RAFT RIVER INJECTION TESTING

MONITOR WELL PLAN

by

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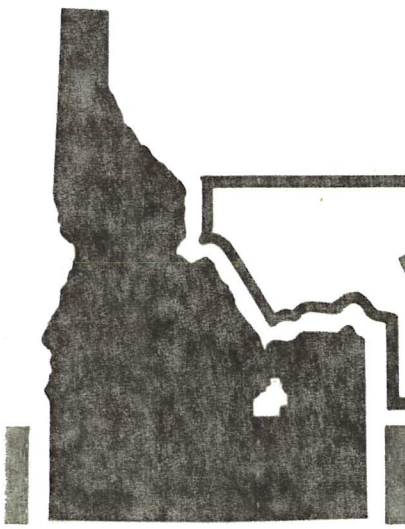

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ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

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1. INTRODUCTION

This report outlines the procedures for establishing a network of shallow and intermediate depth wells that will monitor the effects of geothermal injection in the Raft River Valley. The major environmental concern associated with the development of geothermal resources in the Raft River Valley is the possibility that shallow aquifer systems being used for agricultural and domestic purposes may become contaminated. The Idaho Department of Water Resources (IDWR) declared the Basin a critical groundwater area in 1963, closing it to further groundwater development; thus local users desire to protect the quality and quantity of their limited supply of water. Since little is known of the interactions between the shallow aquifers and the deep geothermal reservoir, the impact of injection of geothermal fluids on the usable water in the valley must be determined.

This monitor well plan is a companion document to the "Management Plan for Fluid Supply and Injection System for the Raft River 5 MW(e) Pilot Power Plant" (GP-124).

2. SCOPE

The objectives of the monitoring program are to determine:

A. If geothermal development in the Raft River Valley degrades the quality of domestic and agricultural water supplies.

B. Through pressure monitoring, if geothermal development affects the quantity of existing domestic and agricultural water supplies.

An environmental monitoring program initiated in 1974 included semiannual chemical sampling of 22 irrigation wells near the Raft River geothermal development, and has provided very useful baseline data. However, the data do not present conclusive evidence that geothermal development will not eventually interfere with shallow aquifers. Several problems have been encountered during the monitoring program; for example, access to the

wells has been limited to the irrigation season (April to September), certain wells that were sampled one year could not be sampled the next, seasonal variations in pumping rates resulted in variations in water quality, and information about the construction and the production zones of the private wells is scarce. As a result, only tentative conclusions can be drawn from the data.

After reviewing the irrigation well monitoring program in 1976, the IDWR recommended that a series of monitor wells be drilled in the valley, completed such that two different depths could be monitored at the same location. As a result of that recommendation, an interagency meeting was held to develop minimal and ideal short-term and long-range monitoring programs. Following extensive discussion of potential aquifer-reservoir interconnections and management utilizing monitoring wells, it was agreed that minimal testing of RRGI-4 would include monitoring of three observation wells for changes in water quality, pressure, and temperature, with the wells located such that potential changes would be detected in the observation wells prior to any alterations in local irrigation or domestic wells. Utilizing the 1423-foot USGS No. 3 well to the west as one of the three, it was determined that two wells would be drilled to the east of RRGI-4: a deep well open at approximately 1500 feet and a shallow well open at $\sim$ 500 feet, with final depth determined by flow rates and temperature of individual wells. Such testing will allow for monitoring of horizontal and vertical movement of injection waters, pressure, and water temperature and quality. It was also suggested that the monitoring program include continuation of current monitoring of the two shallow hot wells and several irrigation wells.

Based on the funding received and these recommendations, it was decided, in October 1977, that two 1500-foot and five 500-foot wells would be drilled to monitor the aquifer that is currently developed (< 500 ft) and that which is potentially developable (< 1500 ft). Since the location of only one of the injection wells (RRGI-4) was known at that time, only two of the seven monitor wells were located: a 500-foot well just west of the greenhouse well and a 1500-foot well to the southeast of RRGI-4. These two wells were eventually completed to 570 feet and 1310 feet, respectively.

The plan for the additional monitor wells was revised after the locations for RRGI-6 and RRGI-7 were finalized. To evaluate the "acceptability" of injection in these wells and in RRGE-3, it was determined that two 1000-foot monitor wells would be more beneficial than one 1500-foot well. These monitor wells will be placed between the injection wells and nearby irrigation wells to the north and east. The locations and planned or actual depths of all seven monitor wells are shown in Figure 1.

3. WELL DESIGN

The following are requirements for the design of each well:

1. Cased so that only specific zones are monitored
2. Casing size large enough for small submersible pump and sampling instruments
3. Gate valve at surface for containment of anticipated artesian flow.

The first monitor well (MW-1) was drilled just west of the greenhouse well (Figure 1) to a depth of 570 feet, with a cable-tool rig. Eight-inch casing was set to 545 feet, the last 40 feet of which were slotted pipe (Figure 2). Hot water was encountered at 526 feet. The completed well will sustain a flow of 30 gpm with little drawdown.

MW-2 was drilled with a rotary rig to a total depth of 1310 feet. Surface pipe (10-inch) was set at 120 feet; the well was cased with 6-inch pipe to 1209 feet (Figure 2).

The anticipated design of the remaining monitor wells is shown in Figure 3. The depths and location of the openhole sections are only estimates and will be determined during drilling by the temperature and flows encountered.

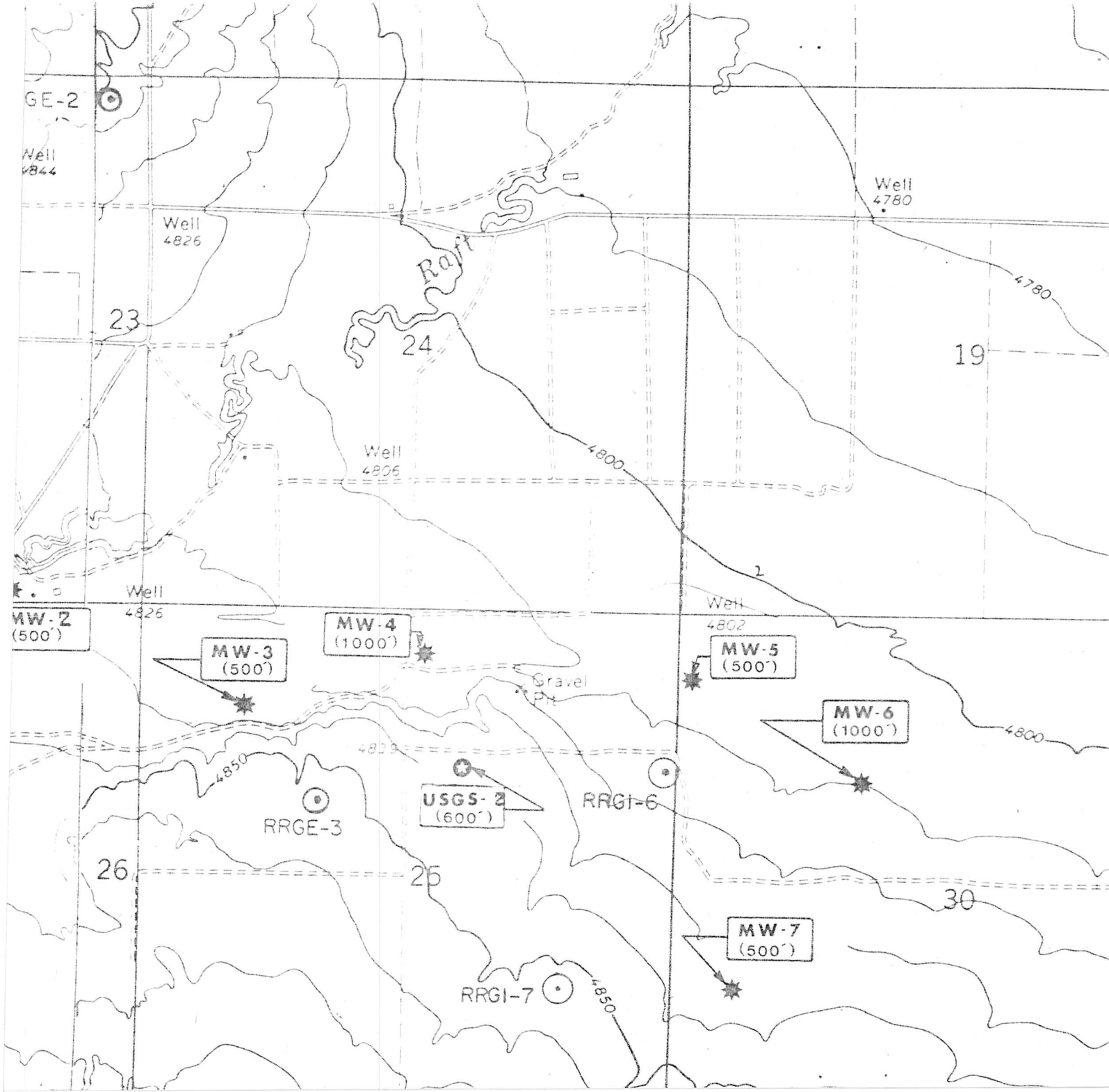

Figure 1. Location Map

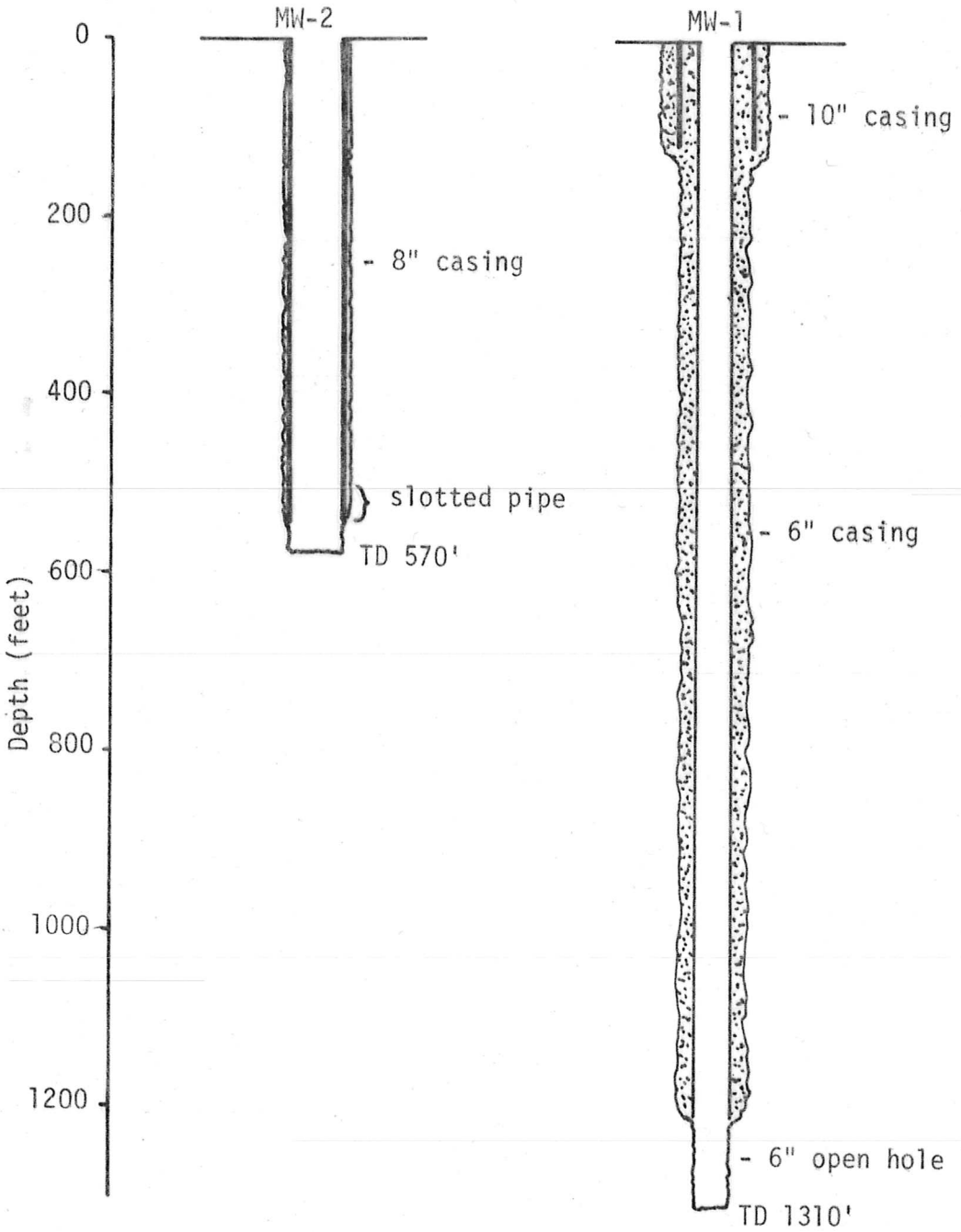

Figure 2 Well Construction

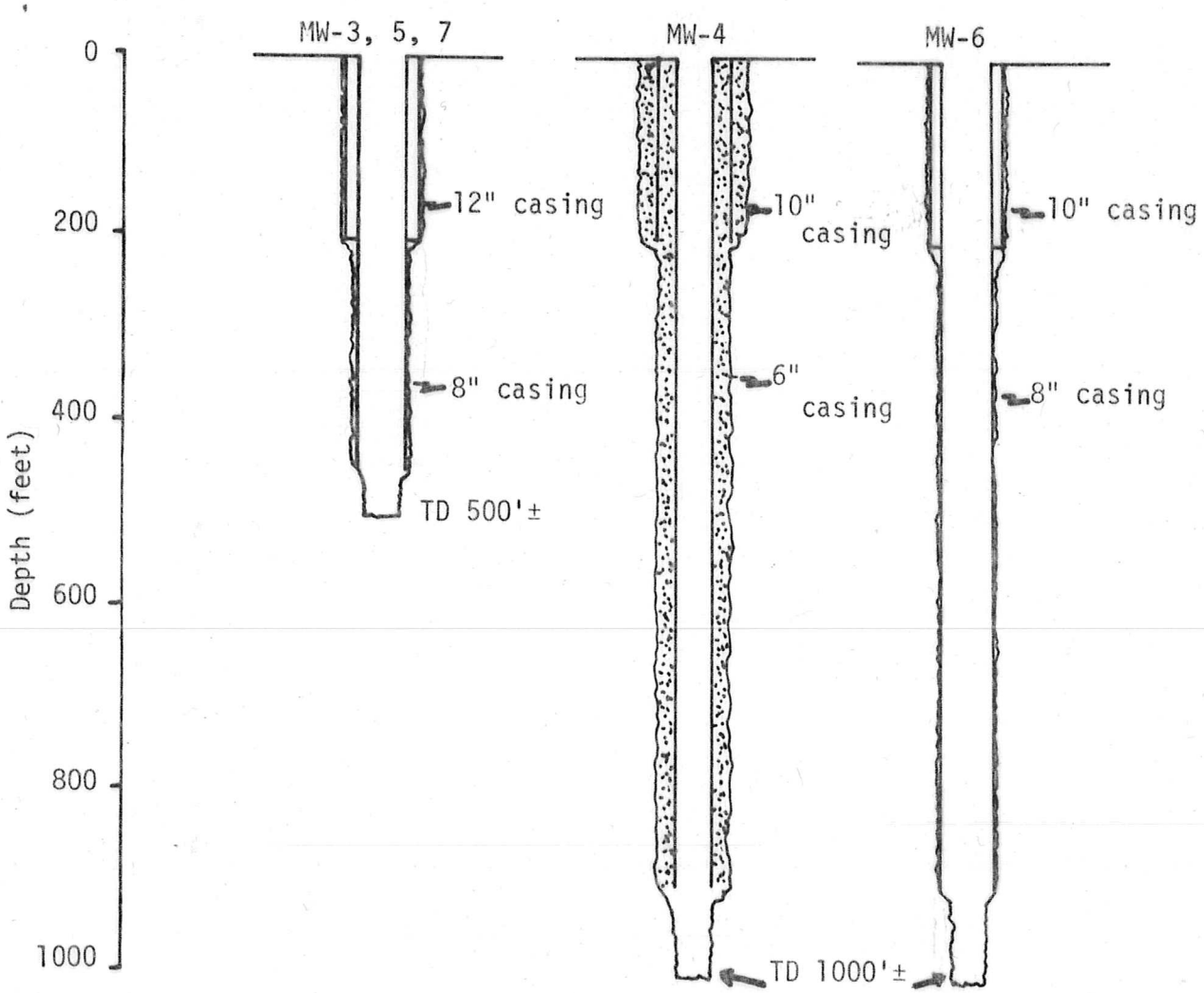

Figure 3 Well Construction

4. MONITORING PROGRAM

Monitoring of each well will begin as soon as they are completed, to obtain baseline data prior to injection tests. It is anticipated that first response of the aquifer to influence from injected geothermal fluids will be a pressure change. Therefore, each well will be equipped with either a recording pressure transducer or a water level recorder, operated continuously during injection.

The importance of water quality preservation has been cited in section 1; thus, measurement of various water chemistry parameters that will monitor any changes in water quality will be performed as follows:

1. Domestic, irrigation, and flowing production wells will be sampled weekly for conductivity, pH, becarbonate, chloride, and fluoride levels.

2. The hot 414-foot flowing BLM well and Crooks 540-foot greenhouse well will be monitored daily during the entire injection period for pH, conductivity, and temperature.

3. Extensive water chemistry analyses will be performed on the monitor wells, USGS-2, USGS-3, the greenhouse well, and the 414-foot BLM well prior to and following each injection test. Analyses will include calcium, iron, potassium, lithium, magnesium, sodium, chloride, carbonate, fluoride, becarbonate, ammonia, nitrate, sulfate, silicon dioxide, pH, conductivity, total dissolved solids, and total suspended solids. Water samples will not be collected during actual injection testing since flowing of the well would interfere with sensitive continual pressure testing.

4. PROGRAM BREAKDOWN

4.1 Management

The Earth and Biological Science Branch of EG&G will manage the monitor well program. DOE-ID will review and approve all proposed plans and any program changes. The IDWR and the USGS will review and comment on all proposed plans and will be kept informed of scheduled tests and data received.

4.2 Schedule

The schedule for the monitor wells is tied closely to the well drilling and reservoir testing schedules and will be modified, if necessary, to reflect changes in those schedules. The monitor well program schedule is shown in Figure 4. To date, two of the seven monitor wells have been completed and the bid packages are being reviewed for three more.

The decision points shown on the schedule are those regarding the acceptability of injection in RRGE-3 and RRGI-6 and 7. The decision points have been scheduled to allow as much data as possible to be collected. These decisons are, however, restricted by the drilling schedule. Each decision will be coordinated with DOE-ID and the Idaho Department of Water Resources.

4.3 Costs

Drilling and Well Completion	$152,000
Pipe and Wellhead Equipment	43,000
Monitoring Equipment	35,000
Chemical Analyses	15,000
Technical Support (2.4 mm)	9,000
Travel	1,000
Total	$255,000*

*Includes $105,000 from I-461 and $150,000 from I-475.

5. REPORTING

Monthly progress reports will be included in the program monthly reports submitted to DOE-ID. Upon completion of the drilling of each monitor well, a completion report will be prepared which will include the drilling report,

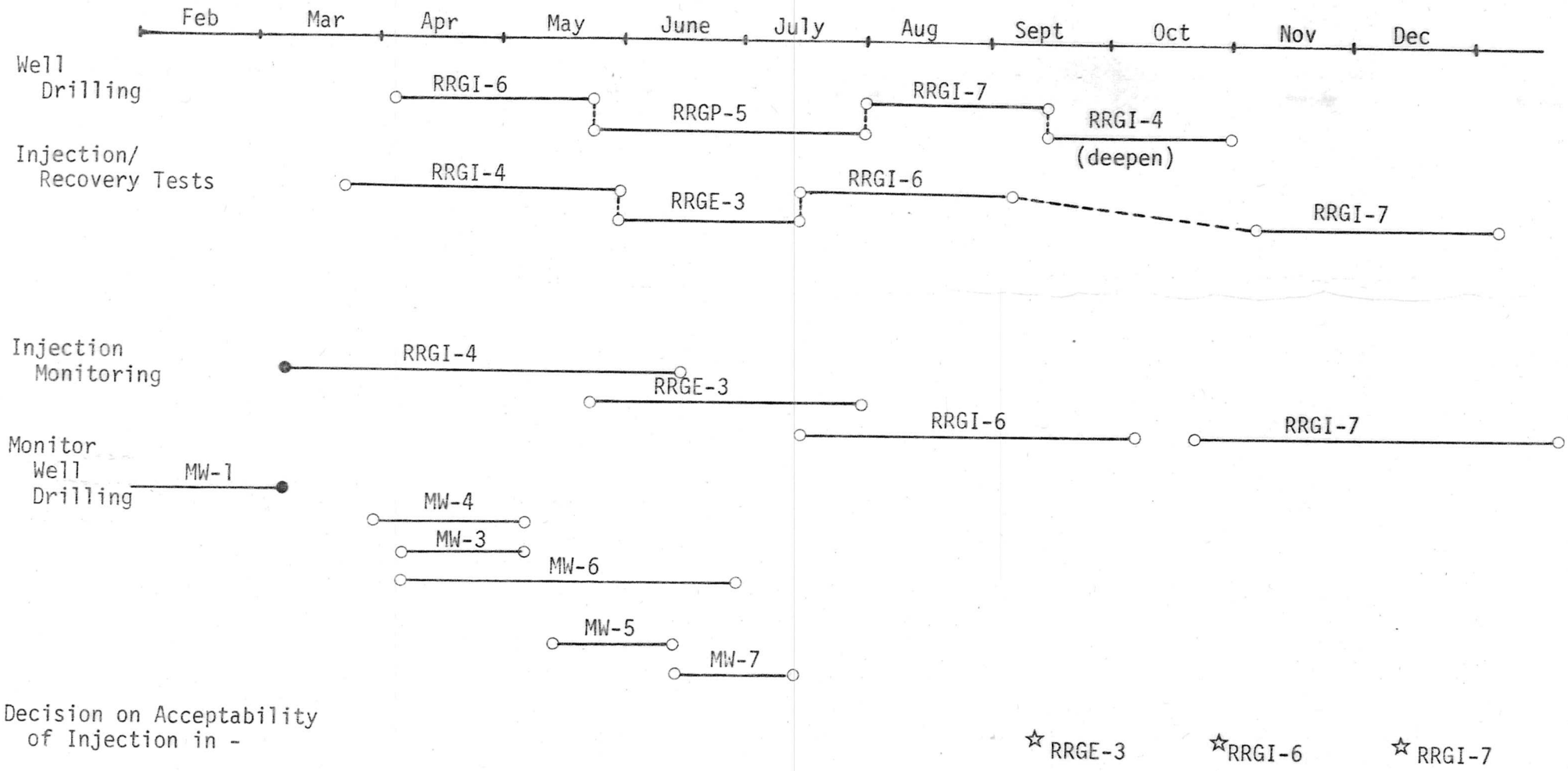

Figure 4 Schedule

well construction, lithology, and any logs run on the well. Results of monitoring will be included in unscheduled communications to DOE-ID, IDWR, and USGS and will be summarized in the program semi-annual report and in the environmental annual report to be issued at the end of FY-1978.