# REPORT ON
# WELL CONSTRUCTION PROGRAM
# MANY GLACIER AREA
# GLACIER NATIONAL PARK, MONTANA

JUNE 5, 1978 - JULY 15, 1978

SUBMITTED TO:
NATIONAL PARK SERVICE
DENVER SERVICE CENTER
LAKEWOOD, COLORADO 80215

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July 31, 1978
Project # 7M099.104B

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LIST OF EXHIBITS

## INTRODUCTION

The main purpose of this report is to present all information obtained in the Many Glacier Drilling Program in the Many Glacier Area of Glacier National Park for the National Park Service (NPS). The NPS retained HKM to supervise the drilling of test holes and the drilling, construction and development of production water supply wells for the Many Glacier area. Billmayer's Water Supply of Kallispell, Montana were retained by HKM as subcontractor to perform all water well related work.

The test hole drilling and well construction phase of the program was initiated June 5, 1978 and completed July 15, 1978. All data obtained in the above program is presented in Exhibits I through VI at the end of this report.

In addition to the above, this report presents the results of the field investigation of the spring serving as the Glacier Park, Inc. caretaker's residence water supply source. The field investigation was performed May 3, 1978 and consisted of locating and inspecting the spring box which provides water for the caretaker's residence.

## DESCRIPTION OF WELL CONSTRUCTION PROGRAM

The well construction program was initiated with a test hole at the site of production well #1 near the caretaker's residence immediately north of Swiftcurrent Lake (Exhibit I). Results of the testhole indicated potential turbidity problems with a production well at this location. Preliminary testing with the drill rig produced a measured flow of 90 gpm from the test well. After consultation with Park personnel it was decided to attempt a test hole at location #2 before either abandoning the first location, or completing a production well and taking special measures to overcome the potential turbidity problem.

A test hole was drilled at location #2 near the boat concessionaire's facility near the southeast edge of Swiftcurrent Lake (Exhibit I).

The test hole was drilled to a total depth of 80 feet at this location but abandoned and backfilled after testing indicated potential production to be less than one gpm. Exhibit II contains all pertinent data regarding this test hole.

A test hole was then drilled at the third location for a production well to serve the horse concessionaire facility and Many Glacier's waste water disposal system water quality laboratory (Exhibit I). The test hole at this location was converted to a 6-inch production well (Production Well #4) after testing indicated production capability in excess of 50 gpm and it was determined that a 6-inch I.D. well would be of adequate size to serve the previously mentioned facilities. Exhibit II contains pertinent data regarding production well #4.

A test hole was drilled at the fourth location inside the Many Glacier Administrative area near Swiftcurrent Campground. Data from the test hole indicated the aquifer at this location to be less than 27 feet thick and the water table to be 8 feet from the land surface. This location was abandoned and backfilled due to the shallow water table and the thinness of the aquifer that would supply a production well. Exhibit II contains pertinent data regarding Test Hole #3.

A fifth test hole was drilled and tested immediately inside Swiftcurrent Campground (Exhibit 1). Data obtained from the test hole was used to design an 8-inch I.D. production well (Production Well #3A) which was subsequently drilled, developed, and tested at this site. Exhibit II contains pertinent data regarding production Well #3A.

The last well completed in the program was production well #1. A 6-inch production well was designed to minimize the previously mentioned potential turbidity problems at this location and subsequently constructed. Data obtained during the drilling and the testing of the test hole indicated that maximum yield of a well at this location should be kept between 50 and 90 gpm to minimize potential turbidity problems. It was decided therefore to construct and develop a 6-inch production well to minimize monetary loss should design and development fail to result in a well capable of producing turbidity free water. Testing after the well was completed and developed indicated that the well was capable of producing in excess of 150 gpm without turbidity problems. Exhibit II contains pertinent data regarding production well #1.

## RESULTS OF TEST PUMPING

An extended pump test was performed on each of the production wells (production wells #1, #3A, #4). Purposes were to further develop the wells and to determine drawdown in the wells at design flows. Drawdown and recovery data obtained in each of the pump tests were also used to estimate the transmissivity of the aquifer penetrated by each of the wells.

### Pump Test-Production Well #1

Production well #1 was pumped approximately 21.5 hours at 90 gpm July 14 and 15, 1978. Drawdown at the end of the test was 1.34 feet. Specific capacity of the well (yield of the well in gpm per foot of drawdown) as indicated by the 21.5 hour test was approximately 61 gpm/ft. Maximum capacity of the well whereby entrance velocity to the well screen would be 0.1 ft/sec. would be approximately 160 gpm. Data collected during the pump tests on Production Well #1 indicated a transmissivity (rate of flow through a vertical section of an aquifer whose height is the thickness of the aquifer and whose width is one foot when the hydraulic gradient is 1.00) for the aquifer supplying this well to be approximately 66,000 gpd/ft. Exhibit III presents field data obtained during the pump test performed on production well #1.

### Pump Test Production Well #3A

Production Well #3A was pumped at a continuous rate of 150 gpm for 23.8 hours July 11 and 12, 1978. Drawdown at the end of the test was 0.79 feet. Specific capacity of the well as indicated by the 23.8 hour test was approximately 190 gpm/ft. Maximum capacity of the well whereby entrance velocity to the well screen would be 0.1 ft/sec. would be about 609 gpm. Data collected during the pump test on production well #3A indicated a transmissivity for the aquifer supplying this well of about 246,400 gpd/ft. exhibit IV presents field data obtained in the pump test performed on production well 3A.

Pump Test Production Well #4

Production well #4 was pumped continuously for 25.3 hours July 11 and 12, 1978. Drawdown at the end of the test was 7.12 feet. Specific capacity of the well as indicated by the 25.3 hour test was approximately 7.02 gpm/ft. Maximum capacity of the well whereby entrance velocity to the well screen would be 0.1 ft/sec. would be approximately 180 gpm. Data collected during the pump test on production well #4 indicated a transmissivity for the aquifer supplying this well of about 14,300 gpd/ft. Exhibit V presents field data obtained in the pump test performed on production well #4.

WATER QUALITY

One water quality sample was taken from each production well near the end of the extended pumping tests. Analyses were performed by Resource Consultants of Billings, Montana according to methods set forth in the Standard methods for the Examination of Water and Wastewater, Fourteenth Edition, published by the American Health Association.

Results of the analyses (Exhibit VI) indicated water from all the wells to be a similar very high quality mixed calcium, magnesium, chloride sulfate type water. Total dissolved solids content ranged from 65 to 69 mg/l and total hardness as calcium carbonate averaged 68 mg/l. Results of water quality analyses indicated water from all three production wells to be within all the Primary Drinking Water Standards and the recommended limits of the Secondary Drinking Water Regulations of the Environmental Protection Agency.

Production Wells #1 and #4 might initially produce a slug of turbid water for a period of 1 to 2 seconds every time the well pumps cycle on. The cause is believed to be colloidal material from the fine glacial silts present in the formations tapped by these wells. It is recommended that all the production wells be pumped to waste for a period of two to four hours at the beginning of each season before being placed on line.

## GLACIER PARK INC. CARETAKER'S RESIDENCE WATER SYSTEM

The water supply source consists of a spring collection box and collector located immediately adjacent to a small creek, approximately 400 feet north of the caretaker's residence. The collection system is estimated to be at an elevation of 50 to 60 feet above the caretaker's residence. The collection system is located immediately adjacent to the previously mentioned creek and consists in part of a concrete collection box with a 4" overflow and 4" collector. The collector (length and material unknown) runs up the bottom of the creek at an estimated depth of 1.0 feet. The collector box does not have a water tight cover and evidently has not been serviced for at least the last 5 years as the existing caretaker, Don Hall, did not know the location of the system until this investigation. Untreated water is provided to the caretaker's residence through a 1¼ inch screened Tee collector with a 1¼ inch gate valve located in the collector box. Water is conveyed by gravity to the residence by 1¼ inch galvanized steel pipe. Exhibit VII shows details of the spring collector box as determined in the May 3, 1978 field investigation.

### Conclusions

Except for the deteriorating cover, the collection system was observed to be in good condition. Due to the collector's shallow depth of burial and its location with respect to the small stream, the source should be considered as being surface water of the stream.

Although no water quality problems have been experienced in the past by the caretaker, it is recommended that the caretaker's residence be included on the new Many Glacier Water System. It is also recommended that consideration be given to keeping the existing spring system as an emergency system for the caretaker's residence provided the system is furnished with a means of disinfection.

EXHIBIT I

VICINITY MAP

SHOWING APPROXIMATE LOCATION OF

MANY GLACIER DRILLING PROGRAM

TEST HOLES AND PRODUCTION WELLS

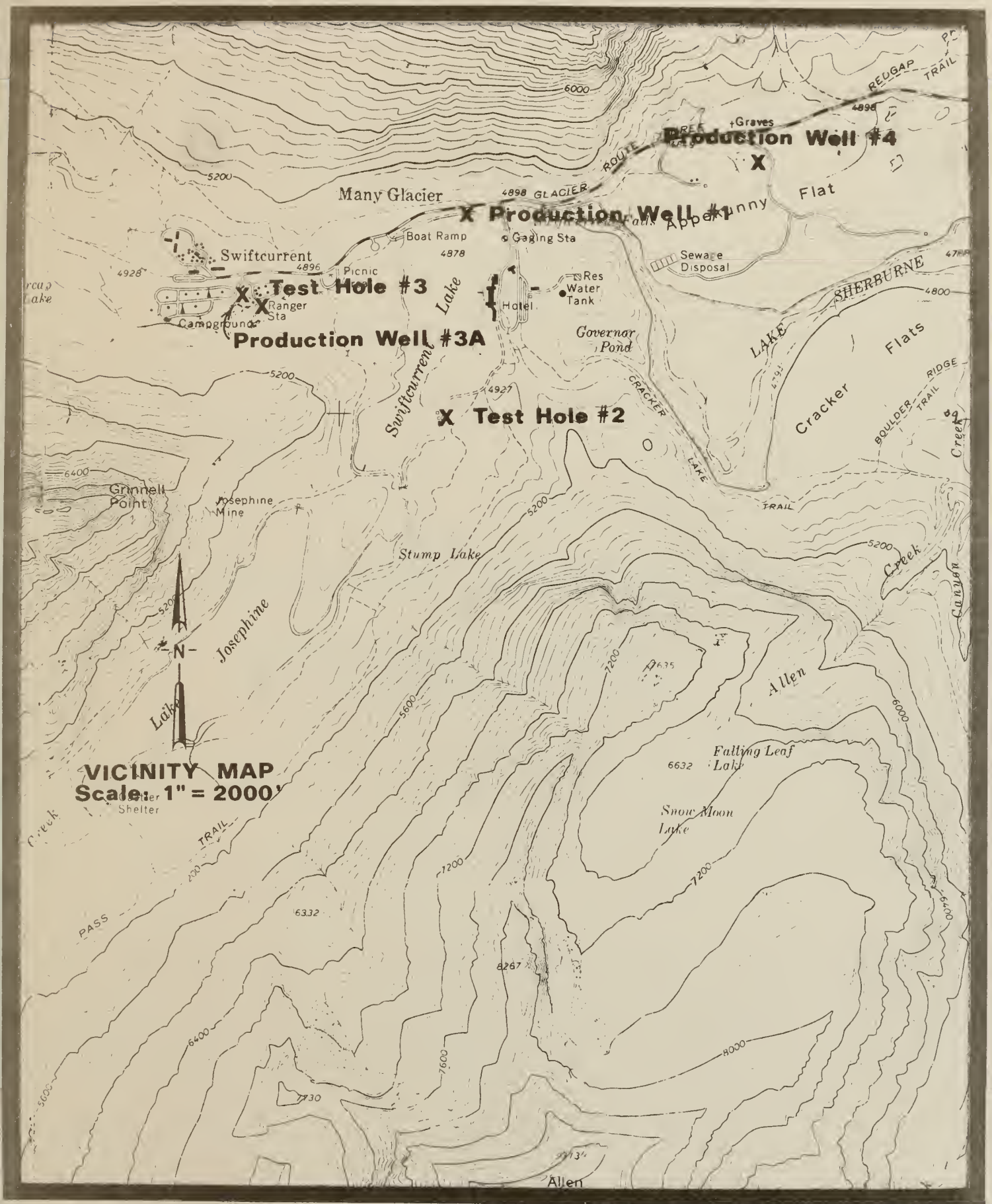



EXHIBIT 1: VICINITY MAP SHOWING APPROXIMATE LOCATION OF MANY GLACIER DRILLING PROGRAM TEST HOLES AND PRODUCTION WELLS

# EXHIBIT II

# LITHOLOGIC LOGS AND COMPLETION RECORDS

# OF

# TEST HOLES AND WELLS CONSTRUCTED

# JUNE 5, 1978 THROUGH JULY 15, 1978

PRODUCTION WELL #1 - CARETAKER' RESIDENCE AREA PRODUCTION WELL

Surface elevation: ±4885 feet

Approximate Location: Latitude 48°47'49", Longitude 113°38'41" (unsurveyed).

Top of casing above landsurface: 2.3 ft.

Date of Construction: July 9, 1978 through July 13, 1978

Well Depth: 61.2 feet

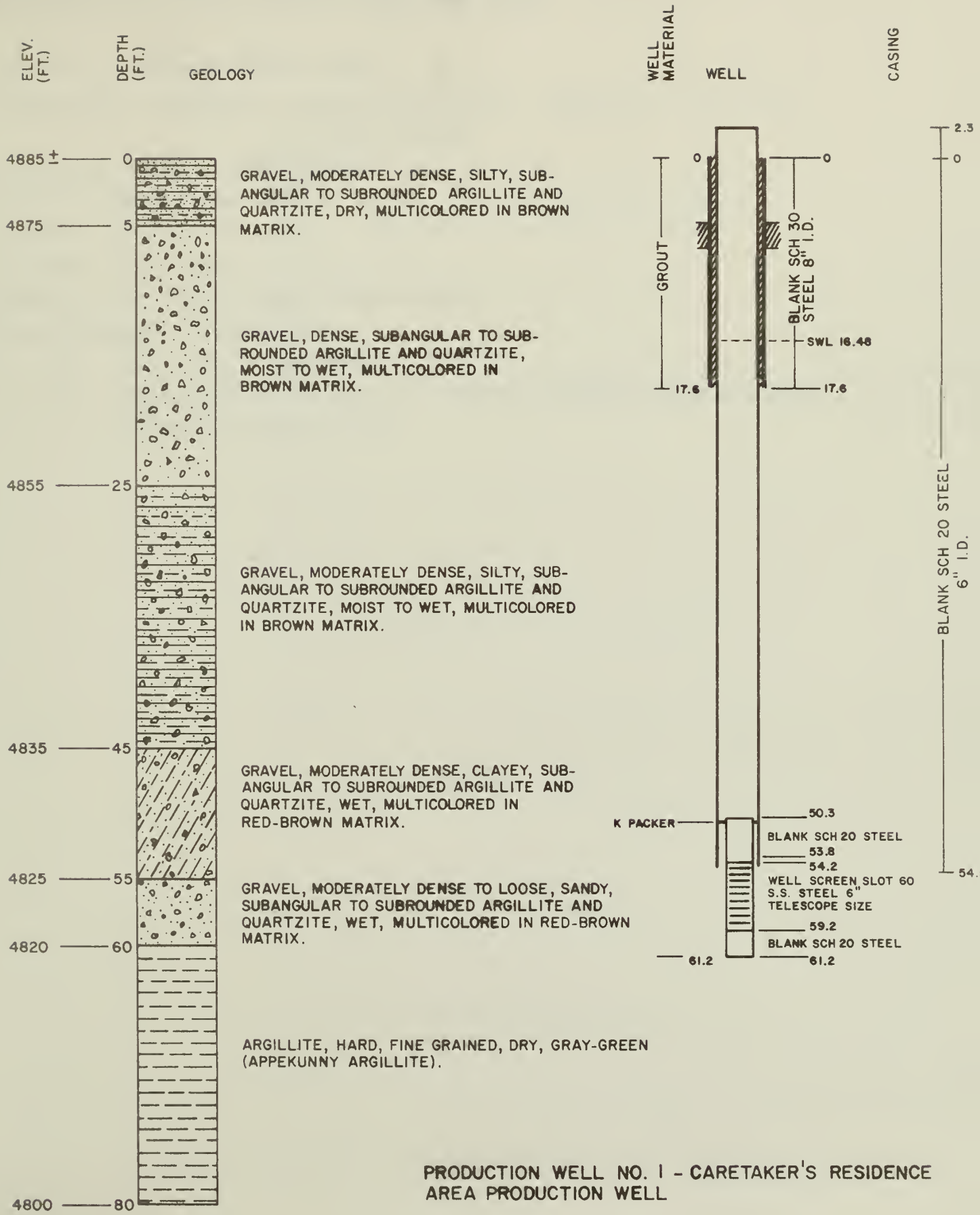
Aquifer: Gravel

Elevation at Total Depth: ±4823.8 feet

Casing size: 6 inches ID

Miscellaneous Well Information:

- Well developed by surging with air for 21 hours.
- 10 HP submersible pump set approximately 48 feet from top of casing for test pumping.
- Well pumped 21.45 hours at constant rate of 90 gpm. Drawdown at end of test at pumping rate of 90 gpm was 1.34 feet.
- Test pumped 50 minutes at constant rate of 150 gpm. Drawdown at end of test at pumping rate of 150 gpm was 2.98 feet.
- Design capacity of 5 feet, 6 inch telescope size, slot 60 stainless steel well screen, is approximately 164 gpm.
- Production well #1 drilled by Air Rotary Method (Ingersol Rand TH-60 Top Head Drive).



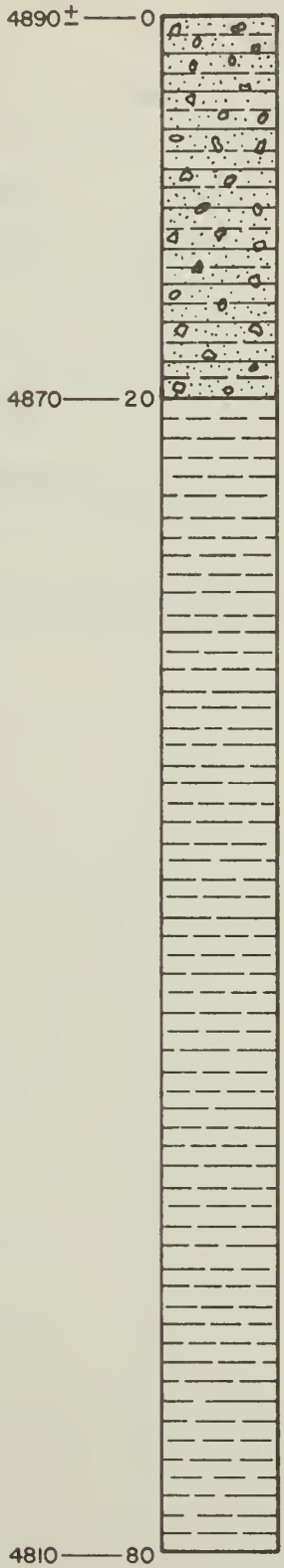

PRODUCTION WELL NO. 1 - CARETAKER'S RESIDENCE AREA PRODUCTION WELL

TEST HOLE #2 - MANY GLACIER AREA TEST HOLE

Surface elevation: ±4890 feet.
Approximate Location: Latitude 48°47'30", Longitude 118°38'44"
(unsurveyed)
Measuring Point: Landsurface
Date of completion: June 7, 1978
Test Hole Depth: 80 feet.
Aquifer: Dry hole
Elevation at Total Depth: ±4810 feet
Miscellaneous Information:

- Dry hole - abandoned.
- Test hole drilled by Air Rotary Method (Ingersol Rand TH-60 Top Head Drive).

TEST HOLE NO. 2 - MANY GLACIER HOTEL AREA TEST HOLE




GRAVEL, DENSE, SILTY, CLAYEY, SUBANGULAR TO SUBROUNDED ARGILLITE AND QUARTZITE, DRY TO SLIGHTLY MOIST, MULTICOLORED IN BROWN MATRIX.

ARGILLITE, HARD, UNIFORMLY FINE GRAINED, DRY, GRAY-GREEN TO GREEN (APPEKUNNY ARGILLITE).

TEST HOLE #3 MANY GLACIER ADMINSTRATIVE AREA TEST HOLE

Surface elevation: ±4910 feet.

Approximate Location: Latitude 48°47'34", Longitude 113°39'10"
(Unsurveyed)

Measuring Point: Landsurface

Date of Completion: June 16, 1978

Test Hole Depth: 53 feet.

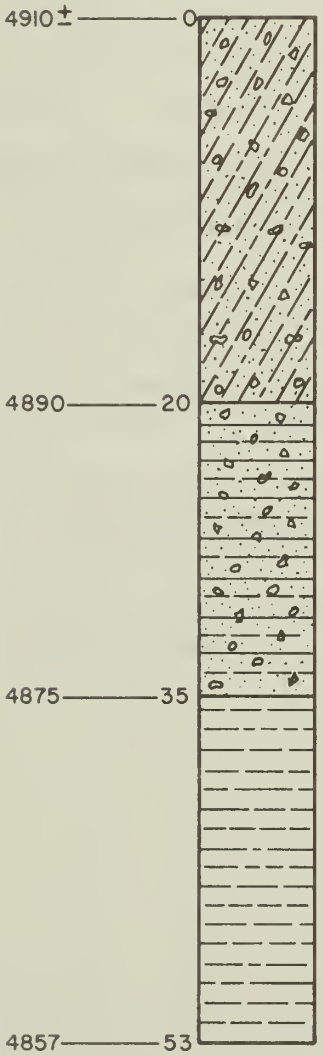
Aquifer: Sand and Gravel

Elevation at Total Depth: ±4857 feet

Miscellaneous Information:

- Test well produced between 60 and 80 gpm.
- Abandoned location because static water level was only 8 feet from land surface
- Test well drilled by Air Rotary Method (Ingersol Rand TH-60, Top head drive).

# TEST HOLE NO. 3 - MANY GLACIER ADMINISTRATIVE AREA




GRAVEL, MODERATELY DENSE, SILTY, CLAYEY, SUBANGULAR TO SUBROUNDED ARGILLITE, MOIST TO WET, MULTICOLORED IN RED-BROWN MATRIX.

GRAVEL, MODERATELY DENSE, SILTY, SANDY, SUBANGULAR TO SUBROUNDED ARGILLITE, WET, RED AND GREEN IN RED-BROWN MATRIX.

ARGILLITE, HARD, FINE GRAINED, DRY, GREEN (APPEKUNNY ARGILLITE).

PRODUCTION WELL 3A - SWIFTCURRENT CAMPGROUND PRODUCTION WELL

Surface Elevation: ±4910 feet.

Approximate location: Latitude 48°47'41", Longitude 113°39'12" (unsurveyed)

Top of casing above landsurface: 2.35 Feet

Date of Construction: June 20, 1978 through July 6, 1978

Well depth: 67.7 feet

Aquifer: Sandy gravel

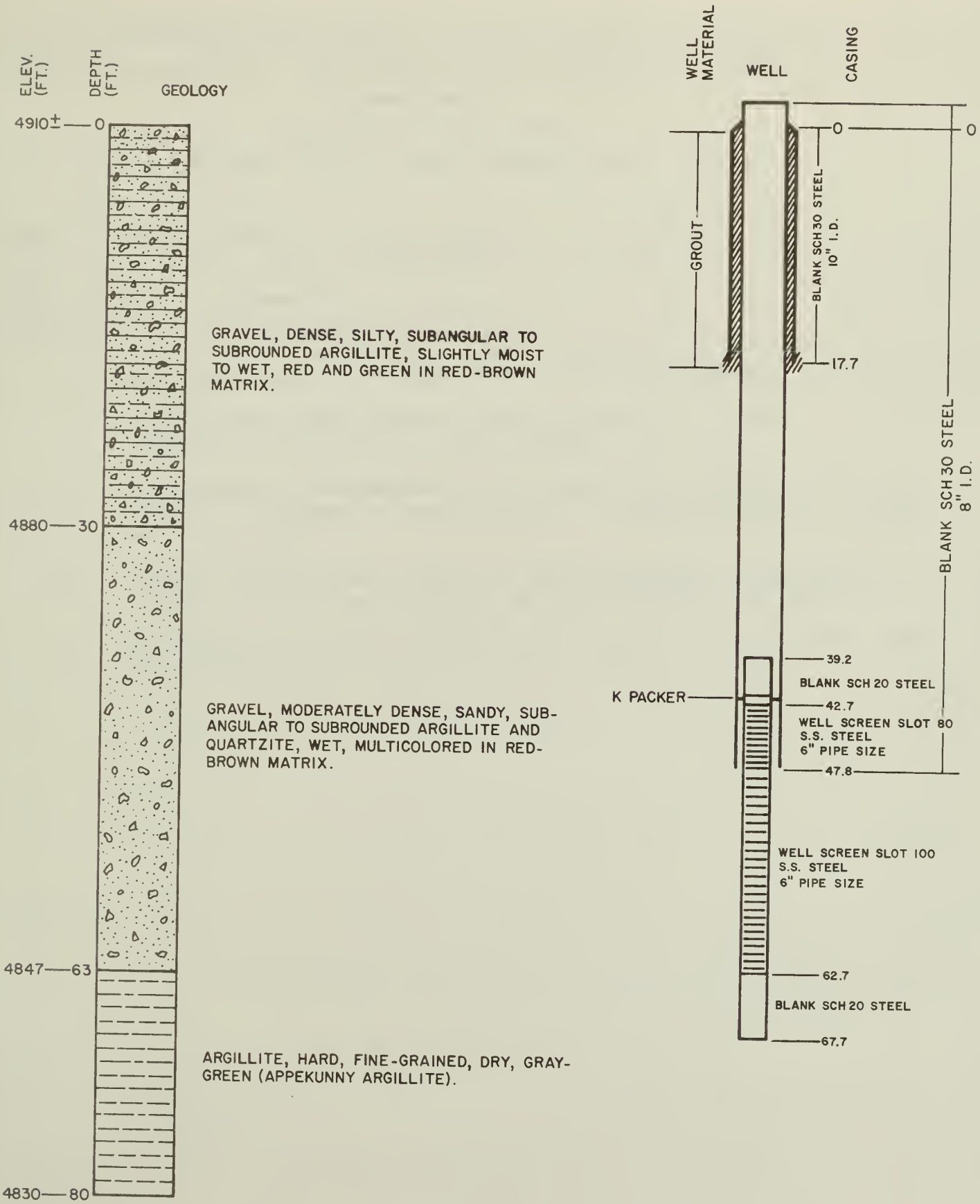
Elevation at total depth: ±4842.3 feet

Casing size: 8 inches ID

Miscellaneous well information:

- Well developed with Air for 19 hours.
- 10 HP submersible pump set approximately 37.33 feet from top of casing for test pumping.
- Well pumped approximately 23.8 hours at constant rate of 150 gpm; Drawdown was 0.79 feet.
- Design capacity of 15 feet, 6 inch pipe size, slot 100 and 5 feet, 6 inch pipe size, slot 80 stainless steel well screen is between 600 and 800 gpm.
- Well drilled by Air Rotary Method (Ingersol Rand TH-60, Top head drive).

# PRODUCTION WELL NO. 3A - SWIFTCURRENT CAMPGROUND PRODUCTION WELL



PRODUCTION WELL #4 - HORSE CONCESSIONAIRE WELL

Surface elevation: ±4881 feet.

Approximate location: Latitude 48°47'54", Longitude 113°38'
(unsurveyed)

Top of casing above landsurface: 1.42 feet.

Date of construction: July 9, 1978 through July 13, 1978.

Well depth: 61 feet.

Aquifer: Sandy gravel

Elevation at total depth: ±4820 feet.

Casing size: 6 inches ID

Miscellaneous well information:

- Well developed by surging with air for 13 hours.
- 10 HP submersible pump set approximately 48 feet from top of casing for test pumping.
- Test pumped approximately 25.3 hours at a constant rate of 50 gpm. Drawdown at end of test at pumping rate of 50 gpm was 7.12 feet.
- Design capacity of 5 feet, 6 inch telescope size, slot 80 stainless steel well screen is approximately 187 gpm.
- Well drilled by Air Rotary Method (Ingersol Rand TH-60, Top head drive).

PRODUCTION WELL NO. 4 - HORSE CONCESSIONAIRE PRODUCTION WELL

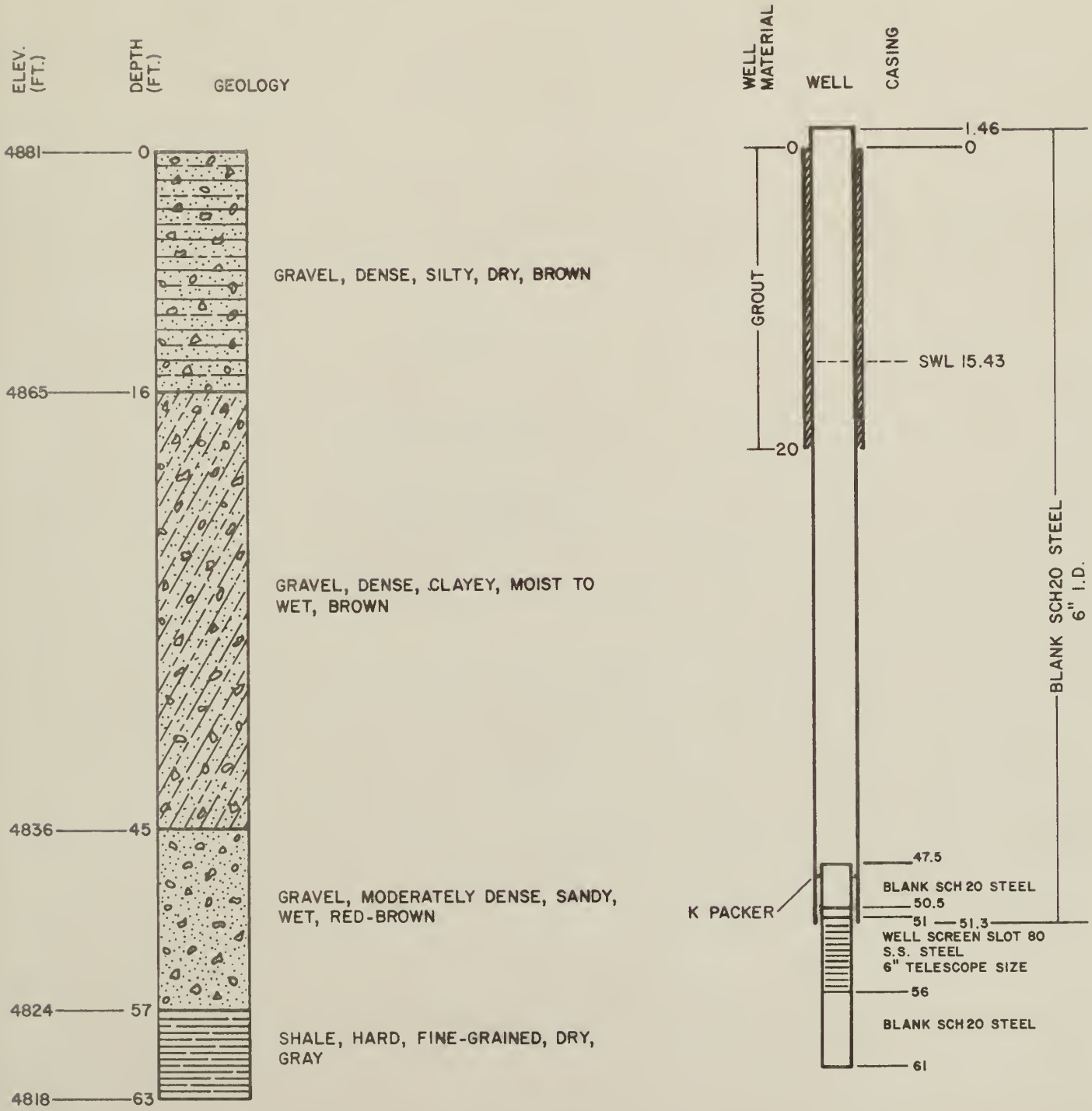


EXHIBIT III

PRODUCTION WELL #1

PUMP TEST DATA

EXHIBIT III-A

SUMMARY OF FIELD DATA

PRODUCTION WELL #1

EXHIBIT III - A.1

## GENERAL INFORMATION PRODUCTION WELL #1

### PRODUCTION WELL #1

Casing diameter = 6 in. (I.D.)
Casing above landsurface = 2.3 ft.
Total depth = 61.2 ft.
Static water level = 16.48 ft.

### FLOW MEASUREMENT

Flow measured with 55 gallon barrel and stopwatch
Average flow during 21.45 hour test = 90 gpm.
Average flow during 50 minute test = 150 gpm.

### DURATION OF TEST

Pumped 21.45 hours (5:17 PM 7/14/78 - 2:47 PM 7/15/78)
Recovery 1.3 hours (2:47 PM 7/15/78 - 4:05 PM 7/15/78)
Pumped 50 minutes (4:10 PM 7/15/78 - 5:00 PM 7/15/78)

### FIELD PARTY

J. R. McGill HKM Associates
D. Billmayer Billmayer Water Supply Co.

EXHIBIT III - A.2
PRODUCTION WELL #1
DRAWDOWN WATER LEVEL MEASUREMENTS
FOR 21.45 HOUR TEST

| TIME | DEPTH TO WATER (FEET) | REMARKS |
|---|---|---|
| 7/14/78 | | |
| 5:17 PM | 6.48 | Static water level |
| 5:18 | ---- | Pump on at 5:18 PM |
| 5:19 | 18.15 | |
| 5:21 | 17.94 | |
| 5:22 | 17.90 | |
| 5:23 | 17.93 | |
| 5:24 | 17.95 | |
| 5:26 | 17.94 | |
| 5:27 | 17.98 | |
| 5:28 | 17.94 | All water level measurements |
| 5:29 | 17.94 | made from top of casing |
| 5:30 | 17.94 | |
| 5:35 | 17.93 | |
| 5:40 | 17.95 | |
| 5:45 | 17.96 | |
| 5:50 | 17.93 | |
| 5:55 | 17.96 | Average Flow = 90 gpm |
| 6:00 | 17.93 | |
| 6:05 | 17.97 | |
| 6:10 | 17.96 | |
| 6:15 | 17.93 | |
| 6:25 | 17.93 | |
| 6:30 | 17.94 | |
| 7:00 | 17.86 | |
| 7:30 | 17.89 | |
| 8:00 | 17.86 | |
| 8:30 | 17.85 | |
| 9:00 | 17.88 | |
| 9:30 | 17.96 | |
| 10:00 | 17.96 | |
| 11:00PM | 17.96 | |
| 7/15/78 | | |
| 12:00AM | 17.96 | |
| 1:00 | 17.96 | |
| 2:00 | 17.94 | |
| 3:00 | 17.92 | |
| 4:00 | 17.91 | |
| 5:00 | 17.90 | |
| 6:00 | 17.89 | |
| 7:00 | 17.88 | |
| 8:00 | 18.03 | Sampled for water quality at |
| 9:00 | 18.04 | 8:27 AM 7/15/78. Field temperature |
| 10:00 | 17.83 | =6°C and Field Conductance = |
| 11:00 AM | 17.81 | 95 micromhos/cm at 25°C. |
| 12:00 PM | 17.85 | |
| 1:00 | 18.03 | |
| 2:00 | 17.80 | |
| 2:45 | 17.82 | |
| 2:47 PM | 17.82 | Pump off at 2:47 PM 7/15/78 |

Note: Pump set approximately 48 feet from top of casing for test.

EXHIBIT III A.3
PRODUCTION WELL #1
RECOVERY WATER LEVEL MEASUREMENTS
FOR 21.45 HOUR TEST

| TIME | DEPTH TO WATER (FEET) | REMARKS |
|---|---|---|
| 7/15/78 | | |
| 2:45 PM | 17.82 | Pumping level before pump OFF |
| 2:47 | ----- | Pump off at 2:47 PM. |
| 2:48.5 | 16.43 | |
| 2:49 | 16.35 | |
| 2:50 | 16.36 | |
| 2:50.5 | 16.40 | |
| 2:51 | 16.40 | |
| 2:52 | 16.40 | |
| 2:53 | 16.41 | |
| 2:54 | 16.40 | |
| 2:55 | 16.38 | |
| 2:56 | 16.41 | |
| 2:58 | 16.40 | |
| 3:00 | 16.41 | All water level measurements |
| 3:05 | 16.41 | made from top of casing. |
| 3:10 | 16.41 | |
| 3:12 | 16.41 | |
| 3:20 | 16.41 | |
| 3:25 | 16.41 | |
| 3:30 | 16.41 | |
| 3:40 | 16.41 | |
| 3:45 | 16.38 | |
| 3:50 | 16.39 | |
| 3:55 | 16.39 | |
| 4:00 | 16.39 | |
| 4:05 PM | 16.39 | End recovery test |

EXHIBIT III - A.4
PRODUCTION WELL #1
DRAWDOWN WATER LEVEL MEASUREMENTS
FOR 50 MINUTE TEST

| TIME | DEPTH OF WATER (FEET) | REMARKS |
|---|---|---|
| 7/15/78 | | |
| 4:05 PM | 16.48 | Static water level |
| 4:10 | --- | Pump on at 4:10 PM |
| 4:10.5 | 18.79 | |
| 4:11 | 18.81 | All water level measurements |
| 4:12 | 19.09 | Made from top of casing |
| 4:13 | 19.24 | |
| 4:14 | 19.34 | |
| 4:15 | 19.38 | |
| 4:17 | 19.40 | Average flow = 150 gpm |
| 4:18 | 19.39 | |
| 4:20 | 19.39 | |
| 4:25 | 19.38 | |
| 4:30 | 19.40 | |
| 4:35 | 19.39 | |
| 4:42 | 19.40 | |
| 4:45 | 19.38 | |
| 4:50 | 19.38 | |
| 4:55 | 19.36 | |
| 5:00 PM | 19.37 | Pump off at 5:00 PM. |

EXHIBIT IV

PRODUCTION WELL # 3A

PUMP TEST DATA

EXHIBIT IV-A

SUMMARY OF FIELD DATA

PRODUCTION WELL # 3A

EXHIBIT IV-A.1

GENERAL INFORMATION PRODUCTION WELL #3A

PRODUCTION WELL #3A

Casing Diameter = 8 In. (ID)
Casing above land surface = 2.35 ft.
Total depth = 67.7 ft.
Static water level = 19.71 ft.

FLOW MEASUREMENT

Flow measured with 55 gallon drum and stopwatch.
Average flow during test = 150 gpm.

DURATION OF TEST

Pumped 23.82 hours (6:39 PM 7/11/78 - 10:03 PM 7/12/78)
Recovery 5.75 hours (10:03 AM 7/12/78 - 4:28 PM 7/12/78)

FIELD PARTY

J. R. McGill HKM Associates
D. Billmayer Billmayer Water Supply Co.

EXHIBIT IV-A.2
PRODUCTION WELL #3A
DRAWDOWN WATER LEVEL MEASUREMENTS

| TIME | DEPTH WATER (FEET) | REMARKS |
|---|---|---|
| 7/11/78 | | |
| 9:00 AM | 19.71 | Static water level |
| 9:45 | 19.71 | Static water level |
| 9:47 | 20.29 | Pump on at 9:46 AM |
| 9:48 | 20.29 | |
| 9:49 | 20.29 | |
| 9:50 | 20.44 | |
| 9:52 | 20.52 | |
| 9:53 | 20.47 | |
| 9:54 | 20.63 | All water level measurements |
| 9:54.5 | 20.49 | made from top of casing |
| 9:55 | 20.56 | |
| 9:56 | 20.52 | |
| 9:57 | 20.52 | |
| 9:58 | 20.50 | |
| 9:59 | 20.50 | |
| 10:00 | 20.52 | |
| 10:05 | 20.54 | |
| 10:10 | 20.56 | Average Flow = 150 gpm. |
| 10:15 | 20.55 | |
| 10:20 | 20.54 | |
| 10:25 | 20.53 | |
| 10:30 | 20.54 | |
| 10:35 | 20.53 | |
| 10:40 | 20.53 | |
| 10:45 | 20.54 | |
| 10:50 | 20.54 | |
| 10:55 | 20.54 | |
| 11:00 | 20.54 | |
| 11:15 | 20.54 | |
| 11:30 | 20.54 | |
| 11:45 AM | 20.54 | |
| 12:00 PM | 20.54 | |
| 12:15 | 20.54 | |
| 12:30 | 20.54 | |
| 12:45 | 20.54 | |
| 1:00 | 20.54 | |
| 1:30 | 20.54 | |
| 2:00 | 20.54 | |
| 2:30 | 20.54 | |
| 3:00 | 20.48 | |
| 3:30 | 20.57 | |
| 4:00 | 20.55 | |
| 4:30 | 20.54 | |
| 5:00 | 20.56 | |
| 6:00 | 20.52 | |
| 7:05 | 20.54 | |
| 8:00 | 20.54 | |
| 9:00 | 20.50 | |
| 10:00 PM | 20.50 | |

EXHIBIT IV-A.2 (Cont.)

| TIME | DEPTH TO WATER (FEET) | REMARKS |
|---|---|---|
| 7/12/78 | | |
| 11:00 PM | 20.50 | |
| 12:00 AM | 20.50 | |
| 1:00 | 20.50 | |
| 2:00 | 20.49 | |
| 3:00 | 20.48 | |
| 4:00 | 20.49 | |
| 4:25 | 20.49 | |
| 5:30 | 20.48 | |
| 6:00 | 20.47 | |
| 6:30 | 20.47 | Sampled for water quality at |
| 7:30 | 20.47 | 9:30 AM 7/12/78. Field tempera- |
| 8:05 | 20.50 | ture = 5°C and field conductance |
| 9:00 | 20.50 | =125 micromhos/cm at 25°C. |
| 10:02 AM | 20.50 | Pump off at 10:03 AM 7/12/78 |

Note: Pump set approximately 39.25 feet from top of casing for test.

EXHIBIT IV-A.3

PRODUCTION WELL #3A RECOVERY WATER LEVEL MEASUREMENTS

| TIME | DEPTH TO WATER (FEET) | REMARKS |
|---|---|---|
| 7/12/78 | | |
| 10:02 AM | 20.50 | Pumping level before pump off |
| 10:03 | --- | Pump Off at 10:03 A.M. |
| 10:04 | 19.90 | |
| 10:05 | 19.71 | |
| 10:06 | 19.73 | |
| 10:07 | 19.73 | |
| 10:08 | 19.69 | |
| 10:09 | 19.69 | |
| 10:10 | 19.68 | All water level measurements |
| 10:11 | 19.67 | made from top of casing |
| 10:12 | 19.67 | |
| 10:13 | 19.66 | |
| 10:14 | 19.66 | |
| 10:16 | 19.66 | |
| 10:20 | 19.65 | |
| 10:25 | 19.60 | |
| 10:35 | 19.58 | |
| 10:40 | 19.59 | |
| 10:45 | 19.58 | |
| 10:50 | 19.58 | |
| 10:55 | 19.58 | |
| 11:00 | 19.58 | |
| 11:05 | 19.58 | |
| 11:10 | 19.57 | |
| 11:15 | 19.57 | |
| 11:20 | 19.61 | |
| 11:40 AM | 19.64 | End recovery test |

EXHIBIT V

PRODUCTION WELL #4

PUMP TEST DATA

EXHIBIT V-A

SUMMARY OF FIELD DATA

PRODUCTION WELL #4

EXHIBIT V- A.1

GENERAL INFORMATION PRODUCTION WELL #4

PRODUCTION WELL #4

Casing Diameter = 6 In. (ID)

Casing above land surface = 1.42 ft.

Total Depth = 61 Ft.

Static Water level = 15.43 ft.

FLOW MEASUREMENT

Flow measured with 55 gallon barrel and stopwatch.

Average flow during test = 50 gpm.

DURATION OF TEST

Pumped 25.27 Hours (1:07 PM 7/12/78 - 2:23 PM 7/13/78)

Recovery 9.35 Hours (2:23 PM 7/13/78 - 6:05 PM 7/13/78)

FIELD PARTY

| | |
|---|---|
| J. R. Mc Gill | HKM Associates |
| D. Billmayer | Billmayer Water Supply Co. |

EXHIBIT V-A.2
PRODUCTION WELL #4
DRAWDOWN WATER LEVEL MEASUREMENTS

| TIME | DEPTH TO WATER (FEET) | REMARKS |
|---|---|---|
| 7/12/78 | | |
| 1:05 PM | 15.43 | Static water level |
| 1:07 | --- | Pump on at 1:07 PM |
| 1:08 | 21.17 | |
| 1:09 | 20.83 | |
| 1:10 | 21.17 | |
| 1:11 | 21.20 | |
| 1:12 | 21.42 | |
| 1:13 | 21.51 | All water level measurements |
| 1:14 | 21.59 | made from top of casing |
| 1:15 | 21.60 | |
| 1:16 | 21.72 | |
| 1:17 | 21.73 | |
| 1:19 | 21.80 | |
| 1:20 | 21.85 | |
| 1:25 | 21.89 | |
| 1:30 | 22.22 | Average Flow = 50 gpm. |
| 1:36 | 22.07 | |
| 1:37 | 22.21 | |
| 1:40 | 22.08 | |
| 1:45 | 21.96 | |
| 1:50 | 22.10 | |
| 1:55 | 22.16 | |
| 2:00 | 22.35 | |
| 2:15 | 22.51 | |
| 2:20 | 22.60 | |
| 2:30 | 22.54 | |
| 2:45 | 22.59 | |
| 3:00 | 22.50 | |
| 3:14 | 23.05 | |
| 3:20 | 21.98 | |
| 3:25 | 22.35 | |
| 3:33 | 22.37 | |
| 3:43 | 22.40 | |
| 3:58 | 22.34 | |
| 4:04 | 22.38 | |
| 4:38 | 22.40 | |
| 5:00 PM | 22.38 | |

EXHIBIT V-A.2 (Cont.)

| TIME | DEPTH TO WATER (FEET) | REMARKS |
|---|---|---|
| 5:30PM | 21.97 | |
| 6:00 | 22.00 | |
| 6:30 | 22.27 | |
| 7:04 | 22.44 | |
| 7:35 | 22.45 | |
| 8:00 | 22.48 | |
| 9:00 | 22.45 | |
| 10:00 | 22.50 | |
| 11:00 PM | 22.54 | |
| 7/13/78 | | |
| 12:00 AM | 22.54 | |
| 1:00 PM | 22.52 | |
| 2:00 | 22.52 | |
| 3:00 | 22.52 | |
| 4:00 | 22.54 | |
| 5:00 | 22.56 | |
| 6:00 | 22.60 | |
| 7:00 | 22.58 | Sampled for water quality at 1:38 PM |
| 7:25 | 22.54 | 7/13/78. Field temperature = 6°C |
| 8:00 | 22.54 | and field conductance = 125 |
| 9:35 | 22.57 | micromhos/cm at 25°C |
| 10:30 | 22.40 | |
| 12:45 | 22.52 | |
| 1:30 | 22.55 | |
| 2:23 PM | 22.53 | Pump off at 2:23 PM 7/13/78 |

Note: Pump set approximately 48 feet from top of casing for test.

EXHIBIT V A.3
PRODUCTION WELL #4
RECOVERY WATER LEVEL MEASUREMENTS

| TIME | DEPTH TO WATER (FEET) | REMARKS |
|---|---|---|
| 7/13/78 | | |
| 2:23 PM | 22.53 | Pumping level before pump off |
| 2:25 | | Pump off at 2:25 PM |
| 2:26 | 17.83 | |
| 2:27 | 17.24 | |
| 2:27.5 | 16.95 | |
| 2:28 | 16.77 | |
| 2:28.5 | 16.61 | |
| 2:29 | 16.47 | All water level measurements |
| 2:30 | 16.39 | Made from top of casing |
| 2:31 | 16.27 | |
| 2:32 | 16.23 | |
| 2:33 | 16.17 | |
| 2:34 | 16.13 | |
| 2:35 | 16.06 | |
| 2:40 | 15.91 | |
| 2:45 | 15.81 | |
| 2:50 | 15.77 | |
| 2:55 | 15.74 | |
| 3:00 | 15.73 | |
| 3:05 | 15.72 | |
| 3:12 | 15.60 | |
| 3:15 | 15.66 | |
| 3:19 | 15.65 | |
| 3:20 | 15.65 | |
| 3:25 | 15.66 | |
| 3:30 | 15.61 | |
| 6:05 PM | 15.67 | End Recovery test. |

EXHIBIT VI

RESULTS OF WATER QUALITY ANALYSES

PRODUCTIONS WELLS #1, #3A and #4

MANY GLACIER AREA

GLACIER NATIONAL PARK, MONTANA

NERGY & ENVIRONMENTAL
RESOURCE CONSULTANTS, INC.
ormerly YAPUNCICH, SANDERSON & BROWN LABS)
Phone (406) 252-6325 ■ 13 North 32nd Street
P.O. Box 593 ■ Billings, Montana 59103

## LABORATORY REPORT

Lab. No. 14502

To HKM Associates Date 8-14-78

Address P.O. Box 31318 Billings, Montana 59107

### WATER ANALYSIS

Caretaker's Residence Well
Production Well #1
Sampled 7-15-78 @ 2:10PM
Field Conductance @ 25°C 95 micromhos/cm
Field temp. 6°C Flow: meas. 90 GPM
Sample Submitted 7-27-78

| CONSTITUENT | MG./L. |
|---|---|
| Potassium | 0.4 |
| Sodium | 0.5 |
| Calcium | 11 |
| Magnesium | 4 |
| Sulfate | 3 |
| Chloride | 3 |
| Iron | <0.01 |
| Nitrate | <0.1 |
| Fluoride | <0.1 |
| Total Dissolved Solids, Calculated | 45 |
| Total Dissolved Solids @ 180°C | 55 |
| Specific Conductance @ 25°C | 94 micromhos/cm |
| Total Hardness as $CaCO_3$ | 41 |
| Alkalinity as $CaCO_3$ | 38 |
| pH 7.6 | |

| | mg./l. | | mg./l. |
|---|---|---|---|
| Arsenic | <0.002 | Mercury | <0.0002 |
| Barium | 0.10 | Selenium | <0.002 |
| Cadmium | <0.002 | Silver | <0.01 |
| Chromium | <0.01 | Lead | <0.01 |
| Manganese | <0.01 | | |

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P.O. Box 593 ■ Billings, Montana 59103

## LABORATORY REPORT

Lab. No. 14482-1

To HKM Associates Date 7-21-78

Address P.O. Box 31318 Billings, Montana 59107

### WATER ANALYSIS

Swift Current Well
Many Glacier Water System
Production Well #3A
Sampled 7-12-78 @ 9:30AM
Field Conductance @ 25°C 125 micromhos/cm
Field Temp. 5°C Flow: meas 150 GPM
Sample Submitted 7-18-78

| CONSTITUENT | MG./L. |
|---|---|
| Sodium | 0.6 |
| Calcium | 16 |
| Magnesium | 7 |
| Sulfate | 6 |
| Chloride | 4 |
| Iron | <0.02 |
| Nitrate | 0.39 |
| Fluoride | <0.1 |
| Total Dissolved Solids, Calculated | 68 |
| Total Dissolved Solids @ 180°C | 65 |
| Specific Conductance @ 25°C | 125 micromhos/cm |
| Total Hardness as $CaCO_3$ | 68 |
| Alkalinity as $CaCO_3$ | 56 |
| pH | 7.8 |

| | mg./l. | | mg./l. |
|---|---|---|---|
| Arsenic | <0.002 | Mercury | <0.0002 |
| Barium | 0.09 | Selenium | <0.002 |
| Cadmium | <0.002 | Silver | <0.01 |
| Chromium | <0.01 | Lead | <0.01 |
| Manganese | <0.02 | | |

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P.O. Box 593 ■ Billings, Montana 59103

## LABORATORY REPORT

Lab. No. 14482-2

To HKM Associates Date 7-21-78

Address P.O. Box 31318 Billings, Montana 59107

### WATER ANALYSIS

Horse Concessionaire Well
Production Well #4
Sampled 7-13-78 @ 1:38PM
Field Conductance @ 25°C 14 micromhos/cm
Field Temp. 6°C Flow: meas 50 GPM
Sample Submitted 7-18-78

| CONSTITUENT | MG./L. |
|---|---|
| Sodium | 1.0 |
| Calcium | 18 |
| Magnesium | 6 |
| Sulfate | 3 |
| Chloride | 4 |
| Iron | <0.02 |
| Nitrate | 0.29 |
| Fluoride | <0.1 |
| Total Dissolved Solids, Calculated | 68 |
| Total Dissolved Solids @ 180°C | 69 |
| Specific Conductance @ 25°C | 128 micromhos/cm |
| Total Hardness as $CaCO_3$ | 68 |
| Alkalinity as $CaCO_3$ | 60 |
| pH | 8.2 |

| | mg./l. | | mg./l. |
|---|---|---|---|
| Arsenic | <0.002 | Mercury | <0.0002 |
| Barium | 0.20 | Selenium | <0.002 |
| Cadmium | <0.002 | Silver | <0.01 |
| Chromium | <0.01 | Lead | <0.01 |
| Manganese | <0.02 | | |

EXHIBIT VII

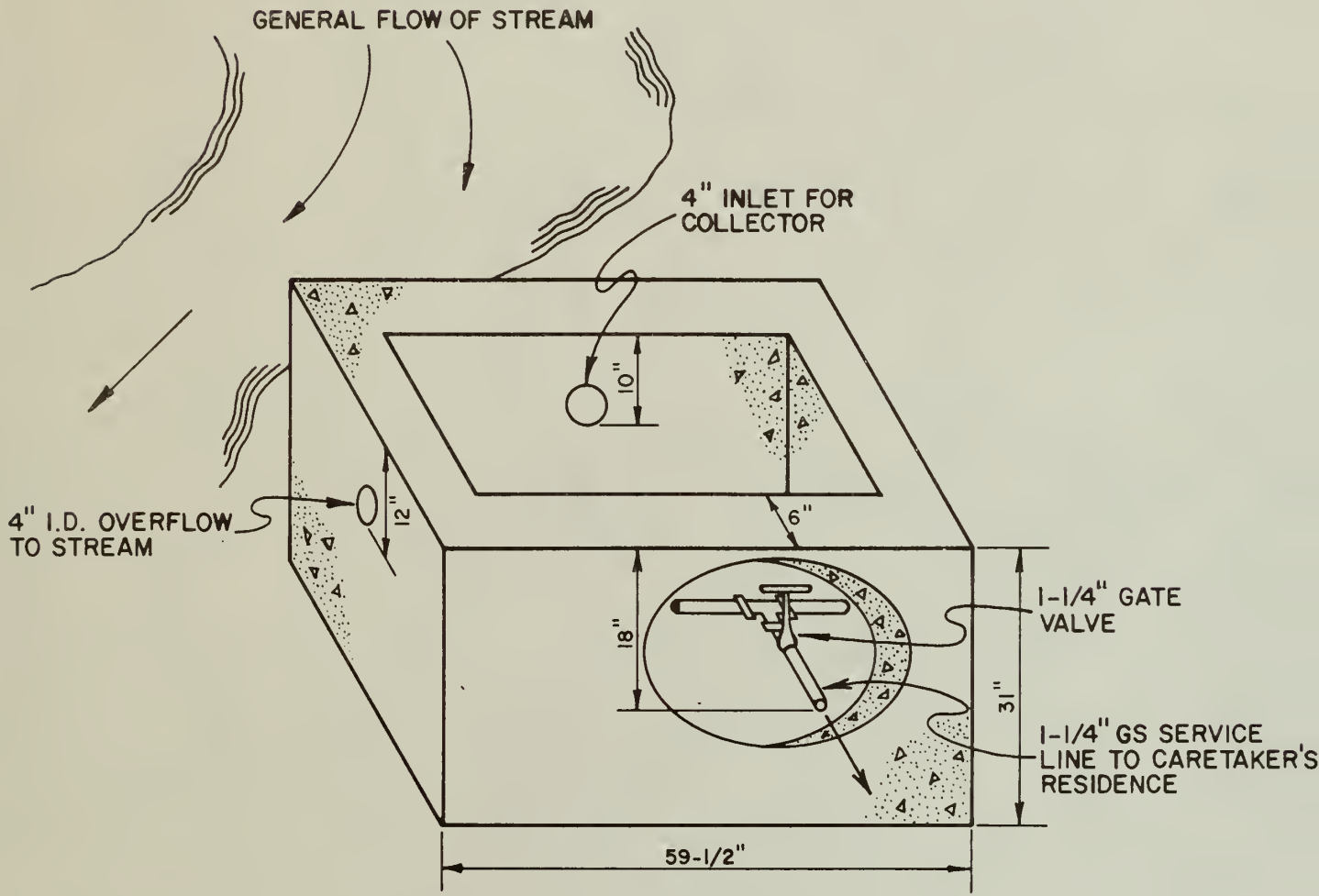
SKETCH OF GENERAL DETAILS

WATER SUPPLY SOURCE

GLACIER PARK INC.

CARETAKER RESIDENCE

EXHIBIT VII: SKETCH OF GENERAL DETAILS, WATER SUPPLY SOURCE, GLACIER PARK, INC., CARETAKER'S RESIDENCE




NOTE: COLLECTOR BOX LOCATED APPROXIMATELY 400 FEET NORTH OF CARETAKER'S RESIDENCE.

COLLECTOR BOX ESTIMATED TO BE AT AN ELEVATION 50 TO 60 FEET ABOVE CARETAKER'S RESIDENCE.

COVER FOR COLLECTOR BOX NOT SHOWN.