THE WELL BUBBLER

REMOTE, SECURE GROUNDWATER WELL MONITORING

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WHY MONITOR MY WELL ?

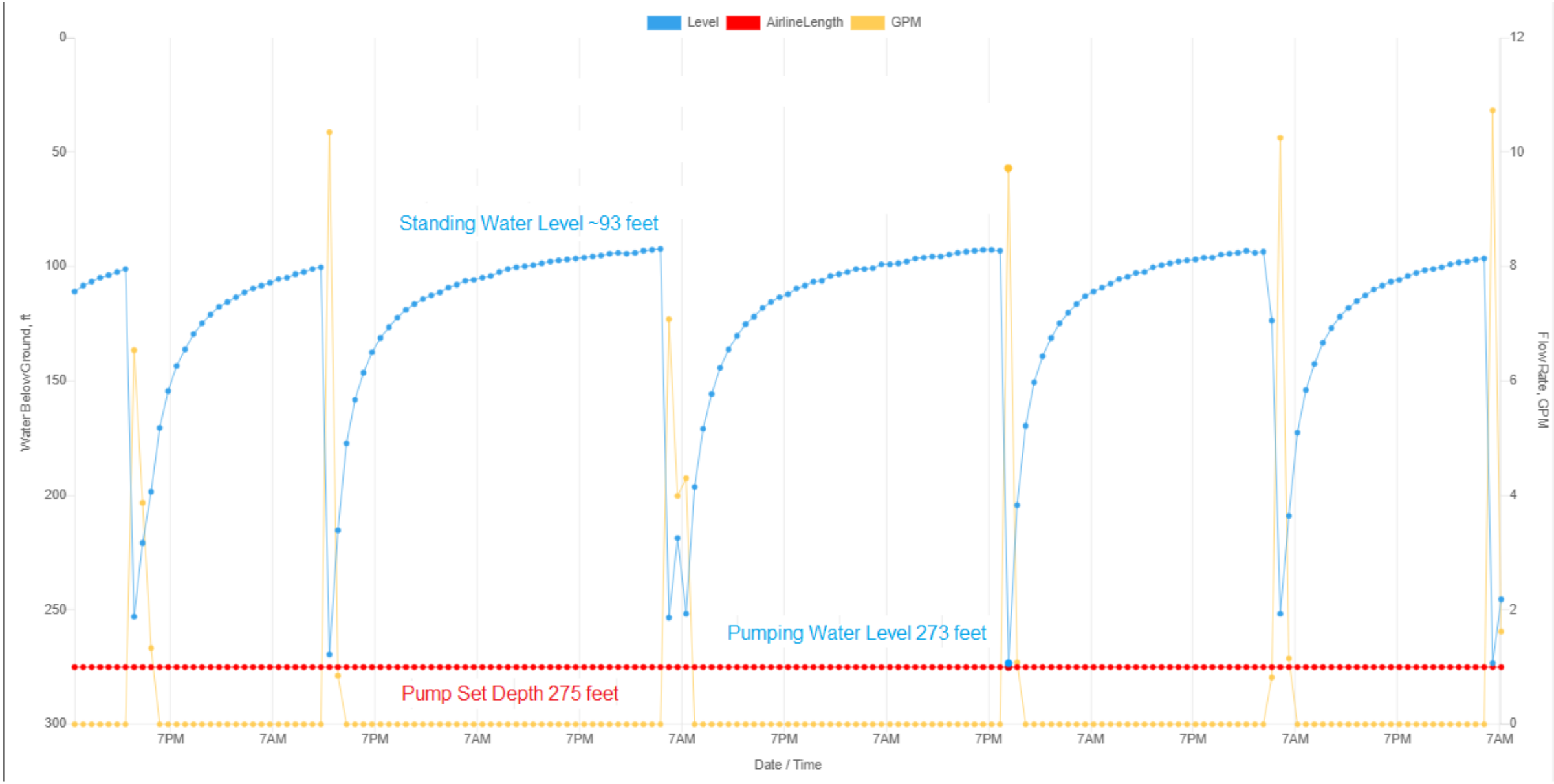
PROTECT THE WELL & PUMP

When water level falls too low the well is over-drafted, often leading to pump and/or motor damage and requiring replacement:

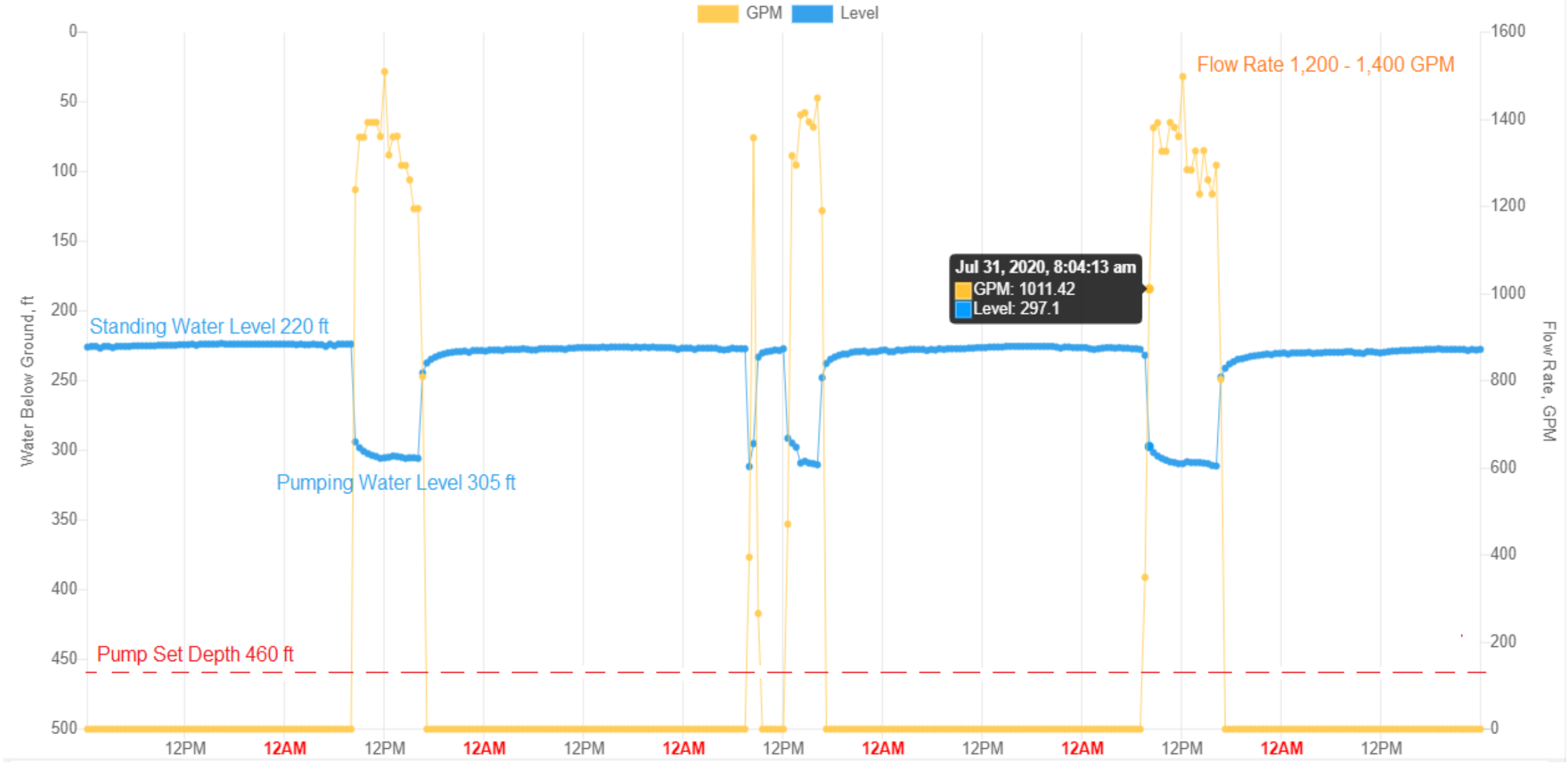
- Submersible motor overheats due to lack of cooling
- Pump impellers damaged due to cavitation (sucking air)
- PVC well casing heat damaged and warped, pump stuck
- Exposed well screen reduces recharge rate

The cost of drilling a new well in California can exceed $100 per foot.

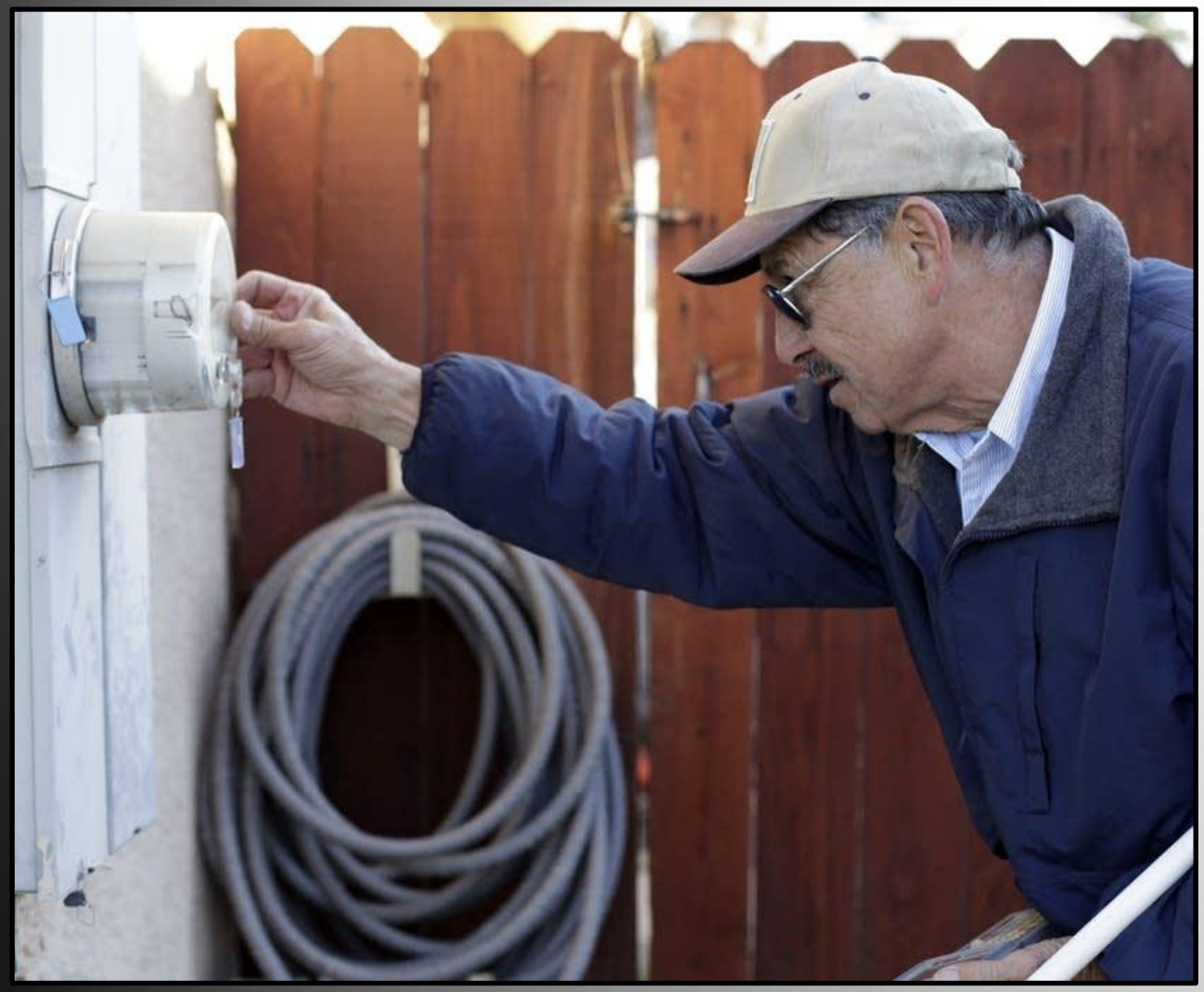
OVER-DRAFTED WELL



BALANCED WELL



WHY MONITOR MY WELL?



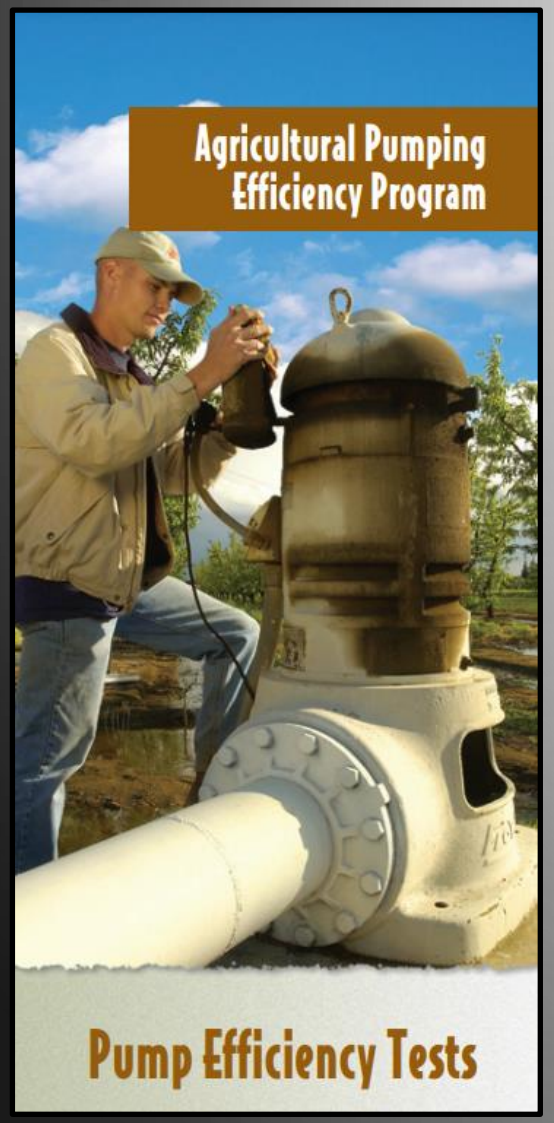
SAVE MONEY

Overall Pumping Efficiency (OPE) is the output hydraulic power of a well, divided by the input power.

It is the “return on investment” of a water well – how much water you are getting for your money.

Pumping well water requires an investment of energy: electric, diesel, natural gas or propane.

OVERALL PUMPING EFFICIENCY



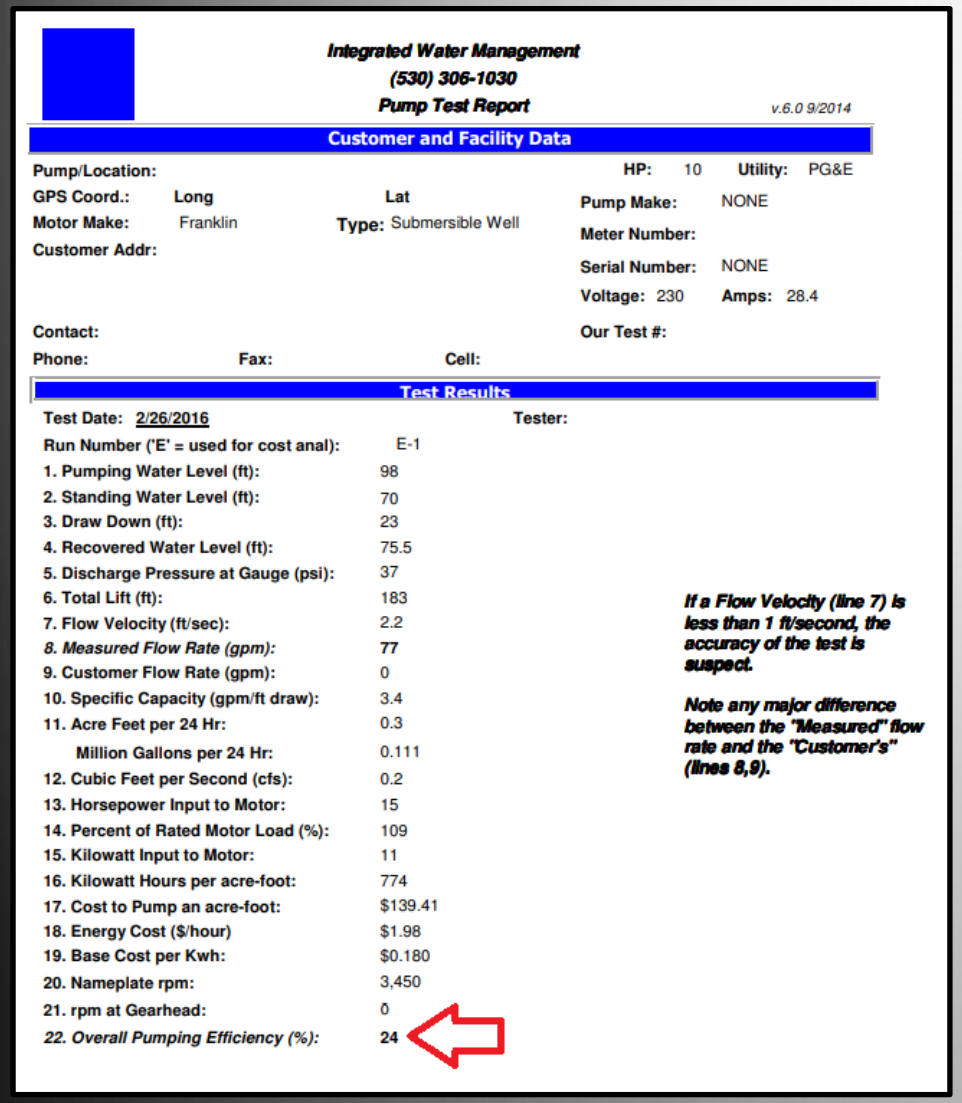
To calculate OPE, the following must be measured:

- Pumping water level (PWL), in feet
- Discharge flow rate, in GPM
- Discharge pressure, in PSI
- Input power, in kW

How are measurements taken?

- The Well Bubbler
- Agricultural Pumping Efficiency Program (APEP)
- Other telemetry products

OVERALL PUMPING EFFICIENCY



Integrated Water Management
(530) 306-1030
Pump Test Report v.6.0 9/2014

Customer and Facility Data

Pump/Location: HP: 10 Utility: PG&E
GPS Coord.: Long Lat Pump Make: NONE
Motor Make: Franklin Type: Submersible Well Meter Number:
Customer Addr: Serial Number: NONE
Voltage: 230 Amps: 28.4
Contact: Our Test #:
Phone: Fax: Cell:

Test Results

Test Date: 2/26/2016 Tester:

Run Number ('E' = used for cost anal):	E-1
1. Pumping Water Level (ft):	98
2. Standing Water Level (ft):	70
3. Draw Down (ft):	23
4. Recovered Water Level (ft):	75.5
5. Discharge Pressure at Gauge (psi):	37
6. Total Lift (ft):	183
7. Flow Velocity (ft/sec):	2.2
8. Measured Flow Rate (gpm):	**77**
9. Customer Flow Rate (gpm):	0
10. Specific Capacity (gpm/ft draw):	3.4
11. Acre Feet per 24 Hr:	0.3
Million Gallons per 24 Hr:	0.111
12. Cubic Feet per Second (cfs):	0.2
13. Horsepower Input to Motor:	15
14. Percent of Rated Motor Load (%):	109
15. Kilowatt Input to Motor:	11
16. Kilowatt Hours per acre-foot:	774
17. Cost to Pump an acre-foot:	$139.41
18. Energy Cost ($/hour)	$1.98
19. Base Cost per Kwh:	$0.180
20. Nameplate rpm:	3,450
21. rpm at Gearhead:	0
22. Overall Pumping Efficiency (%):	**24**

If a Flow Velocity (line 7) is less than 1 ft/second, the accuracy of the test is suspect.

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9).

An OPE of 60-75% indicates a correctly selected pump, in good condition.

An OPE between 30% and 50% indicates an inefficient pump, or an aging one.

A well with an OPE less than 30% requires pump and/or motor service or replacement.

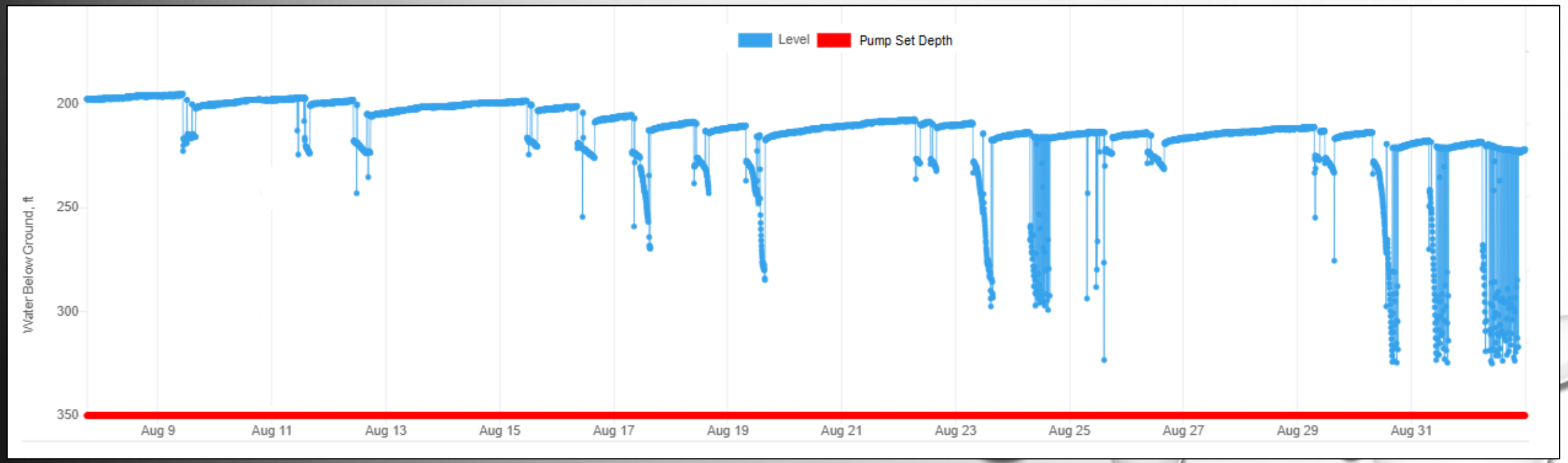
The pump test shown here indicates an OPE of 24% - so, 3/4 of the power used to power the pump is wasted. On inspection, the drop pipe had rusted through, recirculating water back into the well.

MAXIMIZE DAILY PRODUCTION

Standing and pumping water levels decline through the growing season, and in drought

Without monitoring, well becomes over-drafted and daily production is reduced

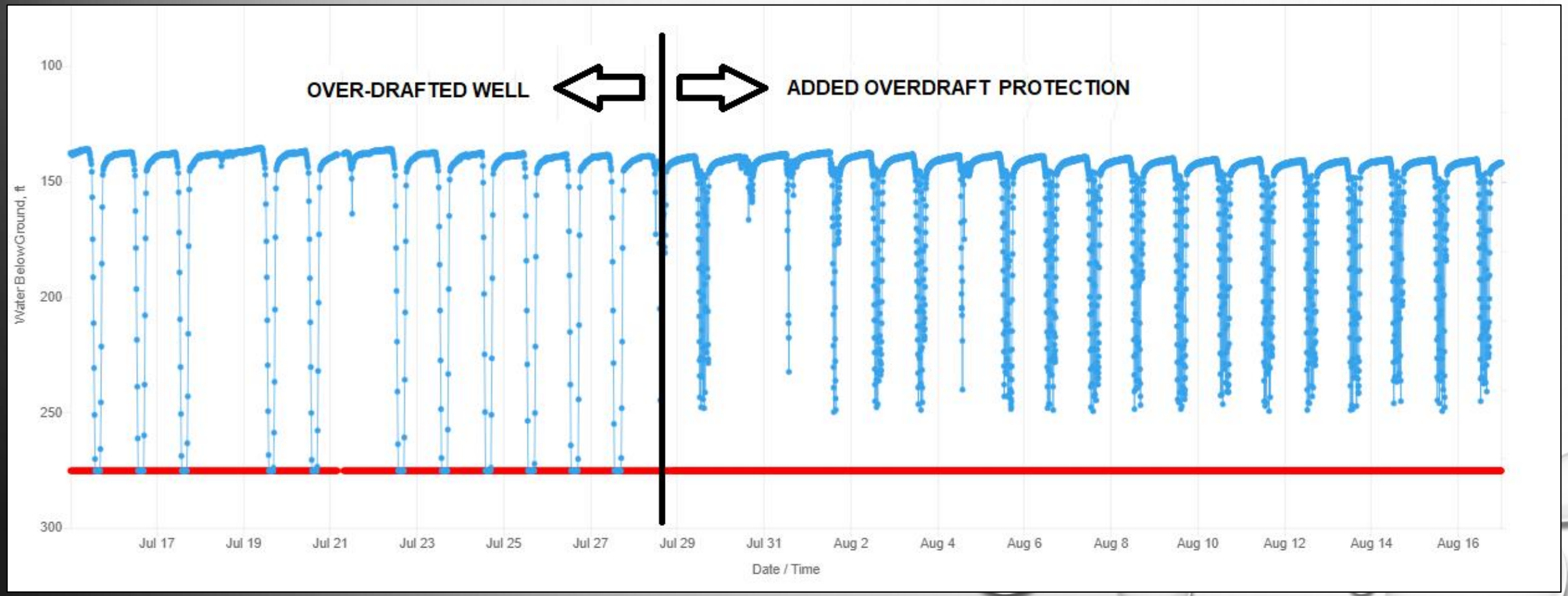
Preventing over-drafting preserves long-term pumping capacity



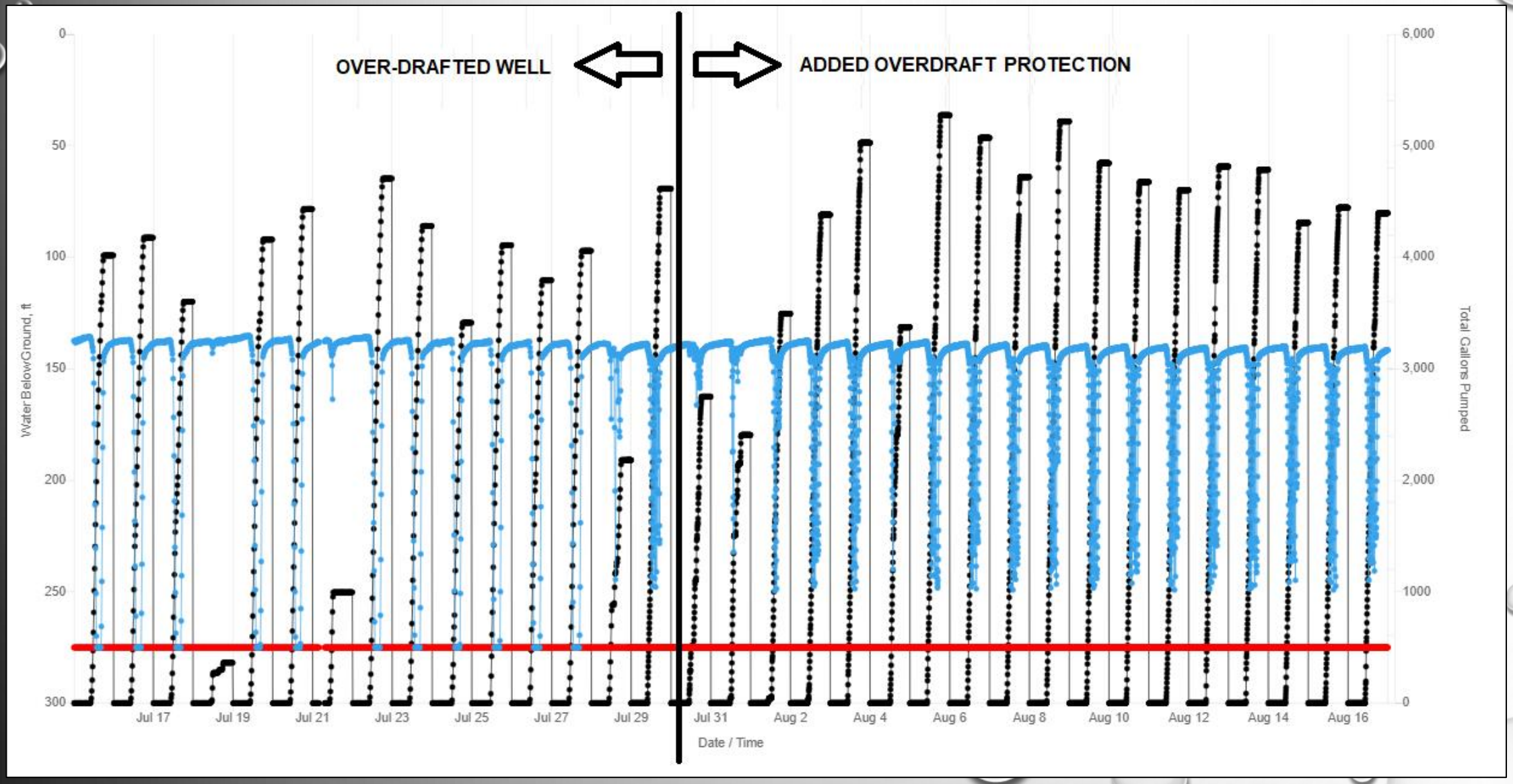
MAXIMIZE DAILY PRODUCTION

- Over-drafted well produces 3,000-5,000 GPD

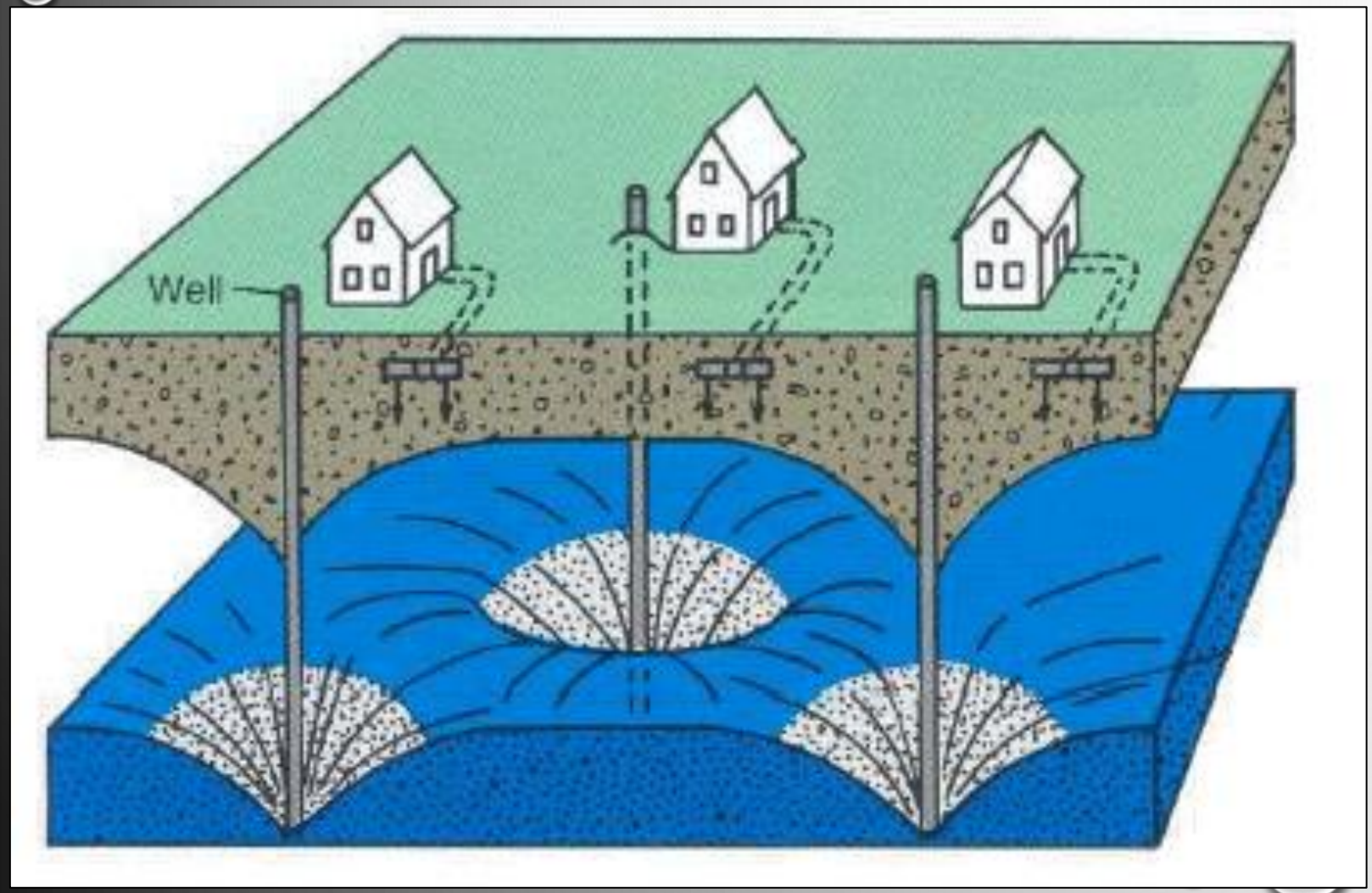
  Managed pumping delivers 4,500-5,500 GPD and protects and pump



MAXIMIZE DAILY PRODUCTION



WHY MONITOR MY WELL?



WELL INTERFERENCE

Two wells “competing” for water from same aquifer

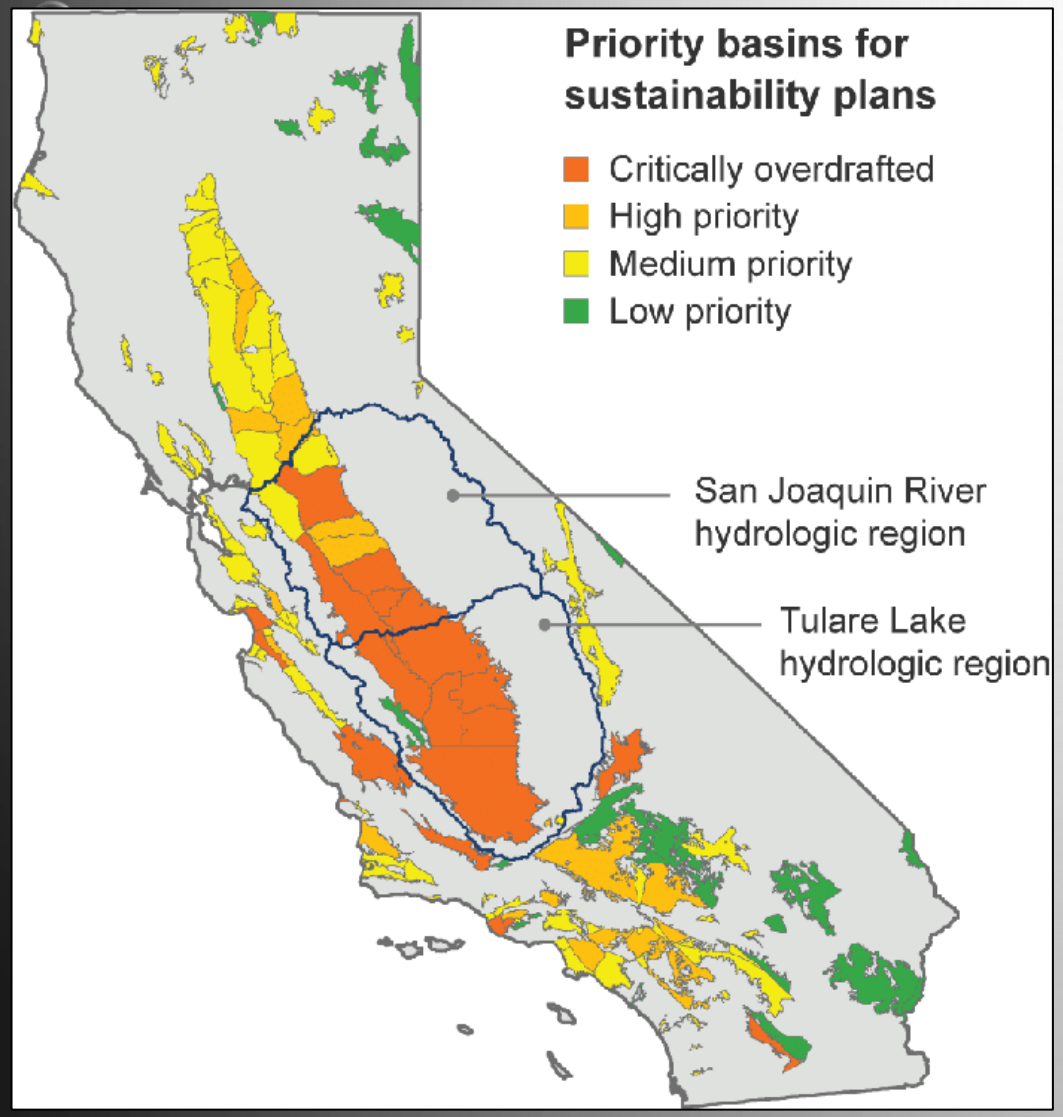
Cones of depression overlap

SWL of one well falls, when neighbor well pumps

Simultaneous measurement proves interference

Cause for legal action in some jurisdictions

WHY MONITOR MY WELL?



REGIONAL SUSTAINABILITY

Aquifer recharge

- Continuous melting of snowpack
- Natural surface water recharge
- Managed recharge

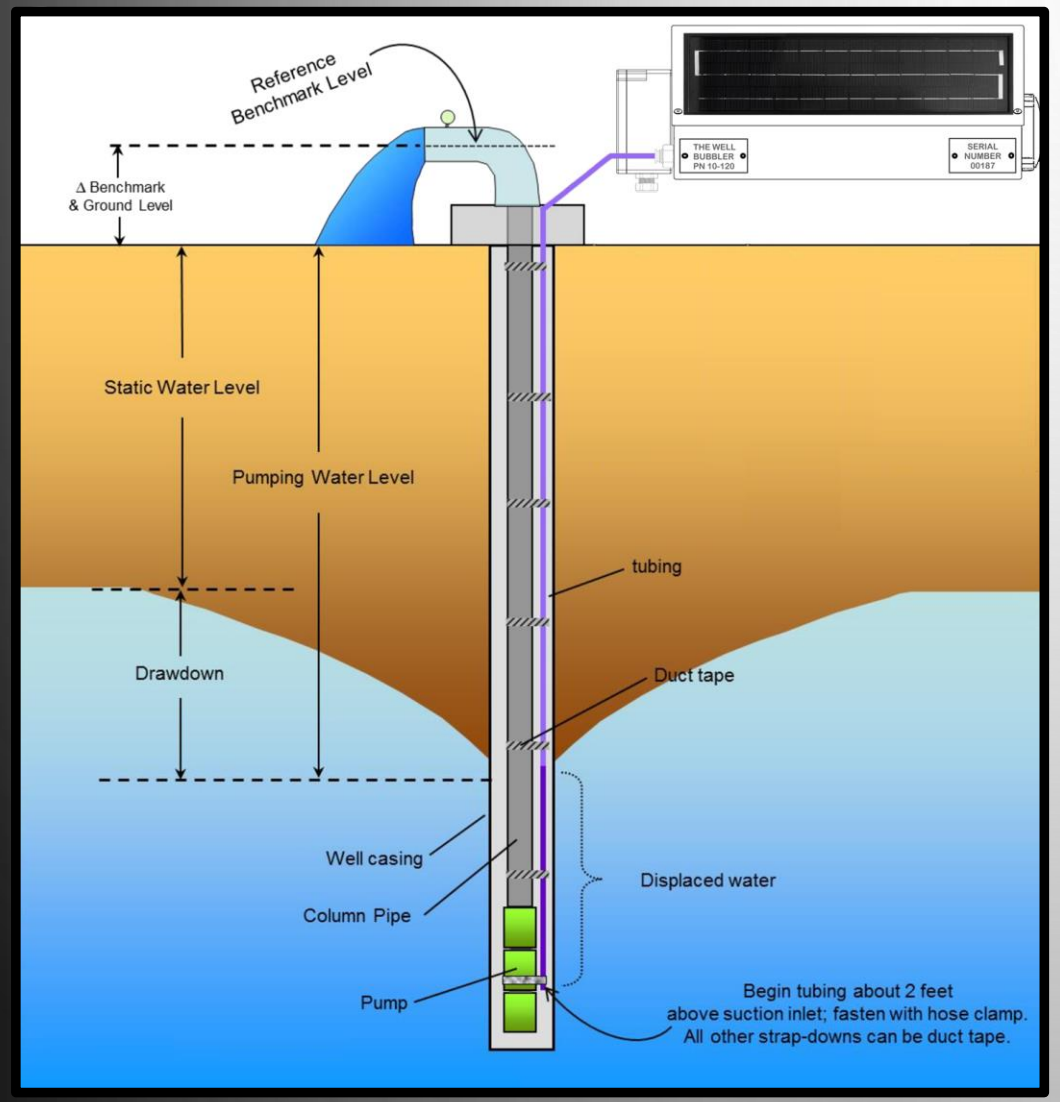
Aquifer withdrawal

- Sum total of well pumping

Unsustainable: falling regional water levels

Sustainable: steady or rising water levels

SENSOR TYPE: WELL BUBBLER



Compressed air is forced through an air line to accurately measure well level.

Pros:

- Compatible with all turbine and submersible wells
- All electronics on surface, only airline in the well
- Measures flow rate, pressure and pump power
- Prevents well over-drafting
- Includes solar, data logging & telemetry
- Repairable without downhole well work

Cons:

- Accuracy limited to ~1 foot
- Compressor life ~5 years

SENSOR TYPE: TRANSDUCER

A well level transducer is a precision pressure sensor which is lowered into the well. The transducers measures, and reports, the water column above it as an electrical signal.

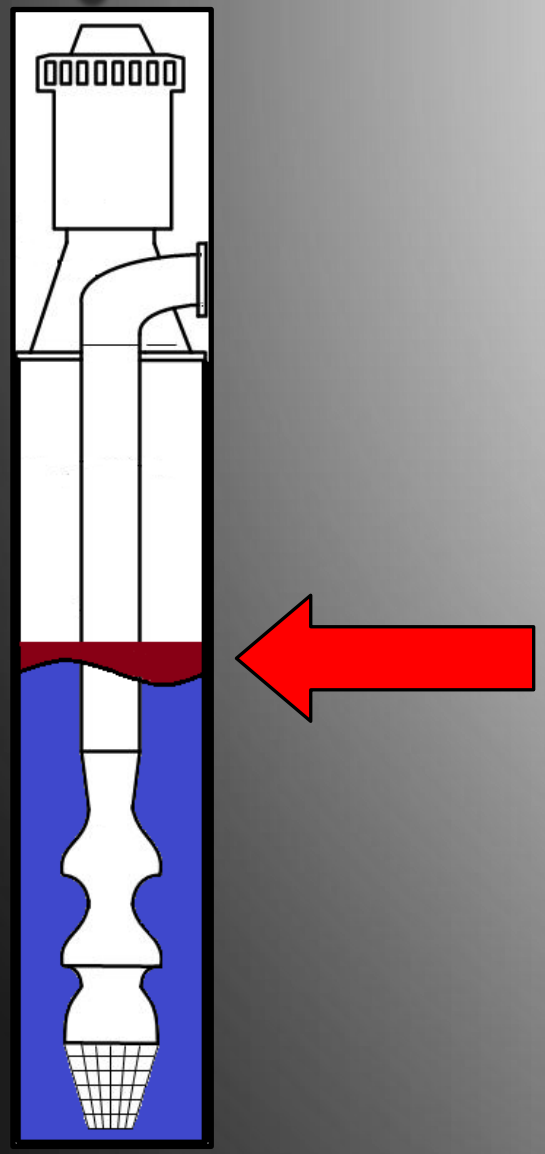
Pros:

- Readily available
- Accurate & precise, with long-term stability

Cons:

- Snags on installation in submersibles & turbines
- Fouled by turbine lubrication oil
- Non-repairable, cannot be field-spliced
- Damages or destroys pump if ingested
- Variable Frequency Drives (VFDs) cause electrical noise in signal
- Poor wellhead access prevents installation
- Require additional equipment to report water level

TRANSDUCERS AND OIL



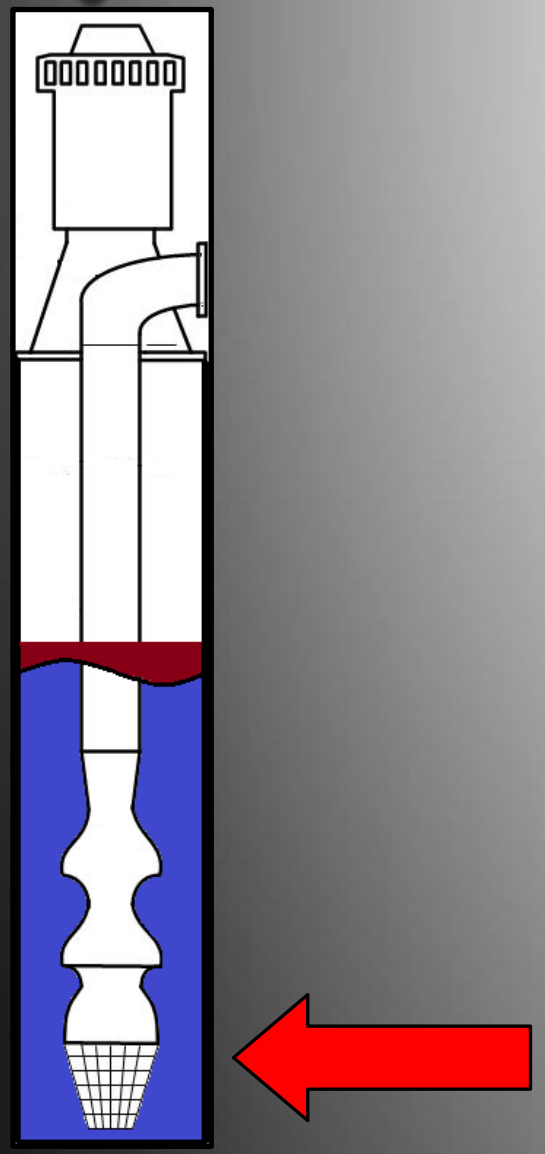
Lubrication oil drips into well

Collects on top of water, congeals

Transducer has small holes to measure pressure

Sensor clogs with oil during installation

TRANSDUCERS AND PUMP DAMAGE



Pump set depth unknown

Sensor set too deep

Sensor and wire ingested by pump

Pump damaged

TRANSDUCERS AND SUBMERSIBLE WIRING

Motor wiring taped to discharge pipe

Over time, wiring comes loose

Sensor wire becomes tangled

Sensor cannot be removed

Pump must be pulled to retrieve sensor

TRANSDUCERS AND VFD NOISE

VFD creates electrical noise

Motor wiring is long and not shielded

Sensor wire runs along motor wiring

Sensor picks up VFD electrical noise

Pumping level cannot be measured

TRANSDUCERS AND WELL ACCESS

Well cap has poor access to casing

Existing ports obstructed

Existing ports too small for transducer

Discharge piping is in the way

Transducer cannot be installed

SENSOR TYPE: ACOUSTIC SENSORS

Sensor sends sound wave into well. Sound wave reflects from water surface and returns to sensor. Sensor calculates distance to water.

Pros

- Easy to install
- Nothing in the well

Cons:

- Wells larger than 8” require sounding tube
- Water level below screen prevents reading
- Engine-driven pumps interfere with measurement
- Downhole equipment and couplings interfere with measurement

ACOUSTIC SENSORS

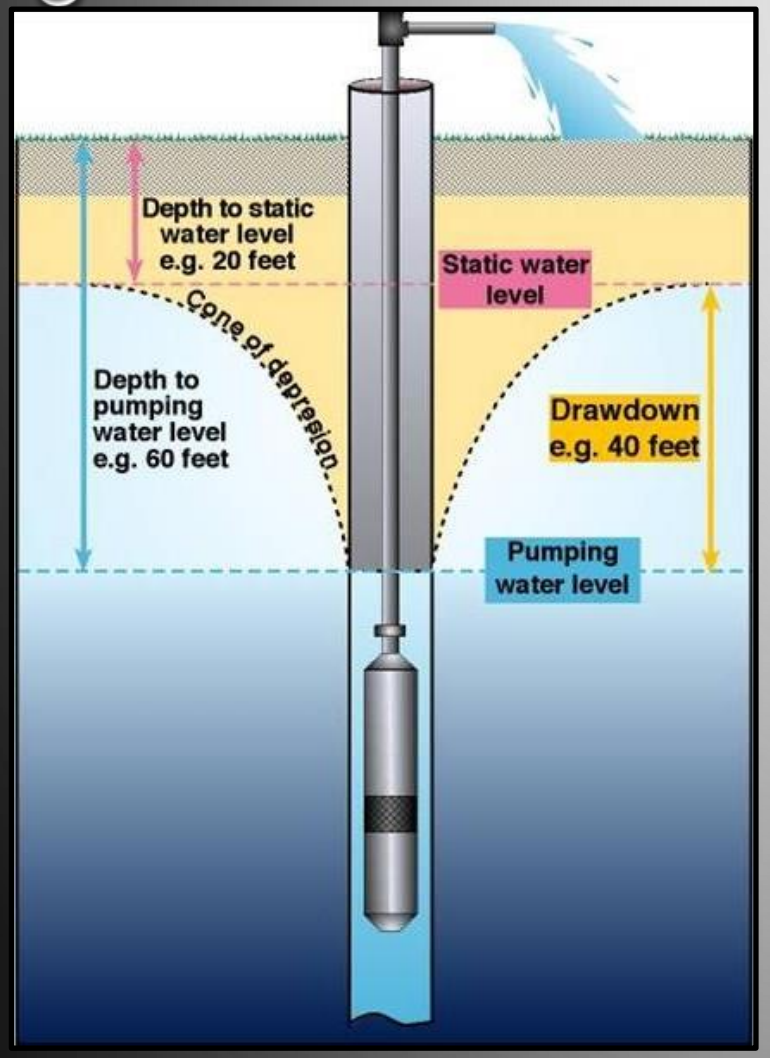
Cons (all information quoted from manufacturer's User Manual)

Wells with large casing diameter required sounding tube "As the well diameter increases, the signal strength weakens and becomes more susceptible to pump noise and imperfections in the well. It is recommended that on wells larger than 8" that a sounding tube be used."

Water level below exposed screen prevents PWL readings "If the perforations are exposed (above the water line) and the exterior of the casing is very porous like crushed stone, then the perforations will dampen the sound pulse and there will be no reflection for the Well Sounder to detect."

Engine-driven well pumps interfere with measurement. "If the pump is exceptionally noisy and or the water level is near or below the pump, it is possible that the noise form the pump could interfere with the depth measurement."

ACOUSTIC SENSORS



Cons (all information quoted from manufacturer's User Manual)

Downhole equipment and couplings cause false echoes which prevent accurate readings.

"Some torque arresters may block more than 90% of the well opening and may cause problems."

"My sounding tube is 3/4" PVC schd 80 with threaded couplings every 20ft. The (acoustic) sounder reads the depth at 20'. Why? The pocket created at each joint is significant compared to the inside diameter of the PVC pipe, and therefore causes the pulse to reflect at each coupling."

SUMMARY

Well Bubbler technology provides accurate, real time well level information allowing irrigators to actively manage water use, well pump activity, and adjust irrigation practices as needed.

QUESTIONS