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AQUIFER TEST PROCEDURES

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by

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FOREWORD

During our evaluation of ground-water quantity throughout the state we often encounter pump test data which are inadequate for aquifer analysis. In many cases much time, effort and money were expended but because of failure to record readily available information, or to make accurate measurements, a test which would have yielded much aquifer data, did not. It is the purpose of this paper to point out precautions that must be taken, the tools needed and the recording of data necessary to produce reliable basic data which can be used for determination of aquifer characteristics.

Aquifer Test Procedures

The primary objective of aquifer tests is to determine the ability of the aquifer to transmit and store water and to determine possible adverse effects on existing wells created by new withdrawals. It is important that everything possible is done to assure that the data are sufficiently detailed and accurate to determine these parameters.

If possible, other wells or springs in addition to the pumped wells, should be measured for drawdown during the aquifer test. Drawdown measurements in at least two wells are necessary to establish the storage coefficient of the aquifer. These wells must be hydraulically open to the aquifer being tested. An examination of the driller's log, where available, will possibly indicate if the wells have been perforated or screened in the same aquifer.

Observation wells accessible to hand measurement are preferable to airline measurements. The accuracy of airlines is questionable and they should be used only if necessary.

Once the observation wells have been selected, the discharging well should be pumped for several hours before the aquifer test to determine the maximum constant discharge which can be maintained, the approximate extent of drawdown, the method best suited for measurement of discharge and the disposal of the pumped water. A constant rate of discharge is important. An electric pump is preferable to gasoline driven pumps as discharge rates usually are more constant.

An accurate means of measuring discharge is essential. Orifice buckets, weirs, flow meters, and orifice plates are useful devices. A simple and accurate method makes use of an open bucket or barrel of known capacity and a stopwatch; the water is discharged into the container, and the time taken to fill it to known capacity is measured. A flow meter may be attached to the discharge pipe and used to monitor outflow from the well. For greater accuracy, place the meter at least 10 pipe diameters downstream and at least 5 pipe diameters upstream from any valve controlling the flow or any elbows or pipe strictures. Water should be discharged away from the immediate test area so that recharge to the aquifer does not occur. Refer to Johnson, Ground Water and Wells, for additional information.

Operating Procedure

It is critical that pumps which might affect drawdown in the aquifer being tested be shut off at least 24 hours before the test is to begin. This allows water in the pumped and observation wells to recover to static or near static conditions. If these nearby pumps cannot be shut down, the pumpage and approximate time of operation should be noted.

It is advisable to record water levels and time of measurements prior to pumping in areas where water levels are affected by tidal movements or barometric changes. These data are used to correct the aquifer test measurements

such that the changes in the latter reflect only the effects of the pumping stress. A microbarograph or Paulin System altimeter are useful in cases of barometric changes.

Once the pump is started, discharge should be maintained at a constant rate. The flow which initially should be less than pump capacity is controlled by means of a valve in the discharge pipe.

The actual measurement of water levels during the test should be made with equipment such as standardized electric tapes (i.e. "Soil Test" or "M scope") or steel tapes. Electric tapes are generally used to measure in pumped wells because the wet casing and turbulence make measurement with a steel tape difficult. The convenience of the electric tape also allows for more rapid measurements during the initial portion of drawdown and recovery where they are greatest. Steel tapes are more accurate and should be used whenever possible.

Because the rate of drawdown is greater during the early part of the test, accurate measurements (to 0.01 feet if possible) are taken with brief intervals between readings (a portable tape recorder may be helpful). The time between measurements is gradually increased as the test progresses. The following table gives a recommended frequency at which measurements should be taken:

Time since pumping started or stopped	Time intervals
0-2 minutes	approx. every 10 seconds
2-5 minutes	30 seconds
5-15 minutes	1 minute
15-50 minutes	5 minutes
50-100 minutes	10 minutes
100 minutes - 5 hours	30 minutes
5 hours - 48 hours	1 hour
48 hours - 6 days	8 hours
6 days - shutdown	24 hours

If an observation well is some distance from the pumped well, the interval of measurement can be greater as the effect of drawdown on this well may not show for some time.

Recovery measurements should be made in the same manner as the drawdown measurements. Once the pump has been turned off, measurements are taken at the same frequency as prescribed for drawdown until the water in each well nears prepumping static conditions. Recovery data are as, or more important than the pumping data especially in cases where discharge rates are not constant throughout the pumping test. Recovery data may also be used to check calculations based on drawdown data.

Both drawdown and recovery data should be recorded on forms similar to the example attached to this procedures report. The owner of the well, location, well number, date, type of test (drawdown or recovery), county, measuring point, type of measuring equipment, elevation of measuring point

and person recording the data, should all be listed on each page. The data will be entered under the columns: depth - referring to depth in feet to water level, s - (drawdown or recovery) in feet, t - referring to time since pump was started or stopped, and r - the distance from the pumped well to the observation well. Remarks will include any additional information such as discharge rate of pumped well (which should be recorded frequently during early part of test and later as often as water level measurements are taken), any changes in conditions, or unusual events such as storms, temperature changes, etc.

Duration of the Aquifer Test

The amount of time the aquifer should be pumped is dependent on the type of aquifer, the degree of accuracy needed to establish the storage coefficient and transmissivity and the rate of pumping. Pumping should continue until equilibrium occurs, that is, until the recharge of the aquifer equals the discharge and the water levels in the wells stabilize. This may occur a few hours after pumping starts, or it may be days or weeks. Some aquifer tests may never achieve equilibrium. Although it is not necessary for the pumping to continue until equilibrium is reached, it is recommended that pumping be continued for as long as possible and at least 24 hours. Recovery measurements should be made for a similar period or until pre-pumping water levels have been attained. The costs of running the pump a few extra hours are low compared with the total costs of the test, and the difference in data could be the difference between a conclusive or inconclusive aquifer test.

Summary

The performance of an aquifer test involves at least the following procedure:

1. Standardize tapes - Steel tapes are the most accurate and should be used whenever possible. E-tapes should be calibrated with a steel tape because slippage of the metal tabs will give erroneous readings. E-tapes are usually used in pumping wells, cascading wells, or wells with wet casings. Usually, it is best to assign one E-tape for all measurements of a particular well. Avoid air-line measurements, or use only when necessary.

2. Synchronize watches - Time is important during the early part of the test. Later, exact time is not needed.

3. Start pump after measuring all static levels - Static levels of all observation wells measured prior to the test are used as the initial static levels. If static levels are changing significantly, measurements should be taken at intervals several days before the test begins to determine the fluctuations such that the measurements taken during the test pumping can be corrected.

4. Measure all wells frequently at first - The most frequent measurements usually are made in the pumped well and in the closest observations wells.

5. Measure pump discharge - Frequent pump discharge measurement with adjustments, if required, assures a constant discharge during the test. As a rule, start the pump discharge at less than capacity to allow for adjustment.

6. Record data on appropriate forms - Use a clipboard at each well with the data sheets clearly labelled as to which well it applies and exact measuring point. The form of the sheet is unimportant but it should tabulate the necessary drawdown data in a systematic manner.

7. Plot drawdown vs time on semi-log paper - Plotting of all wells during the test is very useful because this plot will reveal the effects of boundaries or other disturbing influences if they are encountered. It will also give some indication when enough data capable of a solution have been recorded.

8. Measure recovery - It is advisable to obtain recovery measurements. Recovery measurements are more consistent, especially if pump discharge varies. Recovery data are added confirmation of the drawdown data; measurements should be maintained until static water level is reached.

REFERENCES

Edward E. Johnson, Inc., 1972, Ground Water and Wells, Johnson Div., Univ. Oil Prod. Co., St. Paul, Minn., pp. 81-98.

Kruseman, G.P. and de Ridder, N.A., 1970, Analysis and Evaluation of Pumping Test Data: International Institute for Land Reclamation and Improvement, Wageneninger, the Netherlands; pp. 23-44.

Department of Ecology

DEPARTMENT OF ECOLOGY
WATER RESOURCES DIVISION
OLYMPIA, WASHINGTON 98504

AQUIFER TEST

Sheet_____ of _____

Owner _____ Location _____ Well No. _____

Date _____ Meas. by _____ Test _____ County _____

Meas. point _____ Elev. Meas. Point _____

Meas. equipment _____

DTW_o _____ t_o _____ Q _____ r _____

Date	Hour	Water level			s	t	$\frac{1440r^2}{t}$	Remarks
		Held	Wet	Depth (DTW)				

SH 070-17

Linton says don't use.