



Measuring Water Levels and Conducting Pump Tests

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Introduction:

Water-Level & Pump Test Requirements

1) Permit Conditions

- Static water-level measurements are required for wells on many new permits
- Generally require annual March measurements

2) Pump Test Rules (OAR 690-217)

- A pump test is required for each well on a water right with a priority date > 12/19/1988 prior to issuance of a certificate
- Four-hour minimum pumping time



Introduction:

How We Use Water Level Data

- ❖ GW application reviews
 - Adequate supply for proposed use?
 - Over appropriated?
 - Impact on SW supplies?
- ❖ Interference complaints
 - Well or aquifer problem?
 - Same aquifer
 - Historic water levels?
- ❖ GW management decisions
 - Classifications, Withdrawals, CGWA
 - Conjunctive GW/SW management



Introduction

- ❖ Permit Condition and Pump Test programs are integral parts of OWRD's data collection effort
- ❖ Obtaining highest quality data is a top priority
- ❖ Goal of this talk is to provide info. that makes measuring water levels and conducting pump tests a bit easier.



Overview

- ❖ Part One: Well Identification
 - Tips on properly identifying a well
- ❖ Part Two: Water-Level Measurement
 - What water levels tell us
 - Water-level status
 - Measurement methods
 - How to get good water-level data
 - Miscellaneous Problems
 - Miscellaneous Tips



Overview (continued)

❖ Part Three: Pump Tests

- What is a pump test?
- What pump tests tell us?
- Pump test requirements
- Exemptions
- Discharge measurement methods
- Water-level measurement methods



Overview (continued)

- ❖ Part Three: Pump Tests (continued)
 - Pump test examples
 - Pump test forms
 - Pump test tips



Part One: Well Identification



Well Identification

- ❖ Water levels are of limited value if well construction is unknown
 - Well Logs (Logids)
 - Well Tag (on Well)
- ❖ Or independent well construction information
 - sounded depth
 - casing diameter
 - original owner
- ❖ GPS Location
- ❖ Contact Groundwater staff
- ❖ Ask questions





Well Identification: Useful Questions

- ❖ **Example Questions:**
 - Do you have more than one well?
 - Is this the 350 foot well drilled in 1997?
 - Has this well ever been deepened or altered? When? By whom?
 - Who was the original owner of the well?



Part Two: Water-Level Measurement



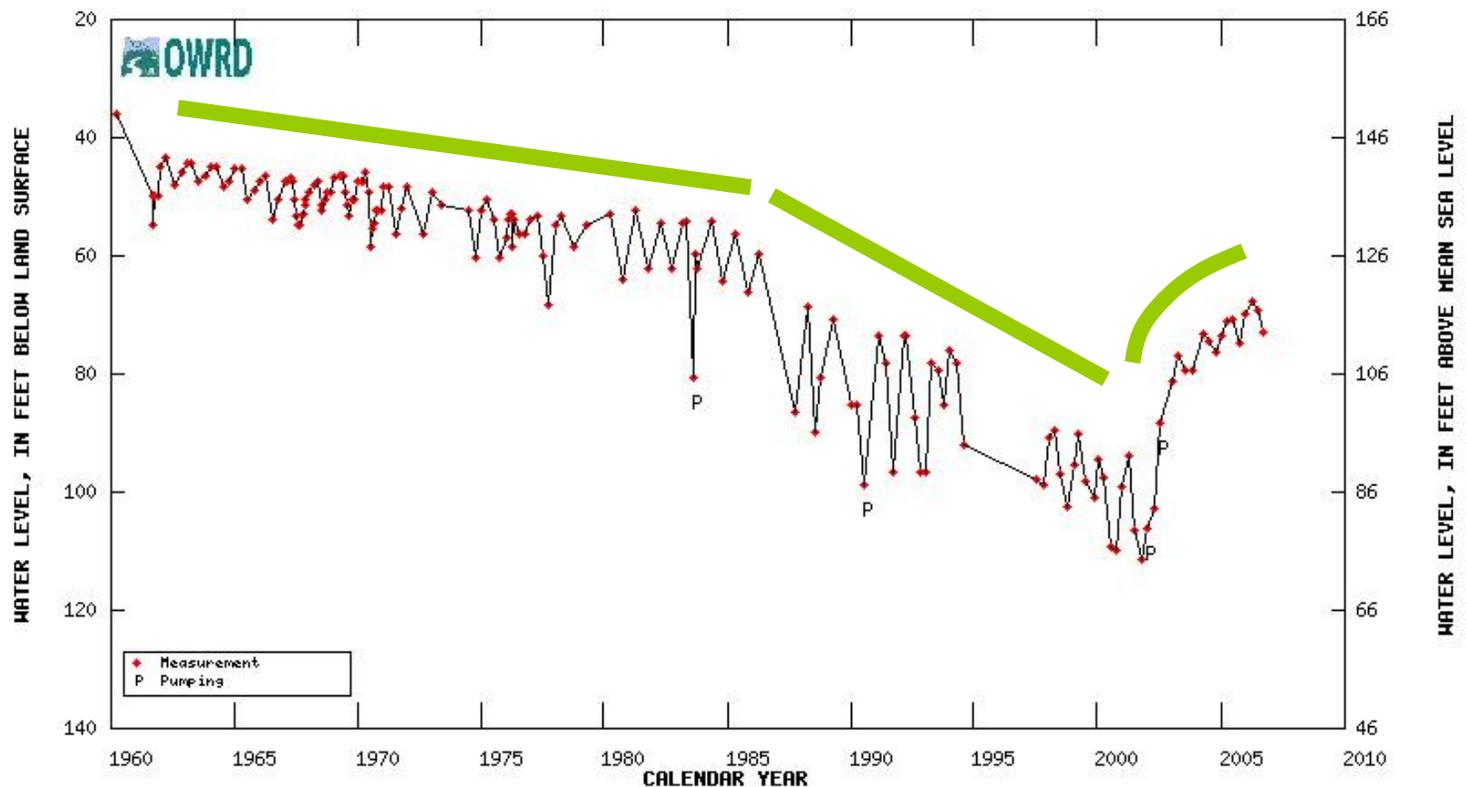
What Water Levels Tells Us

- ❖ How much water is in storage?
- ❖ Is storage changing over time?
 - Natural changes
 - Changes caused by pumping
- ❖ Direction & rate of groundwater movement
- ❖ How groundwater interacts with surface water



Water-Level Measurements Reflect Changes in Aquifer Storage Over Time

Well Location	3,00S1,00M16000
Oregon Water Resources Department Well Log ID	CLAC 8231
Oregon Water Resources Department State Observation Well Number	40
Well depth, in feet below land surface	1000
Land surface elevation, in feet above mean sea level	186
Primary use of well	PUBLIC SUPPLY





Water Level Status

❖ Water level status

- static
- pumping
- rising
- falling
- flowing
- Dry

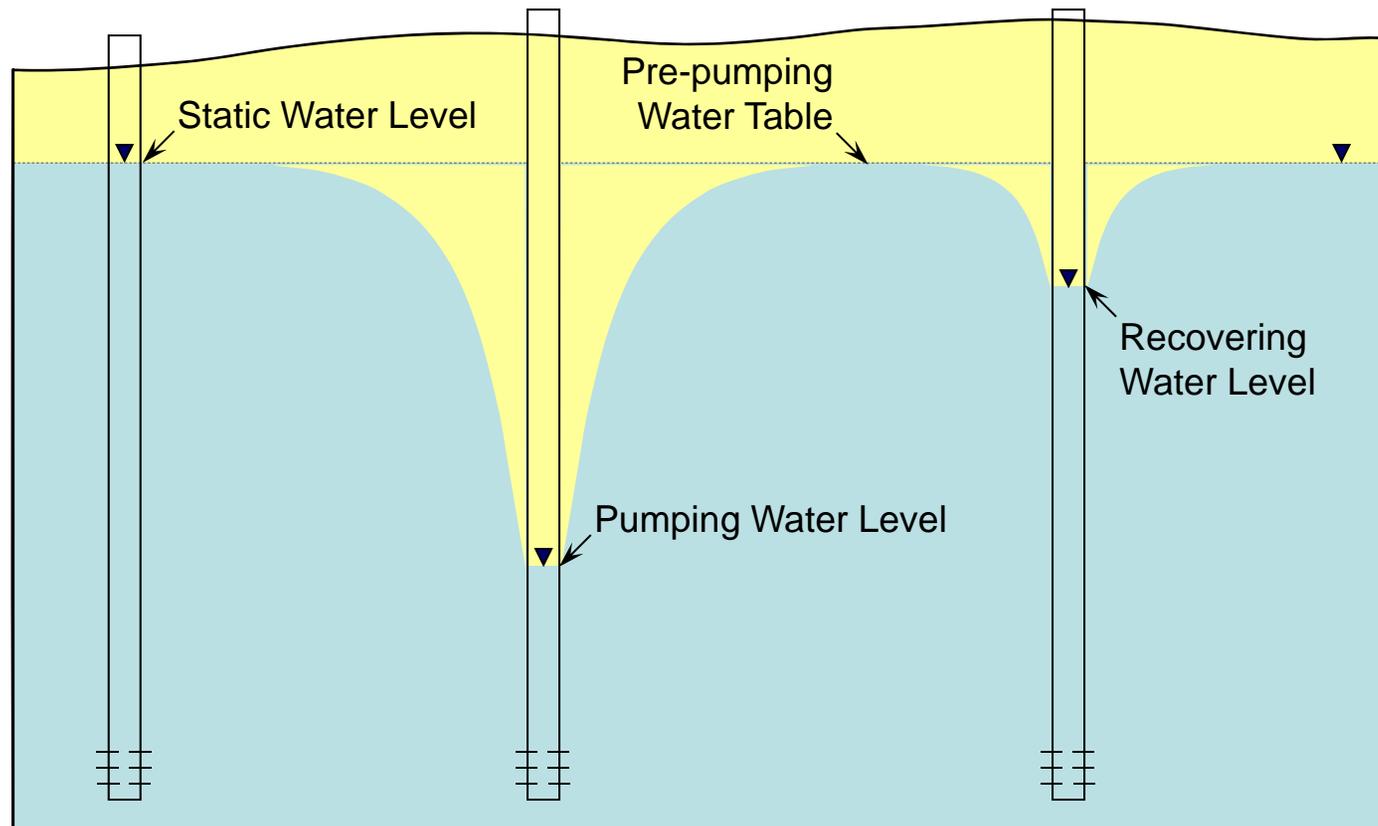


❖ Why do we care?

❖ Static vs recovery water levels (how to tell)



Water Level Status

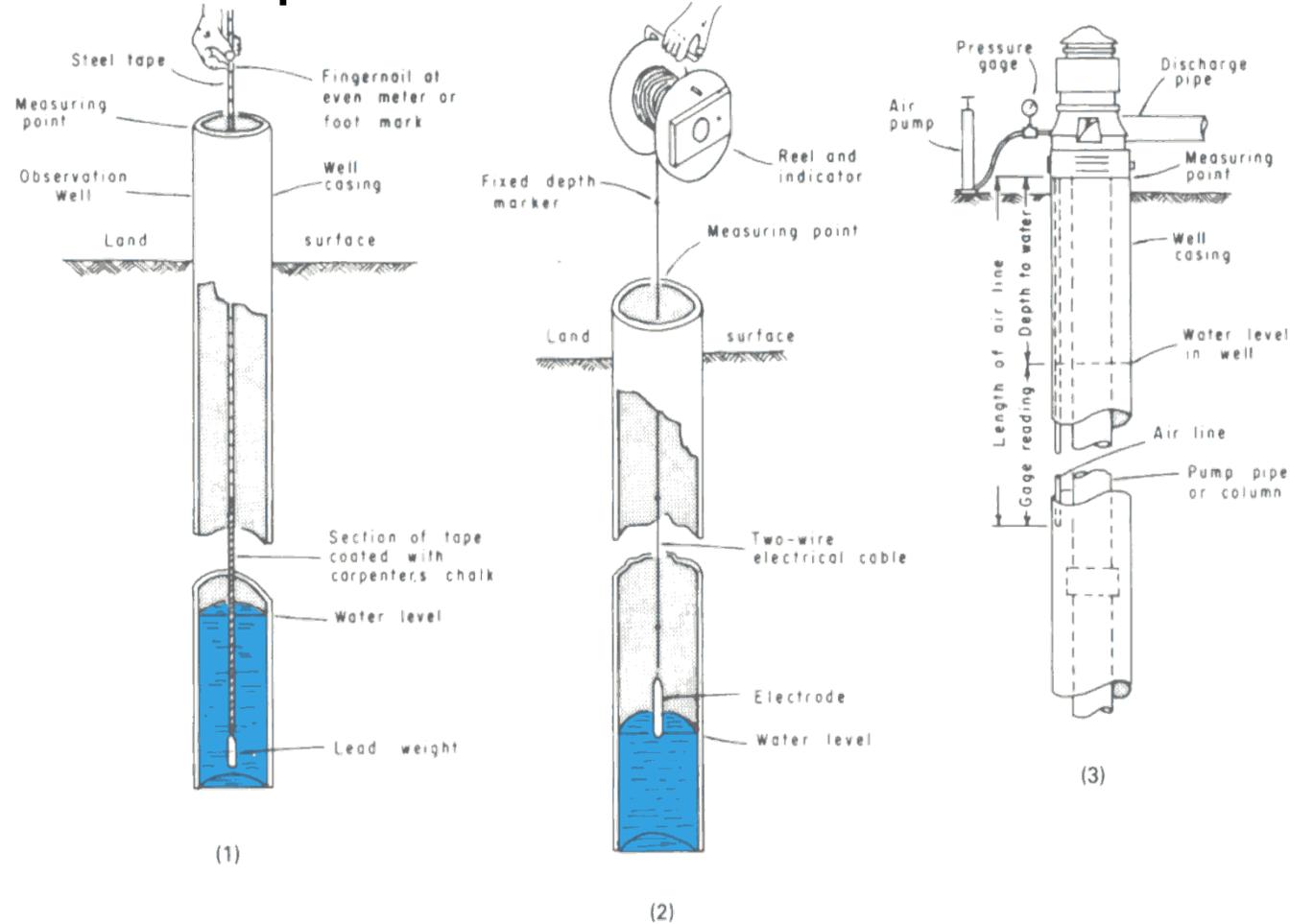




Typical Water Level Measurement Methods

METHODS FOR MEASURING THE DEPTH TO WATER LEVEL IN WELLS

Steel Tape Electric Water Level Meter Air Line



Electrical Tape (E-tape)

Steel Tape

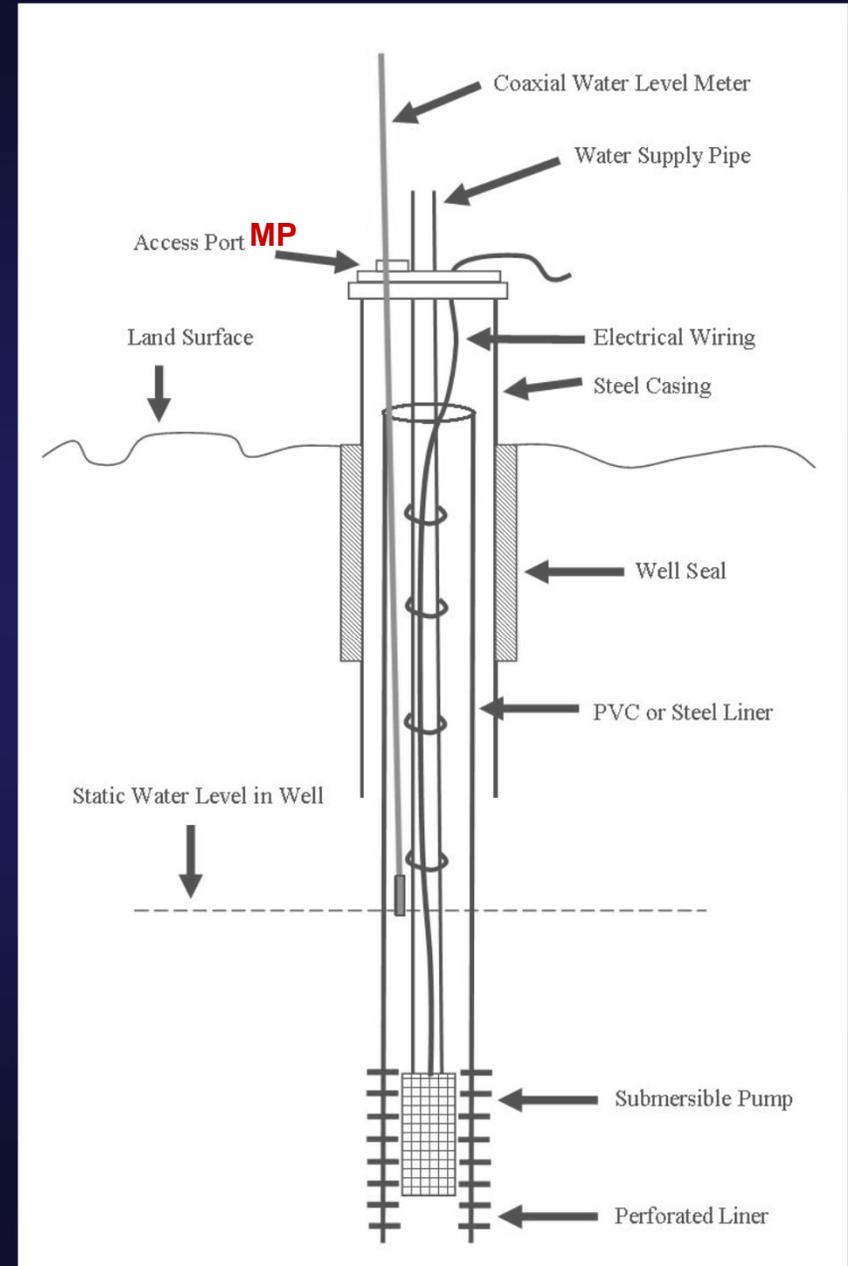
Air Line (and gauge)



Well Diagram

- ❖ Measure water level below Measuring Point (WLBMP)
- ❖ Measure MP height relative to land surface
- ❖ Calculate water level below land surface (WLBLS)

$WLBLS = WLBMP - MP \text{ Height}$
If MP is below land surface, MP Height is a negative number





How To Get Good Water Level Data

Before Going in the Well

- ❖ Clean e-tape contacts
- ❖ Know well construction
 - liner? Total depth? Pump depth?
- ❖ Expected depth to H₂O
- ❖ String weights to come off easily
 - (lose weights, not line)



How To Get Good Water Level Data

On The Way Down

- ❖ Reel line out slowly
- ❖ Monitor line weight
- ❖ Shake to feel free-hanging weights
- ❖ If hung-up
 - raise line 4-5 ft above pick-up point & drop
 - add extra weights
 - try another way in
 - ❖ redirect line through access port
 - ❖ electrical wire port
 - ❖ bolt hole



How To Get Good Water Level Data

On the Way Out

- ❖ Reel line in slowly
- ❖ If hung up
 - don't yank line
 - shake line just below "tension point"
 - pull line slowly to release weights
 - Note "hold point" if line breaks or if strong pull is needed to get free



Miscellaneous Problems

Cascading water

- ❖ chattering signal
- ❖ separate leads 12-18 inches
- ❖ use a shroud
- ❖ decrease sensitivity
- ❖ note “cc wtr” in comments (depth?)



Miscellaneous Problems

Oil on water (turbines)

- ❖ get line thru oil into water
- ❖ shake line to get a good signal
- ❖ raise slowly until signal stops
- ❖ repeat 2-3 times
- ❖ note “oil” in comments



Miscellaneous Tips

- ❖ Keep equipment clean / sanitized
- ❖ Record all numbers carefully
- ❖ Double-check all calculations
- ❖ Make sure you are at the right well



Part Three: Pump Tests



Pump Test Definition

A **controlled procedure** in which water is withdrawn from a well at a **constant rate** for a specified period of time and in which the **water level** in the well is **measured at specified intervals before, during and after pumping** (OAR 690-217-0010(6)).



Information Provided by Pump Tests

- ❖ Well performance
 - Yield
 - Drawdown
 - Well efficiency
- ❖ Aquifer transmissivity (“permeability”)
- ❖ Estimate of future drawdown
- ❖ Estimate of well interference
- ❖ Degree of connection between aquifer & stream
- ❖ Presence of hydraulic barriers (aquifer boundaries)



Minimum Test Requirements

- ❖ Pump must be idle 16 hours prior to test
- ❖ Three static water level msmts within hour prior to test
- ❖ Discharge
 - Constant rate
 - Near as possible to rate used during normal use
 - Measure at beginning of test and each hour during test
- ❖ Pumping phase
 - 4 hours
 - 0-10 minutes: measure wtr lvls every 2 minutes
 - 10-30 minutes: measure wtr lvls every 5 minutes
 - 30-240 minutes: measure wtr lvls every 15 minutes
- ❖ Water level msmts – Recovery phase
 - 4 hours or until 90% recovery
 - 0-10 minutes: measure wtr lvls every 2 minutes
 - 10-30 minutes: measure wtr lvls every 5 minutes
 - 30-240 minutes: measure wtr lvls every 15 minutes



Preferred Test Procedures

- ❖ Pump must be idle 16 hours prior to test
- ❖ ~~Three static water level msmts within hour prior to test~~ Static water level msmts every 20 mins. 2-3 hrs prior to test
- ❖ Discharge
 - Constant rate
 - Near as possible to rate used during normal use
 - ~~Measure at beginning of test and each hour during test~~ Measure on same frequency as water levels
- ❖ Pumping phase
 - 4 hours
 - ~~0-10 minutes: measure wtr lvls every 2 minutes~~ Measure every minute if possible, more important to record exact time (to nearest second) than to measure on set intervals
 - 10-30 minutes: measure wtr lvls every 5 minutes
 - 30-240 minutes: measure wtr lvls every 15 minutes
- ❖ Water level msmts – Recovery phase
 - ~~4 hours or until 90% recovery~~ If 90% recovery occurs within minutes, measure to 95 or 100% recovery
 - ~~0-10 minutes: measure wtr lvls every 2 minutes~~ Measure every minute if possible, more important to record exact time (to nearest second) than to measure on set intervals
 - 10-30 minutes: measure wtr lvls every 5 minutes
 - 30-240 minutes: measure wtr lvls every 15 minutes



Exemptions

❖ Multiple Well Exemptions

- Same owner as tested well
- Wells must produce from same aquifer as tested well
- Wells must be within five miles of tested well
- Exemption must be requested in writing
- Well reports must be supplied for all wells to document aquifer source

❖ Complete Exemptions

- Possible in some cases
- Request must be submitted in writing

❖ Tests Not Required for

- Infiltration galleries, collector wells
- Wells > 36 inch diameter & <30 feet deep



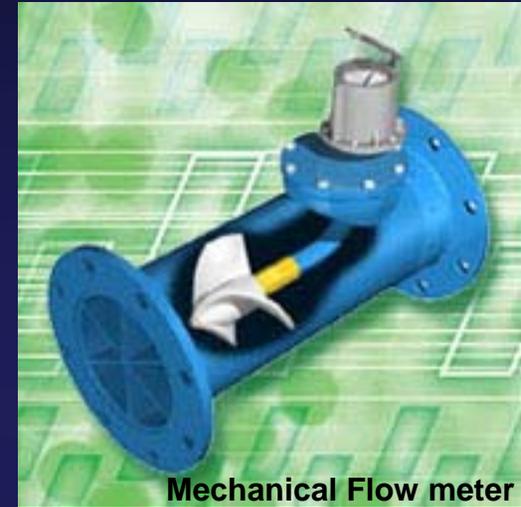
Acceptable Discharge Measurement Methods

- ❖ Properly installed & calibrated flow meter
- ❖ Properly installed weir or flume
- ❖ Properly installed & calibrated orifice plate & manometer
- ❖ Properly installed ultrasonic flow meter
- ❖ Volume / time method (calibrated bucket & stopwatch)



Discharge Measurement Methods

Ultrasonic Flow meter



Bucket and Stopwatch



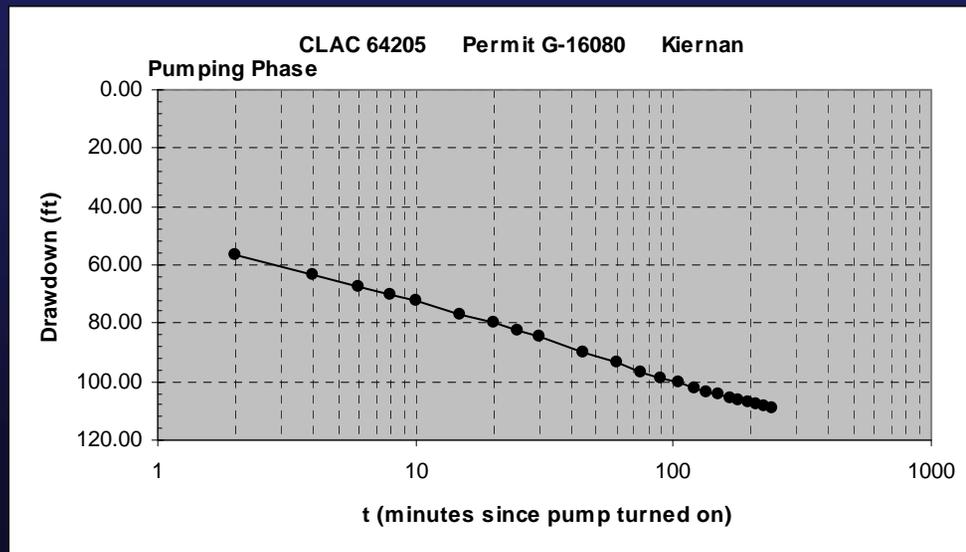
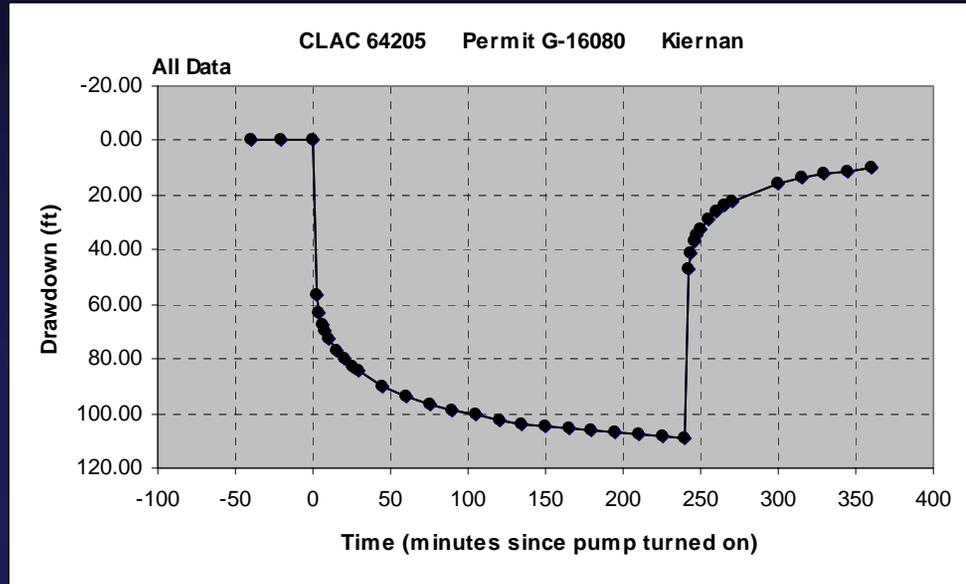


Acceptable Water Level Measurement Methods & Standards

- ❖ Electric measuring tape (etape)
 - Depth markings at least every 5 feet
 - Accurate to 0.5% of measurement interval
 - Msmts reported to a precision of at least 1/10th of a foot
- ❖ Air line and pressure gage
 - Only if depth to water is >300 feet
 - Accuracy verified by at least 1 msmt with an etape
- ❖ Steel tape (for static water levels only)

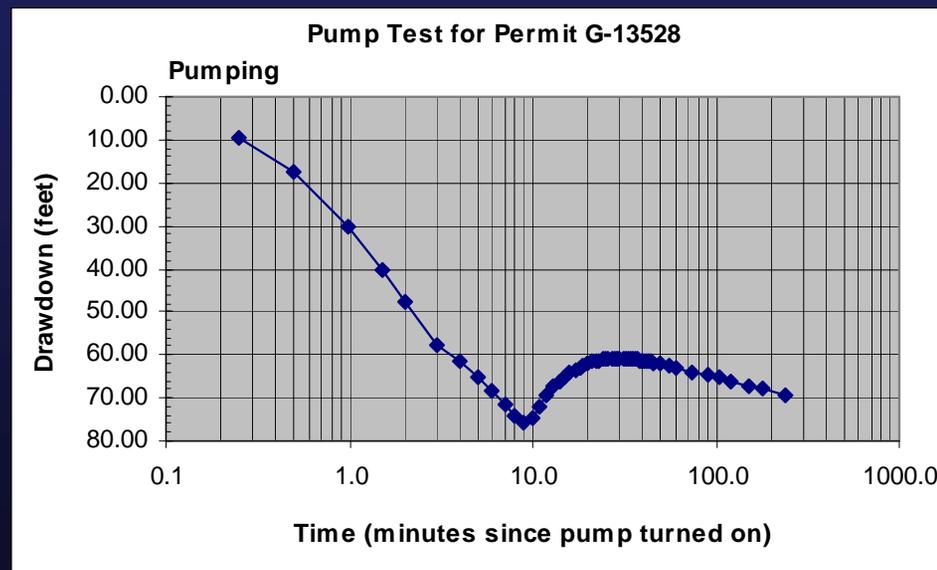
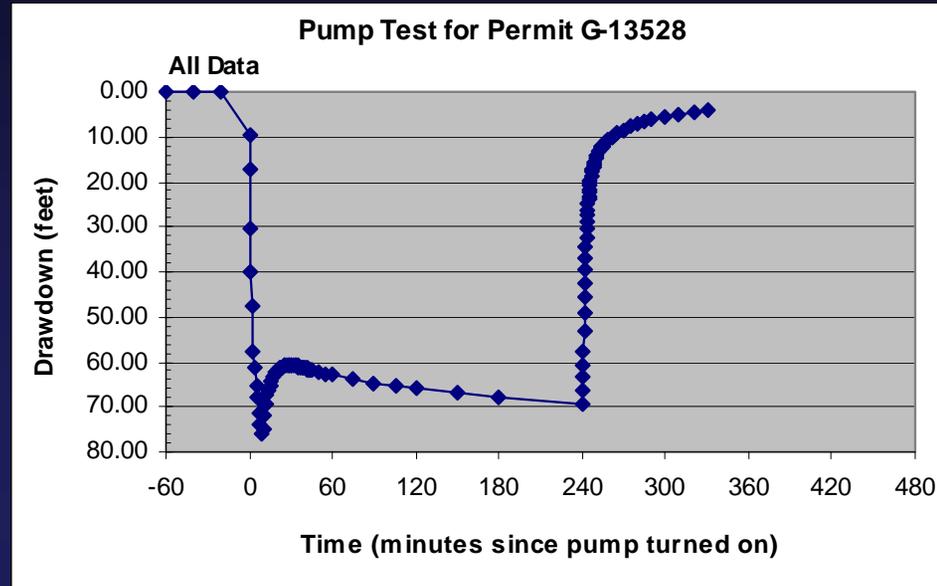


Pump Test Example 1 – Good Test



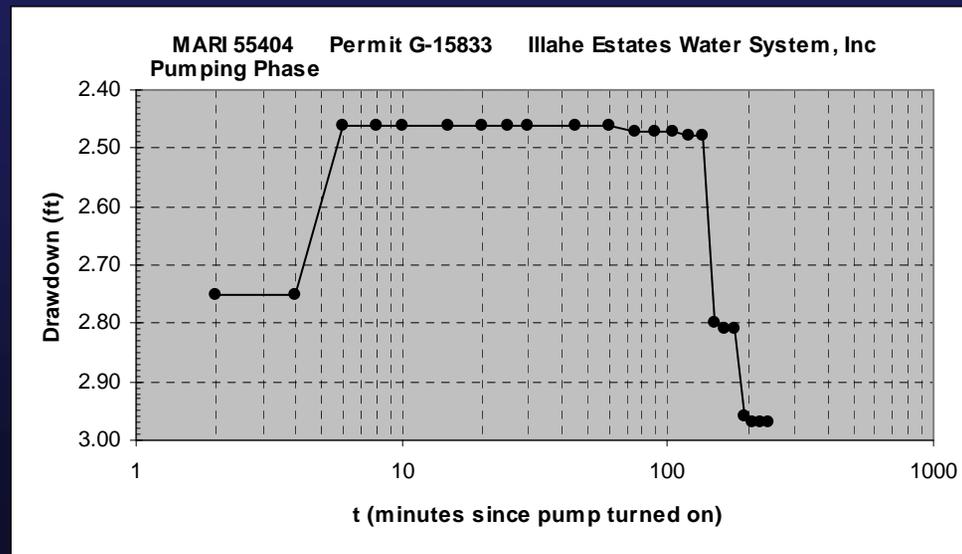
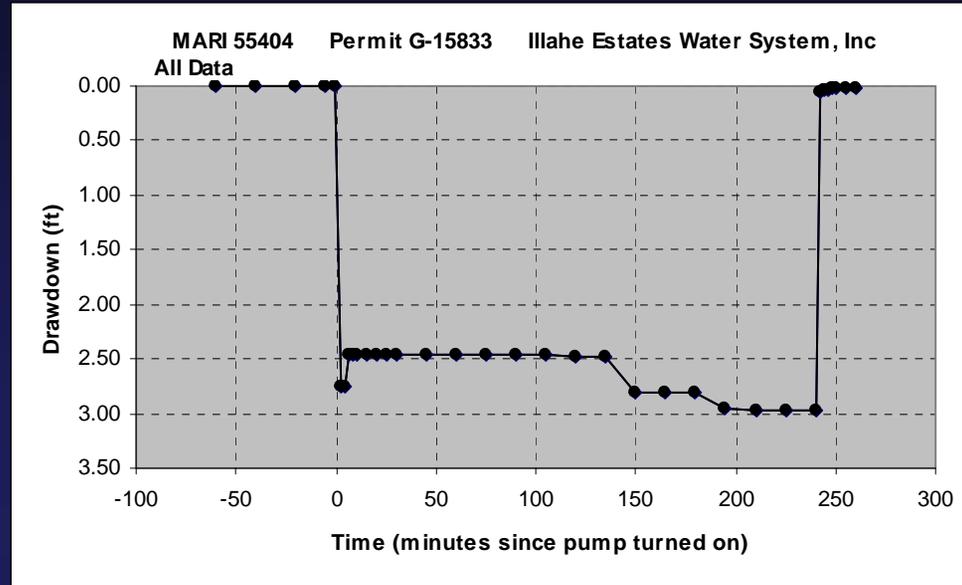


Pump Test Example 2 – Pumping Rate not Constant





Pump Test Example 3 – Poor Quality





Pump Test Forms - Cover Sheet (Top)

Oregon Water Resources Department PUMP TEST FORM COVER SHEET

Well Owner:

Name: _____
Address: _____
County: _____
City: _____ State: **OR** Zip: _____
Original owner (from well log): _____

Well Location:

Township: _____ **S** Range: _____ **E**
Section: _____ 1/4 : **NE** 1/16 **NE** 1/64 : **NE**
Well depth: _____ Date drilled: _____
Owners well no. (if any): _____
POD ID: _____

Water Right Information:

Application: _____ Permit: _____ Certificate: _____
Is this well listed on more than one water right? Yes If yes, list additional water rights below:
Application: _____ Permit: _____ Certificate: _____
Application: _____ Permit: _____ Certificate: _____

Pump Test:

Test Conducted by: _____ Well Owner? Yes
Company: _____
Address: _____ Date of Test: _____
City: _____ State: **OR** Zip: _____
Daytime phone: _____

Method of discharge measurement (see our brochure for more information): **Flow meter**
Method of water-level measurement (pick one or enter other method used): **Choose or enter method**
Length of air line (if used): _____

Pump type (pick one or enter other method used): **Choose one or enter alternative**
Was the pump test conducted during normal use of the well? Yes Note: _____

Are you aware of any wells, other than domestic or stock wells, pumping within 1000 feet of the tested well during the test or within 24 hours prior to the test? Yes Note: _____



Pump Test Forms - Cover Sheet (Bottom)

If yes, give approximate distances to each and approximate pumping rate of each. If possible, indicate if they were turned on or off during the test: _____

Is there a lake, stream or other surface water body within ¼ mile of the tested well? Yes If yes, give approximate distance from the well and approximate elevation difference between the surface water and the well head. Approx. distance: _____ ft Approx. elevation difference: _____ ft

Well elevation is below surface water body.

Description of measuring point (e.g. top port of 1 inch port pipe, west side) _____

Measuring point distance below land surface _____ feet.

Static water level measurements: (A minimum of three measurements are required in the hour before pumping begins at no less than 20 minutes apart):

Time	Depth to water below meas. point	Depth to water below land surface
_____	_____	_____
_____	_____	_____
_____	_____	_____

Discharge measurements: (A discharge measurement is required at the start of pumping and at least once an hour during the test; additional measurements should be noted on the Pump Test Data Sheet):

Time	Discharge Rate	Discharge Units (e.g. gpm, cfs, etc)
_____	_____	<u>gpm (gallons per minute)</u>
_____	_____	<u>gpm (gallons per minute)</u>
_____	_____	<u>gpm (gallons per minute)</u>
_____	_____	<u>gpm (gallons per minute)</u>
_____	_____	<u>gpm (gallons per minute)</u>

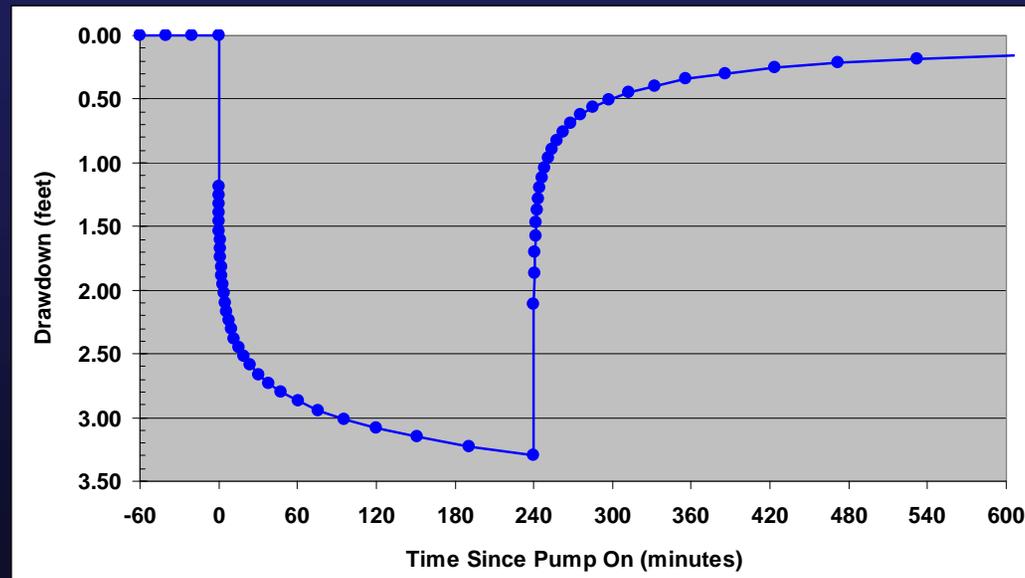
Time pump turned on: Date _____ Time _____
 Time pump turned off: Date _____ Time _____
 Total pumping time: _____ hours _____ minutes

Note: Well must be idle for at least 16 hours prior to the test.



Pump Test Tips

- ❖ Know something about well system before you begin the pump test
 - Do the discharge lines need to be pressurized?
 - Where is the valve that regulates flow from the well?
 - Ask the owner!
- ❖ Record exact time of water-level measurement
 - Most important in early drawdown/recovery





Resources

Pump Test Rules:

http://arcweb.sos.state.or.us/pages/rules/oars_600/oar_690/690_217.html

Permit Condition Water-Level Form:

http://www.oregon.gov/owrd/pubs/docs/forms/permit_condition_wl_form.pdf

Pump Test Forms:

http://www.oregon.gov/owrd/pages/pubs/forms.aspx#Pump_Test

Well Log Database:

http://apps.wrd.state.or.us/apps/gw/well_log/Default.aspx

Water Rights Database:

<http://apps.wrd.state.or.us/apps/wr/wrinfo/>

Water Level Data:

http://www.oregon.gov/owrd/pages/gw/well_data.aspx



OWRD Hydrogeologists by Basin

