CGA Standard Practice Series

**California Groundwater Association**

*An NGWA Affiliate State*

700 R Street

Suite 200 Sacramento, CA 95811

cga@groundh2o.org

916-231-2134

# Article 460 - WELL YIELD PUMPING TESTS FOR 1-4 RESIDENTIAL CONNECTIONS

**Adopted by the CGA Board of Directors on October 14, 2006**

## BACKGROUND

**As of 2006 approximately 32% of California counties require a pumping test to verify adequate well yield prior to acquiring a building permit for a single residential connection. The remaining counties either allow air lift indicator tests to demonstrate sufficient water or impose no requirements at all.**

**As rural areas increase in population and demographics change, increasing stress is being placed on groundwater resources in certain areas of the state. In regions identified as being water scarce, additional county governments have begun to write ordinances requiring pumping tests in an effort to protect property owners.**

**The methodologies used to run these tests vary widely. Some jurisdictions endeavor to demonstrate the likely availability of adequate water under current conditions. Others attempt to provide safeguards against extreme future declines in the resource.**

**In a few cases imposed requirements are so stringent that individual property development may become prohibitively expensive or even impossible.**

### Discussion

**Climatic changes and the complexity of geologic formations make annual recharge unpredictable which in turn makes it difficult, if not impossible, to reliably forecast long term sustainability of an individual well. Even with extensive hydrogeologic analysis or excessive pumping times there are no absolute guarantees of future water production in a particular well. Arbitrarily stringent testing requirements mostly result only in an increased burden on a property owner without significant benefits in terms of long term reliability.**

Pumping tests designed to prove water availability for parcel creation, or to determine a sustainable water source for a community water system, may require extended pumping time and detailed analysis of time-drawdown and time-recovery data. However, for this particular application a practical pumping test is one that will demonstrate that the well will yield a minimum volume of water over a reasonable time sufficient for normal household duty cycles and will provide some information regarding recovery into the borehole.

## GENERAL PROTOCOL

Pumping test methodologies for this application can be generally categorized as:

- Total yield within a specified time
- Discharge yield after specified time or after well volume dewatering
- Constant flow rate at a constant pumping level for a specified time
- A combination of these

Additionally, following the end of pumping, recovery to a specified water level may be imposed.

The protocol used may be governed by such aspects as minimum acceptable well yields, minimum thresholds for storage requirements, number of connections, and local aquifer characteristics. The specific testing procedures will be determined by the jurisdiction having authority, must be well defined, and shall be empirical in nature. A specific form to record test results and data should be provided by the authority.

### Pumping Time

Pumping duration will be directly related to the test methodology and the time limitations imposed by the jurisdiction having authority. Once borehole storage has been removed characteristics of the well may be established within 8 hours, particularly for those relatively high production residential wells of 5 gpm or more. In the absence of hydrogeologic analysis, which is an unnecessary burden and expense for this application, further pumping usually does not provide significant additional benefit. Data from lower production wells may be more reliable with longer pumping, but even then, continuing much beyond 24 hours generally shows diminishing benefits.

## Water Level Recovery

Water level recovery data is often used in aquifer analysis. Following constant discharge and draw down pumping, residual drawdown measurements are used to calculate coefficients of transmissivity. Such analysis is, however, beyond the scope of well yield tests for residential water use. Nevertheless, even in these empirical yield tests recharge should be observed. Some conclusions may be drawn by a return, or non return, of water level to a percentage of the static water level at the beginning of the test. A failure for water level recovery to reach a reasonable level within a reasonable time may indicate the aquifer is a closed system with little or no recharge. However, caution must be exercised when stipulating recovery levels or time limits for those levels to be reached.

When observing water level recovery during aquifer analysis, 90% recovery is a typical benchmark. This percentage has been arrived at primarily by the observation that most wells recover to that level within a reasonable time relative to the pumping duration. However, very reliable wells that drawdown very little during the pumping phase of a test may be affected by abnormal conditions. In areas where the cone of depression is large, or seasonal/regional water level decline is in process, or the pumped well is being impacted by nearby wells, 90% recovery may not occur within anticipated time limits. To address these impacts a higher water level return within longer time limits should be considered, preferably as a subsequent alternative.

While the 90% recovery benchmark may be applicable to residential yield tests, the time allowed for that recovery may exceed the drawdown phase of the test. Regardless of the pumping duration, the volume of water pumped during these limited yield tests will generally exceed water use during a normal 24 hour duty cycle. Therefore 90% recovery within 24 hours or 150% of pumping duration, whichever is longer, is an acceptable target. Should the water level fail to return to within the 90% prescribed level within that time, then the water level should be monitored for one additional week. Then, after one week, the water level should return to within 95% of the starting water level. Failure to return to either of these prescribed levels may indicate the well is inadequate or that further testing may be required.

Because a return to a percentage of the static water level could be a factor in a given well's meeting jurisdictional criteria, thereby passing or failing a prescribed test, determining that static water level prior to test pumping is a critical factor. Static water level is generally defined as the water level in the well when it is not being pumped. However, if the well has been idle for a long period, the measured water level may not be indicative of the level under normal operation. For example, water in a well under artesian pressure in a confined aquifer may reach its “working” static level and return to 100 feet from the surface in a few hours or even minutes. Sitting idle however, the water level may continue to slowly rise over the next several days, weeks, or months. The level eventually reached should not be considered the “working” static water level during normal operation.

To remove any “false head” and determine the effective static water level for purposes of testing, the well may be pumped for any duration at any time prior to beginning the test but all pumping should cease at least 24 hours prior to beginning the test. Recovery requirements would then be based on the “working water level” established following this pre-pumping.

## Seasonality

Particularly with short term pumping durations, adjustments for seasonality may be necessary or at least prudent. Many wells, particularly those that are supplied from upper weathered or fracture zones, may show significant declines during late summer and fall compared to production rates determined during spring or early summer months*.

To address this, acceptable yield may be calculated as a percentage of the pumping yield determined during testing, with the percentage seasonally adjusted.

** Dry season may be defined differently in desert regions*



## Equipment

The equipment used for a pumping test will depend on the actual methodology used. All will require a properly calibrated totalizing flow meter to accurately measure discharge rates and cumulative yield. Field calibration of flow meters is acceptable, with accuracy verified through the use of a bucket and stop watch during the test. Generally, water should be discharged far enough away from the well head so that data is not influenced. For the relatively short pumping durations required for these applications, 50 to 100 feet down gradient will normally be sufficient.

## Qualified Personnel

By far the majority of California counties require testing under supervision of one of the following California professional licenses:

- C57 well drilling contractor
- C61/D21 pump contractor
- Professional Geologist, Certified Engineering Geologist, or Certified Hydrogeologist
- Professional Civil Engineer with experience in groundwater hydrology

Only properly classified contractors are licensed to install for compensation the pumping equipment necessary for testing, while Professional Geologists or Certified Hydrogeologists are required only if groundwater surveys are performed with attendant data analysis and reports. Each of the disciplines listed above is recognized under California law as being capable of performing pumping tests and gathering the empirical data for this application as defined in this standard.

## SUGGESTED PROTOCOLS

The following are typical procedures that are commonly used to demonstrate available water for residential domestic use.

### Total Yield

In this procedure a specified total volume must be pumped within a specified time. The volume to be pumped will be based on the minimum well yield as established by the authority having jurisdiction. Data is reliable only if the specified volume is credited after first removing all borehole storage. This is best verified by calculating casing storage, discharging that volume, and then continuing until the prescribed thresholds are reached. Alternatively, required pumping volumes can be large enough to ensure casing storage will have been removed under all situations.

Reliability is further improved if the minimum required well yield is also demonstrated at the end of the test period.

Additional benefits may be realized if minimum recovery is required, as described above.

## Minimum Discharge Yield

**In this procedure the minimum well yield as established by the authority having jurisdiction must be proven after a specified pumping time has passed; or after a specific number of well volumes has been discharged.**

**Additional benefits may be realized if minimum recovery is required, as described above.**

## Constant Pumping Level

**In this procedure the minimum well yield as established by the authority having jurisdiction must be proven after drawdown to a constant pumping level and for a specified time.**

**Additional benefits may be realized if minimum recovery is required, as described above.**

## RECOMMENDATIONS

1. **CGA recommends pumping tests as the most reliable method to demonstrate well yield. However, in regions where general water conditions or historical aquifer data allow, a controlled air lift test may be sufficient to describe water availability.**

2. **Where pumping tests are required by a jurisdiction the specific procedures must be clearly defined by that jurisdiction. Reporting forms shall be provided by the authority.**

3. **Pumping tests for residential wells should be done under the supervision of one of the following California professional licenses:**

   - **C57 well drilling contractor**
   - **C61/D21 pump contractor**
   - **Professional Geologist, Certified Engineering Geologist, or Certified Hydrogeologist**
   - **Professional Civil Engineer with experience in groundwater hydrology**

4. **Where pumping tests are performed a properly calibrated totalizing flow meter, installed as per manufacturer's recommendations, shall be used to record discharge rate from a pumped well.**

5. **Where water level measurements are required a sounding tube shall be available throughout the total maximum drawdown range of the well. The sounding tube shall be capable of accommodating an electrical sounder, a pressure transducer, or an air tube. If total length of the tube is known, it may serve as the air tube.**

**Flow rates, total gallons pumped, and water levels (where applicable) shall be recorded at regular intervals.**

* * * *

**Adopted by the CGA Board of Directors on October 14, 2006**

**NOTE: This Standard, Article 460 & Standard Article 495 replace existing article 450 - production testing- small capacity wells, adopted in 1992. Any copy of Article 450 should be destroyed, as it is now obsolete.**