Training Guide

An Introduction to Well Drawdown

Rural and Small Systems Training Guide

An Introduction to Well Drawdown

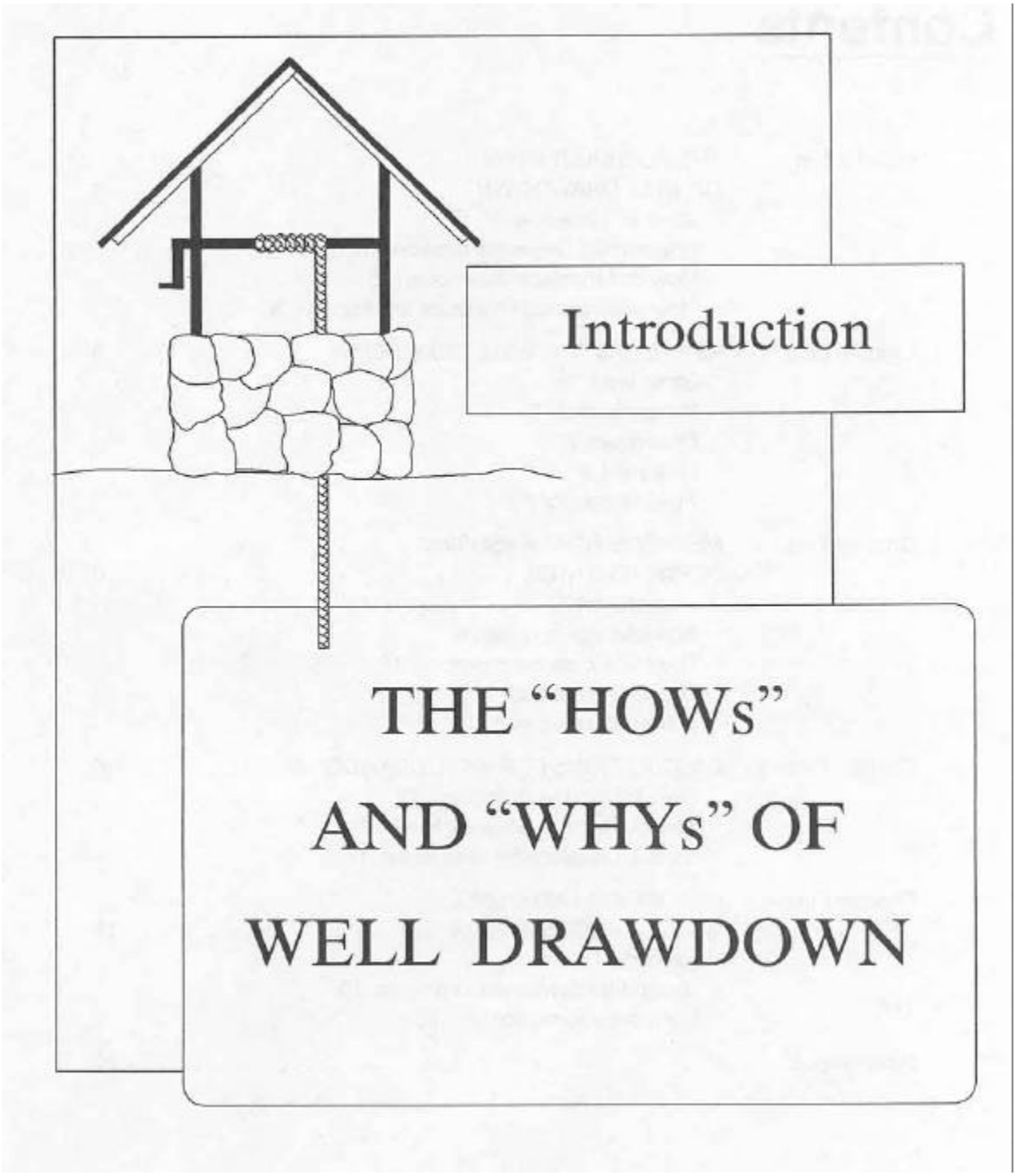
Michael J. Lytle, Arizona Water Association
Contributing Author
Paul Markowski, Nebraska Rural Water Association
Contributing Author

National Rural Water Association

An Introduction to Well Drawdown

 Although the information in this training guide has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement CT901680 with amendments to the National Rural Water Association, it has not been subjected to the Agency's publications review process and therefore, it has not been approved for publication as an EPA document. The contents do not necessarily reflect the views and policies of EPA, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. For additional copies contact your state rural water association or Training Department, National Rural Water Association, 2915 South 13th Street, Duncan, OK 73533.

Contents


Introduction
THE "HOWs"
AND "WHYs" OF
WELL DRAWDOWN

THIS NATIONAL RURAL WATER ASSOCIATION TRAINING

guide is an introduction to well drawdown. On the following pages, you will learn the basic vocabulary of drawdown, ways to make drawdown measurements and tips for recording and using your findings.

What is "drawdown?"

Drawdown is the drop in the level of water in a well when water is being pumped. Drawdown is usually measured in feet or meters.

Why should I measure drawdown?

One of the most important reasons for measuring drawdown is to make sure that your source is adequate and not being depleted. The data you collect to calculate drawdown can tell you if your supply is slowly declining. Early detection of this can give you time to explore alternative sources, establish conservation measures or obtain any special funding you might need to get a new water source.

Drawdown measurements give you important information about the performance and efficiency of your wells. You can combine drawdown data with well yield to evaluate the efficiency and performance of a well.

Drawdown measurements can also help you detect some other problems in their early stages. For example, accurate drawdown measurements can be used with well yield data to detect the plugging of a well screen by encrustation or if a pump needs adjustment.

Another reason for taking drawdown measurements is the law in your state may require them. Some regulatory agencies ask for routine drawdown tests as well as other quality checks such as tests for pH and alkalinity levels. Be sure to check the regulations in your area.

How do I measure drawdown?

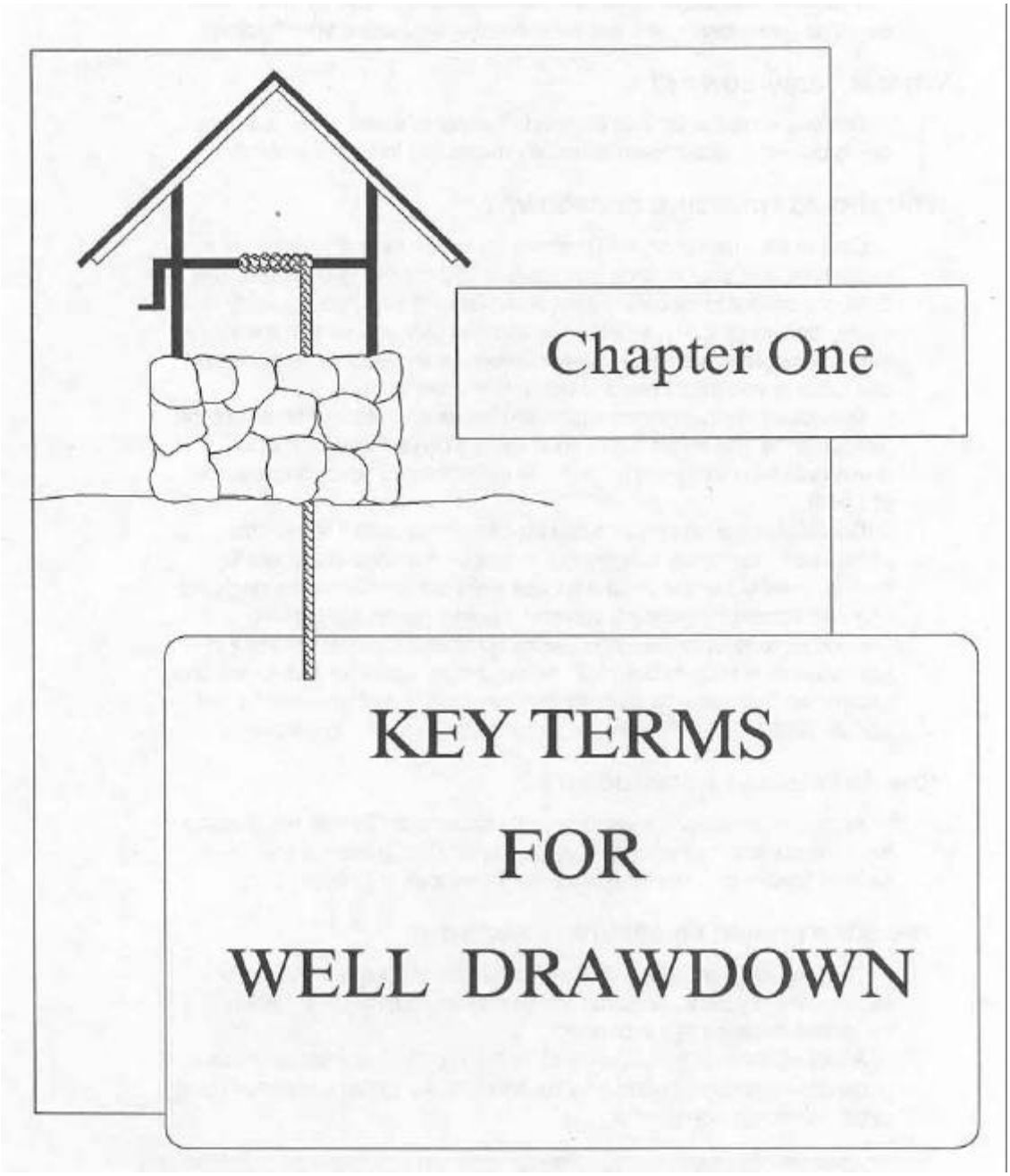
Accurate drawdown measurements depend on finding the distance from the surface to the water level in a well. This guide will review several "depth to water" measurement methods in Chapter 2.

How often should I measure drawdown?

This depends entirely on the performance of your wells and the regulations in your area. Some states require routine tests. Others leave that decision to the operator.

A well which produces plenty of water, recovers quickly and has a small drawdown may need only routine checks. Other wells may need to be monitored constantly.

It is important to remember that this training guide is merely an introduction to well drawdown. If you do not have the proper equipment or training to take well drawdown measurements, contact the professional water association in your area for help.


Chapter One
KEY TERMS
FOR
WELL DRAWDOWN

SEVERAL KEY TERMS ASSOCIATED WITH WELL DRAWDOWN are listed below.

Static level

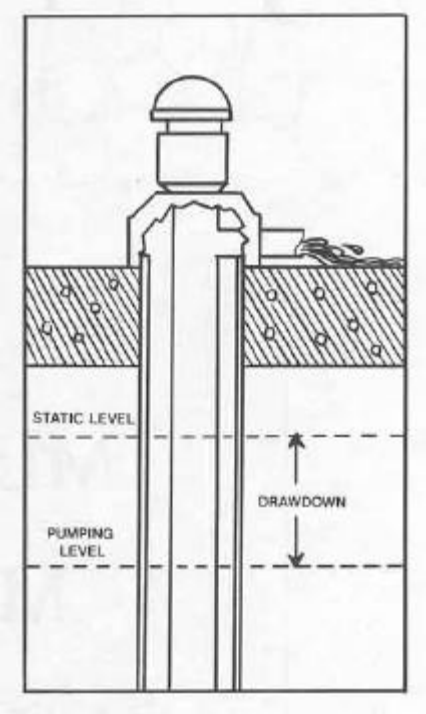
Static level is the level of water in a well when no water is being taken from the well by pumps It is usually expressed as the distance in feet or meters from the ground surface to the water level.

Pumping level

Pumping level is the level of water in the well during pumping. This, too, is usually expressed as the distance in feet or meters from the ground surface to the water level.

Drawdown

Drawdown is the drop in level of water in a well when water is being pumped. Drawdown measurements record the difference (in feet or meters) between the static level and the pumping level.

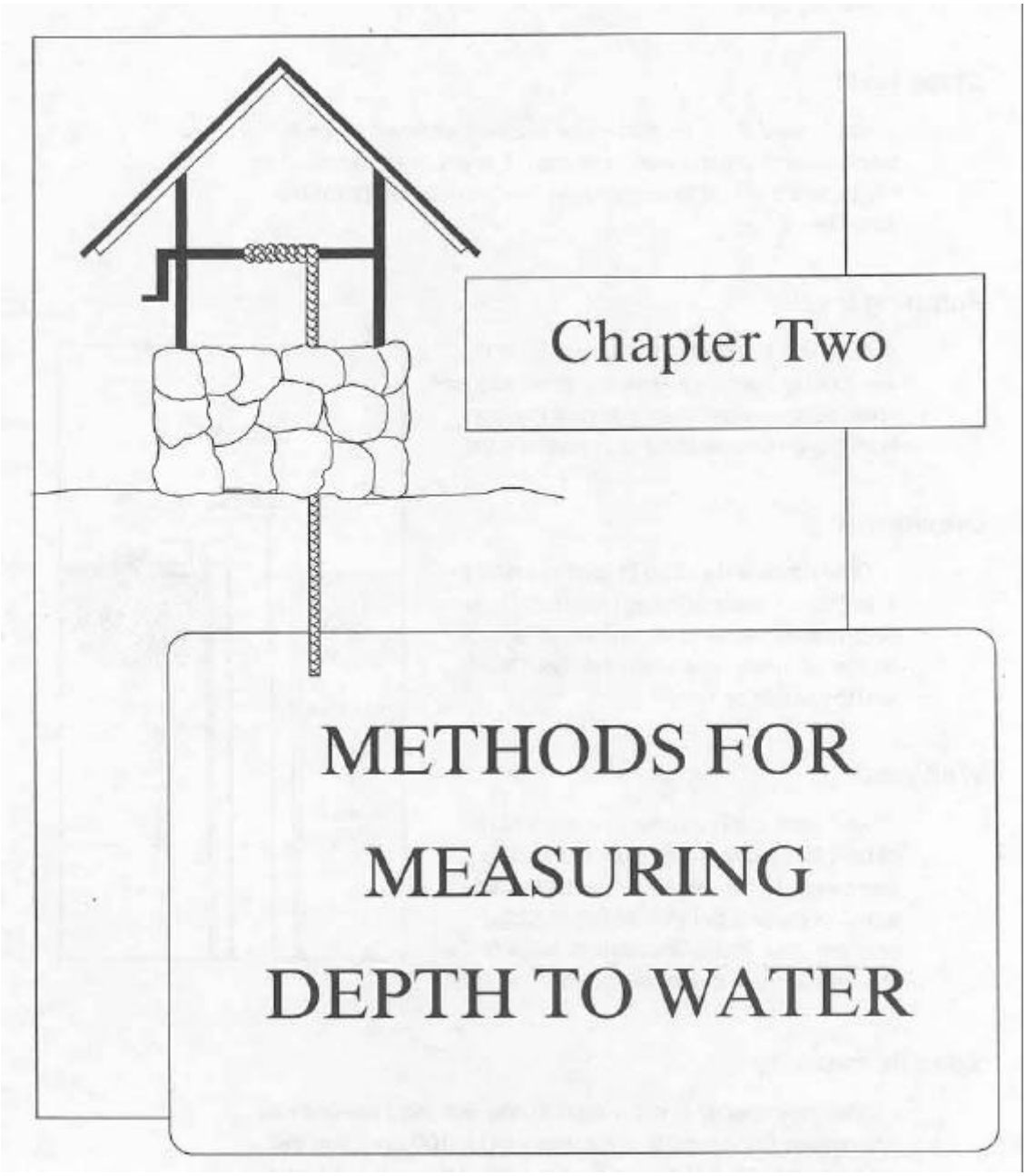


Well yield

Well yield is the volume of water per unit of time that is produced from the well by pumping. Usually, well yield is measured in terms of gallons per minute (gpm) or gallons per hour (gph). Sometimes, large flows are measured in cubic feet per second (cfs)

Specific capacity

Specific capacity is expressed as the well yield per unit of drawdown. For example, if the well yield is 100 gpm and the drawdown is 10 ft, the specific capacity of the well is 10 gpm per feet of drawdown.


Chapter Two
METHODS FOR
MEASURING
DEPTH TO WATER

TO FIND THE DRAWDOWN OF A WELL, YOU MUST KNOW
the distance from the surface to the water level in the well This chapter will review several measurement methods, including the electric sounder and the airline.

This chapter will also review some more recent developments in measurement technology, including the use of transducers and acoustic well sounders.

Transducers

A more recent application of technology to well testing has been the development of transducers for measuring depth to water. A transducer is a device that converts input energy of one form into output energy of another.

Transducers work by sending information to equipment above ground level about the pressure of the column of water over them. If you know the exact depth of the transducer, you can use this information to find the water level at any time.

Acoustic well sounder

An acoustic well sounder uses sound waves to measure the depth to water level. This device operates by bouncing sound waves off the surface of the water.

Advantages of the acoustic well sounder are that it is easy to operate, gives you instant data and cannot contaminate the well (that is, no measuring devices touch the water and there are no probes or wires to hang up).

Acoustic well sounders use sound waves to measure depth. (Photo courtesy of Toole & Sons Drilling. Used by permission.)

The electric sounder method

The electric sounder method (sometimes called the electrictape method) is an accurate method of determining the depth to water level. It is often used in tests where turbulence may interfere with other measurement methods (such as the air line method reviewed later in this chapter).

Before using the electric sounder, test it by placing the electrode in a pail of water. The milliampere meter should register a flow of current.

A basic electric sounder consists of:

- An electrode
- A dry-cell battery
- A pair of insulated wires marked at regular intervals (usually every 5 ft) Weights
- A milliampere meter (or some other device to show the flow of current such as a bell or light.)

One end of the pair of insulated wires is connected to a drycell battery and a milliampere meter. The other end is attached to an electrode. The electrode contains the exposed ends of the wires separated by an air gap. Several manufacturers sell electric sounders, or you may construct your own
.

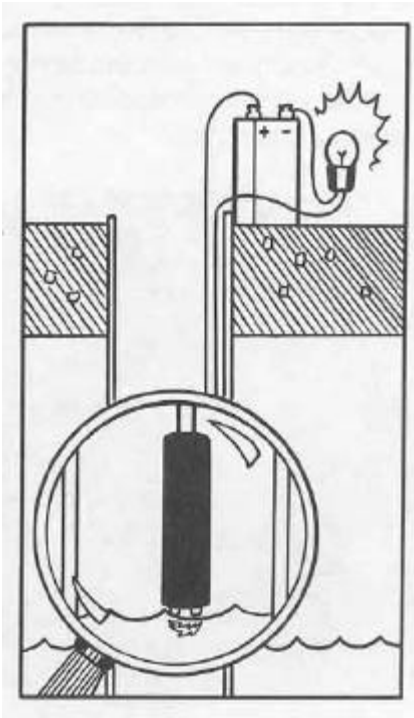
If the measuring markers or clips on the wire are not permanent, check them to make sure they don't slide down on the wire.

Operating an electric sounder

An electric sounder works by lowering the electrode into water. When the electrode contacts water, a circuit is completed and the current flow registers on a light, bell or meter.

Using an electric sounder to measure depth to water

Slowly lower the electrode into the well until the milliampere meter detects a steady current. Lower the line another ten feet to see if the milliampere meter continues to register. If it doesn't, or if it fluctuates, the electrode may not have reached



The drawing at left illustrates the equipment you need to measure depth to water by the electric sounder method.

NOTE: This drawing does not show the proper procedure for gaining access to a well. For assistance, contact the appropriate manufacturer's representative or professional water association in your area.

the water level. (Something else, such as cascading water from the well screen, may be interfering.)

If the milliampere meter does not fluctuate after you have lowered it another ten feet, pull the wire back to the first point where the current registered. This is the water level.

To find the depth to water:

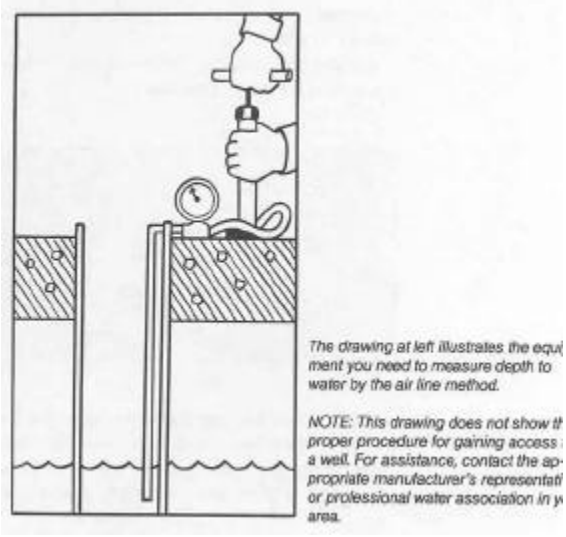
1.Hold the place on the wire where you first detected the current. You can use a clothespin, tape or the nail on your index finger.
2.Pull the wire out of the well until you see a regular marker on the wire.
3.Record the reading on the marker.
4.Measure the distance from the marker to the place you are holding on the wire.
5.Add this measurement to the reading on the marker to find the depth to water.

The air line method

Another method for measuring well drawdown is the air line method. The principle for this method of measurement is shown in the figure.

If one end of an open tube is put under water, the water will rise in the tube until it equals the water level outside the tube. If you supply enough air pressure to the tube, you can push the water back out of the tube. The amount of air pressure you need to do this can be expressed in "feet of water."

If you know the length of tube, and the pressure you need to push the water out, you can find the depth to water. Simply subtract the pressure from the length of the tube.



The drawing at left illustrates the equi ment you need to measure depth to water by the air line method.

NOTE: This drawing does not show th proper procedure for gaining access a well. For assistance, contact the ap propriate manufacturer's representati or professional water association in y area.

For example, a tube is 100 *ft* long, and the pressure to clear the tube is 20 *ft* of water. To find the distance from the top of the tube to the water level, subtract 20 *ft* from 100 *ft. In* this case, the distance from the top of the tube to the water level is 80 *ft.*

Equipment

To measure the depth to water you will need:

- An air line of known length
- A tee in the line with attachments for a pressure gauge and an air pump
- A pump
- A pressure gauge

If your system is installing plastic or flexible air line tubes, be sure to fasten the tube so that it hangs straight.

Some wells are equipped with a small air line tube that extends from the top of the well to several feet below the lowest anticipated level of water during prolonged pumping. These lines are usually made of plastic (PVC), copper or brass, and are 1/8" to 1/4" in diameter. In order for the air line method to work correctly, the tube must be air tight.

Finding the depth to water

Attached an air pump (such as a tire pump) and pressure gauge to the tee in the air line. Fill the line with air until the gauge pressure is constant. Record the pressure. Subtract this from the length of the air line to find the depth to water.

Install the air line so that it is well above or below the intake of the pump. This avoids turbulence.

If you are measuring drawdown in feet or meters, the best gauge to use is one with a scale reading in feet or meters of water. If, however, your gauge is calibrated in some other scale, you will have to convert your readings to the appropriate units.

Example:

Air line = 150 feet
Gauge reading = 80 feet
The static water level is 70 feet.

If you are measuring drawdown in feet or meters, the best gauge to use is one with a scale reading in feet or meters of water. If, however, your gauge is calibrated in some other scale, you will have to convert your readings to the appropriate units.

If your gauge is calibrated in pounds per square inch (psi), you can convert your readings to "feet of water" by multiplying the number or pounds by 2.31.

If the gauge does not register while you are pumping, check for a hole in the air line and leaks in the valve stem and connections.

Example:

To convert 45 psi to "feet of water" multiply by 2.31

45 psi x 2.31 = 104 feet

If you do not know the length of the air line.

For the air line method to be accurate, you must know the length of the air line tube. This should be in the original well plans. If you don't know the length of the air line tube, you can find it by following these steps:

1. Pump air into the line until the pressure stabilizes.
2. Find the static level with an electric sounder or by some other method.
3. Add the static level and gauge reading to find the length of the air line tube.

Example:

Static level = 145 ft
Gauge reading = 16 psi
16 psi X 2.31 = 37 ft
The air line tube is 182 ft long

The air line with chart method

A variation of the air line method is to attach a chart recorder to the line. By supplying a steady and continuous supply of air to the line, you can get constant information about the water level in a well. These recordings can be saved as a permanent record of the water levels.

The wetted tape method

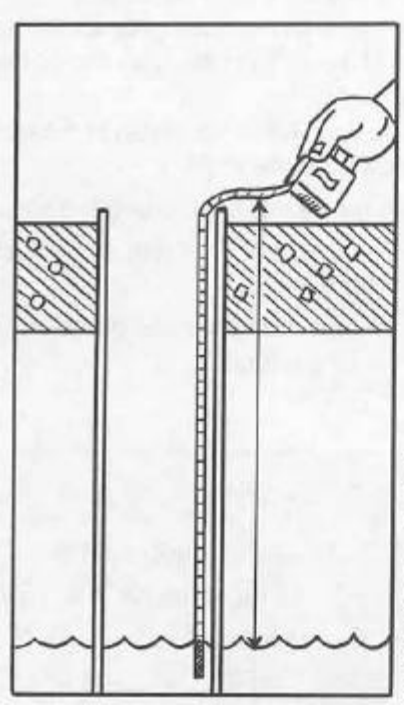
An old-fashioned way to measure depth to water is the wetted tape method. It is typically used for depths up to 80 or 90 feet. In order to use this method, you must already know the depth to water within a few feet.

To use the wetted tape method, you will need:

- A steel measuring tape
- A weight
- Carpenter's chalk

To measure the depth of water, attach the weight to the end of the measureing tape. Coat the lower 3 to 4 ft. of the tape with carpenter's chalk. Lower the tape into the well until the lower part of the tape is under water, then lower the tape a little more until the next foot marker is at the surface level.

Record the number of feet indicated. Remove the tape from the well and record the length of tape that was under water. (The chalk which was under water will be wet or washed away.) The difference in these two measurements is the depth to water.



The drawing at left illustrates the equipment you need to measure depth to water by the wetted tape method.

NOTE: This drawing does not show the proper procedure for gaining access to a well. For assistance, contact the appropriate manufacturer's representative or professional water association in your area.

Example:

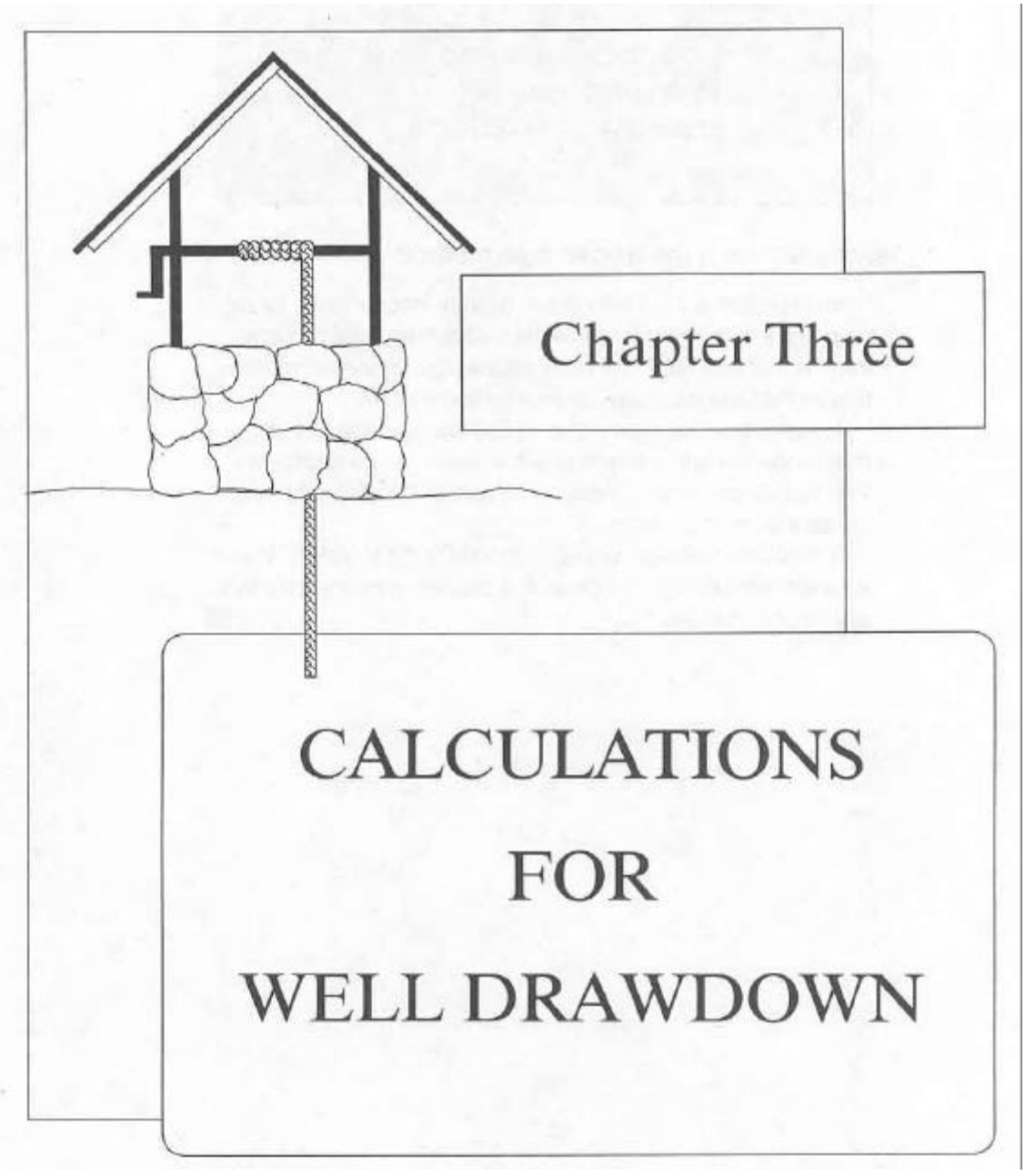
Tape reading at surface level: 65 ft
Tape under water: 2 ft
Water level: 65 - 2 = 63 ft.

Disadvantages of the wetted tape method

In some cases this method can be very inaccurate. If, for example, the water level is below the well screen, water flowing into the well can wash the chalk off the tape. Heavy condensation on the tape may also wash away some chalk.

Another disadvantage of the wetted tape method is that you must know the approximate depth to water before you begin. This test doesn't work unless only a part of the chalked end of the tape dips under water.

A third disadvantage of this method is that it is difficult to use for wells more than 100 ft deep. For deeper wells, the long tape is difficult to handle.


Chapter Three
CALCULATIONS
FOR
WELL DRAWDOWN

YOU CAN CALCULATE WELL DRAWDOWN IN THREE SIMPLE steps. Use one of the methods described in *Chapter* 2 to find the depth to water.

Step 1: Find the static level

1.Manually turn off the pump. Make sure you understand the operation of the pump controls. Also, be sure that manual operation will not harm or unreasonably interfere with normal functions. Attach a tag to the switch with the time, date and reason the pump was turned off. (This tells others about the test and helps to remind you to turn the pump back on when you are finished.)

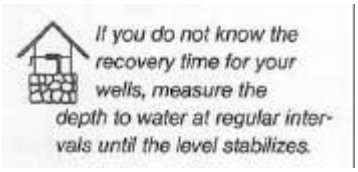
2.When the well has fully recovered, measure the depth to water. This is the static level.

Getting access to the well

Getting access to the well to take drawdown measurements is sometimes difficult. Ideally, you can gain access to your wells through a pipe intended for measurements that is welded into the side of the casing. If, for example, your well has a sanitary seal and you are unsure how to proceed, contact the professional water association in your area for help.

Well recovery

The recovery time of a well is the time required for the aquifer to stabilize at the static water level once pumping has stopped. The rate of your well's recovery determines how long you should wait before finding the static level. For some wells, 30 minutes is long enough. For others you must wait much longer.



Step 2: Find the pumping level

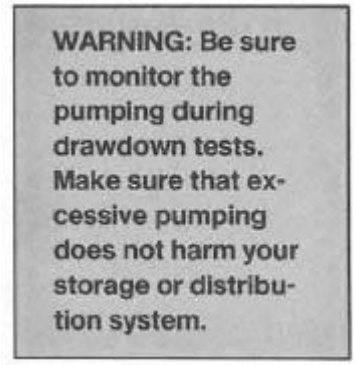
1. Turn on the pump. Again, be sure you understand the control and that you are sure no harm to the pump or system will occur. Tag the switch with the time, date and reason the pump is on. Allow it to pump until the well reaches a constant pumping rate or yield.

2. Measure the depth to water at regular intervals until the water level stops dropping. This is the pumping level.

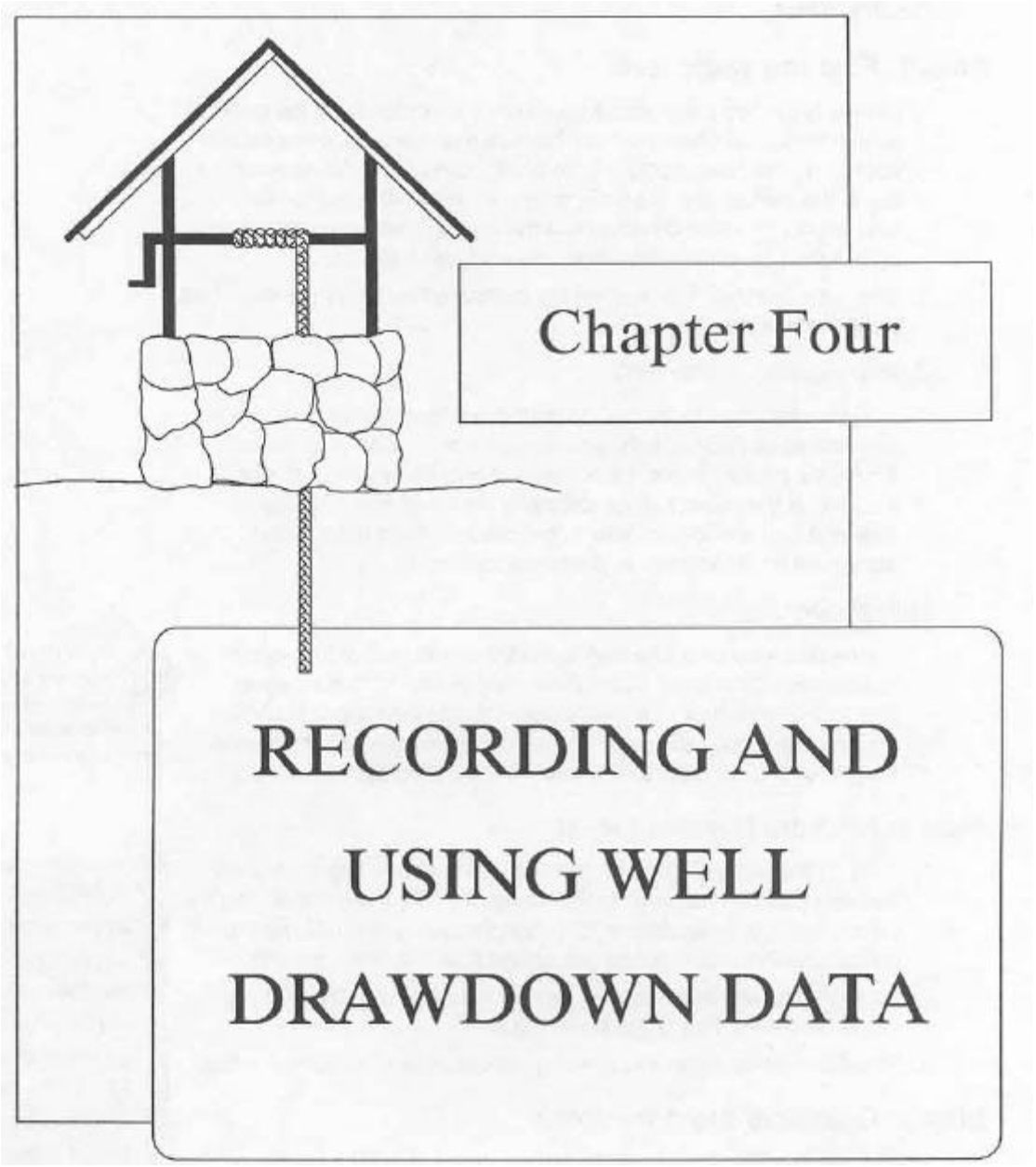
3. Reset the pump control to the original setting and remove the tag.

Step 3: Calculate the drawdown

Calculate the drawdown by subtracting the static level from the pumping level.



For example, if the static level is 65 feet and the pumping level is 72 feet, the drawdown is 7 feet.


Chapter Four
RECORDING AND
USING WELL
DRAWDOWN DATA

HERE ARE SOME FINAL TIPS FOR COLLECTING AND saving well testing data. Also listed are some ways that you can use well drawdown measurements.

Records

Make sure you have a file set up for each well in your system. This file should contain such information as:

- Operating records
- Maintenance records
- Initial design plans
- Construction records
- Well acceptance test
- Pump data
- Well abandonment records

Operating records

Operating records should contain information about the static and pumping levels of a well, plus other important data. Some state regulatory agencies require this information in ground water operations reports.

Using drawdown measurements

The data you gather from drawdown measurements can give you valuable information about the condition and operation of your wells. To make the best use of drawdown data, however, you also need to know your wells' yields. With this information, you can evaluate the efficiency and performance of your pumps, wells and aquifer.

For more information . . .

For more information, see the references listed in the bibliography, or contact the professional water association in your area.

Bibliography

Anderson, Keith E., ed. **Water Well Handbook,** 3rd ed. Rolla, Missouri: Missouri Water Well & Pump Contractors Assn., Inc., 1973.

Driscoll, F. G. **Groundwater and Wells,** 2nd ed. St. Paul, Minnesota: Johnson Division, UOP Inc., 1986.

Ground Water and Wells: A Reference Book for the Water-Well Industry. Saint Paul, Minnesota: Johnson Division, UOP Inc., 1975.

Groundwater Manual for B-Well and C-Well Training Courses. North Carolina Waterworks Operators Association Manual Committee, 1983.

Kerri, Kenneth D., ed. **Water Supply System Operation: A Field Study Training Program.** Sacramento: California State University, 1983.

"Measuring Well Drawdown and Specific Capacity." **Opflow.** Vol. 14, No. 5. May, 1988, pp. 4-5.

Operation and Maintenance Manual for Small Water Systems. New Mexico Health & Environment Department, Environmental Improvement Division.

Small System Water Operator's Manual. National Rural Water Association.