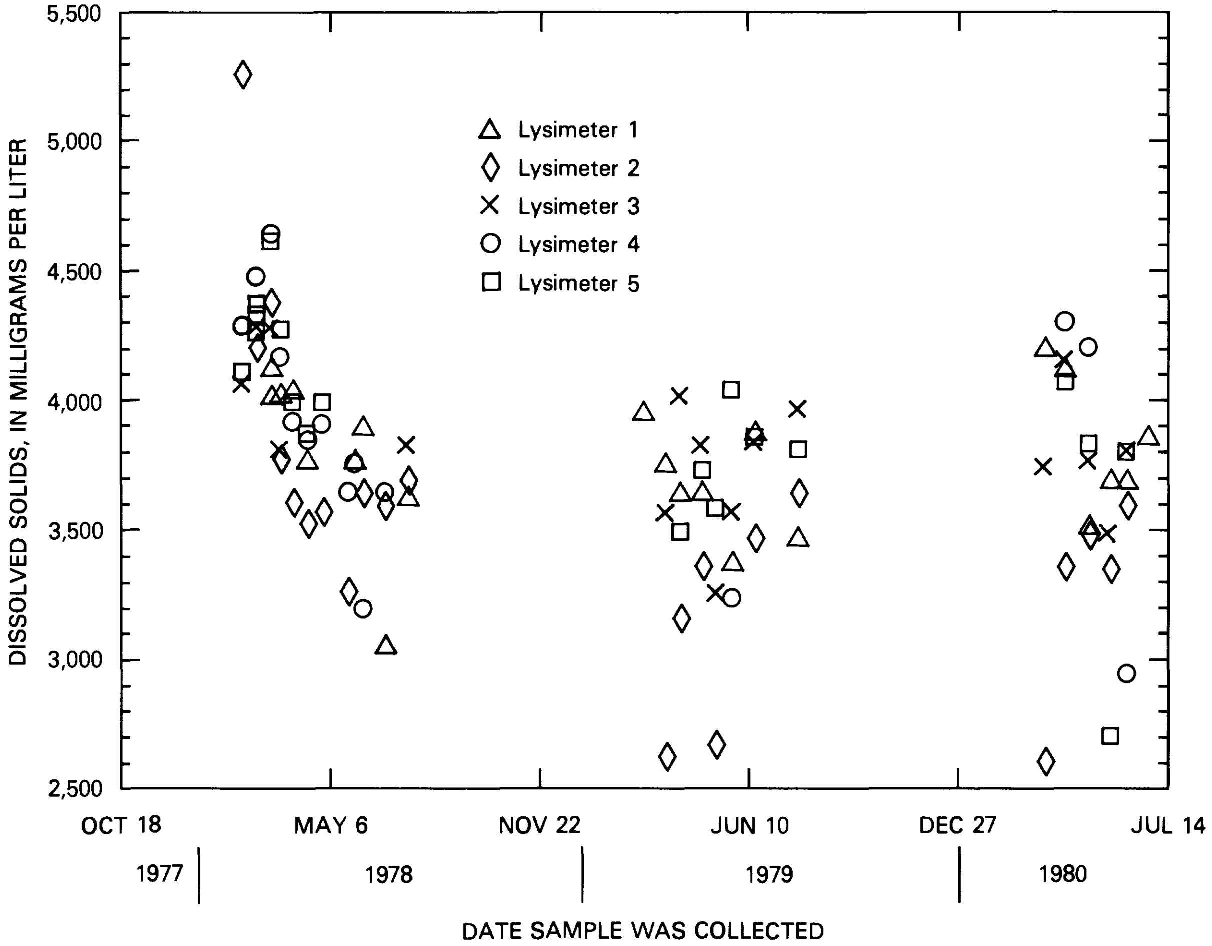


Figure 21.--Dissolved-solids concentration in samples of water from the five lysimeters compared to date of collection.

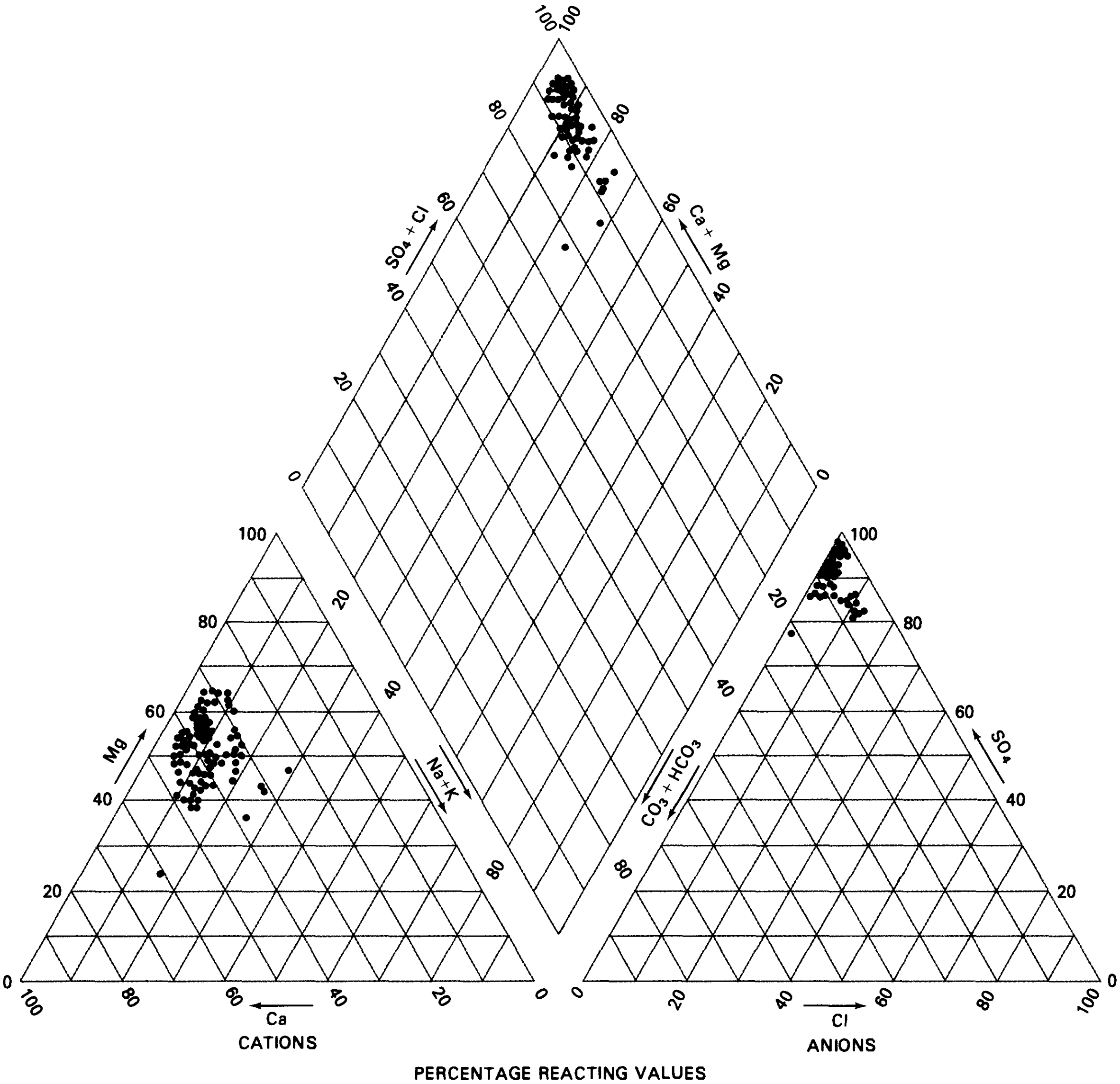


Figure 22.--Piper-trilinear diagram showing lysimeter data.

It initially was assumed that large dissolved-solids concentrations would occur in the lysimeter leachate, and with time, the readily soluble minerals would be removed from the system, resulting in smaller dissolved-solids concentrations. No clear pattern of increasing or decreasing concentrations is present. The changes that occur in concentrations simply may represent the natural variations of an average concentration. Additional years of data collection are needed before trends can be established. However, the hypothesized decrease in concentrations is not evident from these data.

Seasonal inputs, kinetics, quantity of discharge, and other factors may affect the chemical composition of the lysimeter leachate within the year. The date of collection may be important in many instances, which means that there is a within-year effect or trend with time. For example, water that remains in the lysimeter during the winter has a longer residence time than water flowing through the lysimeters during the spring. Consequently, there is additional time for chemical reactions and equilibration to occur. Although minor fluctuations did occur during the year, the changes were not distinct enough to clearly identify a within-year trend.

Three conclusions from the general water chemistry are:

1. The water chemistry of all lysimeters is essentially the same; the data from these lysimeters will be analyzed as a group.

2. A difference occurs in the concentrations of ions flowing through the lysimeters on a year-to-year basis. However, the variations simply may represent natural variation.

3. The within-year variation in the water chemistry is minor.

The average concentrations of the major cations and anions in the lysimeter meter leachate were:

Cations		Anions	
Calcium	460 mg/L	Sulfate	2,540 mg/L
Magnesium	370 mg/L	Bicarbonate	224 mg/L
sodium	111 mg/L		

During the summer of 1977, the equivalent of 1 year's precipitation was applied directly as one quantity, to lysimeters 2, 3, 4, and 5. The water seemed to pipe down the walls of the lysimeters rather than saturate and flow through the spoil material. This water application then was discontinued. As has been shown, the water chemistry of lysimeter 1 is the same as lysimeters 2, 3, 4, and 5. Therefore, the application of water does not seem to have had a substantial effect on the coal-spoil water chemistry.

The first quantity of water applied was approximately 200 gal at each lysimeter, except for lysimeter 1 where no water was applied. One month later, in August, water was applied for the second and final time as follows:

Lysimeter 1 - 0 gal
2 - 300 gal
3 - 200 gal
4 - 300 gal
5 - 400 gal

The water applied was from the Yampa River. The water was sampled before being transported in a water tank to the lysimeter site. The water from the tank was sampled before being applied to the lysimeters. The dissolved-solids concentration of the applied water was one order of magnitude less than the dissolved-solids concentration of coal-spoil water that discharged from the lysimeters. The samples associated with the water application are reported in the "Supplementary Water-Quality Data" section at the back of the report, in tables 9-22.

Dissolved-Solids Concentration

This section will be a discussion of major cations and anions in the lysimeter leachate. The possible processes that cause the dissolved-solids concentrations also will be examined.

The average dissolved-solids concentration at the lysimeters decreased from 3,962 mg/L during 1978 to 3,560 mg/L during 1979, but increased slightly to 3,667 mg/L during 1980. The change probably represents just the natural fluctuations of an average value. The important consideration is evaluating the large dissolved-solids concentration.

The large dissolved-solids concentration (fig. 21) in the lysimeter leachate could inhibit plant growth on the coal spoil. The dissolved-solids concentration of the leachate also may increase concentrations in nearby natural ground- and surface-water systems.

Piper-Trilinear Diagram

A Piper-trilinear diagram depicts the ionic composition of a water sample. The points reference only percent composition and give no indication about concentrations. Therefore, a sample containing 50 mg/L of calcium, 50 mg/L of magnesium, and 50 mg/L of sodium plus potassium would plot at exactly the same point as a sample containing 5,000 mg/L of each of the named cations. The water quality of the samples obtained from the lysimeters is presented in tables 4-8 (in the "Supplementary Water-Quality Data" section at the back of the report). The homogeneity of the ionic composition of the samples is shown by the clustering of the points on the Piper-trilinear diagram in figure 22. The samples are strongly dominated by calcium, magnesium, and sulfate ions.

Sources of Dissolved Solids

Calcium, magnesium, and sulfate are the dominant ions in the coal-spoil leachate. The cations, calcium and magnesium, probably come from carbonate minerals that have been dissolved by carbonic acid or sulfuric acid. Carbonic acid is formed naturally when carbon dioxide gas (CO_2) dissolves in water. Sources of carbon dioxide are the atmosphere, decaying organic matter, and plant respiration. Sulfuric acid is formed by the oxidation and dissolution of minerals such as pyrite (FeS_2). Gypsum is a source of sulfate.

Atmospheric Carbon Dioxide, Decay of Organic Matter, and Plant Respiration

The atmospheric partial pressure of carbon dioxide (PCO_2) is approximately $10^{-3.5}$ atm. Therefore, water from precipitation that enters the coal spoil should have a PCO_2 of about $10^{-3.5}$ atm. If the PCO_2 of water in the coal spoil is greater than $10^{-3.5}$ atm, then the indication is that CO_2 is being added within the coal spoil during percolation. The subsurface sources of CO_2 would be decay of organic matter, plant respiration, and dissolution of carbonates by sulfuric acid. Production of CO_2 by oxidation of organic matter commonly is expressed by:

$$CH_2O + O_2 \rightarrow CO_2 + H_2O. \qquad (2)$$

However, the coal spoil had little vegetation and contained very little freshly deposited organic matter during the study.

If PCO_2 is less than atmospheric PCO_2, that indicates the coal spoil assimilates CO_2 faster than it is replaced. PCO_2 levels may decline because of mineral-water reactions. The CO_2 combines with water to form carbonic acid (H_2CO_3). The carbonic acid then dissociates:

$$H_2CO_3 \rightarrow H^+ + HCO_3^-. \qquad (3)$$

$$HCO_3^- \rightarrow H^+ + CO_3^{-2}. \qquad (4)$$

The slightly acidic environment then facilitates the dissolution of carbonate rocks, such as calcite and dolomite. As a result, carbonic acid and CO_2 are consumed, and calcium, magnesium, and bicarbonate ions are released to solution.

For example, the equations for calcite and for dolomite dissolution are:

$$CaCO_3 + H_2CO_3 \rightarrow Ca^{+2} + 2HCO_3^-. \qquad (5)$$

$$CaMg(CO_3)_2 + 2H_2CO_3 \rightarrow Ca^{+2} + Mg^{+2} + 4HCO_3^-. \qquad (6)$$

Without additional CO_2 being introduced to the deeper soil water, the PCO_2 concentration will decrease.

The spoil material in the lysimeters was not saturated with water. Therefore, atmospheric CO_2 should have been able to enter the spoil-material pore space and combine with water to form carbonic acid throughout the lysimeter depth. Thus, the coal spoil was an open rather than a closed system.

Both Garrels and Christ (1965) and Krauskopf (1979) show methods to calculate ion concentrations that result from calcite dissolution by carbonic acid. Similar calculations can be made for dolomite. However, the calculated concentrations are smaller than are present in the lysimeter leachate. Krauskopf (1979) notes that, when comparing theoretically derived numbers to actual measured concentrations in natural waters, the measured concentrations "are embarrassingly high, much higher than can be accounted for even with generous assumptions about temperature, CO_2 pressure, and acidity." He attributes the large concentrations of carbonate derived ions to be mainly the result of both the effect of other electrolytes in solution and ion association.

Considering the preceding comments of Krauskopf (1979), dissolution of calcite and dolomite by carbonic acid could account for the calcium and magnesium found in the lysimeter leachate. Dissolution of these minerals does not account for the presence of sulfate. However, dissolution of gypsum or pyrite can account for the sulfate in the solution.

Mineral Weathering

Gypsum.--Sulfate is an ion that comprises a large percentage of the dissolved-solids load. One source of the sulfate is gypsum. Gypsum is ubiquitous in the study area, and even small quantities of gypsum could account for the concentrations of sulfate found in the lysimeter leachate.

Pyrite oxidation.--Pyrite also is a possible source of sulfate. Pyrite that is present in the shallow coal spoil can be oxidized:

$$2FeS_2 + 7O_2 + 2H_2O \rightarrow 2Fe^{+2} + 4SO_4^{-2} + 4H^+. \tag{7}$$

The sulfuric acid then forms from this reaction and can dissolve carbonate rocks containing calcite:

$$2CaCO_3 + H_2SO_4 \rightarrow 2Ca^{+2} + 2HCO_3^- + SO_4^{-2}; \tag{8}$$

or dolomite:

$$CaMg(CO_3)_2 + H_2SO_4 \rightarrow Ca^{+2} + Mg^{+2} + SO_4^{-2} + 2HCO_3^-. \tag{9}$$

The sulfate ions produced in the above reactions may remain in solution and may be transported in recharge water to a deeper aquifer. Alternatively, if evapotranspiration is occurring, gypsum may precipitate within the coal spoil:

$$Ca^{+2} + SO_4^{-2} + 2H_2O \rightarrow CaSO_4 \cdot 2H_2O. \tag{10}$$

Subsequent infiltration of water can redissolve the precipitated gypsum. Even if pyrite is present in concentrations less than 1 percent, this presence still could account for all the sulfate present in the coal-spoil water.

Carbonic-acid dissolution of carbonate rocks, combined with gypsum dissolution, may be the major reactions in the system; or, more likely, these reactions and pyrite oxidation could be occurring simultaneously. The water chemistry of the lysimeter leachate probably is the result of a carbon-dioxide driven system, gypsum dissolution, and pyrite oxidation.

Following carbonate dissolution, dissolved ions may flow from the coal spoil, or they may precipitate following evapotranspiration as the source mineral or a different mineral. Plots of saturation indices, as calculated by WATEQF (Plummer and others, 1976), are compared to date for selected minerals (figs. 23, 24, and 25). Values plotted are the saturation indices where zero indicates the equilibrium condition. A saturated condition means if the mineral is present, it is in equilibrium with the solution and should not undergo additional dissolution. Calcite, dolomite, and gypsum generally are

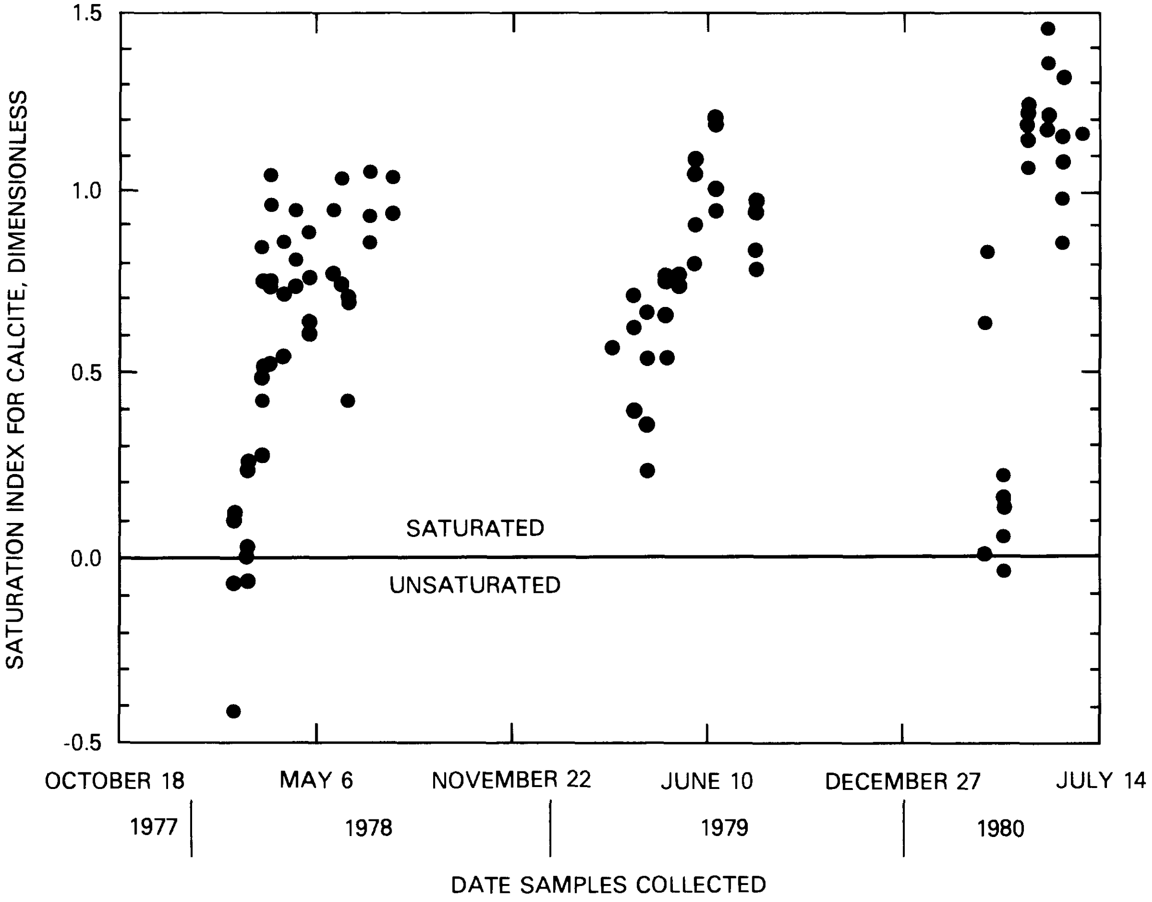


Figure 23.--Saturation indices for calcite compared to date samples were collected from the lysimeters.

saturated in the waters in the lysimeters and minerals should not dissolve any further. However, in the future, gypsum may dissolve in the presence of less-mineralized water; thus, gypsum can be a long-term source of calcium and sulfate.

Another process that could occur in a coal spoil is cation exchange. In this process, calcium and magnesium are exchanged for adsorbed sodium and potassium on the clays in shales that are abundant in the coal spoil. For example:

$$Na_2(Clay) + Ca^{+2} \rightarrow Ca(Clay) + 2Na^{+}. \qquad (11)$$

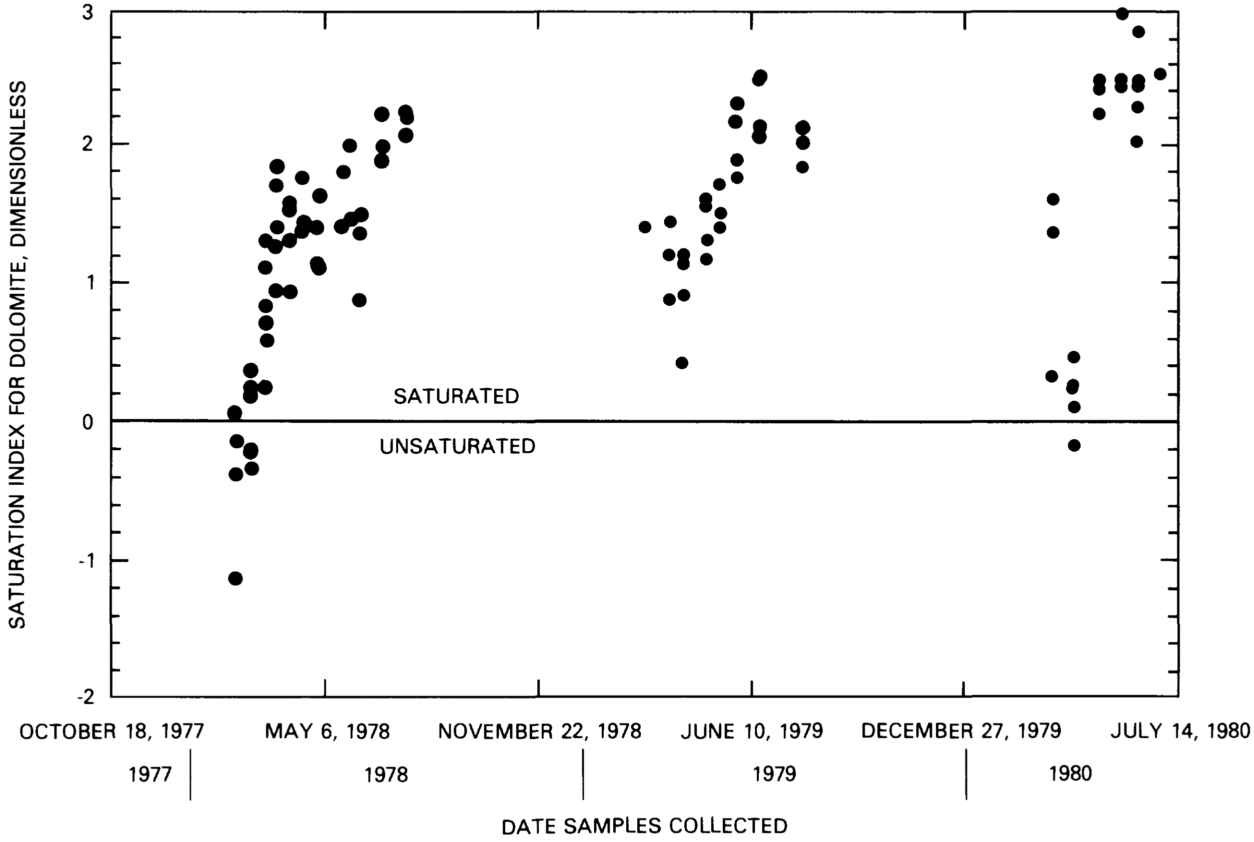


Figure 24.--Saturation indices for dolomite compared to date samples were collected from the lysimeters.

Therefore, cation exchange can help account for the presence of sodium and potassium in the coal-spoil leachate. However, the small concentration of these ions indicates that cation exchange is not a major process occurring in the lysimeters.

Still another process that could occur in the coal spoils is the weathering of potassium and sodium feldspars to kaolinite, which releases potassium and sodium to solution. The weathering is a very slow process compared to cation exchange.

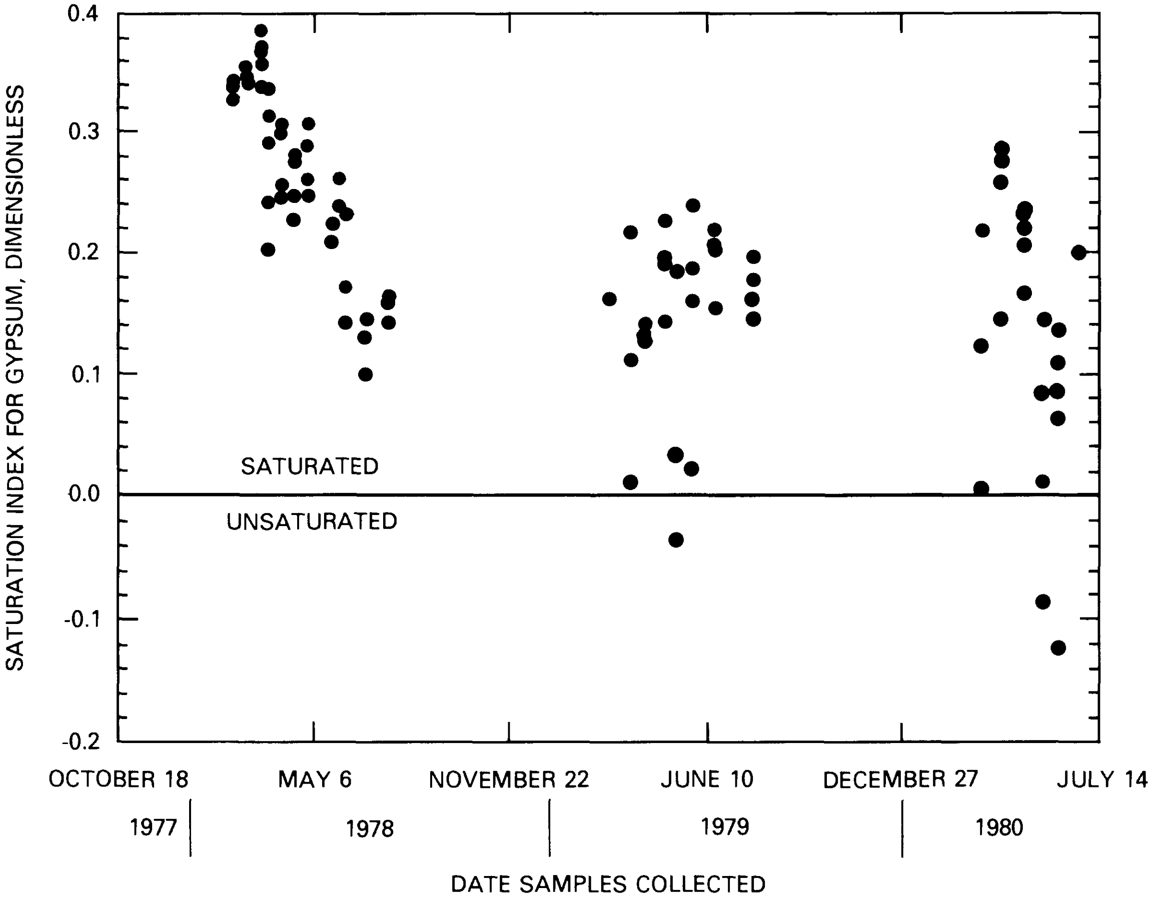


Figure 25.--Saturation indices for gypsum compared to date samples were collected from the lysimeters.

In addition to the cations and anions previously discussed, nitrogen (dissolved nitrite plus nitrate, as nitrogen), and selenium are in large concentrations in the lysimeter leachate. The large nitrogen concentrations were present only in samples collected during the early part of the study; whereas, the large selenium concentrations were present in all samples collected.

The U.S. Environmental Protection Agency (1976) limit for concentrations of dissolved nitrate as nitrogen for domestic water supply is 10 mg/L, and large concentrations of dissolved nitrate as nitrogen can cause methemoglobinemia in infants. Large concentrations of dissolved nitrate as nitrogen in the coal spoils may be due to intense fertilization of the coal spoils by the mine operators. The study area had just been recontoured and reclaimed following mining, and revegetation activities were ongoing. The following table shows the rapid decline in dissolved-nitrogen con-centrations after 1978.

Year	Lysimeter				
	1	2	3	4	5
1978	49	43	51	25	36
1979	15	7	2	8	2
1980	3	8	1	1	<1

Note: All values are average annual concentrations in milligrams per liter (mg/L) of nitrogen (dissolved nitrite plus dissolved nitrate as nitrogen), for 3 years (1978, 1979, 1980).

Concentrations of selenium should not exceed 10 μg/L for domestic water supplies (U.S. Environmental Protection Agency, 1976). Although selenium is essential and beneficial to man, excessive concentrations are considered toxic and have symptoms that are similar to arsenic poisoning. The concentration of selenium in the lysimeter leachate exceeded 10 μg/L for all but one sample, and average selenium concentrations were one order of magnitude greater than the U.S. Environmental Protection Agency standards for drinking water supplies.

Lysimeter	Average selenium concentration
1	174 μg/L
2	169 μg/L
3	128 μg/L
4	105 μg/L
5	161 μg/L

In addition to exceeding drinking water standards, these large selenium concentrations may preclude other uses of the water from the coal spoils, because selenium can be taken up by plants, which if consumed by livestock or wildlife may be harmful.

SUMMARY AND CONCLUSIONS

Water quantity and water quality in a coal spoil and an adjacent undisturbed site in northwestern Colorado were compared, using 5 drainage-type lysimeters and 21 soil-water access tubes at the coal spoil and 8 access tubes at the undisturbed site. The coal spoil had one access tube in each lysimeter and eight access tubes in the coal spoil near the lysimeters. The study was made during the first 3 years after reclamation.

Soil-water content was measured to a depth of 6 ft with a neutron probe. The quantity of water that entered the coal spoil and the undisturbed soil was about the same. However, the rate at which water flowed through the systems and the quantity of water present at different depths at certain times of the year were different. Comparison of measured average total maximum and average total minimum soil-water content and soil porosity showed that the undisturbed soil was near saturation throughout the year at depths of about 4.5 to 5 ft. Soil-water content at the 6-ft depth varied by 1 to 3 percent during the year. Because weathered shale occurs below this depth, a minimal quantity of water percolates to recharge deeper aquifers. In contrast, the coal spoil was not near saturation, and water moved freely to a depth of at least 6 ft. Soil-water content at the 6-ft depth varied from 5 to 7 percent during the year. In fact, at a depth of 8 ft, 2 to 6 in. of water per unit surface area per year was percolating through the lysimeters and potentially could have recharged deeper aquifers. The natural recharge to aquifers in the area was estimated to be about 0.5 in/yr. Even though the differences between measured potential coal-spoil recharge and the undisturbed-soil estimated recharge may have seemed large, it needs to be noted that these values were for the first 3 years after reclamation. Subsequent weathering of the spoil, coal-spoil settling, vegetation development, and other factors may reduce coal-spoil recharge in the future.

Although the lysimeter coal-spoil material varied in texture, and 8 to 18 in. of topsoil was initially applied to two of the five lysimeters, the chemical composition of the leachate remained initially the same. No differences in chemical concentrations were detected from year-to-year or within any year. The average concentrations of the major ions in the leachate were: calcium, 460 mg/L; magnesium, 370 mg/L; sulfate, 2,540 mg/L; sodium, 111 mg/L; and bicarbonate, 224 mg/L.

Carbonic-acid dissolution of carbonate rocks, dissolution of gypsum, and cation exchange on clays can account for concentrations of the major cations and anions found in the lysimeter leachate. Atmospheric carbon dioxide is the major source of carbon dioxide for forming carbonic acid. The carbonic acid then dissolves calcite and dolomite and results in calcium, magnesium, and bicarbonate in solution. Gypsum dissolution results in calcium and sulfate in solution.

Pyrite oxidation also could initiate the chemical reactions that account for the quality of coal-spoil water. Sulfuric acid is formed during pyrite oxidation. The acid then dissolves carbonate minerals such as calcite and dolomite. After reaction of the acid with carbonates, the coal-spoil water may become saturated with gypsum, and authigenic precipitation of gypsum can follow. The result is that the precipitated gypsum, in addition to the gypsum already present in the spoil, could continue to be a source of calcium and sulfate for a long time. The water chemistry of the coal spoil probably is the result of combined effects of carbonate dissolution by a carbon-dioxide-driven process, pyrite oxidation, and dissolution of gypsum. The small quantities of sodium and potassium present indicate that cation exchange may be occurring on the clays present; however, the exchange is a minor factor in the overall coal-spoil water chemistry.

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SUPPLEMENTARY WATER-QUALITY DATA

The following abbreviations are used in tables 4-22.

°C,	degree Celsius
µS/CM,	microsiemens per centimeter at 25 degrees Celsius
MG/L,	milligram per liter
FET-FLD,	Fixed end-point titration-field
µG/L,	microgram per liter
IT-LAB,	incremental titration-laboratory
--,	no data
<,	less than
ND,	not detected
AC-FT,	acre foot
RECOV.,	recoverable

Table 4.--*Water-quality data from Lysimeter 1*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	pH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	CARBONATE FET-FLD (MG/L AS CO3)	NITROGEN, NO$_2$+NO$_3$ DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
MAR										
11-----	2.0	4,080	10.2	7.8	6.6	0	84	.00	<.010	2,700
11-----	2.0	4,080	10.2	7.9	5.2	0	86	.00	<.010	2,800
20-----	3.5	4,240	9.8	7.8	6.6	0	100	.06	.020	2,900
APR										
01-----	5.0	4,230	9.8	7.5	16	0	69	.40	.130	3,200
15-----	6.0	3,910	9.5	7.9	4.2	0	36	.03	.010	2,900
29-----	6.0	3,830	8.9	7.8	6.3	0	35	.03	.010	3,000
MAY										
23-----	9.5	3,720	8.4	8.0	3.4	0	25	.00	<.010	--
30-----	10.0	3,880	8.4	8.0	2.2	0	26	.03	.010	2,800
JUN										
07-----	10.5	3,870	8.3	7.8	3.6	0	28	.00	<.010	2,500
28-----	18.0	3,890	6.6	8.3	1.2	0	26	.03	.010	2,400
28-----	18.0	3,600	6.6	8.3	--	--	--	--	--	--
JUL										
20-----	18.0	3,900	6.6	8.3	1.2	0	26	.00	<.010	2,600

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (µG/L AS AS)
MAR												
11---	2,500	600	300	120	1	9	53	32	2,400	.30	10	2
11---	2,500	610	300	120	1	8	47	32	2,500	.30	10	1
20---	2,700	570	370	83	.7	6	21	25	2,300	.30	89	1
APR												
01---	2,900	580	420	54	.4	4	14	3.7	2,500	.20	7.0	1
15---	2,800	530	390	55	.4	4	20	7.4	2,500	.40	8.4	<1
29---	2,900	560	400	54	.4	4	23	7.4	2,600	.40	9.7	1
MAY												
23---	--	500	--	62	--	3	23	5.6	2,400	.40	8.9	1
30---	2,700	500	380	60	.5	4	24	5.7	2,600	.40	9.2	<1
JUN												
07---	2,400	420	360	380	3	24	28	5.6	2,500	--	11	<1
28---	2,300	410	340	62	.5	5	38	2.8	2,000	.50	15	<1
28---	--	--	--	--	--	--	--	--	--	--	--	--
JUL												
20---	2,500	420	380	65	.6	5	47	5.5	2,500	.40	23	2

Table 4.--*Water-quality data from Lysimeter 1*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978--Continued

DATE	ARSENIC TOTAL (µG/L AS AS)	BORON, DIS-SOLVED (µG/L AS B)	BORON, TOTAL RECOV-ERABLE (µG/L AS B)	CADMIUM DIS-SOLVED (µG/L AS CD)	CADMIUM TOTAL RECOV-ERABLE (µG/L AS CD)	CHRO-MIUM, TOTAL RECOV-ERABLE (µG/L AS CR)	COPPER, DIS-SOLVED (µG/L AS CU)	COPPER, TOTAL RECOV-ERABLE (µG/L AS CU)	IRON, TOTAL RECOV-ERABLE (µG/L AS FE)	IRON, DIS-SOLVED (µG/L AS FE)	LEAD, DIS-SOLVED (µG/L AS PB)	LEAD, TOTAL RECOV-ERABLE (µG/L AS PB)
MAR												
11...	--	90	--	<2	--	--	3	--	--	<10	<2	--
11...	--	90	--	<2	--	--	3	--	--	<10	4	--
20...	--	110	--	3	--	--	3	--	--	30	10	--
APR												
01...	--	70	--	ND	--	--	ND	--	--	<10	ND	--
15...	--	60	--	<2	--	--	<2	--	--	20	3	--
29...	--	60	--	<2	--	--	2	--	--	<10	7	--
MAY												
23...	--	50	--	2	--	--	3	--	--	<10	15	--
30...	--	60	--	<2	--	--	2	--	--	30	2	--
JUN												
07...	--	70	--	2	--	--	2	--	--	<10	2	--
28...	--	60	--	<2	--	--	3	--	--	50	4	--
28...	1	--	150	--	<2	<20	--	12	80	--	--	6
JUL												
20...	--	90	--	6	--	--	5	--	--	60	--	--

DATE	MANGA-NESE, TOTAL RECOV-ERABLE (µG/L AS MN)	MANGA-NESE, DIS-SOLVED (µG/L AS MN)	MOLYB-DENUM, DIS-SOLVED (µG/L AS MO)	MOLYB-DENUM, TOTAL RECOV-ERABLE (µG/L AS MO)	NICKEL, DIS-SOLVED (µG/L AS NI)	NICKEL, TOTAL RECOV-ERABLE (µG/L AS NI)	VANA-DIUM, DIS-SOLVED (µG/L AS V)	ZINC, DIS-SOLVED (µG/L AS ZN)	ZINC, TOTAL RECOV-ERABLE (µG/L AS ZN)	ANTI-MONY, DIS-SOLVED (µG/L AS SB)	ANTI-MONY, TOTAL (µG/L AS SB)
MAR											
11...	--	30	2	--	7	--	0	20	--	--	--
11...	--	20	3	--	4	--	0	20	--	--	--
20...	--	40	4	--	<2	--	0	30	--	<1	--
APR											
01...	--	20	5	--	5	--	0	<20	--	<1	--
15...	--	<10	4	--	5	--	0	20	--	1	--
29...	--	20	2	--	ND	--	0	20	--	<1	--
MAY											
23...	--	20	4	--	ND	--	0	20	--	1	--
30...	--	20	4	--	4	--	0	20	--	<1	--
JUN											
07...	--	<10	4	--	4	--	0	20	--	<1	--
28...	--	20	4	--	5	--	0	30	--	3	--
28...	20	--	--	7	--	8	--	--	20	--	<1
JUL											
20...	--	<10	5	--	8	--	--	--	--	--	--

Table 4.--*Water-quality data from Lysimeter 1*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978--Continued

DATE	ALUM-INUM, TOTAL RECOV-ERABLE (μG/L AS AL)	ALUM-INUM, DIS-SOLVED (μG/L AS AL)	SELE-NIUM, DIS-SOLVED (μG/L AS SE)	SELE-NIUM, TOTAL (μG/L AS SE)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	MERCURY DIS-SOLVED (μG/L AS HG)	MERCURY TOTAL RECOV-ERABLE (μG/L AS HG)	ALKA-LINITY LAB (MG/L AS CACO3)	BICAR-BONATE IT-LAB (MG/L AS HCO3)
MAR										
11...	--	<100	290	--	4000	5.5	<.1	--	210	260
11...	--	<100	290	--	4100	5.6	<.1	--	210	260
20...	--	20	100	--	4000	5.5	<.1	--	210	260
APR										
01...	--	<100	380	--	4000	5.5	<.1	--	250	310
15...	--	<100	270	--	3800	5.1	<.1	--	170	210
29...	--	<100	350	--	3900	5.3	<.1	--	180	220
MAY										
23...	--	<100	<1	--	--	--	<.1	--	160	190
30...	--	<100	230	--	3800	5.1	<.1	--	120	150
JUN										
07...	--	<100	190	--	3900	5.3	<.1	--	110	140
28...	--	<100	170	--	3100	4.2	<.1	--	120	150
28...	30	--	--	190	--	--	--	<.1	--	--
JUL										
20...	--	10	290	--	3600	4.9	<.1	--	120	150

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979

DATE	TEMPER-ATURE (°C)	SPE-CIFIC CON-DUCT-ANCE (μS/CM)	OXYGEN, DIS-SOLVED (MG/L)	PH (STAND-ARD UNITS)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	CAR-BONATE FET-FLD (MG/L AS CO3)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)
MAR									
01...	24.0	4170	6.8	7.7	6.8	0	30	.09	.030
23...	6.0	4130	9.5	7.9	5.0	0	1.9	.03	.010
APR									
06...	8.0	4050	8.4	7.8	5.8	0	16	.00	<.010
27...	10.0	4020	12.1	8.1	2.0	0	16	.00	<.010
MAY									
10...	8.5	3820	13.6	7.9	8.3	0	14	.03	.010
25...	16.5	3840	7.4	8.1	1.9	0	14	.00	<.010
JUN									
16...	16.0	3950	7.3	8.3	1.2	0	14	.00	<.010
JUL									
27...	20.0	3400	6.6	8.1	1.7	0	16	.00	<.010

Table 4.--*Water-quality data from Lysimeter 1*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	SODIUM+ POTASSIUM DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
MAR											
01...	2800	2600	420	420	60	.5	4	--	19	5.4	2800
23...	2800	2600	430	420	50	.4	4	--	16	1.8	2700
APR											
06...	2700	2500	360	430	46	.4	4	--	16	1.4	2600
27...	2700	2600	420	400	47	.4	4	--	20	1.4	2600
MAY											
10...	1100	800	330	75	66	.9	11	110	44	1.9	2500
25...	970	850	390	--	49	.4	4	72	--	1.4	2800
JUN											
16...	2700	2600	450	390	59	.5	4	95	36	1.8	2800
JUL											
27...	2700	2600	440	380	59	.5	10	100	42	2.0	2400

DATE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (μG/L AS AS)	ARSENIC TOTAL (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	CADMIUM SUSPENDED RECOVERABLE (μG/L AS CD)	CADMIUM TOTAL RECOVERABLE (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	COPPER, SUSPENDED RECOVERABLE (μG/L AS CU)	COPPER, TOTAL RECOVERABLE (μG/L AS CU)
MAR											
01...	.30	10	1	1	70	2	0	<2	3	1	4
23...	.40	7.6	<1	1	60	ND	0	ND	<2	0	ND
APR											
06...	.40	6.9	<1	1	50	ND	2	2	<2	3	4
27...	.40	7.7	<1	<1	60	ND	1	<2	<2	1	2
MAY											
10...	.40	8.7	1	1	50	ND	2	2	ND	2	2
25...	.50	7.8	<1	<1	50	ND	12	12	ND	5	5
JUN											
16...	.50	9.5	1	1	60	ND	0	ND	<2	5	6
JUL											
27...	.50	18	1	1	40	<2	0	ND	2	1	3

Table 4.--*Water-quality data from Lysimeter 1*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	IRON, SUS- PENDED RECOV- ERABLE (μG/L AS FE)	IRON, TOTAL RECOV- ERABLE (μG/L AS FE)	IRON, DIS- SOLVED (μG/L AS FE)	LEAD, DIS- SOLVED (μG/L AS PB)	LEAD, SUS- PENDED RECOV- ERABLE (μG/L AS PB)	LEAD, TOTAL RECOV- ERABLE (μG/L AS PB)	MANGA- NESE, SUS- PENDED RECOV. (μG/L AS MN)	MANGA- NESE, TOTAL RECOV- ERABLE (μG/L AS MN)	MANGA- NESE, DIS- SOLVED (μG/L AS MN)	MOLYB- DENUM, DIS- SOLVED (μG/L AS MO)	MOLYB- DENUM, SUS- PENDED RECOV. (μG/L AS MO)
MAR											
01...	10	60	50	<2	0	<2	10	20	<10	5	0
23...	20	50	30	3	10	13	0	20	20	4	1
APR											
06...	10	70	60	ND	11	11	0	20	20	3	3
27...	0	30	30	ND	110	110	0	<10	<10	3	3
MAY											
10...	0	20	30	ND	37	37	0	20	20	3	2
25...	20	40	20	ND	7	7	0	20	20	<1	5
JUN											
16...	--	--	20	ND	7	7	--	--	20	2	1
JUL											
27...	50	70	20	ND	15	15	0	20	20	4	0

DATE	MOLYB- DENUM, TOTAL RECOV- ERABLE (μG/L AS MO)	NICKEL, DIS- SOLVED (μG/L AS NI)	NICKEL, SUS- PENDED RECOV- ERABLE (μG/L AS NI)	NICKEL, TOTAL RECOV- ERABLE (μG/L AS NI)	VANA- DIUM, DIS- SOLVED (μG/L AS V)	ZINC, DIS- SOLVED (μG/L AS ZN)	ZINC, SUS- PENDED RECOV- ERABLE (μG/L AS ZN)	ZINC, TOTAL RECOV- ERABLE (μG/L AS ZN)	ALUM- INUM, TOTAL RECOV- ERABLE (μG/L AS AL)	ALUM- INUM, DIS- SOLVED (μG/L AS AL)	ALUM- INUM, SUS- PENDED RECOV. (μG/L AS AL)
MAR											
01...	3	4	1	5	0	40	0	40	30	<100	30
23...	5	3	2	5	0	20	10	30	20	<100	20
APR											
06...	6	4	3	7	0	30	0	30	60	<100	60
27...	6	ND	3	3	0	30	10	40	40	<100	40
MAY											
10...	5	ND	4	4	0	30	10	40	70	20	50
25...	5	ND	0	ND	0	20	0	20	110	<100	110
JUN											
16...	3	<2	6	7	0	30	10	40	120	<100	120
JUL											
27...	4	2	3	5	<1	20	10	30	110	<100	110

Table 4.--*Water-quality data from Lysimeter 1*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	SELENIUM, DISSOLVED (µG/L AS SE)	SELENIUM, SUSPENDED TOTAL (µG/L AS SE)	SELENIUM, TOTAL (µG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (µG/L AS HG)	MERCURY SUSPENDED RECOVERABLE (µG/L AS HG)	MERCURY TOTAL RECOVERABLE (µG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)
MAR										
01...	230	0	230	4000	5.4	<.1	.3	.3	160	190
23...	180	20	200	3800	5.1	<.1	.0	<.1	210	250
APR										
06...	120	20	140	3700	5.0	<.1	.0	<.1	190	230
27...	150	0	150	3700	5.0	<.1	.1	<.1	130	160
MAY										
10...	82	28	110	3300	4.5	<.1	.2	.2	340	410
25...	120	0	110	3400	4.6	<.1	.2	.2	120	150
JUN										
16...	120	10	130	3900	5.3	<.1	.0	<.1	120	150
JUL										
27...	97	3	100	3500	4.7	<.1	.0	<.1	110	130

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)
MAR										
19...	8.0	4340	--	7.8	6.6	2.5	.09	.030	2900	2700
APR										
07...	4.0	4040	9.3	7.3	18	2.0	.09	.030	3100	2900
30...	12.0	4070	8.5	8.4	1.3	2.3	.03	.010	2700	2500
MAY										
20...	11.0	3960	--	8.6	1.2	3.2	.12	.040	2600	2400
JUN										
05...	16.5	4060	--	8.2	1.6	3.2	.09	.030	2800	2700
26...	19.5	4130	--	8.4	1.0	3.8	.03	.010	2900	2800

Table 4.--*Water-quality data from Lysimeter 1*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980--Continued

DATE	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	PERCENT SODIUM	SODIUM+ POTAS- SIUM DIS- SOLVED (MG/L AS NA)	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	SULFATE DIS- SOLVED (MG/L AS SO4)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	SILICA, DIS- SOLVED (MG/L AS SIO2)	ARSENIC DIS- SOLVED (μG/L AS AS)
MAR												
19...	410	460	60	.5	4	88	28	.30	3100	.30	8.6	1
APR												
07...	470	470	45	.4	3	63	18	.10	3000	.30	6.6	0
30...	480	360	36	.3	3	--	20	.80	2500	.40	7.6	1
MAY												
20...	380	390	75	.6	6	--	79	2.9	2600	.50	11	2
JUN												
05...	360	460	45	.4	3	--	28	1.9	2700	.30	8.5	1
26...	450	430	46	.4	3	--	33	3.2	2800	.40	12	1

DATE	BORON, DIS- SOLVED (μG/L AS B)	CADMIUM DIS- SOLVED (μG/L AS CD)	COPPER, DIS- SOLVED (μG/L AS CU)	IRON, SUS- PENDED RECOV- ERABLE (μG/L AS FE)	IRON, TOTAL RECOV- ERABLE (μG/L AS FE)	IRON, DIS- SOLVED (μG/L AS FE)	LEAD, DIS- SOLVED (μG/L AS PB)	MANGA- NESE, SUS- PENDED RECOV. (μG/L AS MN)	MANGA- NESE, TOTAL RECOV- ERABLE (μG/L AS MN)	MANGA- NESE, DIS- SOLVED (μG/L AS MN)	MOLYB- DENUM, DIS- SOLVED (μG/L AS MO)
MAR											
19...	70	0	2	60	110	50	0	0	10	20	3
APR											
07...	60	0	2	10	50	40	0	0	20	20	3
30...	50	0	1	40	80	40	0	0	10	10	3
MAY											
20...	80	1	5	20	80	60	0	0	10	10	4
JUN											
05...	60	1	7	150	180	30	4	70	80	10	4
26...	90	1	4	50	90	40	2	0	20	20	4

Table 4.--*Water-quality data from Lysimeter 1*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980--Continued

DATE	NICKEL, DIS- SOLVED (µG/L AS NI)	VANA- DIUM, DIS- SOLVED (µG/L AS V)	ZINC, DIS- SOLVED (µG/L AS ZN)	ALUM- INUM, DIS- SOLVED (µG/L AS AL)	SELE- NIUM, DIS- SOLVED (µG/L AS SE)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	SOLIDS, DIS- SOLVED (TONS PER AC-FT)	MERCURY DIS- SOLVED (µG/L AS HG)	ALKA- LINITY LAB (MG/L AS CACO3)	BICAR- BONATE IT-LAB (MG/L AS HCO3)
MAR										
19...	2	3	70	0	120	4200	5.7	.0	220	268
APR										
07...	3	1	10	30	110	4100	5.6	.0	180	220
30...	4	1	10	20	98	3500	4.8	.0	170	207
MAY										
20...	4	3	20	20	97	3700	5.0	.0	250	305
JUN										
05...	5	3	0	20	98	3700	5.0	.0	130	159
26...	6	2	20	10	78	3900	5.3	.0	130	159

Table 5.--*Water-quality data from Lysimeter 2*

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)
FEB										
11...	3.0	5560	9.6	7.2	30	95	.00	<.010	2900	2700
25...	6.0	4230	9.2	7.4	11	82	.03	.010	2900	2800
MAR										
11...	2.0	4200	10.3	7.7	6.1	84	.00	<.010	3100	2900
20...	3.0	3940	10.2	8.0	3.7	46	.00	<.010	2700	2500
APR										
01...	5.0	3800	9.5	7.8	6.8	29	.03	.010	2800	2600
15...	5.5	3680	9.7	8.0	3.0	24	.03	.010	2600	2500
29...	6.0	3670	9.2	7.8	5.1	16	.03	.010	2900	2700
MAY										
23...	10.0	3560	8.5	8.0	3.0	22	.00	<.010	2300	2200
JUN										
07...	10.5	3750	8.5	8.1	1.9	25	.00	<.010	2700	2600
28...	17.0	3880	7.1	8.3	.9	23	.03	.010	2600	2500
28...	17.0	3750	7.1	8.3	--	--	--	--	--	--
JUL										
20...	16.0	3980	7.2	8.4	.9	26	.00	<.010	2600	2500

DATE	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (μG/L AS AS)	ARSENIC TOTAL (μG/L AS AS)
FEB												
11...	530	390	240	2	13	360	41	3100	.30	26	2	--
25...	600	340	100	.8	7	59	25	2600	.30	13	1	--
MAR												
11...	600	390	63	.5	4	23	22	2800	.30	9.2	1	--
20...	420	400	50	.4	4	14	14	2500	.30	44	<1	--
APR												
01...	490	380	44	.4	3	13	4.3	2400	.30	6.7	<1	--
15...	460	360	50	.4	4	22	13	2400	.40	8.1	<1	--
29...	500	390	48	.4	3	30	16	2400	.40	9.6	1	--
MAY												
23...	460	280	60	.5	5	38	12	2200	.40	11	1	--
JUN												
07...	470	360	65	.5	5	35	13	2500	.40	11	<1	--
28...	400	380	62	.5	5	56	8.7	2500	.40	14	1	--
28...	--	--	--	--	--	--	--	--	--	--	--	1
JUL												
20...	400	390	81	.7	6	96	11	2500	.40	21	1	--

Table 5.--*Water-quality data from Lysimeter 2*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978--Continued

DATE	BORON, DISSOLVED (µG/L AS B)	BORON, TOTAL RECOVERABLE (µG/L AS B)	CADMIUM DISSOLVED (µG/L AS CD)	CADMIUM TOTAL RECOVERABLE (µG/L AS CD)	CHROMIUM, TOTAL RECOVERABLE (µG/L AS CR)	COPPER, DISSOLVED (µG/L AS CU)	COPPER, TOTAL RECOVERABLE (µG/L AS CU)	IRON, TOTAL RECOVERABLE (µG/L AS FE)	IRON, DISSOLVED (µG/L AS FE)	LEAD, DISSOLVED (µG/L AS PB)	LEAD, TOTAL RECOVERABLE (µG/L AS PB)	MANGANESE, TOTAL RECOVERABLE (µG/L AS MN)
FEB												
11...	310	--	<2	--	--	<2	--	--	30	7	--	--
25...	90	--	ND	--	--	<2	--	--	<10	<2	--	--
MAR												
11...	60	--	3	--	--	3	--	--	20	3	--	--
20...	60	--	3	--	--	3	--	--	260	5	--	--
APR												
01...	60	--	ND	--	--	3	--	--	<10	2	--	--
15...	50	--	ND	--	--	ND	--	--	20	3	--	--
29...	60	--	<2	--	--	3	--	--	<10	6	--	--
MAY												
23...	60	--	ND	--	--	3	--	--	<10	2	--	--
JUN												
07...	60	--	2	--	--	2	--	--	20	<2	--	--
28...	60	--	<2	--	--	6	--	--	50	9	--	--
28...	--	130	--	<2	<20	--	8	70	--	--	4	20
JUL												
20...	80	--	3	--	--	4	--	--	50	--	--	--

DATE	MANGANESE, DISSOLVED (µG/L AS MN)	MOLYBDENUM, DISSOLVED (µG/L AS MO)	MOLYBDENUM, TOTAL RECOVERABLE (µG/L AS MO)	NICKEL, DISSOLVED (µG/L AS NI)	NICKEL, TOTAL RECOVERABLE (µG/L AS NI)	VANADIUM, DISSOLVED (µG/L AS V)	ZINC, DISSOLVED (µG/L AS ZN)	ZINC, TOTAL RECOVERABLE (µG/L AS ZN)	ANTIMONY, DISSOLVED (µG/L AS SB)	ANTIMONY, TOTAL (µG/L AS SB)	ALUMINUM, TOTAL RECOVERABLE (µG/L AS AL)
FEB											
11...	20	2	--	2	--	1	20	--	--	--	--
25...	20	4	--	<2	--	0	20	--	--	--	--
MAR											
11...	20	2	--	11	--	0	<20	--	--	--	--
20...	30	3	--	2	--	0	20	--	1	--	--
APR											
01...	<10	3	--	3	--	0	<20	--	<1	--	--
15...	<10	4	--	2	--	0	<20	--	<1	--	--
29...	<10	<1	--	ND	--	0	20	--	<1	--	--
MAY											
23...	<10	3	--	ND	--	0	20	--	1	--	--
JUN											
07...	<10	4	--	<2	--	0	20	--	<1	--	--
28...	20	2	--	4	--	1	20	--	2	--	--
28...	--	--	7	--	8	--	--	20	--	2	20
JUL											
20...	20	4	--	7	--	--	--	--	--	--	--

Table 5.--*Water-quality data from Lysimeter 2*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978--Continued

DATE	ALUMINUM, DISSOLVED (µG/L AS AL)	SELENIUM, DISSOLVED (µG/L AS SE)	SELENIUM, TOTAL (µG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (µG/L AS HG)	MERCURY TOTAL RECOVERABLE (µG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)	CARBONATE IT-LAB (MG/L AS CO3)
FEB										
11...	<100	500	--	5300	7.2	<.1	--	250	300	.00
25...	<100	150	--	4200	5.7	<.1	--	150	180	.00
MAR										
11...	10	210	--	4400	5.9	<.1	--	160	190	.00
20...	20	160	--	3800	5.1	<.1	--	190	230	.00
APR										
01...	<100	180	--	3600	4.9	<.1	--	220	270	.00
15...	<100	100	--	3500	4.8	<.1	--	160	190	.00
29...	<100	120	--	3600	4.8	<.1	--	160	200	.00
MAY										
23...	<100	66	--	3300	4.4	<.1	--	150	180	.00
JUN										
07...	<100	76	--	3600	4.9	<.1	--	110	130	.00
28...	<100	60	--	3600	4.9	<.1	--	90	110	.00
28...	--	--	65	--	--	--	<.1	--	--	--
JUL										
20...	10	130	--	3700	5.0	<.1	--	110	140	.00

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
MAR									
23...	6.0	2920	8.9	7.9	4.8	3.7	.12	.040	1900
APR									
06...	8.0	3510	93.0	7.5	11	4.0	.00	<.010	2000
27...	11.0	3690	11.4	8.1	2.0	4.9	.03	.010	2300
MAY									
10...	8.0	3120	14.9	8.2	2.2	6.8	.21	.070	1700
25...	15.5	3500	7.3	8.3	1.2	8.1	.00	<.010	2400
JUN									
16...	16.0	3800	7.2	8.5	.8	8.6	.00	<.010	2400
JUL									
27...	20.0	4080	7.0	8.2	1.6	12	.09	.030	2500

Table 5.--*Water-quality data from Lysimeter 2*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	SODIUM+ POTASSIUM DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)
MAR											
23...	1700	300	270	52	.5	6	--	46	2.1	1800	.40
APR											
06...	1800	350	270	55	.5	6	--	35	2.6	2300	.40
27...	2200	380	340	64	.6	5	--	54	3.1	2400	.40
MAY											
10...	1500	270	250	110	1	12	210	95	4.4	1800	.40
25...	2300	420	330	64	.6	5	74	10	3.9	2300	.40
JUN											
16...	2300	410	330	96	.9	8	180	87	5.1	2400	.40
JUL											
27...	2400	410	360	98	.9	7	210	110	4.9	2500	.40

DATE	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (µG/L AS AS)	ARSENIC TOTAL (µG/L AS AS)	BORON, DISSOLVED (µG/L AS B)	CADMIUM DISSOLVED (µG/L AS CD)	CADMIUM SUSPENDED RECOVERABLE (µG/L AS CD)	CADMIUM TOTAL RECOVERABLE (µG/L AS CD)	COPPER, DISSOLVED (µG/L AS CU)	COPPER, SUSPENDED RECOVERABLE (µG/L AS CU)	COPPER, TOTAL RECOVERABLE (µG/L AS CU)	IRON, SUSPENDED RECOVERABLE (µG/L AS FE)
MAR											
23...	7.9	1	1	50	<2	0	ND	ND	1	<2	30
APR											
06...	7.5	1	1	50	ND	1	<2	2	4	6	0
27...	8.0	1	1	60	ND	0	ND	2	0	2	10
MAY											
10...	11	1	1	60	ND	0	ND	ND	2	2	0
25...	7.1	<1	1	50	<2	0	ND	<2	5	6	30
JUN											
16...	10	1	1	50	ND	0	ND	2	6	8	--
JUL											
27...	16	1	1	60	ND	1	<2	3	1	4	60

Table 5.--*Water-quality data from Lysimeter* 2--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	IRON, TOTAL RECOV-ERABLE (µG/L AS FE)	IRON, DIS-SOLVED (µG/L AS FE)	LEAD, DIS-SOLVED (µG/L AS PB)	LEAD, SUS-PENDED RECOV-ERABLE (µG/L AS PB)	LEAD, TOTAL RECOV-ERABLE (µG/L AS PB)	MANGA-NESE, SUS-PENDED RECOV. (µG/L AS MN)	MANGA-NESE, TOTAL RECOV-ERABLE (µG/L AS MN)	MANGA-NESE, DIS-SOLVED (µG/L AS MN)	MOLYB-DENUM, DIS-SOLVED (µG/L AS MO)	MOLYB-DENUM, SUS-PENDED RECOV. (µG/L AS MO)	MOLYB-DENUM, TOTAL RECOV-ERABLE (µG/L AS MO)
MAR											
23...	60	30	5	6	11	0	<10	<10	4	0	4
APR											
06...	40	40	<2	9	10	0	<10	<10	3	2	5
27...	30	20	ND	62	62	0	<10	<10	2	3	5
MAY											
10...	30	30	ND	9	9	10	20	<10	3	1	4
25...	40	<10	ND	5	5	0	<10	<10	<1	5	5
JUN											
16...	--	20	ND	8	8	--	--	<10	2	0	2
JUL											
27...	70	<10	ND	4	4	0	20	20	3	0	2

DATE	NICKEL, DIS-SOLVED (µG/L AS NI)	NICKEL, SUS-PENDED RECOV-ERABLE (µG/L AS NI)	NICKEL, TOTAL RECOV-ERABLE (µG/L AS NI)	VANA-DIUM, DIS-SOLVED (µG/L AS V)	ZINC, DIS-SOLVED (µG/L AS ZN)	ZINC, SUS-PENDED RECOV-ERABLE (µG/L AS ZN)	ZINC, TOTAL RECOV-ERABLE (µG/L AS ZN)	ALUM-INUM, TOTAL RECOV-ERABLE (µG/L AS AL)	ALUM-INUM, DIS-SOLVED (µG/L AS AL)	ALUM-INUM, SUS-PENDED RECOV. (µG/L AS AL)	SELE-NIUM, DIS-SOLVED (µG/L AS SE)
MAR											
23...	2	2	4	2	20	10	30	40	<100	40	120
APR											
06...	4	5	9	2	20	10	30	60	<100	60	140
27...	ND	0	ND	2	30	0	30	50	30	20	180
MAY											
10...	ND	4	4	9	20	20	40	90	20	70	150
25...	ND	2	2	3	20	0	20	80	<100	80	190
JUN											
16...	2	4	6	5	20	10	30	60	<100	60	220
JUL											
27...	2	5	7	4	<20	10	20	<100	<100	100	230

Table 5.--*Water-quality data from Lysimeter* 2--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	SELENIUM, SUSPENDED TOTAL (μG/L AS SE)	SELENIUM, TOTAL (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (μG/L AS HG)	MERCURY SUSPENDED RECOVERABLE (μG/L AS HG)	MERCURY TOTAL RECOVERABLE (μG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)	CARBONATE IT-LAB (MG/L AS CO3)
MAR										
23...	10	130	2600	3.6	<.1	.0	<.1	200	240	.00
APR										
06...	10	150	3200	4.3	<.1	.0	<.1	180	220	.00
27...	10	190	3400	4.6	<.1	.0	<.1	130	160	.00
MAY										
10...	10	160	2700	3.6	<.1	.2	.2	160	190	.00
25...	0	180	3200	4.4	<.1	.1	<.1	110	130	.00
JUN										
16...	20	240	3500	4.7	<.1	.0	<.1	130	160	1.0
JUL										
27...	0	230	3600	4.9	<.1	.0	<.1	130	160	.00

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)
MAR										
19...	8.0	2940	--	7.9	7.7	6.0	.34	.110	1800	1500
APR										
07...	4.0	3720	9.4	7.3	23	6.5	.12	.040	2700	2500
30...	12.0	3870	8.0	8.2	2.3	7.3	.15	.050	2800	2600
MAY										
20...	--	3780	--	8.3	2.7	--	.25	.080	2200	1900
JUN										
05...	15.0	4090	--	8.4	1.2	11	.12	.040	2600	2400

Table 5.--*Water-quality data from Lysimeter 2*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980--Continued

DATE	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	PERCENT SODIUM	SODIUM+ POTAS-SIUM DIS-SOLVED (MG/L AS NA)	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SULFATE DIS-SOLVED (MG/L AS SO4)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	ARSENIC DIS-SOLVED (μG/L AS AS)
MAR												
19...	310	240	73	.8	8	130	61	2.8	1700	.30	8.3	1
APR												
07...	390	410	49	.4	4	79	23	4.8	2300	.30	7.8	0
30...	430	410	49	.4	4	--	31	5.9	2400	.40	8.9	1
MAY												
20...	320	340	110	1	9	--	96	5.0	2300	.50	13	2
JUN												
05...	330	420	89	.8	7	--	91	6.0	2500	.30	11	2

DATE	BORON, DIS-SOLVED (μG/L AS B)	CADMIUM DIS-SOLVED (μG/L AS CD)	COPPER, DIS-SOLVED (μG/L AS CU)	IRON, SUS-PENDED RECOV-ERABLE (μG/L AS FE)	IRON, TOTAL RECOV-ERABLE (μG/L AS FE)	IRON, DIS-SOLVED (μG/L AS FE)	LEAD, DIS-SOLVED (μG/L AS PB)	MANGA-NESE, SUS-PENDED RECOV. (μG/L AS MN)	MANGA-NESE, TOTAL RECOV-ERABLE (μG/L AS MN)	MANGA-NESE, DIS-SOLVED (μG/L AS MN)	MOLYB-DENUM, DIS-SOLVED (μG/L AS MO)
MAR											
19...	60	0	3	10	50	40	0	0	10	20	4
APR											
07...	70	0	1	30	70	40	0	0	20	20	3
30...	60	0	1	80	120	40	0	0	10	10	3
MAY											
20...	90	0	4	60	80	20	1	0	10	10	4
JUN											
05...	80	0	3	120	170	50	2	80	90	10	4

Table 5.--*Water-quality data from Lysimeter* 2--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980--Continued

DATE	NICKEL, DIS-SOLVED (μG/L AS NI)	VANA-DIUM, DIS-SOLVED (μG/L AS V)	ZINC, DIS-SOLVED (μG/L AS ZN)	ALUM-INUM, DIS-SOLVED (μG/L AS AL)	SELE-NIUM, DIS-SOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	MERCURY DIS-SOLVED (μG/L AS HG)	ALKA-LINITY LAB (MG/L AS CACO3)	BICAR-BONATE IT-LAB (MG/L AS HCO3)
MAR										
19...	2	6	20	0	66	2600	3.5	.0	300	366
APR										
07...	2	1	10	20	170	3400	4.6	.0	230	281
30...	4	2	10	0	220	3500	4.7	.0	190	232
MAY										
20...	3	11	20	10	200	3400	4.6	.0	280	341
JUN										
05...	3	10	0	10	240	3600	4.9	.0	160	195

Table 6.--*Water-quality data from Lysimeter 3*

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
FEB									
11...	3.0	4300	9.6	7.2	16	62	.00	<.010	3000
25...	6.0	4240	9.2	7.4	13	61	.03	.010	3200
MAR									
11...	2.0	4120	10.2	7.7	7.0	65	.00	<.010	3100
20...	2.5	4000	9.6	7.8	5.1	44	.15	.050	2900
JUL									
20...	18.0	3920	6.8	8.3	1.0	24	.03	.010	2700

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)
FEB											
11...	2900	590	370	69	.5	5	30	32	2600	.30	12
25...	3000	590	410	58	.4	4	18	31	2800	.30	10
MAR											
11...	2900	560	420	46	.4	3	15	30	2800	.30	7.5
20...	2700	470	420	48	.4	3	11	26	2500	.30	41
JUL											
20...	2600	410	410	59	.5	4	50	17	2700	.40	15

Table 6.--*Water-quality data from Lysimeter 3*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978--Continued

DATE	ARSENIC DIS-SOLVED (μG/L AS AS)	BORON, DIS-SOLVED (μG/L AS B)	CADMIUM DIS-SOLVED (μG/L AS CD)	COPPER, DIS-SOLVED (μG/L AS CU)	IRON, DIS-SOLVED (μG/L AS FE)	LEAD, DIS-SOLVED (μG/L AS PB)	MANGA-NESE, DIS-SOLVED (μG/L AS MN)	MOLYB-DENUM, DIS-SOLVED (μG/L AS MO)	NICKEL, DIS-SOLVED (μG/L AS NI)	VANA-DIUM, DIS-SOLVED (μG/L AS V)	ZINC, DIS-SOLVED (μG/L AS ZN)
FEB											
11...	<1	70	ND	<2	<10	ND	20	<1	4	0	20
25...	1	60	ND	2	<10	4	20	4	2	0	20
MAR											
11...	1	50	<2	2	<10	ND	20	2	5	0	20
20...	<1	50	2	2	20	6	20	4	ND	0	20
JUL											
20...	2	70	2	3	80	--	20	5	7	--	--

DATE	ANTI-MONY, DIS-SOLVED (μG/L AS SB)	ALUM-INUM, DIS-SOLVED (μG/L AS AL)	SELE-NIUM, DIS-SOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	MERCURY DIS-SOLVED (μG/L AS HG)	ALKA-LINITY LAB (MG/L AS CACO3)	BICAR-BONATE IT-LAB (MG/L AS HCO3)	CAR-BONATE IT-LAB (MG/L AS CO3)
FEB									
11...	--	<100	210	4100	5.5	<.1	130	160	.00
25...	<1	<100	130	4300	5.8	<.1	160	200	.00
MAR									
11...	--	<100	180	4300	5.8	<.1	180	220	.00
20...	1	30	90	3800	5.2	<.1	160	200	.00
JUL									
20...	--	10	100	3800	5.2	<.1	110	130	.00

Table 6.--*Water-quality data from Lysimeter 3*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
MAR									
23...	5.0	3870	9.2	7.8	5.1	1.7	.06	.020	2500
APR									
06...	9.0	3990	9.8	7.9	2.8	1.1	.00	<.010	2600
27...	11.5	4030	12.3	8.0	1.8	1.0	.00	<.010	2900
MAY									
10...	8.5	3530	12.0	8.1	3.6	1.6	.06	.020	2400
25...	17.0	3840	7.2	8.2	1.1	.96	.00	<.010	2800
JUN									
16...	17.0	3960	7.3	8.3	1.0	2.0	.00	<.010	2800
JUL									
27...	20.0	3500	6.8	8.1	1.7	3.8	.03	.010	2700

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	SODIUM+POTASSIUM DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)
MAR											
23...	2300	330	410	65	.6	5	--	46	1.9	2600	.30
APR											
06...	2500	330	430	55	.5	4	--	26	1.9	3100	.40
27...	2800	450	430	56	.5	4	85	29	1.8	2800	.40
MAY											
10...	2200	300	390	80	.7	7	120	44	2.0	2300	.40
25...	2700	440	410	55	.5	6	85	--	2.0	2600	.40
JUN											
16...	2700	440	410	69	.6	5	110	40	2.1	2800	.40
JUL											
27...	2600	430	400	74	.6	5	140	70	2.0	2900	.40

Table 6.--*Water-quality data from Lysimeter 3*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (µG/L AS AS)	ARSENIC TOTAL (µG/L AS AS)	BORON, DISSOLVED (µG/L AS B)	CADMIUM DISSOLVED (µG/L AS CD)	CADMIUM SUSPENDED RECOVERABLE (µG/L AS CD)	CADMIUM TOTAL RECOVERABLE (µG/L AS CD)	COPPER, DISSOLVED (µG/L AS CU)	COPPER, SUSPENDED RECOVERABLE (µG/L AS CU)	COPPER, TOTAL RECOVERABLE (µG/L AS CU)	IRON, SUSPENDED RECOVERABLE (µG/L AS FE)
MAR											
23...	7.7	1	<1	50	ND	13	13	2	0	<2	20
APR											
06...	6.5	1	1	40	ND	1	<2	<2	3	4	20
27...	6.9	<1	1	50	ND	0	ND	<2	4	5	20
MAY											
10...	8.2	1	1	50	ND	0	ND	ND	2	2	10
25...	7.1	<1	1	50	<2	0	ND	<2	4	5	10
JUN											
16...	8.1	1	1	40	ND	0	ND	ND	9	9	--
JUL											
27...	11	1	1	30	ND	1	<2	<2	1	2	10

DATE	IRON, TOTAL RECOVERABLE (µG/L AS FE)	IRON, DISSOLVED (µG/L AS FE)	LEAD, DISSOLVED (µG/L AS PB)	LEAD, SUSPENDED RECOVERABLE (µG/L AS PB)	LEAD, TOTAL RECOVERABLE (µG/L AS PB)	MANGANESE, SUSPENDED RECOV. (µG/L AS MN)	MANGANESE, TOTAL RECOVERABLE (µG/L AS MN)	MANGANESE, DISSOLVED (µG/L AS MN)	MOLYBDENUM, DISSOLVED (µG/L AS MO)	MOLYBDENUM, SUSPENDED RECOV. (µG/L AS MO)	MOLYBDENUM, TOTAL RECOVERABLE (µG/L AS MO)
MAR											
23...	60	40	2	130	130	0	<10	<10	3	1	4
APR											
06...	60	40	<2	8	9	10	20	<10	3	2	5
27...	40	20	ND	13	13	0	<10	<10	2	1	3
MAY											
10...	30	20	ND	17	17	10	20	<10	1	2	3
25...	20	<10	ND	3	3	0	20	20	4	1	5
JUN											
16...	--	<10	ND	8	8	--	--	<10	1	1	2
JUL											
27...	30	20	ND	3	3	0	20	20	2	0	2

Table 6.--*Water-quality data from Lysimeter 3*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	NICKEL, DISSOLVED (µG/L AS NI)	NICKEL, SUSPENDED RECOVERABLE (µG/L AS NI)	NICKEL, TOTAL RECOVERABLE (µG/L AS NI)	VANADIUM, DISSOLVED (µG/L AS V)	ZINC, DISSOLVED (µG/L AS ZN)	ZINC, SUSPENDED RECOVERABLE (µG/L AS ZN)	ZINC, TOTAL RECOVERABLE (µG/L AS ZN)	ALUMINUM, TOTAL RECOVERABLE (µG/L AS AL)	ALUMINUM, DISSOLVED (µG/L AS AL)	ALUMINUM, SUSPENDED RECOV. (µG/L AS AL)	SELENIUM, DISSOLVED (µG/L AS SE)
MAR											
23...	ND	5	5	2	20	20	40	60	<100	60	130
APR											
06...	4	5	9	1	20	10	30	50	<100	50	140
27...	ND	0	ND	2	30	0	30	50	<100	50	150
MAY											
10...	ND	4	4	9	20	20	40	90	20	70	130
25...	ND	1	<2	3	20	0	20	70	<100	70	140
JUN											
16...	2	2	4	5	30	0	30	90	<100	90	150
JUL											
27...	2	4	6	5	20	0	20	<100	<100	100	150

DATE	SELENIUM, SUSPENDED TOTAL (µG/L AS SE)	SELENIUM, TOTAL (µG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (µG/L AS HG)	MERCURY SUSPENDED RECOVERABLE (µG/L AS HG)	MERCURY TOTAL RECOVERABLE (µG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)	CARBONATE IT-LAB (MG/L AS CO3)
MAR										
23...	0	130	3600	4.9	<.1	.0	<.1	160	200	.00
APR										
06...	0	140	4000	5.5	<.1	.0	<.1	110	140	.00
27...	0	140	3800	5.2	<.1	.0	<.1	90	110	.00
MAY										
10...	0	130	3300	4.4	<.1	.2	.2	210	250	.00
25...	20	160	3600	4.9	<.1	.1	<.1	90	110	.00
JUN										
16...	20	170	3800	5.2	<.1	.0	<.1	110	130	.00
JUL										
27...	0	150	4000	5.4	<.1	.0	<.1	110	130	.00

Table 6.--*Water-quality data from Lysimeter 3*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)
MAR										
19...	--	4160	--	--	--	2.0	.15	.050	2600	2400
APR										
07...	4.0	4160	9.2	7.5	10	.98	.09	.030	3200	3000
30...	12.5	4140	8.2	8.4	1.2	.79	.03	.010	3000	2900
MAY										
20...	10.5	3730	--	8.3	2.5	1.2	.21	.070	2400	2100
JUN										
05...	15.5	4190	--	8.4	1.0	.98	.09	.030	2700	2600

DATE	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	SODIUM+ POTASSIUM DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (µG/L AS AS)
MAR												
19...	390	400	81	.7	6	120	43	1.2	2700	.30	8.1	1
APR												
07...	460	510	57	.4	4	75	18	2.1	3000	.30	5.9	0
30...	450	450	47	.4	3	--	23	3.0	2700	.40	7.0	1
MAY												
20...	340	380	110	1	9	--	80	2.2	2400	.50	11	2
JUN												
05...	330	460	66	.6	5	--	55	1.8	2800	.30	8.4	2

Table 6.--*Water-quality data from Lysimeter 3*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980--Continued

DATE	BORON, DIS- SOLVED (μG/L AS B)	CADMIUM DIS- SOLVED (μG/L AS CD)	COPPER, DIS- SOLVED (μG/L AS CU)	IRON, SUS- PENDED RECOV- ERABLE (μG/L AS FE)	IRON, TOTAL RECOV- ERABLE (μG/L AS FE)	IRON, DIS- SOLVED (μG/L AS FE)	LEAD, DIS- SOLVED (μG/L AS PB)	MANGA- NESE, SUS- PENDED RECOV. (μG/L AS MN)	MANGA- NESE, TOTAL RECOV- ERABLE (μG/L AS MN)	MANGA- NESE, DIS- SOLVED (μG/L AS MN)	MOLYB- DENUM, DIS- SOLVED (μG/L AS MO)
MAR											
19...	60	0	2	10	60	50	0	0	10	20	3
APR											
07...	50	0	1	40	70	30	0	10	20	10	3
30...	40	0	1	70	110	40	0	0	10	10	3
MAY											
20...	90	0	3	30	60	30	1	0	10	10	3
JUN											
05...	60	0	3	530	550	20	1	0	20	20	4

DATE	NICKEL, DIS- SOLVED (μG/L AS NI)	VANA- DIUM, DIS- SOLVED (μG/L AS V)	ZINC, DIS- SOLVED (μG/L AS ZN)	ALUM- INUM, DIS- SOLVED (μG/L AS AL)	SELE- NIUM, DIS- SOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	SOLIDS, DIS- SOLVED (TONS PER AC-FT)	MERCURY DIS- SOLVED (μG/L AS HG)	ALKA- LINITY LAB (MG/L AS CACO3)	BICAR- BONATE IT-LAB (MG/L AS HCO3)
MAR										
19...	1	5	20	0	68	3800	5.1	.0	190	232
APR										
07...	3	2	10	20	110	4200	5.7	.0	170	207
30...	3	2	10	10	110	3800	5.1	.0	150	183
MAY										
20...	3	19	20	20	91	3500	4.8	.0	260	317
JUN										
05...	4	10	20	30	100	3800	5.2	.0	130	159

Table 7.--*Water-quality data from Lysimeter 4*

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)
FEB										
11...	3.0	4930	9.4	6.8	43	42	.00	<.010	2900	2800
25...	6.0	4810	9.2	7.1	23	37	.03	.010	3100	3000
MAR										
11...	2.0	4690	10.4	7.6	8.4	40	.00	<.010	3100	3000
20...	3.0	4330	10.0	8.0	4.8	24	.12	.040	2900	2700
APR										
01...	5.0	4200	9.4	7.8	9.6	19	.03	.010	2800	2500
15...	6.0	4040	9.5	8.0	4.8	19	.06	.020	2600	2300
29...	6.0	3930	9.3	7.9	6.1	17	.03	.010	2700	2500
MAY										
23...	10.0	3920	8.5	8.1	3.4	20	.00	<.010	2500	2300
30...	10.0	3840	8.3	8.2	2.1	19	.03	.010	2600	2400
JUN										
07...	10.5	4000	8.4	8.0	3.0	21	.00	<.010	2400	2300
28...	17.0	4020	6.9	8.2	1.7	20	.03	.010	2300	2200
28...	17.0	4000	6.9	8.2	--	--	--	--	--	--

DATE	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (μG/L AS AS)	ARSENIC TOTAL (μG/L AS AS)
FEB												
11...	620	340	160	1	10	60	330	2500	.20	13	<1	--
25...	630	370	190	2	12	25	300	2700	.20	11	<1	--
MAR												
11...	610	390	190	2	12	19	250	2900	.30	9.0	1	--
20...	560	370	180	2	12	15	170	2600	.30	23	<1	--
APR												
01...	500	370	190	2	13	9.8	68	2500	.30	7.7	1	--
15...	480	330	190	2	14	15	97	2500	.40	8.3	<1	--
29...	490	360	180	2	13	17	47	2600	.40	8.6	1	--
MAY												
23...	470	310	190	2	14	20	44	2400	.40	8.7	1	--
30...	480	330	190	2	14	22	37	2500	.40	7.7	<1	--
JUN												
07...	380	360	200	2	15	22	38	2500	--	--	<1	--
28...	380	330	190	2	15	26	46	2500	.40	9.8	1	--
28...	--	--	--	--	--	--	--	--	--	--	--	1

Table 7.--*Water-quality data from Lysimeter 4*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978--Continued

DATE	BORON, DISSOLVED (μG/L AS B)	BORON, TOTAL RECOVERABLE (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	CADMIUM TOTAL RECOVERABLE (μG/L AS CD)	CHROMIUM, TOTAL RECOVERABLE (μG/L AS CR)	COPPER, DISSOLVED (μG/L AS CU)	COPPER, TOTAL RECOVERABLE (μG/L AS CU)	IRON, TOTAL RECOVERABLE (μG/L AS FE)	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)	LEAD, TOTAL RECOVERABLE (μG/L AS PB)	MANGANESE, TOTAL RECOVERABLE (μG/L AS MN)
FEB												
11...	140	--	<2	--	--	<2	--	--	<10	ND	--	--
25...	80	--	ND	--	--	2	--	--	<10	ND	--	--
MAR												
11...	70	--	<2	--	--	3	--	--	<10	<2	--	--
20...	70	--	2	--	--	2	--	--	<10	6	--	--
APR												
01...	70	--	ND	--	--	3	--	--	20	ND	--	--
15...	60	--	ND	--	--	ND	--	--	20	2	--	--
29...	60	--	<2	--	--	<2	--	--	30	7	--	--
MAY												
23...	50	--	<2	--	--	2	--	--	<10	2	--	--
30...	70	--	<2	--	--	2	--	--	110	4	--	--
JUN												
07...	60	--	2	--	--	<2	--	--	20	5	--	--
28...	70	--	<2	--	--	3	--	--	50	ND	--	--
28...	--	140	--	3	<20	--	6	230	--	--	6	<10

DATE	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)	MOLYBDENUM, TOTAL RECOVERABLE (μG/L AS MO)	NICKEL, DISSOLVED (μG/L AS NI)	NICKEL, TOTAL RECOVERABLE (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)	ZINC, TOTAL RECOVERABLE (μG/L AS ZN)	ANTIMONY, DISSOLVED (μG/L AS SB)	ANTIMONY, TOTAL (μG/L AS SB)	ALUMINUM, TOTAL RECOVERABLE (μG/L AS AL)
FEB											
11...	20	<1	--	<2	--	4	20	--	--	--	--
25...	20	3	--	2	--	4	20	--	--	--	--
MAR											
11...	20	2	--	4	--	3	20	--	--	--	--
20...	20	3	--	2	--	1	20	--	<1	--	--
APR											
01...	<10	2	--	4	--	0	<20	--	<1	--	--
15...	<10	1	--	4	--	0	<20	--	<1	--	--
29...	<10	<1	--	<2	--	0	20	--	<1	--	--
MAY											
23...	<10	3	--	2	--	0	20	--	<1	--	--
30...	<10	3	--	5	--	0	20	--	<1	--	--
JUN											
07...	<10	3	--	4	--	0	20	--	<1	--	--
28...	20	1	--	5	--	0	20	--	3	--	--
28...	--	--	7	--	8	--	--	20	--	1	40

Table 7.--*Water-quality data from Lysimeter 4*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978--Continued

DATE	ALUMINUM, DISSOLVED (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SELENIUM, TOTAL (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (μG/L AS HG)	MERCURY TOTAL RECOVERABLE (μG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)	CARBONATE IT-LAB (MG/L AS CO3)
FEB										
11...	20	130	--	4300	5.8	<.1	--	140	170	.00
25...	<100	200	--	4500	6.1	<.1	--	150	180	.00
MAR										
11...	10	75	--	4700	6.3	<.1	--	170	210	.00
20...	20	150	--	4200	5.7	<.1	--	250	300	.00
APR										
01...	<100	83	--	3900	5.3	<.1	--	310	380	.00
15...	<100	50	--	3900	5.2	<.1	--	250	300	.00
29...	<100	44	--	3900	5.3	<.1	--	220	270	.00
MAY										
23...	<100	46	--	3700	5.0	<.1	--	200	240	.00
30...	20	42	--	3800	5.1	<.1	--	170	210	.00
JUN										
07...	0	30	--	3200	5.0	<.1	--	160	190	.00
28...	<100	35	--	3700	5.0	<.1	--	140	170	.00
28...	--	--	33	--	--	--	<.1	--	--	--

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
MAY									
25...	15.0	3500	7.0	8.3	2.5	7.8	.06	.020	1800

Table 7.--*Water-quality data from Lysimeter 4*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	SODIUM+ POTASSIUM DISSOLVED (MG/L AS NA)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)
MAY											
25...	1600	300	260	280	3	39	410	18	2200	.50	9.0

DATE	ARSENIC DISSOLVED (μG/L AS AS)	ARSENIC TOTAL (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	CADMIUM SUSPENDED RECOVERABLE (μG/L AS CD)	CADMIUM TOTAL RECOVERABLE (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	COPPER, SUSPENDED RECOVERABLE (μG/L AS CU)	COPPER, TOTAL RECOVERABLE (μG/L AS CU)	IRON, SUSPENDED RECOVERABLE (μG/L AS FE)	IRON, TOTAL RECOVERABLE (μG/L AS FE)
MAY											
25...	1	3	70	ND	0	ND	2	5	7	30	40

DATE	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)	LEAD, SUSPENDED RECOVERABLE (μG/L AS PB)	LEAD, TOTAL RECOVERABLE (μG/L AS PB)	MANGANESE, SUSPENDED RECOV. (μG/L AS MN)	MANGANESE, TOTAL RECOVERABLE (μG/L AS MN)	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)	MOLYBDENUM, SUSPENDED RECOV. (μG/L AS MO)	MOLYBDENUM, TOTAL RECOVERABLE (μG/L AS MO)	NICKEL, DISSOLVED (μG/L AS NI)
MAY											
25...	<10	ND	4	4	0	<10	<10	4	2	6	<2

DATE	NICKEL, SUSPENDED RECOVERABLE (μG/L AS NI)	NICKEL, TOTAL RECOVERABLE (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)	ZINC, SUSPENDED RECOVERABLE (μG/L AS ZN)	ZINC, TOTAL RECOVERABLE (μG/L AS ZN)	ALUMINUM, TOTAL RECOVERABLE (μG/L AS AL)	ALUMINUM, DISSOLVED (μG/L AS AL)	ALUMINUM, SUSPENDED RECOV. (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SELENIUM, SUSPENDED TOTAL (μG/L AS SE)
MAY											
25...	1	2	0	20	0	20	70	<100	70	170	10

Table 7.--*Water-quality data from Lysimeter 4*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	SELENIUM, TOTAL (µG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (µG/L AS HG)	MERCURY SUSPENDED RECOVERABLE (µG/L AS HG)	MERCURY TOTAL RECOVERABLE (µG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)	CARBONATE IT-LAB (MG/L AS CO3)
MAY									
25...	180	3200	4.4	<.1	.0	<.1	230	280	.00

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)
APR										
07...	4.0	4500	9.4	7.3	22	.65	.15	.050	2900	2700
30...	12.0	4400	8.2	8.3	1.9	.47	.03	.010	2800	2600
JUN										
05...	15.5	3480	--	8.5	2.1	1.8	.21	.070	1600	1300

DATE	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	SODIUM+ POTASSIUM DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (µG/L AS AS)
APR												
07...	470	410	230	2	15	270	44	10	3000	.30	8.1	0
30...	470	400	190	2	13	--	36	280	2700	.40	8.9	1
JUN												
05...	230	250	240	3	23	--	110	8.6	1900	.40	13	3

Table 7.--*Water-quality data from Lysimeter 4*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980

DATE	BORON, DIS- SOLVED (μG/L AS B)	CADMIUM DIS- SOLVED (μG/L AS CD)	COPPER, DIS- SOLVED (μG/L AS CU)	IRON, SUS- PENDED RECOV- ERABLE (μG/L AS FE)	IRON, TOTAL RECOV- ERABLE (μG/L AS FE)	IRON, DIS- SOLVED (μG/L AS FE)	LEAD, DIS- SOLVED (μG/L AS PB)	MANGA- NESE, SUS- PENDED RECOV. (μG/L AS MN)	MANGA- NESE, TOTAL RECOV- ERABLE (μG/L AS MN)	MANGA- NESE, DIS- SOLVED (μG/L AS MN)	MOLYB- DENUM, DIS- SOLVED (μG/L AS MO)
APR											
07...	70	0	1	30	50	20	0	10	20	10	2
30...	60	0	1	100	140	40	0	10	20	10	2
JUN											
05...	100	0	3	170	190	20	5	0	10	10	3

DATE	NICKEL, DIS- SOLVED (μG/L AS NI)	VANA- DIUM, DIS- SOLVED (μG/L AS V)	ZINC, DIS- SOLVED (μG/L AS ZN)	ALUM- INUM, DIS- SOLVED (μG/L AS AL)	SELE- NIUM, DIS- SOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	SOLIDS, DIS- SOLVED (TONS PER AC-FT)	MERCURY DIS- SOLVED (μG/L AS HG)	ALKA- LINITY LAB (MG/L AS CACO3)	BICAR- BONATE IT-LAB (MG/L AS HCO3)
APR										
07...	6	1	10	30	220	4300	5.9	.0	230	280
30...	2	1	20	20	200	4200	5.7	.0	199	243
JUN										
05...	4	24	10	30	100	3000	4.0	.0	310	378

Table 8.--*Water-quality data from Lysimeter 5*

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
FEB									
11...	3.0	4680	9.6	7.2	22	40	.00	<.010	2800
25...	6.0	4680	9.4	7.1	27	44	.03	.010	3000
25...	6.0	4670	9.4	7.1	27	43	.03	.010	2900
25...	6.0	4700	9.6	7.3	17	46	.03	.010	3000
MAR									
11...	2.0	4660	10.4	7.4	14	56	.00	<.010	3100
20...	3.0	4520	10.2	8.1	3.4	30	.06	.020	3000
APR									
01...	5.0	4290	9.5	7.8	8.6	28	.03	.010	2900
15...	5.5	4180	9.2	7.7	12	27	.03	.010	2800
29...	6.0	4000	9.6	7.9	6.0	25	.00	<.010	2800
MAY									
23...	10.0	4140	8.5	7.7	12	26	.00	<.010	--

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)
FEB											
11...	2600	620	310	180	2	12	42	260	2400	.20	14
25...	2800	640	330	180	1	12	25	270	2500	.30	12
25...	2700	620	330	180	2	12	25	270	2600	.30	12
25...	2800	640	340	180	1	11	25	270	2600	.30	12
MAR											
11...	2900	640	360	180	1	11	21	250	2800	.30	.1
20...	2800	600	370	180	1	11	11	210	2600	.30	28
APR											
01...	2600	560	360	160	1	11	7.2	96	2500	.40	9.8
15...	2500	540	350	160	1	11	14	87	2400	.30	12
29...	2600	530	360	150	1	10	15	68	2600	.40	11
MAY											
23...	--	510	--	160	--	7	19	60	2500	.40	12

Table 8.--*Water-quality data from Lysimeter* 5--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978--Continued

DATE	ARSENIC DIS-SOLVED (μG/L AS AS)	BORON, DIS-SOLVED (μG/L AS B)	CADMIUM DIS-SOLVED (μG/L AS CD)	COPPER, DIS-SOLVED (μG/L AS CU)	IRON, DIS-SOLVED (μG/L AS FE)	LEAD, DIS-SOLVED (μG/L AS PB)	MANGA-NESE, DIS-SOLVED (μG/L AS MN)	MOLYB-DENUM, DIS-SOLVED (μG/L AS MO)	NICKEL, DIS-SOLVED (μG/L AS NI)	VANA-DIUM, DIS-SOLVED (μG/L AS V)	ZINC, DIS-SOLVED (μG/L AS ZN)
FEB											
11...	<1	80	<2	<2	<10	ND	20	<1	6	2	20
25...	1	90	ND	<2	<10	3	20	<1	4	2	20
25...	<1	80	ND	2	<10	3	<10	3	2	2	20
25...	1	80	ND	2	<10	2	20	2	2	2	20
MAR											
11...	1	70	<2	3	<10	2	20	2	5	4	20
20...	<1	80	3	2	<10	9	20	2	2	1	20
APR											
01...	<1	80	ND	3	<10	2	20	1	4	0	<20
15...	<1	80	ND	<2	220	6	<10	1	6	0	<20
29...	2	70	2	2	20	17	<10	<1	<2	0	20
MAY											
23...	2	90	ND	2	<10	ND	20	1	4	0	<20

DATE	ANTI-MONY, DIS-SOLVED (μG/L AS SB)	ALUM-INUM, DIS-SOLVED (μG/L AS AL)	SELE-NIUM, DIS-SOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	MERCURY DIS-SOLVED (μG/L AS HG)	ALKA-LINITY LAB (MG/L AS CACO3)	BICAR-BONATE IT-LAB (MG/L AS HCO3)	CAR-BONATE IT-LAB (MG/L AS CO3)
FEB									
11...	--	10	130	4100	5.6	<.1	180	220	.00
25...	--	<100	130	4300	5.8	<.1	170	210	.00
25...	--	<100	80	4300	5.9	<.1	170	210	.00
25...	--	<100	150	4400	5.9	<.1	170	210	.00
MAR									
11...	--	<100	120	4600	6.3	<.1	180	220	.00
20...	1	20	98	4300	5.8	<.1	220	270	.00
APR									
01...	<1	<100	130	4000	5.4	<.1	280	340	.00
15...	<1	<100	140	3900	5.3	<.1	310	380	.00
29...	<1	<100	90	4000	5.4	<.1	250	300	.00
MAY									
23...	1	<100	96	--	--	<.1	280	340	.00

Table 8.--*Water-quality data from Lysimeter 5*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
APR									
06...	9.0	3930	9.4	7.9	5.0	3.6	--	--	1600
27...	11.0	4300	11.9	7.9	3.8	2.2	.00	<.010	2400
MAY									
10...	9.0	3850	12.7	7.7	12	2.3	.06	.020	2300
25...	15.5	4120	6.9	8.0	4.8	1.5	.00	<.010	2800
JUN									
16...	16.5	4040	7.0	8.4	1.4	1.9	.00	<.010	2600
JUL									
27...	20.0	3500	6.8	8.2	1.5	2.0	.00	<.010	2400

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	SODIUM+POTASSIUM DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)
APR											
06...	1400	340	190	210	2	21	290	84	15	2500	--
27...	2300	420	330	180	2	14	240	62	27	2600	.30
MAY											
10...	2000	420	300	180	2	14	240	56	20	2400	.30
25...	2500	480	380	160	1	11	200	36	14	2800	.40
JUN											
16...	2400	450	360	170	2	12	210	40	22	2700	.50
JUL											
27...	2300	420	330	190	2	14	250	56	17	2700	.50

Table 8.--*Water-quality data from Lysimeter 5*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	SILICA, DIS- SOLVED (MG/L AS SIO2)	ARSENIC DIS- SOLVED (µG/L AS AS)	ARSENIC TOTAL (µG/L AS AS)	BORON, DIS- SOLVED (µG/L AS B)	CADMIUM DIS- SOLVED (µG/L AS CD)	CADMIUM SUS- PENDED RECOV- ERABLE (µG/L AS CD)	CADMIUM TOTAL RECOV- ERABLE (µG/L AS CD)	COPPER, DIS- SOLVED (µG/L AS CU)	COPPER, SUS- PENDED RECOV- ERABLE (µG/L AS CU)	COPPER, TOTAL RECOV- ERABLE (µG/L AS CU)	IRON, SUS- PENDED RECOV- ERABLE (µG/L AS FE)
APR											
06...	8.9	1	1	60	3	0	<2	2	3	5	0
27...	9.1	<1	1	70	ND	0	ND	<2	1	2	10
MAY											
10...	11	<1	1	90	ND	1	<2	ND	2	2	20
25...	11	<1	<1	80	ND	0	ND	ND	8	8	10
JUN											
16...	9.1	1	1	60	ND	0	ND	ND	2	2	--
JUL											
27...	10	1	1	80	ND	0	ND	2	1	3	80

DATE	IRON, TOTAL RECOV- ERABLE (µG/L AS FE)	IRON, DIS- SOLVED (µG/L AS FE)	LEAD, DIS- SOLVED (µG/L AS PB)	LEAD, SUS- PENDED RECOV- ERABLE (µG/L AS PB)	LEAD, TOTAL RECOV- ERABLE (µG/L AS PB)	MANGA- NESE, SUS- PENDED RECOV. (µG/L AS MN)	MANGA- NESE, TOTAL RECOV- ERABLE (µG/L AS MN)	MANGA- NESE, DIS- SOLVED (µG/L AS MN)	MOLYB- DENUM, DIS- SOLVED (µG/L AS MO)	MOLYB- DENUM, SUS- PENDED RECOV. (µG/L AS MO)	MOLYB- DENUM, TOTAL RECOV- ERABLE (µG/L AS MO)
APR											
06...	60	50	ND	12	12	10	20	<10	1	4	5
27...	30	20	ND	7	7	0	<10	20	2	2	4
MAY											
10...	50	30	ND	11	11	0	<10	20	<1	0	<1
25...	30	20	3	78	81	0	<10	<10	<1	2	2
JUN											
16...	--	20	ND	11	11	--	--	<10	1	0	1
JUL											
27...	90	<10	ND	5	5	0	20	20	2	0	1

Table 8.--*Water-quality data from Lysimeter 5*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979--Continued

DATE	NICKEL, DISSOLVED (µG/L AS NI)	NICKEL, SUSPENDED RECOVERABLE (µG/L AS NI)	NICKEL, TOTAL RECOVERABLE (µG/L AS NI)	VANADIUM, DISSOLVED (µG/L AS V)	ZINC, DISSOLVED (µG/L AS ZN)	ZINC, SUSPENDED RECOVERABLE (µG/L AS ZN)	ZINC, TOTAL RECOVERABLE (µG/L AS ZN)	ALUMINUM, TOTAL RECOVERABLE (µG/L AS AL)	ALUMINUM, DISSOLVED (µG/L AS AL)	ALUMINUM, SUSPENDED RECOV. (µG/L AS AL)	SELENIUM, DISSOLVED (µG/L AS SE)
APR											
06...	5	4	9	--	40	0	50	50	<100	50	200
27...	ND	7	7	0	30	10	40	40	<100	40	310
MAY											
10...	ND	6	6	1	20	10	30	110	20	90	230
25...	3	0	2	0	20	10	30	60	<100	60	250
JUN											
16...	3	3	6	0	20	10	30	160	<100	160	230
JUL											
27...	3	4	7	<1	<20	20	30	140	<100	140	200

DATE	SELENIUM, SUSPENDED TOTAL (µG/L AS SE)	SELENIUM, TOTAL (µG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (µG/L AS HG)	MERCURY SUSPENDED RECOVERABLE (µG/L AS HG)	MERCURY TOTAL RECOVERABLE (µG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)	CARBONATE IT-LAB (MG/L AS CO3)
APR										
06...	0	190	3500	4.8	<.1	--	--	210	250	.00
27...	0	290	3700	5.1	<.1	.0	<.1	160	190	.00
MAY										
10...	0	230	3600	4.9	<.1	.1	<.1	300	370	.00
25...	0	250	4000	5.5	<.1	.1	<.1	250	300	.00
JUN										
16...	0	230	3900	5.3	<.1	.0	<.1	170	200	1.0
JUL										
27...	10	210	3800	5.2	<.1	.0	<.1	120	150	.00

Table 8.--*Water-quality data from Lysimeter 5*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)
APR										
07...	4.0	4250	9.6	7.1	33	.09	.12	.040	2900	2700
30...	12.0	4240	7.8	8.2	3.1	.03	.03	.010	2800	2600
MAY										
20...	10.5	3350	--	8.1	7.3	.33	.21	.070	1600	1100
JUN										
05...	15.5	4300	--	8.1	4.7	.07	.09	.030	2600	2300

DATE	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	SODIUM+ POTASSIUM DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (µG/L AS AS)
APR												
07...	500	410	160	1	10	190	32	31	2800	.30	5.3	4
30...	490	390	140	1	10	--	27	19	2600	.40	11	1
MAY												
20...	270	230	150	2	15	--	140	8.8	1600	.50	14	3
JUN												
05...	390	390	160	1	12	--	56	14	2600	.30	13	1

Table 8.--*Water-quality data from Lysimeter 5*--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980--Continued

DATE	BORON, DIS-SOLVED (μG/L AS B)	CADMIUM DIS-SOLVED (μG/L AS CD)	COPPER, DIS-SOLVED (μG/L AS CU)	IRON, SUS-PENDED RECOV-ERABLE (μG/L AS FE)	IRON, TOTAL RECOV-ERABLE (μG/L AS FE)	IRON, DIS-SOLVED (μG/L AS FE)	LEAD, DIS-SOLVED (μG/L AS PB)	MANGA-NESE, SUS-PENDED RECOV. (μG/L AS MN)	MANGA-NESE, TOTAL RECOV-ERABLE (μG/L AS MN)	MANGA-NESE, DIS-SOLVED (μG/L AS MN)	MOLYB-DENUM, DIS-SOLVED (μG/L AS MO)
APR											
07...	70	0	1	10	50	40	2	10	20	10	2
30...	70	0	1	60	100	40	0	0	10	20	0
MAY											
20...	110	0	2	80	120	40	0	0	10	10	1
JUN											
05...	100	0	4	70	100	30	2	0	10	20	1

DATE	NICKEL, DIS-SOLVED (μG/L AS NI)	VANA-DIUM, DIS-SOLVED (μG/L AS V)	ZINC, DIS-SOLVED (μG/L AS ZN)	ALUM-INUM, DIS-SOLVED (μG/L AS AL)	SELE-NIUM, DIS-SOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	MERCURY DIS-SOLVED (μG/L AS HG)	ALKA-LINITY LAB (MG/L AS CACO3)	BICAR-BONATE IT-LAB (MG/L AS HCO3)
APR										
07...	7	1	0	20	210	4100	5.5	.0	210	256
30...	5	1	10	40	200	3800	5.2	.0	250	305
MAY										
20...	5	20	50	30	100	2700	3.7	.0	470	573
JUN										
05...	6	7	20	20	130	3800	5.2	.0	300	366

Table 9.--*Water-quality data from Yampa River above Hayden, first application each day*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
JUL 23...	19.0	305	--	7.8	3.8	120	150	0	.13	.06	.020
AUG 17...	19.5	220	7.5	8.3	1.2	120	150	0	.33	.09	.030

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
JUL 23...	120	0	32	8.8	22	.9	29	2.7	12	28
AUG 17...	110	0	28	9.0	28	1	36	2.9	16	30

DATE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)
JUL 23...	.20	5.2	1	60	ND	2	100	2	20	2
AUG 17...	.30	1.6	<1	80	ND	ND	90	2	20	<1

DATE	NICKEL, DISSOLVED (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)	ANTIMONY, DISSOLVED (μG/L AS SB)	ALUMINUM, DISSOLVED (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (μG/L AS HG)
JUL 23...	2	0	4	<1	<100	<1	190	--	<.5
AUG 17...	5	0	2	<1	10	1	190	.26	<.5

Table 10.--*Water-quality data from Yampa River above Hayden, second application each day*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
JUL											
23...	26.0	300	--	8.6	.6	110	140	0	.03	.09	.030
AUG											
18...	18.0	320	6.2	8.0	2.4	120	150	0	.01	.06	.020

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
JUL										
23...	120	0	32	8.6	20	.8	27	2.6	11	26
AUG										
18...	110	0	30	8.8	30	1	36	3.0	18	32

DATE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (µG/L AS AS)	BORON, DISSOLVED (µG/L AS B)	CADMIUM DISSOLVED (µG/L AS CD)	COPPER, DISSOLVED (µG/L AS CU)	IRON, DISSOLVED (µG/L AS FE)	LEAD, DISSOLVED (µG/L AS PB)	MANGANESE, DISSOLVED (µG/L AS MN)	MOLYBDENUM, DISSOLVED (µG/L AS MO)
JUL										
23...	.20	5.4	1	60	ND	2	90	3	30	<1
AUG										
18...	.30	1.8	1	80	ND	ND	30	2	30	<1

DATE	NICKEL, DISSOLVED (µG/L AS NI)	VANADIUM, DISSOLVED (µG/L AS V)	ZINC, DISSOLVED (µG/L AS ZN)	ANTIMONY, DISSOLVED (µG/L AS SB)	ALUMINUM, DISSOLVED (µG/L AS AL)	SELENIUM, DISSOLVED (µG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (µG/L AS HG)
JUL									
23...	<2	0	4	<1	<100	<1	180	--	<.5
AUG									
18...	2	0	2	<1	10	<1	200	.27	<.5

Table 11.--*Water-quality data from Yampa River above Hayden, third application each day*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
JUL 24...	19.0	320	--	8.4	.9	110	140	0	.08	.09	.030
AUG 18...	22.5	310	9.0	8.6	.6	120	150	1	<.10	.06	.020

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
JUL 24...	110	0	29	8.5	19	.8	27	2.7	11	28
AUG 18...	110	0	29	8.7	31	1	38	3.1	17	29

DATE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)
JUL 24...	.20	7.0	1	60	ND	2	210	<2	60	<1
AUG 18...	.30	1.9	1	80	ND	ND	60	2	20	1

DATE	NICKEL, DISSOLVED (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)	ANTIMONY, DISSOLVED (μG/L AS SB)	ALUMINUM, DISSOLVED (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (μG/L AS HG)
JUL 24...	ND	0	ND	<1	40	2	180	--	<.5
AUG 18...	2	0	ND	<1	10	<1	200	.27	<.5

Table 12.--*Water-quality data from Yampa River above Hayden, fourth application each day*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
JUL										
24...	22.0	300	7.7	4.8	120	150	0	.10	.06	.020

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
JUL										
24...	130	6	37	8.9	19	.7	24	2.7	9.9	28

DATE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (µG/L AS AS)	BORON, DISSOLVED (µG/L AS B)	CADMIUM DISSOLVED (µG/L AS CD)	COPPER, DISSOLVED (µG/L AS CU)	IRON, DISSOLVED (µG/L AS FE)	LEAD, DISSOLVED (µG/L AS PB)	MANGANESE, DISSOLVED (µG/L AS MN)	MOLYBDENUM, DISSOLVED (µG/L AS MO)
JUL										
24...	.20	7.5	1	60	ND	<2	110	<2	30	1

DATE	NICKEL, DISSOLVED (µG/L AS NI)	VANADIUM, DISSOLVED (µG/L AS V)	ZINC, DISSOLVED (µG/L AS ZN)	ANTIMONY, DISSOLVED (µG/L AS SB)	ALUMINUM, DISSOLVED (µG/L AS AL)	SELENIUM, DISSOLVED (µG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	MERCURY DISSOLVED (µG/L AS HG)
JUL								
24...	<2	0	ND	<1	<100	<1	190	<.5

Table 13.--*Water-quality data from Yampa River above Hayden, fifth application each day*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
JUL 24...	22.0	310	8.5	.8	120	150	0	.03	.06	.020

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
JUL 24...	120	0	34	9.1	20	.8	26	2.8	9.8	27

DATE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)
JUL 24...	.20	8.0	1	60	ND	2	120	<2	20	1

DATE	NICKEL, DISSOLVED (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)	ANTIMONY, DISSOLVED (μG/L AS SB)	ALUMINUM, DISSOLVED (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	MERCURY DISSOLVED (μG/L AS HG)
JUL 24...	2	0	2	1	<100	1	190	<.5

Table 14.--*Water-quality data from Yampa River water, after transportation to lysimeter site, first application each day*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
JUL 23...	21.5	250	8.0	2.2	110	140	0	.05	.06	.020

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
JUL 23...	110	0	31	8.6	22	.9	29	2.7	13	26

DATE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)
JUL 23...	.20	5.2	1	70	ND	3	90	2	20	1

DATE	NICKEL, DISSOLVED (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)	ANTIMONY, DISSOLVED (μG/L AS SB)	ALUMINUM, DISSOLVED (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	MERCURY DISSOLVED (μG/L AS HG)
JUL 23...	<2	0	4	<1	10	<1	180	<.5

Table 15.--*Water-quality data from Yampa River water, after transportation to lysimeter site, second application each day*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
JUL											
23...	26.0	290	--	8.1	1.8	110	140	0	.03	.03	.010
AUG											
18...	21.0	320	7.2	8.2	1.5	120	150	0	<.10	.06	.020

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
JUL										
23...	110	0	30	8.2	20	.8	28	2.6	11	24
AUG										
18...	110	0	29	8.9	30	1	37	3.0	16	30

DATE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (µG/L AS AS)	BORON, DISSOLVED (µG/L AS B)	CADMIUM DISSOLVED (µG/L AS CD)	COPPER, DISSOLVED (µG/L AS CU)	IRON, DISSOLVED (µG/L AS FE)	LEAD, DISSOLVED (µG/L AS PB)	MANGANESE, DISSOLVED (µG/L AS MN)	MOLYBDENUM, DISSOLVED (µG/L AS MO)
JUL										
23...	.20	5.4	1	60	ND	<2	150	3	20	<1
AUG										
18...	.20	1.7	<1	80	ND	ND	90	2	20	1

DATE	NICKEL, DISSOLVED (µG/L AS NI)	VANADIUM, DISSOLVED (µG/L AS V)	ZINC, DISSOLVED (µG/L AS ZN)	ANTIMONY, DISSOLVED (µG/L AS SB)	ALUMINUM, DISSOLVED (µG/L AS AL)	SELENIUM, DISSOLVED (µG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (µG/L AS HG)
JUL									
23...	<2	0	8	<1	<100	1	170	--	<.5
AUG									
18...	3	0	8	1	10	<1	190	.26	<.5

Table 16.--*Water-quality data from Yampa River water, after transportation to lysimeter site, third application each day*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
JUL 24...	21.0	300	--	7.8	3.8	120	150	0	.06	.06	.020
AUG 18...	--	--	7.5	--	--	120	150	--	<.10	.06	.020

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
JUL 24...	120	0	32	8.6	20	.8	27	2.7	9.9	25
AUG 18...	110	0	29	8.8	30	1	37	3.1	15	29

DATE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)
JUL 24...	.20	7.1	1	60	ND	2	200	<2	20	<1
AUG 18...	.20	1.8	<1	80	ND	<2	80	2	20	<1

DATE	NICKEL, DISSOLVED (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)	ANTIMONY, DISSOLVED (μG/L AS SB)	ALUMINUM, DISSOLVED (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (μG/L AS HG)
JUL 24...	2	0	ND	<1	<100	1	180	--	<.5
AUG 18...	3	0	ND	<1	<100	<1	190	.26	<.5

Table 17.--*Water-quality data from Yampa River water, after transportation to lysimeter site, fourth application each day*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
JUL 24...	22.0	320	8.3	1.2	120	150	0	.04	.06	.020

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
JUL 24...	120	0	33	8.5	19	.8	25	2.7	9.7	24

DATE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (µG/L AS AS)	BORON, DISSOLVED (µG/L AS B)	CADMIUM DISSOLVED (µG/L AS CD)	COPPER, DISSOLVED (µG/L AS CU)	IRON, DISSOLVED (µG/L AS FE)	LEAD, DISSOLVED (µG/L AS PB)	MANGANESE, DISSOLVED (µG/L AS MN)	MOLYBDENUM, DISSOLVED (µG/L AS MO)
JUL 24...	.20	7.5	1	60	ND	<2	120	2	20	<1

DATE	NICKEL, DISSOLVED (µG/L AS NI)	VANADIUM, DISSOLVED (µG/L AS V)	ZINC, DISSOLVED (µG/L AS ZN)	ANTIMONY, DISSOLVED (µG/L AS SB)	ALUMINUM, DISSOLVED (µG/L AS AL)	SELENIUM, DISSOLVED (µG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	MERCURY DISSOLVED (µG/L AS HG)
JUL 24...	<2	0	ND	<1	10	<1	180	<.5

Table 18.--*Water-quality data from Yampa River water, after transportation to lysimeter site, fifth application each day*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM
JUL 24...	120	150	.03	.09	.030	130	2	35	9.2	20	.8	25

DATE	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	ARSENIC DISSOLVED (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)
JUL 24...	2.8	9.7	26	.20	8.1	1	60	2	<2	130	2

DATE	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)	NICKEL, DISSOLVED (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)	ANTIMONY, DISSOLVED (μG/L AS SB)	ALUMINUM, DISSOLVED (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	MERCURY DISSOLVED (μG/L AS HG)
JUL 24...	30	1	2	0	2	1	<100	<1	190	<.5

Table 19.--*Water-quality data from lysimeter 2 following water application*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
JUL									
24...	19.0	2000	--	7.8	4.8	16	.03	.010	1700
AUG									
19...	16.0	2900	7.0	7.8	6.6	35	.21	.070	2100
23...	19.0	4000	5.8	7.9	4.2	77	.00	<.010	2900

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)
JUL											
24...	1500	350	200	41	.4	5	17	17	1500	.40	7.9
AUG											
19...	1900	430	260	50	.5	5	19	18	1900	<.10	.5
23...	2700	630	320	110	.9	8	27	33	2600	.40	13

DATE	ARSENIC DISSOLVED (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)	NICKEL, DISSOLVED (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)
JUL											
24...	<1	240	<2	4	30	2	30	3	6	0	50
AUG											
19...	<1	170	<2	<2	20	4	20	3	5	0	<20
23...	<1	200	ND	<2	20	2	20	2	4	0	<20

DATE	ANTIMONY, DISSOLVED (μG/L AS SB)	ALUMINUM, DISSOLVED (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (μG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)	CARBONATE IT-LAB (MG/L AS CO3)
JUL									
24...	1	<100	170	2300	--	<.5	160	190	.00
AUG									
19...	<1	<100	90	3000	4.0	<.5	210	260	.00
23...	<1	<100	500	4200	5.7	<.5	170	210	.00

Table 20.--*Water-quality data from lysimeter 3 following water application*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
JUL									
24...	18.0	3120	--	7.8	--	22	.03	.010	2000
AUG									
19...	16.0	3500	6.9	7.4	18	50	.03	.010	2900
23...	19.0	4000	6.2	7.9	5.0	60	.03	.010	3100

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)
JUL											
24...	1800	400	240	51	.5	5	21	20	1800	.50	7.9
AUG											
19...	2700	580	350	61	.5	4	22	26	2500	<.10	.5
23...	2900	610	380	73	.6	5	19	32	2700	.40	12

DATE	ARSENIC DISSOLVED (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)	NICKEL, DISSOLVED (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)
JUL											
24...	<1	260	<2	4	50	2	40	3	9	0	30
AUG											
19...	1	120	ND	ND	20	2	30	2	6	0	20
23...	<1	110	ND	<2	<10	2	20	2	5	0	20

DATE	ANTIMONY, DISSOLVED (μG/L AS SB)	ALUMINUM, DISSOLVED (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (μG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)	BONATE IT-LAB (MG/L AS CO3)
JUL									
24...	<1	20	150	2700	--	<.5	140	170	.00
AUG									
19...	<1	<100	300	3900	5.3	<.5	240	290	.00
23...	<1	20	400	4200	5.7	<.5	210	250	.00

Table 21.--*Water-quality data from lysimeter 4 following water application*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (μS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
JUL									
24...	17.0	2500	--	7.7	7.7	12	.03	.010	1400
AUG									
19...	16.0	2800	6.6	7.2	27	24	.09	.030	1900
23...	19.0	4300	5.8	7.6	11	41	.06	.020	3100

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)
JUL											
24...	1200	320	150	120	1	15	32	100	1300	.30	12
AUG											
19...	1700	410	210	130	1	13	21	150	1700	.10	1.3
23...	2900	670	340	200	2	12	18	300	2500	.10	5.2

DATE	ARSENIC DISSOLVED (μG/L AS AS)	BORON, DISSOLVED (μG/L AS B)	CADMIUM DISSOLVED (μG/L AS CD)	COPPER, DISSOLVED (μG/L AS CU)	IRON, DISSOLVED (μG/L AS FE)	LEAD, DISSOLVED (μG/L AS PB)	MANGANESE, DISSOLVED (μG/L AS MN)	MOLYBDENUM, DISSOLVED (μG/L AS MO)	NICKEL, DISSOLVED (μG/L AS NI)	VANADIUM, DISSOLVED (μG/L AS V)	ZINC, DISSOLVED (μG/L AS ZN)
JUL											
24...	<1	440	<2	4	50	<2	30	1	6	0	6
AUG											
19...	<1	210	ND	<2	20	2	30	1	5	0	20
23...	<1	140	ND	<2	<10	2	30	2	6	4	<20

DATE	ANTIMONY, DISSOLVED (μG/L AS SB)	ALUMINUM, DISSOLVED (μG/L AS AL)	SELENIUM, DISSOLVED (μG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (μG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)	CARBONATE IT-LAB (MG/L AS CO3)
JUL									
24...	<1	<100	130	2200	--	<.5	200	240	.00
AUG									
19...	<1	<100	200	2900	3.9	<.5	220	270	.00
23...	<1	<100	400	4400	5.9	<.5	220	270	.00

Table 22.--*Water-quality data from lysimeter 5 following water application*

WATER-QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TEMPERATURE (°C)	SPECIFIC CONDUCTANCE (µS/CM)	OXYGEN, DISSOLVED (MG/L)	PH (STANDARD UNITS)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHATE, ORTHO, DISSOLVED (MG/L AS PO4)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	HARDNESS (MG/L AS CACO3)
JUL									
24...	18.0	1300	--	7.6	6.4	3.5	.03	.010	720
AUG									
17...	18.0	1600	5.6	7.4	12	7.7	.03	.010	930
23...	19.0	3600	6.0	8.1	2.2	32	.06	.020	2200

DATE	HARDNESS, NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)
JUL											
24...	590	160	77	58	.9	15	6.6	35	610	.50	11
AUG											
17...	770	210	98	81	1	16	20	56	780	.50	11
23...	2100	530	220	190	2	15	25	170	2000	.40	14

DATE	ARSENIC DISSOLVED (µG/L AS AS)	BORON, DISSOLVED (µG/L AS B)	CADMIUM DISSOLVED (µG/L AS CD)	COPPER, DISSOLVED (µG/L AS CU)	IRON, DISSOLVED (µG/L AS FE)	LEAD, DISSOLVED (µG/L AS PB)	MANGANESE, DISSOLVED (µG/L AS MN)	MOLYBDENUM, DISSOLVED (µG/L AS MO)	NICKEL, DISSOLVED (µG/L AS NI)	VANADIUM, DISSOLVED (µG/L AS V)	ZINC, DISSOLVED (µG/L AS ZN)
JUL											
24...	<1	100	<2	2	50	3	20	1	6	0	4
AUG											
17...	<1	180	<2	2	30	2	30	1	4	0	4
23...	<1	130	ND	<2	<10	2	30	1	6	0	<20

DATE	ANTIMONY, DISSOLVED (µG/L AS SB)	ALUMINUM, DISSOLVED (µG/L AS AL)	SELENIUM, DISSOLVED (µG/L AS SE)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	MERCURY DISSOLVED (µG/L AS HG)	ALKALINITY LAB (MG/L AS CACO3)	BICARBONATE IT-LAB (MG/L AS HCO3)	CARBONATE IT-LAB (MG/L AS CO3)
JUL									
24...	<1	<100	8	1100	--	<.5	131	160	.00
AUG									
17...	<1	10	100	1400	1.9	<.5	160	190	.00
23...	<1	<100	250	3400	4.6	<.5	140	170	.00

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