GWPD 12—Measuring water levels in a flowing well

VERSION: 2010.1

PURPOSE: To measure low-pressure or high-pressure hydraulic head in flowing wells.

Materials and Instruments

1. Low-pressure head measurement
   - Short length of transparent plastic tubing
   - Hose clamps
   - Measuring scale
2. High-pressure head measurement
   - Flexible hose with a 3-way valve
   - Hose clamps
   - Altitude or pressure gauge with proper pressure range, and spare gauges
   - Small open end wrench
   - Soil-pipe test plug, also known as a sanitary seal, is a length of small-diameter pipe, generally 0.75 inch, surrounded by a rubber packer. The packer can be expanded by an attached wingnut to fit tightly against the inside of the well casing or discharge pipe. Soil-pipe test plugs are available from most plumbing-supply stores in 2- to 10-inch diameter sizes. The small-diameter pipe is threaded so that it can be attached to a valve, hose, or pressure gauge.
3. Pencil or pen, blue or black ink. Strikethrough, date, and initial errors; no erasures
4. Calibration and maintenance logbook
5. Water-level measurement field form

Data Accuracy and Limitations

1. Low-pressure head measurements are most feasible with heads less than 6 feet above land surface.
2. With care and experience, low-pressure head measurements can be measured to an accuracy of 0.1 foot.
3. Accuracy is a function of calibration, maintenance, and the quality and range of the pressure gauge. High-pressure head measurements using a pressure gauge can be as accurate as 0.1 foot, but may only be accurate to 1 foot or more, depending on the gauge accuracy and range.
4. A pressure gauge is the most accurate in the middle third of the gauge's range. Never let the well pressure exceed the altitude/pressure gauge limits.
5. Never connect a gauge to a well that uses a booster pump in the system, because the pump could start automatically and the resulting pressure surge may ruin the gauge.
6. Closing or opening a valve or test plug in a flowing well should be done gradually. If pressure is applied or released suddenly, the well could be permanently damaged by the "water-hammer effect" by caving of the aquifer material, breakage of the well casing, or damage to the distribution lines or gauges. To reduce the possibility of water-hammer effect, a pressure-snubber should be installed ahead of the altitude/pressure gauge.
7. Ideally, all flow from the well should be shut down so that a static water-level measurement can be made. However, because of well owner objections or system leaks, this is not always possible. If the well does not have a shut-down valve, it can be shut-in by temporarily installing a soil-pipe test plug on the well or discharge line.
8. If a well has to be shut down, the time required to reach static pressure after shut-in may range from hours to days. Since it may be impractical or impossible to reach true static conditions, record the shut-in time for each gauge reading. During return visits to a particular well, it is desirable to duplicate the previously used shut-in time before making an altitude/pressure-gauge reading.

Advantages

1. Low-pressure head measurement
   - Simpler, faster, safer, and more accurate than the high-pressure head method.
2. High-pressure head measurement
   - Can be used on wells with heads greater than 5 to 6 feet above land surface.

Disadvantages

1. Low-pressure head measurement
   - Impractical for wells with heads greater than 5 to 6 feet above land surface.
2. High-pressure head measurement
   - More complex, slower, less accurate, and more dangerous to make than low-pressure head measurements.
   - Pressure gauges are delicate, easily broken, and subject to erroneous readings if dropped or mistreated.
   - Difficult to calibrate.

Assumptions

1. An established measuring point (MP) exists. See GWPD 3 for technical procedures on establishing an MP.
2. Pressure gauges have been calibrated with a dead-weight tester.
3. A logbook containing all calibration and maintenance records is available for each pressure gauge.
4. Field measurements are recorded on paper forms or handheld computer.
5. The same procedure is used for measurements referenced to altitude or measuring points, but with a different datum correction.
6. The water level is above land surface but referenced to land-surface datum (LSD). Measurements above LSD are recorded as negative numbers.

Instructions

1. Low-pressure head measurement (direct measurement)
   a. Connect a short length of transparent plastic tubing tightly to the well with hose clamps.
   b. Raise the free end of the tubing until the flow stops.
   c. Rest the measuring scale on the MP.
   d. Place the hose against the measuring scale and read the water level directly. Record the measurement time and WL above MP in the appropriate row of the water-level measurement field form for a low-pressure flowing well measurement (fig. 1)—WL above MP.
   e. Add the MP correction to get the depth to water below LSD. An MP correction above LSD is recorded as a negative number by convention.
   f. Repeat steps b–e for a second check reading. If the check measurement does not agree with the original measurement within 0.1 or 0.2 of a foot, continue to make check measurements until the reason for the lack of agreement is determined or until the results are shown to be repeatable. If more than two readings are taken, use best judgment to select the measurement most representative of field conditions.
2. High-pressure head measurement (indirect measurement)
   a. Make sure that all well valves are closed except the one to the pressure gauge. This will prevent use of the well during the measurement period and assure an accurate water-level reading. Record the original position of each valve that is closed (full open, half open, closed, etc.), so that the well can be restored to its original operating condition.
   b. Connect a flexible hose with a 3-way valve to the well with hose clamps. Expanders/reducers are okay.
   c. Select a gauge where the expected water pressure in the well will fall in the middle third of the gauge range. If in doubt, use a pressure gauge with a 100-pound per square inch (psi) range to make an initial measurement, then select the gauge with the proper range for more accurate measurements.
   d. Attach the pressure gauge to one of the two “open” valve positions using a wrench. Never tighten or loosen the gauge by twisting the case because the strain will disturb the calibration and give erroneous readings.
   e. Bleed air from the hose, using the other “open” valve position.

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WATER-LEVEL MEASUREMENT FIELD FORM
Low-Pressure Flowing Well Measurement

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SITE INFORMATION

SITE ID (C1)

Equipment ID

Date of Field Visit

Station name (C12)

WATER-LEVEL DATA

	1	2	3	4	5
Time					
WL below LSD					
MP correction					
WL below LSD					

Measured by _____ COMMENTS*_____

*Comments should include quality concerns and changes in: M.P., ownership, access, locks, dogs, measuring problems, et al.

MEASURING POINT DATA (for MP Changes)

M.P. REMARKS (C324)

BEGINNING DATE (C321) — month – day – year

ENDING DATE (C322) — month – day – year

M.P. HEIGHT (C323) NOTE: (-) for MP below land surface

Final Measurement for GWSI

WATER LEVEL TYPE CODE (C243): L below land surface; M below meas. pt.; S sea level

DATE WATER LEVEL MEASURED (C235)	TIME (C709)	STATUS (C238)	METHOD (C239)	TYPE (C243)	WATER LEVEL (C237)
month – day – year			M		.
		(GWPD12)		(GWPD12)	(GWPD1)

(GWPD4)

METHOD OF WATER-LEVEL MEASUREMENT(C239)

A	B	C	E	G	H	L	M	N	R	S	T	V	Z
airline,	analog,	calibrated airline,	estimated,	pressure gage,	calibrated press. gage,	geophysical logs,	manometer,	non-rec. gage,	reported,	steel tape,	electric tape,	calibrated elec. tape	other

SITE STATUS FOR WATER LEVEL (C238)

D	E	F	G	H	I	J	M	N	O	P	R	S	T	V	W	X	Z	BLANK
dry,	recently flowing,	flowing,	nearby flowing	nearby recently flowing,	injector site,	injector site monitor,	plugged,	measurement discon.,	obstruction,	pumping,	recently pumped,	nearby pumping,	nearby recently pumped,	foreign substance,	well destroyed,	surface water effects,	other	static

Figure 1. Water-level measurement field form for low-pressure flowing well measurements. This form, or an equivalent custom-designed form, should be used to record field measurements.

f. Open the pressure gauge valve slowly to reduce the risk of damage by the water-hammer effect to the well, distribution lines, and gauges. Once the needle stops moving, tap the glass face of the gauge lightly with a finger to make sure that the needle is not stuck.

g. Make sure that the well is not being used by checking to see that there are no fluctuations in pressure.

h. Hold the pressure gauge in a vertical position, with the center of the gauge at the exact height of the MP (fig. 2). Read the pressure gauge and record in the Gauge Reading row of the water-level measurement field form for a pressure gauge measurement (fig. 3). Record measurement time.

i. If the pressure gauge has a calibration correction factor, document it in the Gauge Correction row, and record the Corrected Gauge Reading. Multiply by –2.307 under common freshwater temperatures to convert pounds per square inch to feet of water.

j. Apply the MP correction to get the depth to water above LSD. An MP correction above LSD is recorded as a negative number by convention.

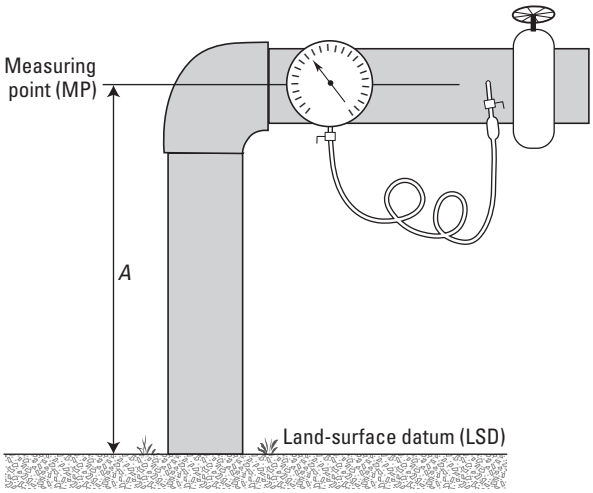

Figure 2. Orientation and position of pressure gauge for measuring water levels in a flowing well.

k. Shut off the well pressure and repeat steps e–i for a second check reading. The measurement should be repeatable within a pressure range based on the range of scale and graduation of the gauge. If more than two readings are taken, use best judgment to select the measurement most representative of field conditions. Document the estimated accuracy of the pressure measurement based on the pressure reading, instrument calibration, the range of the pressure gauge, and manufacturer's guidance.

l. Record the identification number of the pressure gauge with each water-level measurement so that the reading can be back-referenced to the calibration record, if necessary.

Data Recording

All calibration and maintenance data for the pressure gauges are recorded in the calibration logbook. All water-level data are recorded on the water-level measurement field forms (figs. 1 and 2).

References

Cunningham, W.L., and Schalk, C.W., comps., 2011, Groundwater technical procedures of the U.S. Geological Survey, GWPD 3—Establishing a permanent measuring point and other reference marks: U.S. Geological Survey Techniques and Methods 1–A1, 13 p.

Hoopes, B.C., ed., 2004, User's manual for the National Water Information System of the U.S. Geological Survey, Ground-Water Site-Inventory System (version 4.4): U.S. Geological Survey Open-File Report 2005–1251, 274 p.

U.S. Geological Survey, Office of Water Data Coordination, 1977, National handbook of recommended methods for water-data acquisition: Office of Water Data Coordination, Geological Survey, U.S. Department of the Interior, chap. 2, p. 2-11 and 2-12.

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WATER-LEVEL MEASUREMENT FIELD FORM
Pressure Gauge Measurement

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SITE INFORMATION

SITE ID (C1)

Equipment ID

Date of Field Visit

Station name (C12)

WATER-LEVEL DATA

	1	2	3	4	5
Time					
Gauge Reading					
Gauge Correction					
Corrected Gauge Reading					
Conversion to Feet x (–2.307)					
WL below MP					
MP correction					
WL below LSD					

Measured by _____ COMMENTS* _____

*Comments should include quality concerns and changes in: M.P., ownership, access, locks, dogs, measuring problems, et al.

MEASURING POINT DATA (for MP Changes)

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TIME (C709)

STATUS (C238) METHOD (C239) TYPE (C243)

WATER LEVEL (C237)

(GWPD12) (GWPD1) (GWPD4)

METHOD OF WATER-LEVEL MEASUREMENT(C239)

A	B	C	E	G	H	L	M	N	R	S	T	V	Z
airline,	analog,	calibrated airline,	estimated,	pressure gage,	calibrated press. gage,	geophysical logs,	manometer,	non-rec. gage,	reported,	steel tape,	electric tape,	calibrated elec. tape	other

SITE STATUS FOR WATER LEVEL (C238)

D	E	F	G	H	I	J	M	N	O	P	R	S	T	V	W	X	Z	BLANK
dry,	recently flowing,	flowing,	nearby flowing	nearby recently flowing,	injector site,	injector site monitor,	plugged,	measurement discon.,	obstruction,	pumping,	recently pumped,	nearby pumping,	nearby recently pumped,	foreign substance,	well destroyed,	surface water effects,	other	static

Figure 3. Water-level measurement field form for pressure gauge measurements. This form, or an equivalent custom-designed form, should be used to record field measurements.