REPORT OF ENVIRONMENTAL STUDIES
PROPOSED URANIUM HEAP LEACHING PROJECT
NEAR MAYBELL, COLORADO
FOR UNION CARBIDE CORPORATION

Dames & Moore Job No. 0822-081-06

October 8, 1975

Union Carbide Corporation
Mining and Metals Division
Post Office Box 1049
Grand Junction, Colorado 81501

Attention: Mr. Robert C. Beverly

Gentlemen:

This letter transmits six copies of our "Report of Environmental Studies, Proposed Uranium Heap Leaching Project, Near Maybell, Colorado, For Union Carbide Corporation." The report summarizes the geologic, ground water, and surface water conditions in the site vicinity and discusses potential exposure pathways to the environment via ground water.

We appreciate the opportunity to be of service to you. If you have any questions, please contact us.

Yours very truly,

DAMES & MOORE

George C. Toland

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Partner
Professional Engineer No. 8545
State of Colorado

GCT/GWC:ab

Enclosures

REPORT OF ENVIRONMENTAL STUDIES

PROPOSED URANIUM HEAP LEACHING PROJECT

NEAR MAYBELL, COLORADO

FOR UNION CARBIDE CORPORATION

INTRODUCTION

This report presents the results of our environmental studies for your proposed uranium heap leaching project near Maybell, Colorado. This investigation was performed in conjunction with our design study entitled "Report of Leach Heap Liner Design, Proposed Uranium Leach Heap Project, Near Maybell, Colorado, For Union Carbide Corporation."

PURPOSE AND SCOPE

The purpose of this portion of our investigation was to evaluate the geologic and ground water conditions in the area and to assess the impact of the proposed heap leaching project upon the ground water regime.

The scope of our studies included the following:

1. A field exploration and laboratory testing program. The field program consisted of a geologic reconnaissance, the excavation, sampling and logging of 23 test pits in the heap and borrow areas, the drilling, logging and sampling of three monitor wells, and the examination and sampling of existing open pits, waste and mineral dumps.

The laboratory program consisted of permeability, compaction, grain size and direct shear tests, and petrographic and mineralogic identification. A description of the programs and a summary of laboratory data are presented in our design report.

2. An office program consisting of data collection, engineering analyses, and preparation of this report.

PROPOSED ACTIVITIES

Union Carbide Corporation proposes to process uranium mineral at their Maybell, Colorado, property. Very low grade uranium mineral will be mined from open pits and obtained from existing "waste" piles and possibly existing tailings deposits. The mineral will be processed by heap leaching methods. A leach liquor will be obtained by percolation of dilute sulfuric acid through the heap. This liquor will be concentrated in a small ion-exchange unit at the site to yield a product cake. The product cake will be shipped to Gas Hills, Wyoming by truck for final processing. It is anticipated that an effluent from the process will be discharged to an open pit at the site.

Union Carbide Corporation holds a permit for mining and milling operations at the site from the State of Colorado. The permit is currently inactive.

SITE DESCRIPTION

LOCATION:

The proposed mining and heap leaching site is located north of U. S. Highway 40 between Maybell and Lay, Colorado, as shown on Plate 1, Vicinity Map. Two alternate locations for the heap have been considered. The leach heap will be located either in the southwest corner of Section 19, T. 7N., R. 94 W., or in the west-central part of Section 24, T. 7N., R. 95 W., as shown on Plate 2, Plot Plan-Leach Heap Areas. The site may be reached by either of two dirt access roads from Highway 40.

TOPOGRAPHY AND SURFACE FEATURES:

The mine area has a gently rolling topography varying in altitude from 6,200 to 6,700 feet. The area is covered with vegetation of sagebrush and sparse low grasses. Several open pits and waste dumps remain from past mining activities. Surface features and the topography of the area are shown on Plate 1, Vicinity Map.

GEOLOGY:

General. The area is underlain by the Browns Park formation as shown on Plate 3, Local Geology. The Browns Park formation, considered Miocene in age, unconformably overlies formations ranging in age from Precambrian to Eocene. A lithologic description of rock strata occurring in the area is presented on Plate 4, Stratigraphic Description and Symbols.

The Browns Park formation is divided into two units in the site area (Guilinger, 1958):

1. A lower basal conglomerate unit consisting of pebbles and cobbles of milky and clear quartz, red quartzite, granite, gneiss, schist, and basic igneous rocks, all of which are intermixed with some pyroclastic material. This unit varies in thickness from 0 to 150 feet.

2. An upper sandstone sequence consisting of gray-white to buff, partly limonitic stained, loosely consolidated, massive, cross-bedded in part, fine to medium-grained, tuffaceous in part, arkosic, clay and calcium carbonate cemented sandstone. Unoxidized portions of this unit contain microcrystalline pyrite and are usually dark blue in color. The thickness of this unit varies from 0 to 1,200 feet in the area.

The upper sandstone unit is comprised of a pyroclastic facies interfingered with an arkosic facies. Commercial uranium deposits are found in the pyroclastic facies in the upper 700 feet of the sandstone sequence. It is believed that the uranium deposits resulted from leaching of overlying and up-dip tuffaceous rocks by percolating alkali carbonate-bicarbonate ground water and subsequent deposition in deeper tuffaceous beds (Guilinger, 1958).

The most prominent structural feature in the vicinity is the west-plunging Lay syncline. The syncline is a depositional feature of the Browns Park formation. Influx of Browns Park sediment into the deeply-scoured, topographic low within the Mancos shale caused the depositionally controlled Lay syncline to be formed. Faults in the Browns Park formation are inferred to have resulted from recurrent movement along pre-Miocene faults in the underlying rocks. These later adjustments which occurred at varying intervals caused tensional fracturing and displacement in the Browns Park formation. Offsets are mostly small, on the order of 1 to 30 feet, although a fault extending through leach heap alternate area 1 has a displacement of 50 to several hundred feet. Almost all faults in the Browns Park formation in the vicinity trend northwest, approximately parallel to the fault pattern in the older rocks (Guilinger, 1958).

Both proposed heap sites are located on the gently dipping southern flank of the Lay syncline near its axis, as shown on Plate 3. Dips range from 2 to 5 degrees in a northwesterly direction. The Browns Park formation is 850 to 900 feet thick at both sites. North of the Lay syncline, the Browns Park formation dips southward at 10 to 40 degrees.

The Mancos shale underlies the Browns Park formation in the site area. The Mancos shale consists of a thick sequence of dark gray marine shale with lenticular sandstone beds near the top and base. Lithologic descriptions of other formations in the region are presented on Plate 4, Stratigraphic Description and Symbols.

Cross-Section A-A' , Plate 5 shows the subsurface structural relationship of the rock strata in the area.

No oil or gas wells have been drilled within two miles of the proposed heap areas or the Robb Pit.

Leach Heap Alternate Area 1. Proposed leach heap alternate area 1 is underlain by the Browns Park formation. Since the formation is loosely consolidated and poorly cemented to uncemented, the subsurface materials are described herein in accordance with the Unified Soil Classification System.

The upper 1.5 to 4.0 feet of soil underlying the site consists of dark-brown to brown, medium-dense, clayey and silty fine sand (SC-SM). Major roots extend to one inch depth. Underlying the upper layer is a stratum of light-brown to brown, medium-dense, silty fine sand (SM-SP to SM). Below a few tens of feet, the material grades greenish-brown to greenish-blue and is occasionally weakly cemented with calcium carbonate.

The soils are of moderate permeability. As determined by laboratory tests, the clayey and silty fine sand (SC-SM) has a permeability of 4 to 6 gallons per day per square foot. As tested, the silty fine sands (SM-SP) typically vary from 44 to 100 gallons per day per square foot, while silty fine sands (SM) vary from 5 to 13 gallons per day per square foot. Interspersed with these materials are several cemented layers. Although no samples from one of these layers were tested, the material is of low permeability and forms thin perched ground water layers as noted during drilling.

Soil logs and the results of laboratory testing of field samples are presented in the appendix of our design report.

Leach Heap Alternate Area 2. Proposed alternate area 2 is situated upon mine waste fill consisting of loose to medium-dense, brown to greenish-brown, silty fine sand (SM-SP) with occasional gravel and boulders. Thickness of the fill varies from about 10 to 15 feet. Underlying the fill are natural soils consisting of medium-dense, dark brown to brown, silty fine sand of the Browns Park formation. Soil logs and laboratory data are presented in the appendix of our design report.

Rob Pit. Rob Pit has been excavated to a depth of approximately 200 feet during past mining operations. Exposed in the walls of the pit is brown to greenish-brown, medium-dense, silty fine sand (SM-SP to SM). Several lenticular beds, two to three feet in thickness, of calcium carbonate cemented, silty fine sand are interbedded with the uncemented sands.

GROUND WATER

USAGE IN VICINITY:

Ground water is utilized only to a minor extent in the area and data regarding ground water conditions and aquifer properties are meager. Table 1 summarizes data for water wells within five miles of the site as recorded with the Colorado State Engineer. State regulations require the registration of all water wells. Only one well, well No. 1 owned by the BLM, lies within two miles of the site. This well and others in the Browns Park formation typically yield on the order of 10 gallons per minute (gpm). The Brannen well (Well No. 3) reportedly yielded 250 gpm apparently from alluvium along Spring Creek.

BROWNS PARK FORMATION:

Ground water at the site occurs under water table conditions in the Browns Park formation. The shape of the water table in the area is influenced by the local topography and the subsurface geologic structure. The topographic slope is west and southwest toward the Yampa River except east of leach heap area 1 where the slope is easterly. The ground water table often slopes in the direction of the topographic slope because the ground water recharge is greater at higher elevations and movement is toward the discharge points of the lower elevations. Recharge to the formation in the site vicinity occurs by direct infiltration of precipitation and by ground water movement from topographically

TABLE 1

Water Wells Within Five Miles of Site

Ref. No.	Owner	Location	Total Depth (ft)	Reported Yield (gpm)	Main Aquifer*	Static Water Level (ft)/Date Measured	Use**
1	BLM	SW¼ of SE¼ Sec.30,T.7N, R.94W.	185	?	Tbp	100/?	S
2	McIntyre	SW¼ of SW¼ Sec.9,T.7N, R.94W.	200	10	Tbp?	100/ 7-31-68	S
3	Brannen	NE¼ of NW¼ Sec.35,T.8N, R.95W.	71	250	Qal?	14/ 4-15-59	I
4	Eller	SW¼ of NE¼ Sec.32,T.7N, R.95W.	51	10	Qal?	16/ 11-2-63	D

*Main Aquifer: Tbp - Browns Park formation; Qal - alluvium
**Use: S - stockwatering; D - domestic; I - irrigation

Source: Colorado State Engineer (1975)

higher areas lying to the north and northeast. The amount of recharge is probably quite low due to the relatively low precipitation rate and high potential evapotranspiration rate. Ground water probably discharges to the atmosphere as evapotranspiration where the water table lies at depths less than 50 feet and to the Yampa River.

The Browns Park formation dips northwesterly to westerly near the site as discussed in the previous section. Interbedding of layers of different permeability in the formation would facilitate ground water movement in the downdip direction. Faults in the Browns Park beds are mostly of small throw and would likely exert only minor influence upon the overall ground water gradient due to the semi-consolidated nature of the strata.

The net effect of the topography and geologic structure would be expected to produce a water table which slopes from the site to the west intersecting the level of the Yampa River. Water table elevations measured in monitor wells and water wells in the area bear out this relationship as shown on Plate 3. The ground water table slopes westerly to southwesterly at about 100 feet per mile at the site but flattens considerably between leach heap area 2 and the Yampa River.

Three aquifer test wells were drilled near the Rob Pit and analyzed by Trace Elements Corporation in 1959 to determine open pit mine dewatering requirements (Travelli, 1959). The wells were completed

TABLE 2

WATER LEVELS MEASURED IN MONITOR WELLS

AND TEST WELLS

Location	Total Depth (ft)	Collar Elevation (ft)	Depth to Static Water Level (ft)/Date Measured
Monitor Well 1	170	6240*	151.1/5-12-75
Monitor Well 2	202	6166	140.0/7-22-75
Monitor Well 3	230	6186	220.5/7-22-75
Test Well 1	240	6227	135.2/4-59 (sanded on 7-22-75)
Test Well 2	240	6251	187.7/4-59
Test Well 3	240	6237	181.7/4-59
Johnson 1	Unknown	6240*	135.0/4-10-75

*Approximate.

to a depth of 250 feet in the Browns Park formation at the locations shown on Plate 3. Pumping the wells showed that Test Well No. 1 could produce 24 gpm and Test Well No. 2 could produce 6 gpm. Test Well No. 3 could not be pumped due to continued influx of sand but the rate of water inflow was less than the amount extractable by bailer test. Test Well No. 1 was pump tested for two days and water levels were observed in three observation wells. Analysis of the pump test data indicated one of two possibilities; an upper layer of relatively higher permeability and a lower zone of lower permeability below a depth of 159 to 169 feet, or, a thinning of the aquifer. Computed values of transmissibility range from 2110 to 3170 gallons per day per foot for the upper zone and 565 to 755 gallons per day per foot for the lower zone. Dividing the transmissibility of the upper zone by its saturated thickness of 25 feet, results in a permeability of 85 to 127 gallons per day per square foot. These values agree fairly well with those determined in laboratory tests of silty fine sand (SM-SP) occurring at the site. Values determined for the coefficient of storage were 1.5 percent or less. These values are not felt to be representative, however, due to the short test period.

OTHER FORMATIONS:

No ground water information is available for deeper formations in the vicinity because of a lack of wells. However, it is improbable that ground water in these formations would be affected in any way by activities at the site since they are isolated by the thick, impermeable Mancos shale.

GROUND WATER QUALITY:

Water samples from monitor wells at the site will be analyzed by Union Carbide Corporation. Information regarding monitor well construction is presented on Table 3.

SURFACE WATER

The western part of the property is drained by several small ephemeral washes which enter the Yampa River two miles to the southwest. The central and eastern portions of the property are drained by ephemeral streams which enter Lay Creek, an intermittent stream located one to two miles to the south of the property. Lay Creek flows westward and joins the Yampa River about three miles downstream.

The Yampa River is gauged at the U. S. Highway 40 bridge south of the site. At this point the River has a drainage area of 3410 square miles. The average discharge for 54 years is 1543 cubic feet per second (cfs). Extremes in daily flow recorded at the station are a minimum of 2.0 cfs on July 17 through 19, 1934, and a maximum of 17,900 cfs on May 19, 1917. The highest flows occur during the months of March, April, May, and June while the lowest flows occur in August, September, and October. Natural flow of the Yampa River is affected by transbasin diversions, numerous storage reservoirs, and diversions for irrigation for about 65,000 acres above the station and 800 acres below the station (U. S. Geological Survey, 1973). No other streams near the site are gauged.

Water quality has been gauged at the station since November 1950. Dissolved solids have varied from a minimum of 64 milligrams per liter (mg/l) on June 13, 1964, to a maximum of 656 mg/l on August 11,

TABLE 3

MONITOR WELL DATA

MONITOR WELL 1

Collar Elevation: 6240 feet

Diameter: 3 inches

Total Depth: 170 feet

Screened Interval: 150 to 170 feet

Water level/date measured: 151.1 feet/5-12-75

MONITOR WELL 2

Collar Elevation: 6166 feet

Diameter: 4 inches

Total Depth: 202 feet

Screened Interval: 192 to 202 feet

Water level/date measured: 140.0 feet/7-22-75

MONITOR WELL 3

Collar Elevation: 6186 feet

Diameter: 4 inches

Total Depth: 230 feet

Screened Interval: 220 to 230 feet

Water level/date measured: 220.5 feet/7-22-75

For locations see Plates 2 and 3.

1968. Water temperature has varied from a maximum of 29.5°C on August 5, 1963, to minimums of 0°C which have often occurred during winter months (U. S. Geological Survey, 1974).

Radium - 226 and uranium concentrations in the Yampa River have been reported by the U. S. Environmental Protection Agency (1973) for a monitoring station located 5.5 miles west of Maybell. The mean radium - 226 concentration for 47 samples collected during the period 1961 through 1972 has been 0.08 ± 0.06 picocurries per liter (pc/l) and individual samples have varied from 0.010 to 0.150 pc/l. Uranium concentrations for 44 samples collected during the same period averaged 2.48 ± 3.25 microcurries per liter (μc/l) and extremes of 0.50 and 8.0 μc/l have been recorded.

The Yampa River near the site is designated a class B_2 water by the Colorado Water Quality Control Commission.

Water quality data on other streams in the area are not available.

PRECIPITATION AND EVAPORATION:

Average annual precipitation for the U. S. Weather Bureau, Maybell station for the 12 years of record is 11.2 inches (Environmental Data Service, 1959-1971). Rainfall is distributed relatively uniformly throughout the year.

The probable maximum one-hour rainfall is six inches for the site (U. S. Bureau of Reclamation, 1973). The average annual lake evaporation for the site area is 32 inches (Kohler and others, 1959).

DISCUSSION AND CONCLUSIONS

GENERAL:

Supporting data upon which our evaluations are based are presented in the appendix of our report entitled "Report of Leach Heap Liner Design, Proposed Uranium Leach Heap Project, Near Maybell, Colorado, For Union Carbide Corporation," which has been prepared in conjunction with this study.

Sources of wastes and effluents from the treatment process to the ground water environment will consist of seepage, if any, through the soil liner of the leach heap; effluent to be disposed of in an open pit and accidental surface spills, if any. The environmental impact of these possible releases is discussed in the following sections.

SEEPAGE FROM LEACH HEAP:

The leach heap liner will provide seepage control. The liner will be composed of a one-foot-thick layer of compacted silty clay or fine sandy clay excavated from a borrow area some five miles from the site. The in-place soil liner is expected to have a permeability on the order of 0.001 to 0.01 gallons per day per square foot based on the results of laboratory testing. The permeability tests were conducted using both clear water and a ten percent by weight solution of sulfuric acid. Somewhat lower permeabilities were obtained using the sulfuric acid solution since deposition of slimes occurs due to chemical reactions.

The seepage quantity from the heap will be very low. Leaching fluid which infiltrates the heap will perch upon the soil liner and will be collected and removed by the collector drain system. Therefore, virtually no hydraulic head will be applied to the liner. With time the liner will become saturated as moisture is drawn into the material due to capillary action and in response to gravity. Utilizing Darcy's Law, the maximum seepage rate through the liner is estimated to be 0.01 gallons per day per square foot for vertical flow. Utilizing an effective porosity of five to ten percent for the liner soil, assumed from data in Johnson (1967), 37 to 75 days would be required for any seepage to move through the liner. When the liner becomes saturated capillary forces within the very fine-grained liner material will reduce or prevent seepage into the underlying unsaturated coarser-grained soil. Should any seepage escape the liner, the small quantity would likely be retained as soil moisture for long periods of time within a few feet of the liner. Also the seepage would likely be divested of most of its chemical and radiochemical components by ion exchange and reaction with the soil.

Potential exposure pathways must be considered despite the small potential for measurable release of effluent to the main ground water table. Seepage movement would be primarily vertically downward through the Browns Park formation until cemented layers or zones of lower permeability were encountered. These zones would tend to disperse the seepage laterally down dip. Eventually the seepage would encounter the ground water table which lies at a depth of about 150 feet. Thereafter the seepage would mingle with the ground water and would move in response to the water table gradient. However, it is unlikely that effluent would reach the water table because the small amount which might occur would be retained as soil moisture within the unsaturated zone.

EFFLUENT DISCHARGED TO OPEN PITS:

We understand that an effluent may be discharged from the heap leaching facility to the Rob Pit which extends below the ground water table, or to another pit which does not intersect the water table. The chemical and radiochemical characteristics of the effluent are being determined by Union Carbide Corporation and are not available at this time.

Should the effluent be discharged to a pit above the water table, seepage from the pit would move vertically downward through the Browns Park formation until encountering layers of lower permeability which would tend to disperse the seepage laterally downdip. Vertical movement through strata of higher permeability to the water table would be relatively rapid, on the order of several days. However, layers of lower permeability would slow vertical movement appreciably to several months to perhaps a year. Upon encountering the water table the seepage would mix with the ground water and move downgradient at much slower rates as described in the following paragraphs.

Effluent discharged to an open pit intersecting the water table would be diluted with the water in the pit. The diluted liquid would move as ground water in a westerly direction downgradient from the pit.

The ground water table slopes westerly at about 100 feet per mile at the site then flattens greatly between leach heap area 2 and the Yampa River as shown on Plate 3. Utilizing a permeability of 100 gallons per day per square foot, an average value for the more highly permeable strata in the Browns Park formation, and an assumed effective porosity of ten percent, the velocity of ground water movement between Rob Pit and heap area 2 would be 2.5 feet per day in a westerly direction. West of heap area 2 the water table flattens considerably and ground water movement is slowed. The maximum slope of the water table between heap area 2 and the Yampa River would be about 29 feet per mile. Using a permeability of 100 feet per year and an effective porosity of 10 percent, the velocity of ground water movement would be 0.73 feet per day. Total travel time for ground water movement to the Yampa River is computed to be 48 years.

Along the travel path, constituent levels in the effluent would be highly reduced due to dilution, ion exchange, and various chemical reactions.

ACCIDENTAL SURFACE SPILLS:

An accidental surface spill could occur due to the failure of a heap surface compartment containing the sulfuric acid leaching fluid, breakage of a pipe outside the heap or within the ion exchange unit, or due to a transportation accident. Should such a spill occur at the facility the liquid would be retained within a proposed emergency retention area or would infiltrate the surface soils where the liquid would likely be retained as soil moisture. A spill releasing environmentally deleterious or hazardous materials would be recovered to the fullest extent possible.

MONITORING:

We recommend that the effluent discharged from the facility to the open pit be analyzed initially for the constituents shown on Table 4. Constituents present in the effluent in significant concentrations should thereafter be analyzed in the effluent and in water samples from monitor wells at least annually while the facility is in operation. Seepage through the leach heap liner, if any, will be detected by a monitor drain placed under the liner. Should any seepage appear, it should be analyzed for the same constituents analyzed for in the monitor wells.

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The following list of references and plates are attached and complete this report:

References

Plate 1 - Vicinity Map

Plate 2 - Plot Plan - Leach Heap Areas

TABLE 4

ANALYSES TO BE PERFORMED ON INITIAL EFFLUENT SAMPLE

Chemical

pH
Arsenic (As)
Barium (Ba)
Boron (B)
Cadmium (Cd)
Chloride (Cl)
Chromium (Cr^{+6})
Copper (Cu)
Cyanide (CN)
Fluoride (F)
Iron (Fe)
Lead (Pb)
Manganese (Mn)
Mercury (Hg)
Molybdenum (Mo)
Nickel (Ni)
Nitrate (NO_3)
Selenium (Se)
Silver (Ag)
Sulfate (SO_4)
Total Dissolved Solids (TDS)
Zinc (Zn)

Radiochemical

Total Alpha
Radium - 226
Thorium - 230
Uranium - natural

Plate 3 - Local Geology

Plate 4 - Stratigraphic Description and Symbols

Plate 5 - Cross-Section A-A'

Respectfully submitted,

DAMES & MOORE

George C. Toland
Partner
Professional Engineer No. 8545
State of Colorado

GCT/GWC:ab

Attachments

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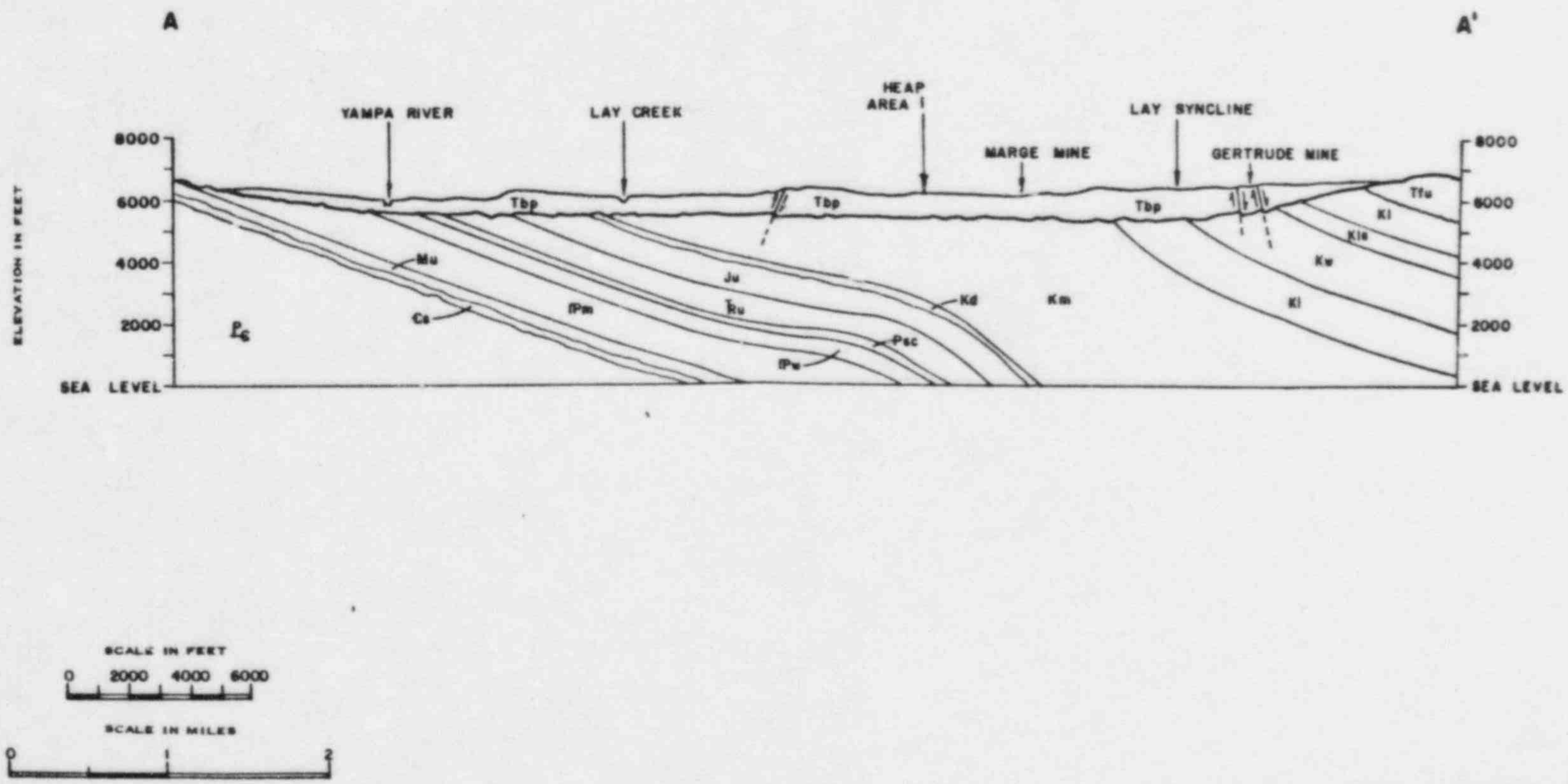


CROSS SECTION A-A'

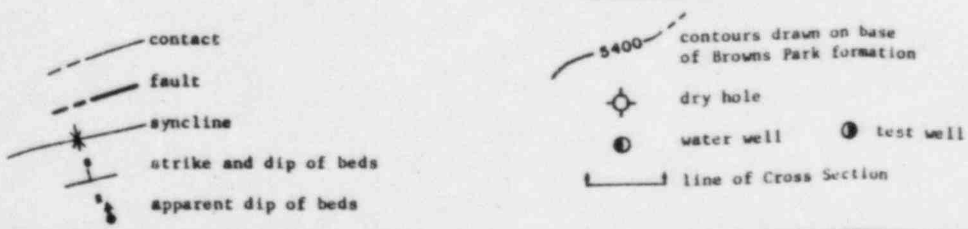
FOR SYMBOLS, SEE PLATE 4
REFERENCE: BERGIN (1959)

PLATE 5

STRATIGRAPHIC DESCRIPTION

Age	Lithologic Symbol	Formation	Lithologic Characteristics
Quaternary	Qal	Alluvium	Unconsolidated gravel, sand, clay and silt
	---unconformity---		
Miocene	Tbp	Browns Park	Soft fine-grained sandstone and hard calcareous sandstone with some thin beds of siltstone and claystone. Basal conglomerate
	---unconformity---		
Eocene	Tw	Wasatch	Claystone, siltstone, mudstone, sandstone, conglomeratic sandstone and conglomerate
	---unconformity---		
Paleocene	Tfu	Fort Union	Conglomerate, conglomeratic sandstone, sandstone, siltstone, shale and coal
	---unconformity---		
Cretaceous	Kl	Lance	Thick massive sandstone with thin, soft sandstone, siltstone, shale and coal
Cretaceous	Kls	Lewis Shale	Calcareous marine shale with thin interbeds of calcareous sandstone
Cretaceous	Kw	Williams Fork	Thick, massive sandstone with soft shale and coal interbeds
Cretaceous	Ki	Iles	Thick, massive sandstone with soft shale and coal interbeds
Cretaceous	Km	Mancos	Marine shale with thick lenticular sandstone beds near bottom and top
Cretaceous	Kd	Dakota	Quartzitic sandstone, shale, and pebble conglomerate
	---unconformity---		
Jurassic	Ju	Undivided	Morrison, Curtis, Entrata and Navajo formations - sandstone and shale
Triassic	TRu	Undivided	Chinle, Shinarump, Moenkopi - siltstone, sandstone, shale, conglomeratic sandstone
Permian	Psc	Maroon	South Creek member of Maroon formation - siltstone and sandstone
Pennsylvanian	IPw	Weber	Massive sandstone
Pennsylvanian	IPm	Morgan	Sandstone, limestone and shale
Mississippian	Mu	Undivided	Limestone and dolomite
	---unconformity---		
Cambrian	Ꞓs	Sawatch	Conglomeratic sandstone and quartzite, shale at base
	---unconformity---		
Precambrian	pꞒ	Uinta Mtn. Group	Quartzite and sandstone

SYMBOLS USED ON PLATE 3



STRATIGRAPHIC DESCRIPTION & SYMBOLS

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PLATE 4

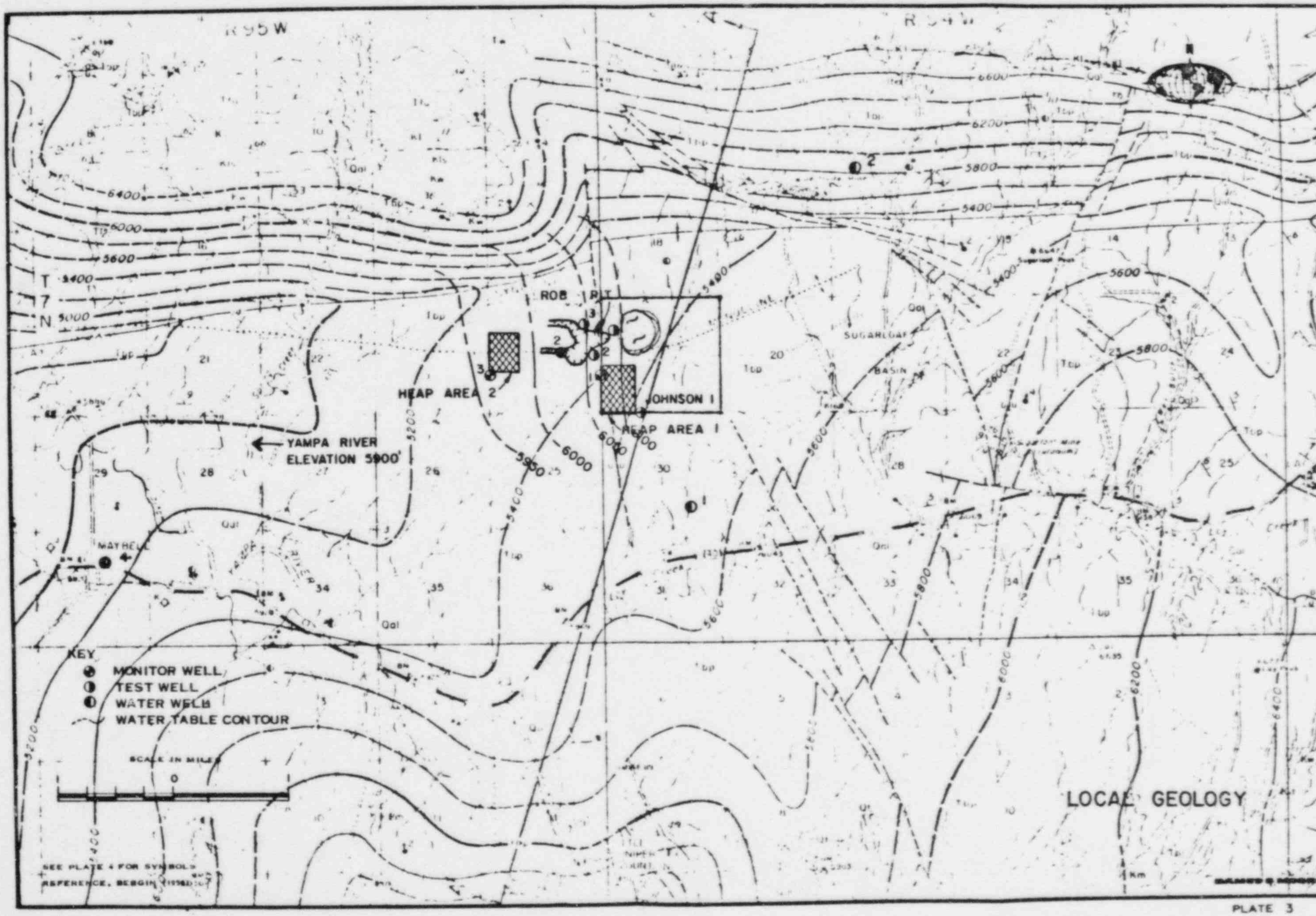
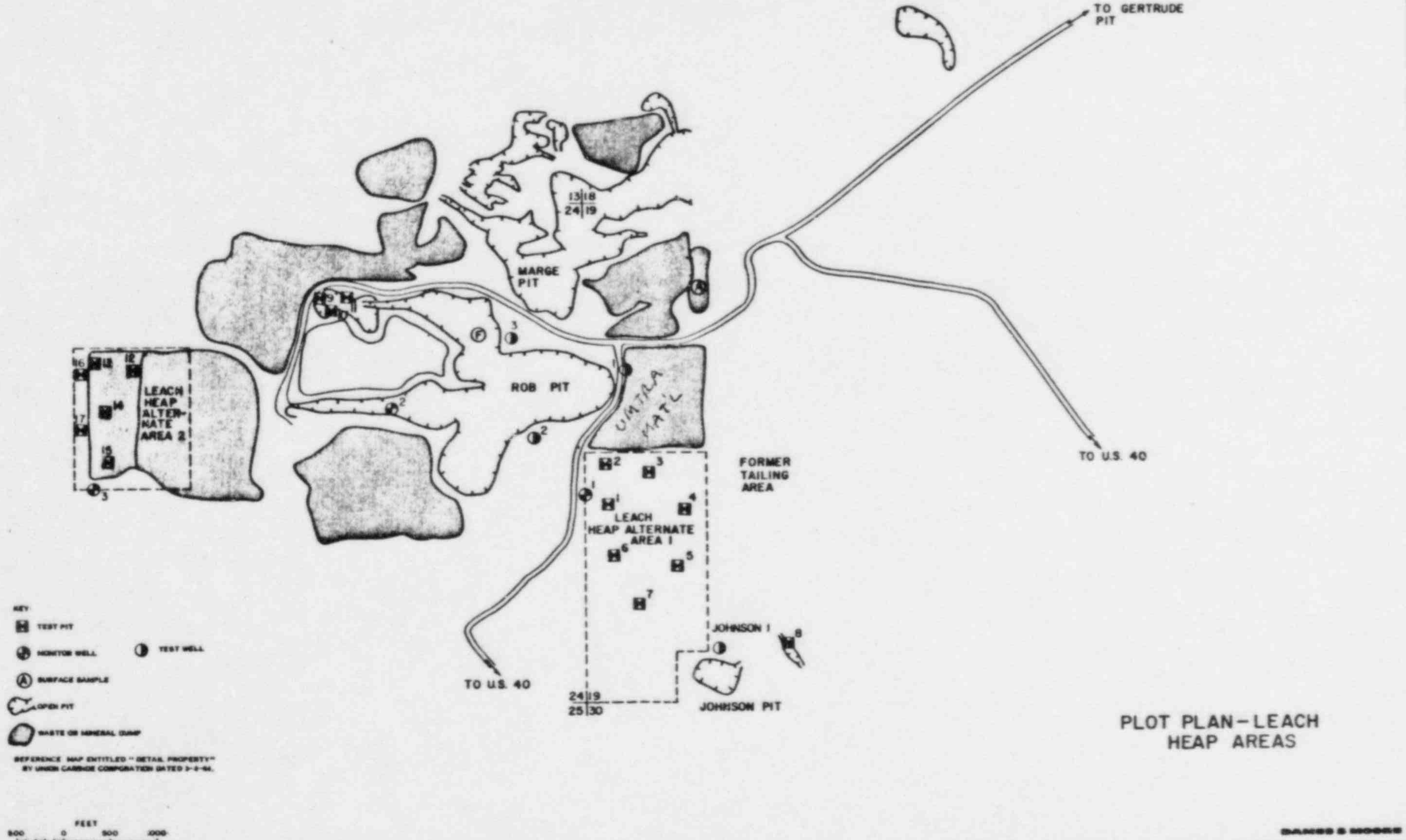

R95W
R94W
T7N
5400
5600
5800
6000
6200
6400
6600
ROB PIT
HEAP AREA 2
HEAP AREA 1
JOHNSON 1
SUGARLOAF BASIN
YAMPA RIVER ELEVATION 5900'
MAYBELL
KEY
MONITOR WELL
TEST WELL
WATER WELL
WATER TABLE CONTOUR
SCALE IN MILES
LOCAL GEOLOGY

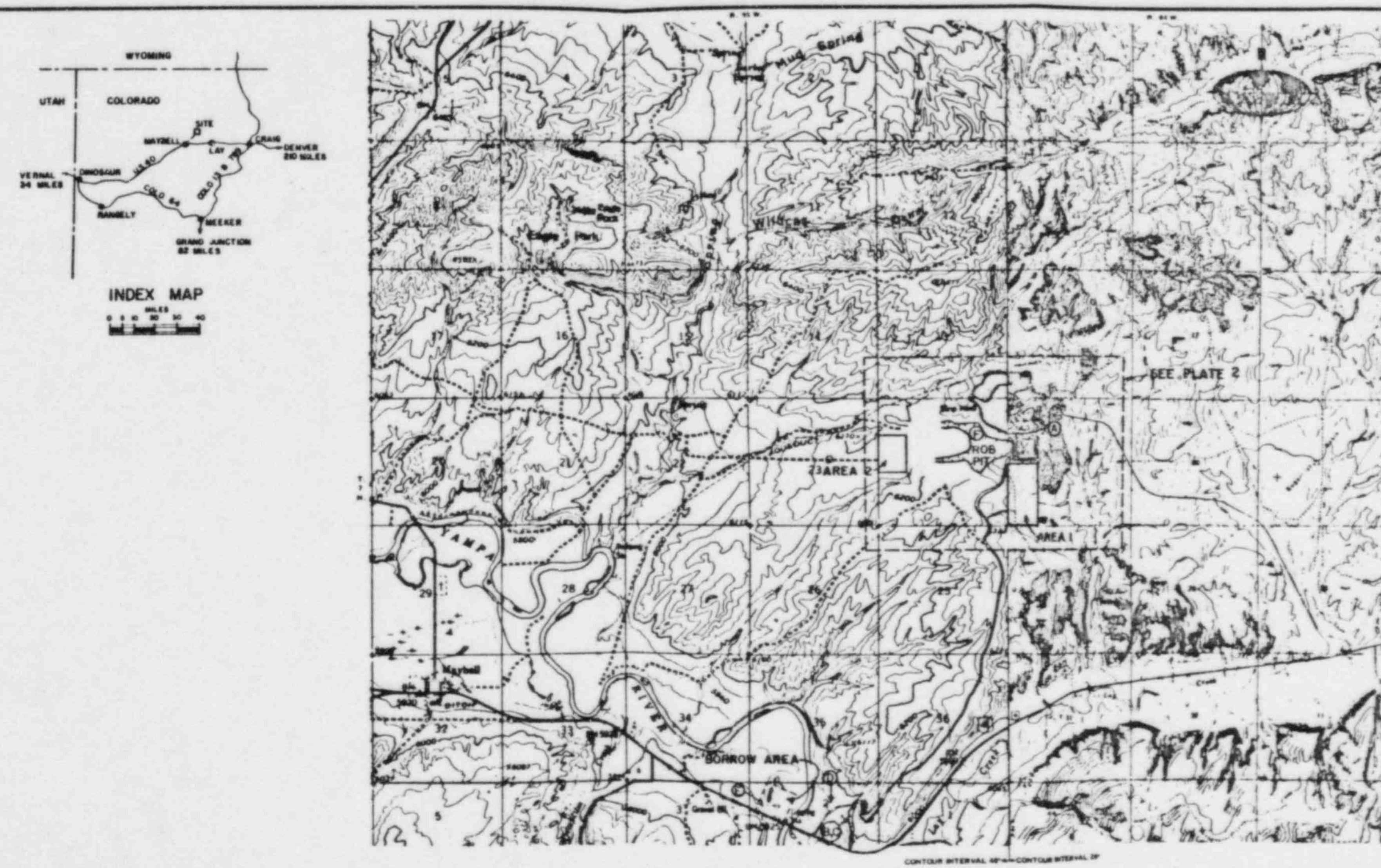
PLATE 3



PLOT PLAN-LEACH HEAP AREAS

DAMES & MOORE

PLATE 2



VICINITY MAP

KEY

Ⓐ SURFACE SAMPLE LOCATION

REFERENCE: U.S.G.S. QUADRANGLES
"MAYBELL, COLO." AND "LAY, COLO."

SCALE IN FEET

2000 0 2000 4000

PLATE 1