

# Agricultural Pumping Efficiency Program



## Pump Efficiency Tests

Helping California Agriculture...



Put More  
Power Through  
the Pump!

# Pump Efficiency Tests



*The Agricultural Pumping Efficiency Program provides subsidized pump efficiency tests to California agriculture. This brochure explains various aspects of pump efficiency tests, how they can save you money, and how you can obtain one. For more information contact the Program at (800) 845-6038 or log on to our website at **[www.pumpefficiency.org](http://www.pumpefficiency.org)**.*

## What is a Pump Test?

A pump test measures various aspects of the pump's operation. The end result of a pump test is an estimate of the overall efficiency of your pump and the cost of running it *under the conditions of the test*. The test may also give an indication of water well performance.

## Who Does the Pump Testing?

Pump tests may be available from:

- Public utilities - using either their own employees or contract testers
- Pump dealers - using their own employees or contract testers
- Independent pump test companies - many of these testers have a public utility background

To obtain a subsidized pump test under the Agricultural Pumping Efficiency Program you must use a participating pump test company. Please call or log on to our web site at **[www.pumpefficiency.org](http://www.pumpefficiency.org)** for a current list of these companies.



## What Does a Pump Tester Measure?

The tester measures at least four variables:

1. Water flow rate
2. Pumping lift (or inlet pressure)
3. Pump discharge pressure
4. Energy input to the pumping plant

Calculations are performed with the flow, lift, and pressure measurements and the results are compared to the energy input. A sample pump test report and an explanation of what it measures and calculates can be found on page 6.

## Why Should I Test My Pump?

Regular pump testing can identify problems before a breakdown occurs or energy bills climb. This allows you to perform an objective economic analysis to identify when it can be profitable to invest in a retrofit or repair. On a new pump, a test will establish a baseline of performance and verify that equipment is operating as designed. A typical analysis of pumping costs derived from a test, along with explanations of the variables used in the calculations, is shown on pages 8 and 9.

## How Do I Prepare for a Pump Test?

Check with your pump tester about how to prepare for a pump test. Some testers use flow measurement equipment that requires an access hole in the pump discharge pipe. Generally, the pump needs to be off in order to cut the hole and insert the device. Some measurement devices do not require this provision.

The pump must be running during the test and there must be someplace for the pumped water to go. If the pump is in a water well, the tester will need to run the pump for about 30-45 minutes to stabilize the pumping water level.

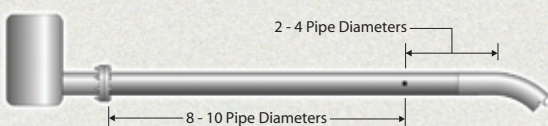
The pump tester will also need information regarding the pump's management and design in order to do a complete cost analysis. Key information will include:

- annual acre-feet pumped (or hours of operation)
- average cost of energy for the year
- intended operating condition
- required flow rate
- required discharge pressure of the pump

If a water well is running when the tester arrives, he will want to shut it off and measure the "recovered water level" of the well. This is valuable information for you that indicates current well performance.

## What Is Needed for Accurate Measurements?

Water flow in a pipe can only be accurately determined if the location for flow measurement (known as the "test section") is free from turbulence. Ideally, the test section should be a run of straight pipe with lengths 8 - 10 pipe diameters upstream and 2 - 4 pipe diameters downstream of the measurement point that are free of obstructions or turns (see the figure below). In addition, access via a sounding tube or a factory-made hole in the discharge head may be needed to determine standing and pumping water levels in a well.



This schematic shows an ideal test section:

- 8 - 10 pipe diameters upstream
- 2 - 4 pipe diameters downstream, clear of obstructions or turns

(For a 6" diameter pipe this would mean 48" to 60" upstream and 12" to 24" downstream clear.)

## Can Two Pumps Be Tested Together?

Pumping plants may be designed with a well pump to lift the water to the surface and a booster pump to supply pressure to the irrigation system. Typically, the well pump is tested first and then the well/booster combination is tested. The booster pump efficiency is determined by subtracting the inlet pressure into the booster. In some cases, amperage and voltage readings for each pump are taken to determine input horsepower.

## What is a Multi-Condition Pump Test?

A pump can operate with a wide variety of flow and pressure outputs. A multi-condition test consists of making the required measurements at several different flow rates. This type of test is useful in situations where the pump design is unknown or where aquifer or discharge conditions have changed substantially.



## How Do I Use the Data from a Pump Test?

You should have a copy of your pump's original pump performance curve. Record the results of each pump test and compare them to that curve and to previous tests. Consult with your pump dealer to determine if a pump adjustment or repair will be profitable.

**IMPORTANT!** *The pump test results are only valid for the combination (or combinations) of flow and total lift measured. You should try to ensure that the test conditions are as close as possible to typical running conditions.*

## How Often Should I Test My Pump?

A pump should be tested every 1 to 3 years depending on the annual usage and severity of operating conditions. For example, you might want to test a well that is pumping a lot of sand every year. On the other hand, a booster pump supplied by clean water might only be tested once every 2 or 3 years.

## How Can I Obtain a Pump Test?

Log on to the Program's web site or call one of the offices listed below to obtain a list of participating pump test companies. You can use any of the companies on this list - just call them to arrange the time of the test. They will handle all of the paperwork and the rebate for the pump test will be paid directly to them.

## Where Can I Get More Information?

Log on to [www.pumpefficiency.org](http://www.pumpefficiency.org) or call the Program using the following toll-free numbers:

- Main Office/San Joaquin Valley - (800) 845-6038
- Northern California - (866) 333-8938
- Southern California - (866) 333-8939
- Central Coast - (866) 473-0847

Please feel free to contact us if you have any questions.

# How to Interpret a Pump Test Report

Run Number 1 of 1	
1. Standing Water Level ( <i>ft</i> ):	43
2. Recovered Water Level ( <i>ft</i> ):	45
3. Draw Down ( <i>ft</i> ):	5
4. Pumping Water Level ( <i>ft</i> ):	48
5. Discharge Pressure at Gauge ( <i>psi</i> ):	20.3
6. Total Lift ( <i>ft</i> ):	95
7. Flow Velocity ( <i>ft/sec</i> ):	3.8
8. Measured Flow Rate ( <i>GPM</i> ):	440
9. Customer Flow Rate ( <i>GPM</i> ):	450
10. Well Specific Capacity ( <i>GPM/ft</i> ):	88
11. Acre-Feet per 24 Hours:	1.9
12. Cubic Feet per Second ( <i>CFS</i> ):	0.98
13. Horsepower Input to Motor:	23.1
14. Percent of Rated Motor Load:	104%
15. Kilowatt Input to Motor:	17.2
16. Kilowatt-Hours per Acre-Foot:	212
17. Cost to Pump an Acre-Foot:	\$22.26
18. Energy Cost ( <i>\$/Hours</i> ):	\$1.81
19. Base Cost per kWh:	\$0.105
20. Name Plate RPM:	1760
21. Measured RPM:	1755
<b>22. Overall Plant Efficiency (%):</b>	<b>45.7%</b>

The results section of an electric-powered pump test report prepared by a participating pump test company of the Program is shown above.

The following explanations can give you a better idea of what is measured and calculated in a pump test:

1. **Standing Water Level** - The water level in the water well when a pump has not been running.
2. **Recovered Water Level** - The water level in the water well 15 minutes after shutting the pump off.



3. **Draw Down** - The difference between the pumping water level (*line 4*) and the standing water level (*line 1*).
4. **Pumping Water Level** - Where the water level in the well stabilizes under constant pumping conditions.
5. **Discharge Pressure at Gauge** - The pressure on the outlet side of the pump.
6. **Total Lift** - Includes the pumping water level, discharge pressure, and any gauge corrections.
7. **Flow Velocity** - How fast the water is moving in the discharge pipe. It should be 1 foot per second or faster to ensure an accurate test.
8. **Measured Flow Rate GPM** - The flow rate measured in gallons per minute using the tester's instruments.
9. **Customer Flow Rate GPM** - The flow rate measured with the customer's flow meter (*if one is present*).
10. **Well Specific Capacity** - The measured flow rate divided by the draw down (*line 8 divided by line 3*). It is a measure of well performance, **not** pump performance.\*
11. **Acre-Feet per 24 Hours** - The number of acre-feet pumped in 24 hours at the measured flow rate. One acre-foot of water is equal to 325,900 gallons of water.
12. **Cubic Feet per Second** - The measured flow rate expressed as cubic feet of water per second.
13. **Horsepower** - The horsepower input to the motor read at the utility meter.
14. **Percent of Rated Motor Load** - The estimated horsepower output of the motor divided by the name plate horsepower. If this is not between 80% and 115% it is an indication that the motor is not matched to the pumping condition.
15. **Kilowatt Input to Motor** - The power input to the motor in terms of kilowatts. One horsepower is equal to 0.746 kilowatts.
16. **Kilowatt-hours per Acre-Foot** - The amount of kilowatt-hours required to pump an acre-foot of water at the operating condition measured.
17. **Cost to Pump an Acre-Foot** - Kilowatt-hours per acre-foot multiplied by the Base Cost per kWh (*line 19*).
18. **Energy Cost (\$/hour)** - The cost per hour to run the pump at the Base Cost per kWh (*line 19*).
19. **Base Cost per kWh** - The average cost of a kilowatt-hour for this account.
20. **Name Plate RPM** - The rated speed of the motor.
21. **Measured RPM** - The actual rotational speed measured.
22. **Overall Plant Efficiency** - The power output of the pump (*a function of the flow rate and total lift*) divided by the input power.\*\*

\* see page 10

\*\* see page 10

# Pumping Cost Analysis

Assumptions	1. Overall plant efficiency is improved to: 66.0%
	2. Motor loaded at: 105%
	3. Flow rate will be: 540 GPM
	4. Total Head will be: 117 feet = 49 ft PWL, 29 psi discharge
	5. Water requirements will be: 122.5 acre-ft/year
Existing Efficiency	
6. kWh/AF:	213
7. Estimated Total kWh:	25,970
8. Average Cost per kWh:	\$0.13
9. Average Cost per hour:	\$3.00
10. Average Cost per Acre-Foot:	\$28.04
11. Estimated Acre-Feet Per Year:	123
12. Overall Plant Efficiency:	45.7%
13. Estimated Total Annual Cost:	\$3,449

**IMPORTANT!** *The pumping cost analysis presented is only valid for the assumptions listed in lines 1 - 5 and for the conditions measured during the test. One or more of the assumed variables resulting from a pump repair could be in error and the economics presented would be misleading. Use this section only as a guide to the magnitude of potential savings. **Always** consult with your pump service company and other available experts before making the decision to retrofit/repair a pump.*

## LINES 1 - 5:

*Lines 1-5 list the important assumptions regarding the pump performance after any retrofit or repair, including:*

1. The improvement expected in Overall Plant Efficiency
2. Motor loading (this may be greater than 100% if it is currently measured as greater than 100%)
3. Any change in Flow Rate
4. Any change in Total Lift
5. Annual water requirements will be assumed to be unchanged

The software used by participating pump test companies allows for any of these assumptions to be changed as needed. You may want to discuss these assumptions with the tester so that they match your expectations (or the expectations of your pump repair company).



Below is an example of the pumping cost analysis section of an electric-powered pump test report prepared by a participating pump test company of the Program.

(PWL = pumping water level)	
Improved Efficiency	Estimated Savings
182	31
22,242	3,728
\$0.13	
\$3.15	\$0.15
\$24.98	\$3.06
123	
66.0%	
<b>\$3,073</b>	<b>\$376</b>

**LINES 6 - 13:**

*Lines 6 - 13 are termed the "Before and After" section and lists statistics based on the measured condition and the improved condition assumed as a result of a retrofit/repair project.*

- 6. *kWh/AF* - The kilowatt-hours required to pump an acre-foot through the system.
- 7. *Estimated Total kWh* - The total kilowatt-hours used annually if the hours of operation or total acre-feet pumped per year are known.
- 8. *Average Cost per kWh* - The average cost per kilowatt-hour as stated by you, or estimated by the tester based on your pump size and rate schedule.
- 9. *Average Cost per Hour* - The average cost per hour to run the pumping plant.
- 10. *Average Cost per Acre-Foot* - The average cost to pump an acre-foot of water through the system.
- 11. *Estimated Acre-Feet per Year* - The estimated acre-feet per year pumped through the system.
- 12. *Overall Plant Efficiency* - The overall pumping plant efficiency (*which may be zero in the case where the pumping water level in a well cannot be measured for some reason*).
- 13. *Estimated Total Annual Cost of Energy* - The estimated annual cost of energy may not include demand charges or other surcharges to run the pump. This will be zero if the annual hours of operation or annual acre-feet pumped are not known.

**IMPORTANT!** *If the annual hours of operation or acre-feet pumped are not known use line 10, the average cost per acre-foot, as an indicator of potential energy and dollar savings.*

\* Well specific capacity is a complex relationship based on the aquifer conditions, well casing diameter, well screen, gravel pack selection, and the initial development. For example, high specific capacity wells in the San Joaquin Valley have specific capacity greater than 100 gpm per foot of draw down. Good wells are between 50 to 100 gpm per foot. Low specific capacity of 5 to 20 gpm per foot may be typical for your area or may indicate a problem. Well performance will generally degrade with time. Well screens can corrode or encrust with various deposits that reduce flow openings into the well. Gravel packs can also experience plugging from fine materials such as silt. Attempting to pump too much water by using too big a pump for the aquifer also results in low well specific capacity. This subject is very important to your pumping costs. Consult with your pump dealer and/or well driller if the pump test history reveals significant reductions in well specific capacity over time.

\*\*Overall plant efficiency can be generally characterized as follows:

- 60% and higher is excellent
- 50% to 60% is good
- 49% or less indicates a pump that may need a retrofit, repair, or adjustment. It also may indicate the pump is not matched to the current required operating conditions. An example of this would be where a water table has dropped substantially over time, increasing the total lift above the original specifications.

Pumps with submersible motors will usually run about 10% lower efficiency in each of the categories above. For example 50% or above would be considered excellent for a submersible pump.

**IMPORTANT!** These are **general** characterizations. *Always consult with your pump service company and other available experts before making the decision to retrofit/repair a pump.*

## The Center for Irrigation Technology

The Center for Irrigation Technology developed and manages the statewide Agricultural Pumping Efficiency Program. CIT is dedicated to advancing water/energy management practices and efficient irrigation technology. Located on the campus of California State University, Fresno, CIT functions as an independent testing laboratory, applied research facility and educational resource to both the public and private sectors. For more information, check the CIT link at [www.pumpefficiency.org](http://www.pumpefficiency.org) or call (800) 845-6038.



## Important!

The Program may be terminated or modified without notice. The Program has a limited budget. Applications for retrofit/repair rebates or pump tests are accepted on a **first-come, first-served basis** until available funds are allocated or the ending date of the program, whichever comes first (visit [www.pumpefficiency.org](http://www.pumpefficiency.org) or call 800.845.6038 for more information).



California consumers are not obligated to purchase any full fee service or other service not funded by this program. This program is funded by California utility ratepayers under the auspices of the California Public Utilities Commission.

Los consumidores en California no estan obligados a comprar servicios completos o adicionales que no esten cubiertos bajo este programa. Este programa esta financiado por los usuarios de servicios públicos en California bajo la jurisdiccion de la Comisión de servicios Públicos de California.





**C**enter for  
**I**rrigation  
**T**echnology

Development and management of the  
Agricultural Pumping Efficiency Program by:

## **The Center for Irrigation Technology**

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