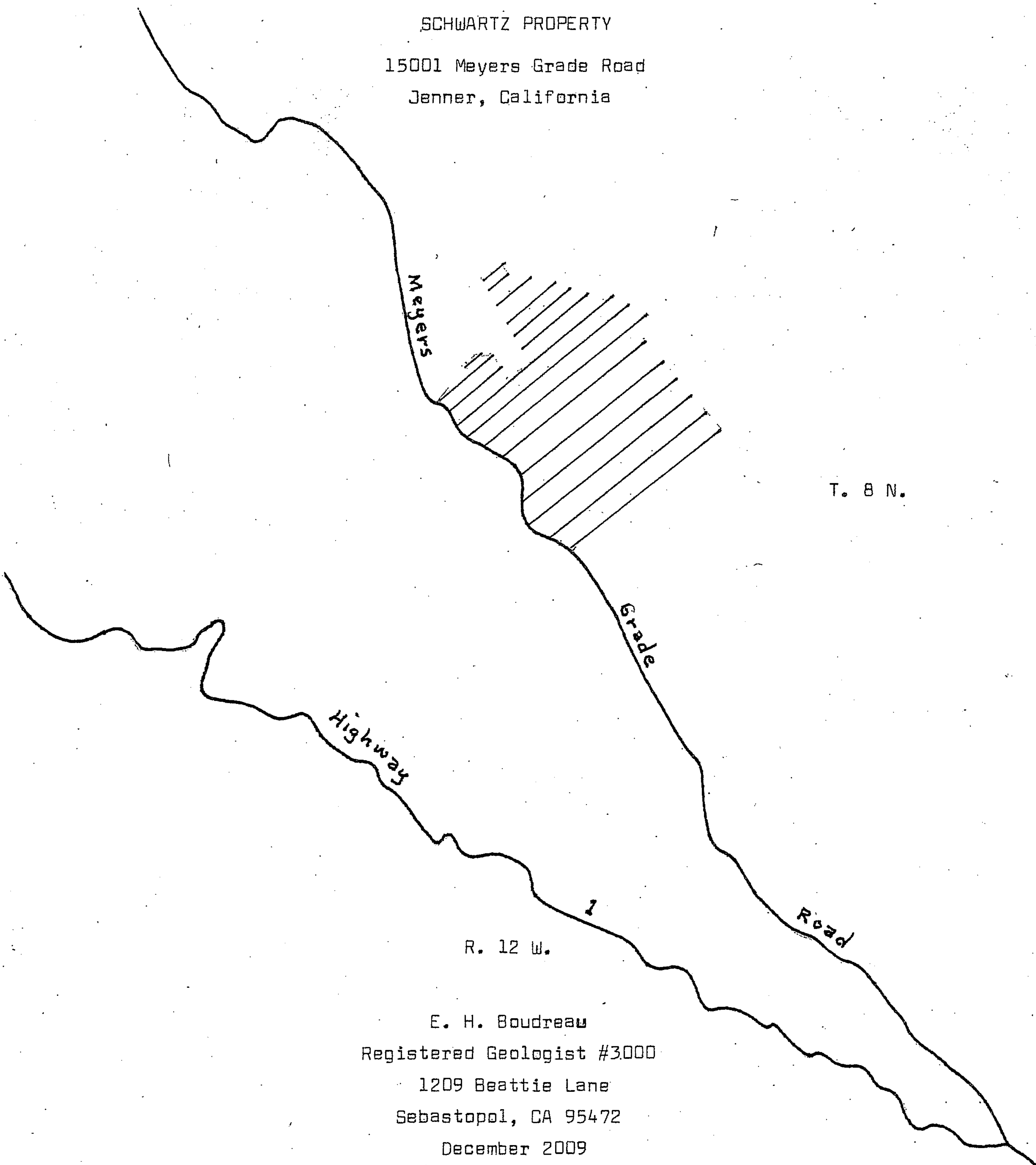
GEOLOGY
&
GROUND WATER POTENTIAL:
SCHWARTZ PROPERTY

15001 Meyers Grade Road
Jenner, California



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INTRODUCTION

The 240-acre Schwartz property lies along the east side of Meyers Grade Road in unsurveyed land in T. 8 N., R. 12 W., MDB&M. Plans are to build a wine tasting room, and there already is a home, and 8 acres of grapes. The Sonoma County Permit & Resource Management Department wants to know if the new well drilled for the tasting room can supply sufficient water for it, and how the pumping of more water from under the property might affect other wells in the area. I am the geologist who has looked into the matter for Mr. Schwartz, and I have studied the surface geology of the area, and the driller's log of the well and the pumping test, to determine the general ground water potential and present and future uses. In order to provide answers to the questions raised by PRMD I have also requested drillers' logs of wells and dry holes from the California Department of Water Resources and sent questionaires to neighbors of Mr. Schwartz. This report contains my observations and conclusions.

GENERAL GEOLOGY

The study area outlined by PRMD along Meyers Grade Road takes in the crest of a high ridge between the elevations of about 1400 to 1640 feet above sea level. Most of the bedrock is masked by soil cover, but there are enough outcrops and drillers' logs to give a rough picture of the geologic situation. Some general information on the surface geology of the region is shown on maps accompanying the California Division of Mines & Geology's Special Report 120, on a scale of one mile to the inch.

Franciscan Formation

All the bedrock in the area belongs to the Mesozoic-age Franciscan Formation, which is 100-140 million years old and an estimated 50,000 feet thick. This unit underlies most of Sonoma County, along with much of the rest of the Coast Range in California. It is made up of a group of highly consolidated marine sediments (sandstone, shale and chert), marine volcanics called "greenstone," intrusive bodies of serpentine, and metamorphosed derivatives of these rocks.

During their long history the Franciscan rocks have been strongly deformed and broken during episodes of folding, fracturing and faulting caused by stresses in Earth's crust. These actions, coupled with the original heterogeneous buildup of the unit, have created such a complex structural arrangement of the rocks that it is impossible to make exact predictions of the conditions at depth.

The rock around the tasting room well is sandstone (cemented sand), but around it is melange with a high percent of shale (compacted clay). Melange is the rockmix found along wide fault zones. Along the north boundary of the property there is greenstone, with its characteristic red-brown soil.

Figure 1 is a map showing the boundaries of the properties in the study area, the topography, surface geology, and the sites of known wells, dry holes, and a spring. Also shown is the location of the geologic cross section through the study area that is illustrated in Figure 2. This shows the possible relationships of the rocks and the water table at depth, as projected from available information.

GROUND WATER & WELLS

All ground water in the area comes from local rainfall that has percolated down into the rock, and it exists in small, open fractures in the zone of saturated rock below the water table. Annual rainfall averages about 48 inches per year, or 4 acre-feet per acre.

Ground Water Principles

A well is successful when it penetrates permeable rock below the water table, allowing usable amounts of water to flow through the rock and into the well. The well's yield depends on the rock's thickness and its degree of permeability. The methods used in drilling, equipping, and developing the well influence its maximum yield, its operating characteristics, and life.

Permeability is a measure of the ease with which water moves through rock, and it depends on the amount and size, and interconnectedness, of the pore spaces in the rock. The amount of water that a rock contains may have no bearing on how much it will yield, as a clay can be 40% water by weight and still be impermeable as the water is held in the clay by capillary forces. It is impossible in advance of drilling to predict exactly how much usable water will be found beneath the surface, although with enough information on the local geology fairly accurate estimates can be made. From past drilling in the Franciscan, the general permeabilities of its rocktypes are known.

With favorable geology governing the availability of ground water, it follows that the most practical exploration technique for finding water is to try to drill in the most permeable rock, and to avoid drilling in impermeable rock. In complex situations, as in the Franciscan with its mixture of impermeable and potentially permeable rocktypes, drilling involves taking a risk; so, the information obtained during the drilling must be interpreted right along to see if the test hole should go deeper.

Since Franciscan rocks are so highly-consolidated (from deep burial for millions of years), they have no primary (or intergranular) porosity and permeability as occurs in loose sand and gravel, and the result is many dry holes. Successful wells have penetrated zones in the hardest and most brittle of the rocktypes (the sandstone, chert, and greenstone) where faulting and fracturing have created some secondary porosity and permeability in the form of small, open fractures. Rarely do shale and serpentine contain open fractures, since their rather soft and therefore semi-plastic natures cause the breaks in them to be sealed by the pressure of the overlying rock; so, they are impermeable and yield little or no water.

There is no way of locating the open, water-bearing fractures, or to measure their yields, except by drilling. An extensive pumping test is needed to determine the well's sustained yield.

The yield of a Franciscan well depends on the number, width, and extent of the water-bearing fractures penetrated, but often it is less than 10 gpm since the fractures make up but a small portion (perhaps 1-2%) of the total volume of the rock. Some wells yield 500 gpm, and 20 to 50 gpm is common. Most wells that penetrate a fair thickness of the right rocktypes yield at least enough water for a home. Initial yields may drop off with sustained pumping if the permeable rock is only a small mass surrounded by impermeable rock that blocks recharge of the pumped-out fractures.

When exploring in essentially massive rock for water-bearing fractures, a depth of about 300 feet is the point of diminishing returns for a domestic well. The reason is that increasing pressure with depth tends to seal deep fractures. Sometimes deeper drilling is justified, as on a steep ridge made up of highly-fractured rock, there being a deep water table and little side pressure.

Most water in the Franciscan is of good mineral quality, but there can be troublsome amounts of dissolved iron, manganese, calcium carbonate (hardness), hydrogen sulfide, and methane. Probably most of the iron comes from oxidizing pyrite (FeS_2) that was deposited in fault zones by hot mineralized water at some time in the past; but this iron can be removed from water by passing it through a water softener, or it can be allowed to precipitate and settle out in a storage tank.

Potentially permeable Franciscan rock is hard, and so rotary drilling equipment is needed. Cabletool rigs are too slow, and bucket rigs cannot drill it at all.

When exploring in hard rock for small water-bearing fractures, the air-rotary method of drilling is preferable over the mud-rotary method for the following reasons:

1. The locations and approximate yields of the fractures are known as soon as they are penetrated because the water is blown right to the surface and can be measured with a bucket and a watch.

2. There is no risk in plugging the water-bearing fractures with stiff, viscous mud and thus sealing-off part--or even all--of the water. This is especially important in marginal wells.

3. Only the right amount of casing is used, and the perforations are sited opposite the permeable zones.

4. The mineral quality of the water from different zones can be checked.

If caving conditions in the hole cause mud to be used, then a chemical, self-liquifying mud should be used instead of bentonite clay.

Schwartz Wells

Figure 3 is a diagram of the tasting room well, and Figure 4 is a diagram of its pumping test, which produced 3.5 gpm. The well was drilled with air-rotary equipment to 320, and cased to 280 feet. From the surface to 240 the rock was mainly sandstone, and below that sheared shale (clay). Static was at 70 feet. A 12-hour pumping test showed 3.5 gpm, with the static at 50 feet and the pumping level at 266. Recovery after the test was complete. Some 1200 feet to the southeast of the tasting room well are 2 wells and 2 dry holes in melange terraine.

Neighbors' Wells

The California Department of Water Resources has no drillers' logs for the area. Two neighbors responded to my questionaire: the property to the north relies on a spring; to the west the Soper property has wells but no information was provided, except that they have never run out of water.

Ground Water In Storage

I estimate that the well's sandstone underlies about 4 acres. With a saturated thickness of 150 feet, and a specific yield of one percent, there would be 6 acre-feet of water in storage for the well to draw upon for the tasting room.

Ground Water Recharge

With 4 acre-feet of rainfall per year, the sandstone around the tasting room well gets 16 acre-feet. The soil type is Hugo, gravelly loam and gravelly, sandy, clay loam, with permeability from 0.63 to 2.0 inches per hour. If 25 percent of the rainfall could percolate down, recharge would be 4 acre-feet per year. Slopes are moderate.

Schwartz Water Use

The 4 people who live on the property probably use 2/3 acre-foot of water per year, as the average per person water use in Sonoma County per year is 150 gallons per day. An acre-foot of water is 326,000 gallons, and so it is a year's supply for 6 people. This water comes from the other Schultz wells by the house, springs and the pond. The pond holds 10 acre-feet, and water from it serves the house garden and the vineyard.

There are 8,000 vines that get 20 gallons of irrigation water per year, which totals about 1/2 acre-foot (160,000 gallons).

No more grapes are planned for the property.

Neighbors' Water Use

There are 10 people in 3 homes on the 9-acre property just to the north of Schwartz who rely on water from a spring that is about 800 feet north of the Schwartz tasting room well. This water looks to be coming from the body of greenstone in that area, and not from the Schwartz well's sandstone. The spring's flow is said to have dropped off somewhat over the past 10 years, and now in the summer months the usage is restricted to household only.

There are wells on the 480 or so acres of the Soper property on the west side of Meyers Grade Road, but no information on locations, depths, use or production. Just a statement that they have never gone dry.

Owners of 4 other properties along the road did not respond to my questionaire, but I could see a home and a wellhouse on one of them.

Projected Schwartz Water Use

The tasting room is to be open for 7 days a week for 9 months of the year, and for 5 days of the week for 3 months in the winter. Ten promotional events and 8 special events are proposed for the non-winter months. The maximum number of people at an event would be 150, the total per year could be up to 2100. Average water use per person might be 5 gallons, or a total of 10,500 gallons per year; with a maximum per day of 750 gallons.

The tasting room will employ one full time and one part time person, who might use another 20 gallons per day. Their use could total about 7,500 gallons per year.

Yearly water use might be 18,000 gallons per year, with a maximum of less than 800 gallons per day.

SUMMARY & CONCLUSIONS

The Schwartz property is underlain by a great thickness of consolidated rock of the Franciscan Formation. Much of the rock is impermeable shale, but there are bodies of potentially permeable sandstone and greenstone. The tasting room well taps fractured sandstone that yields 3.5 gpm, and there are other favorable looking sites worth drilling. Of course, a well must be used for a year to get the best idea of the balance between pumpage and recharge, but 3.5 gpm is 5,000 gallons per day. Tasting room water use will be a maximum of around 750 gallons per day, and 18,000 gallons per year.

Water in storage available to the well might be 6 acre-feet, or about 2 million gallons.

Ground water recharge could be 4 acre-feet per year, or about 1.3 million gallons.

From surface evidence, there is no connection between the Schwartz well and the failing spring 800 feet to the north, as the sandstone and the greenstone are separated by a belt of impermeable shale. Any other wells on other properties are at least 1200 feet distant.

From all the available evidence the well should support the tasting room without interfering with wells and springs on neighboring properties.

E. H. Boudreau

Registered Geologist

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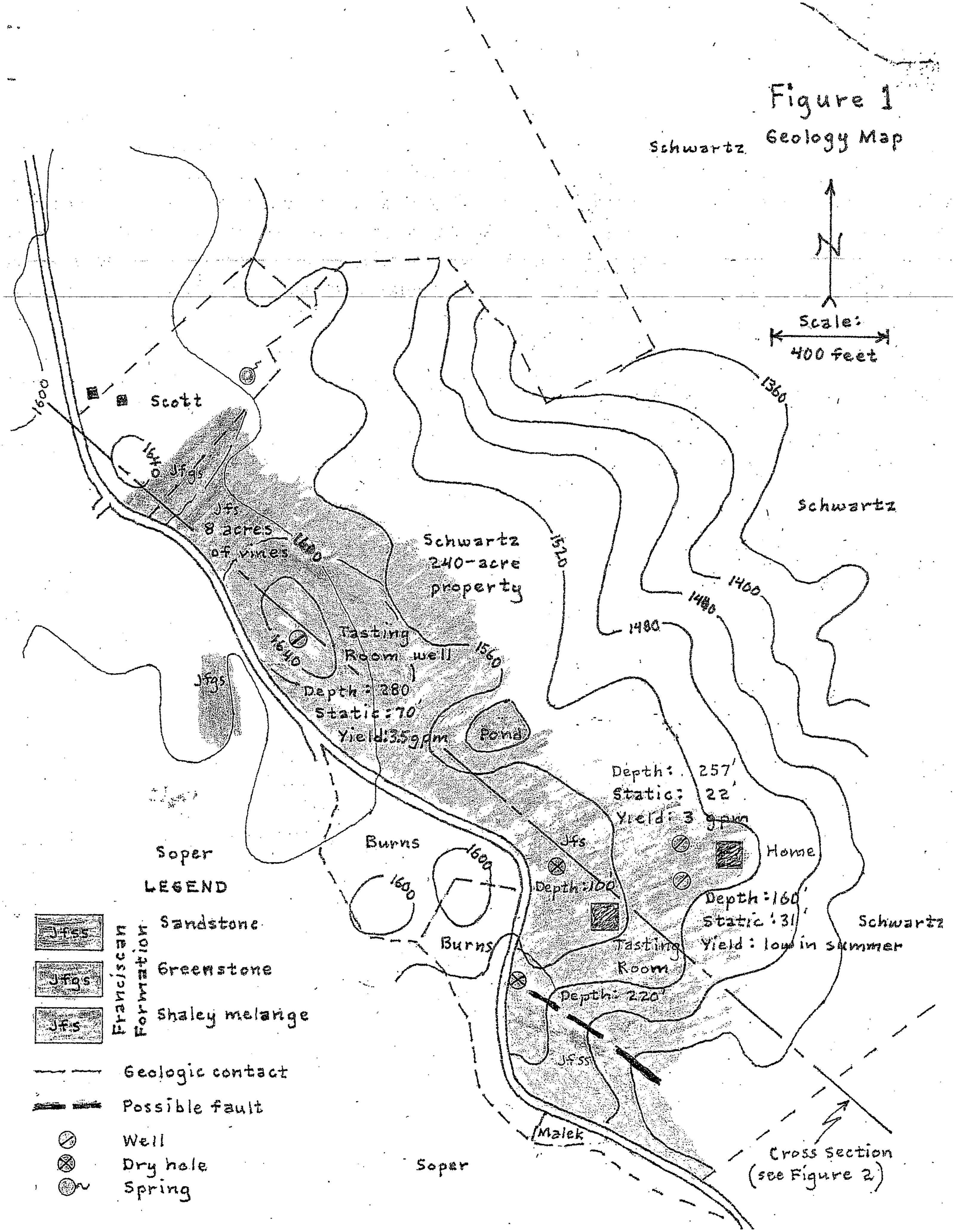
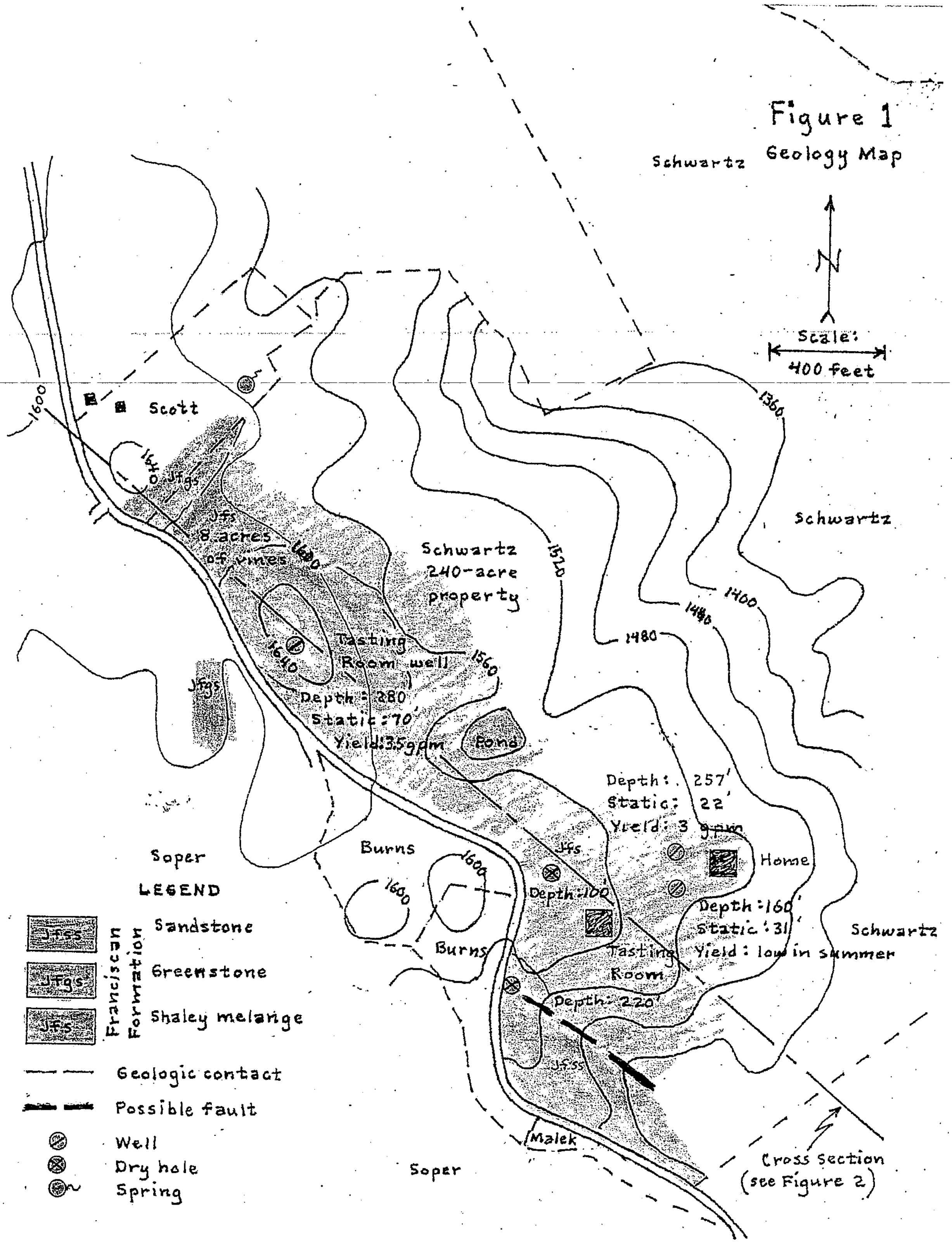


Figure 1
Geology Map
N
Scale:
400 feet
Schwartz
Scott
Jfgs
Jfs
8 acres of vines
Schwartz 240-acre property
Tasting Room well
Depth: 280
Static: 70'
Yield: 35 gpm
Pond
Depth: 257'
Static: 22'
Yield: 3 gpm
Home
Depth: 160'
Static: 31'
Yield: low in summer
Depth: 160
Tasting Room
Depth: 220'
Jfss
Burns
Soper
Malek
Cross Section (see Figure 2)
1600
1640
1560
1520
1480
1400
1360
LEGEND
Franciscan Formation
Jfss Sandstone
Jfgs Greenstone
Jfs Shaley melange
Geologic contact
Possible fault
Well
Dry hole
Spring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Scale:
400 feet
Schwartz
Scott
Schwartz
240-acre
property
Jfs
8 acres
of vines
Jfgs
Tasting
Room well
Depth: 280'
Static: 70'
Yield: 3.5gpm
Pond
Depth: 257'
Static: 22'
Yield: 3 gpm
Home
Depth: 100'
Depth: 160'
Static: 31'
Yield: low in summer
Tasting
Room
Depth: 220'
Jfss
Schwartz
Soper
Burns
Burns
Malek
Soper
Cross Section
(see Figure 2)
1600
1640
1680
1560
1520
1480
1440
1400
1360
LEGEND
Jfss Sandstone
Jfgs Greenstone
Jfs Shaley melange
Franciscan Formation
Geologic contact
Possible fault
Well
Dry hole
Spring

Figure 2

Cross Section

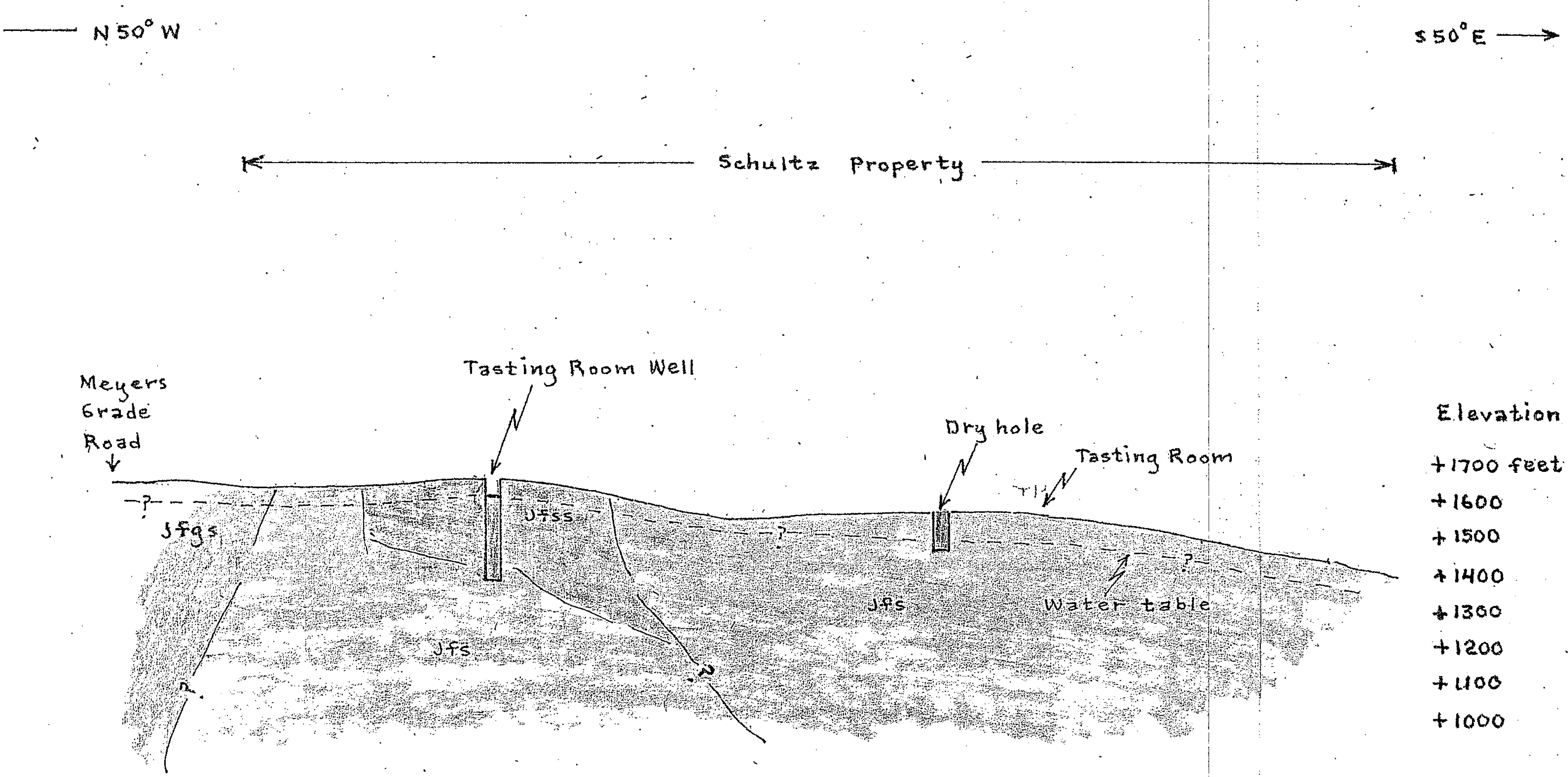

Figure 3

Well Diagram

Schwartz well (Fort Ross Vineyard)
Fisch Brothers
Air-rotary drilled
October 2009

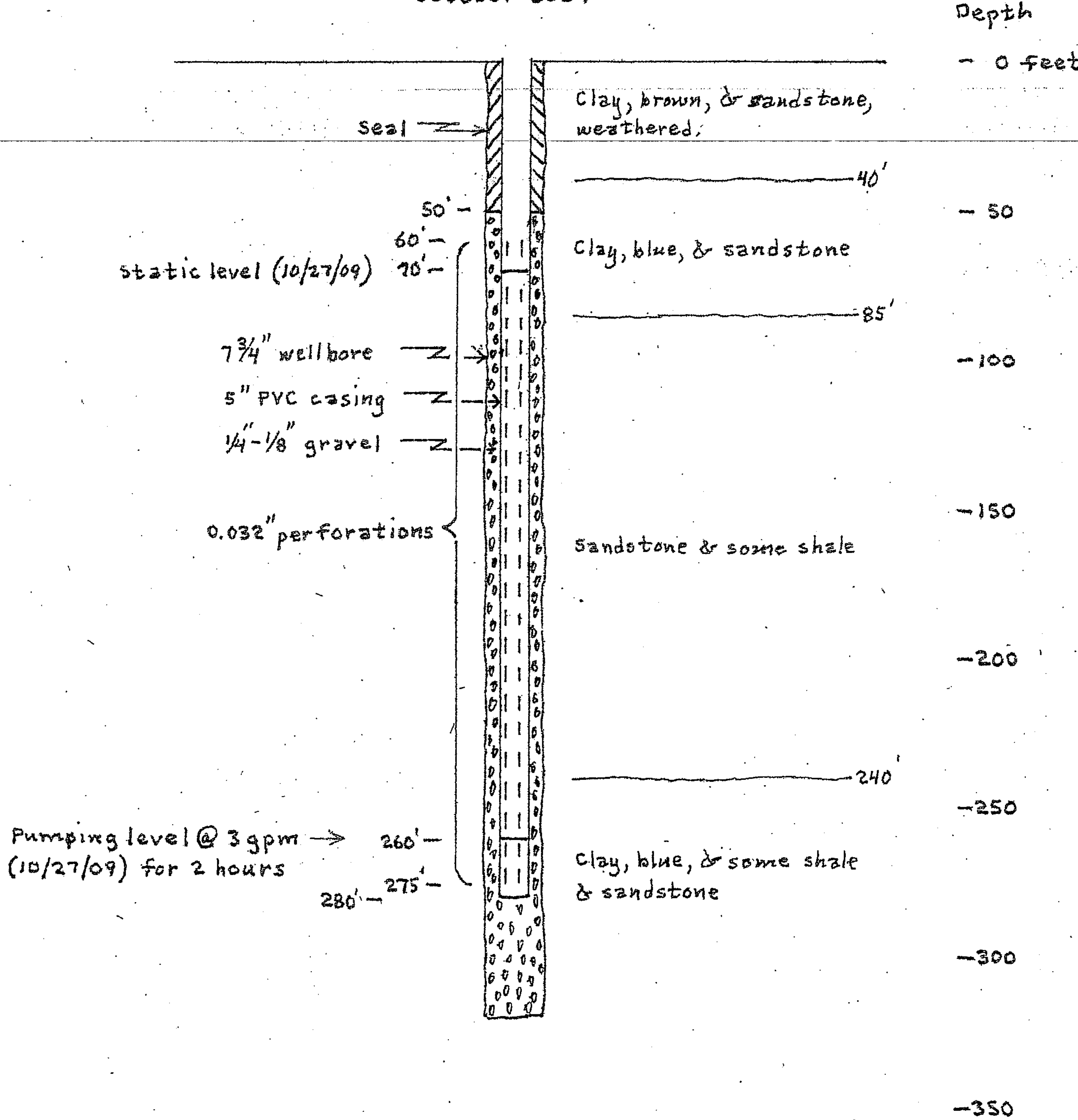

Figure 4

Pumping Test