A Guide for Private Domestic Well Owners

Compiled by the
California State Water Resources Control Board
Division of Water Quality
GAMA Program

Revised April 2011

TABLE OF CONTENTS

Revised April 2011

DISCLAIMER

This document is provided for informational purposes only. Water quality problems in private domestic wells may occur even when precautions are taken. This guide can help well owners with water quality testing and interpretation, and contains tips to help preserve and maintain a problem-free, clean well. For additional questions, please contact your local environmental health agency, or contact GAMA Program Manager John Borkovich at 916-341-5779.

ACRONYMS and ABBREVIATIONS

mg/l = milligrams per liter
µg/l = micrograms per liter. A microgram is 1/1000th of a milligram
Mgal = million gallons
Mgal/day = million gallons per day
CDPH = California Department of Public Health
DTSC = Department of Toxic Substances Control
DWR = Department of Water Resources
SWRCB = State Water Resources Control Board
US EPA = United States Environmental Protection Agency
USGS = United States Geological Survey

Revised April 2011

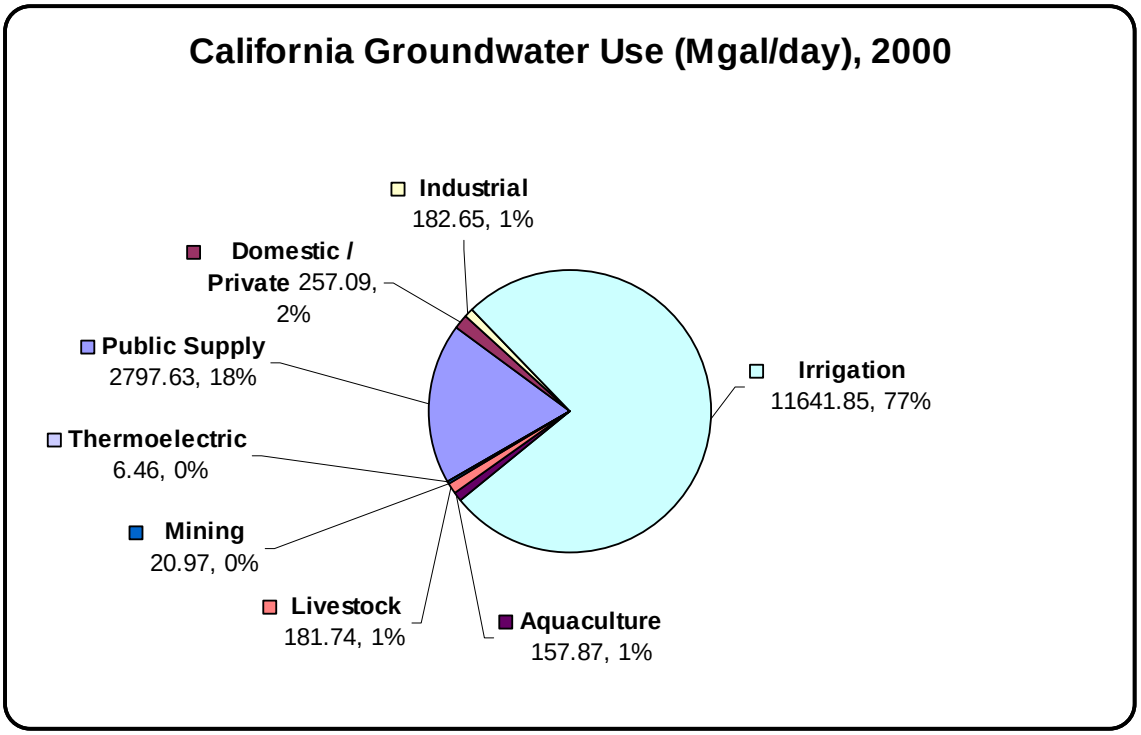
INTRODUCTION

What is Groundwater?
Groundwater is water that fills spaces between soil and rocks in the ground. Most groundwater comes from rain and snow that falls to the ground and percolates downward through naturally-occurring openings. Irrigation water, percolation ponds, and other sources can also contribute to groundwater. The area in the ground that is filled with water is called the saturated zone, and the top of the saturated zone is called the water table. The water table can be very near or far below the ground surface.

Who Uses Groundwater?
Approximately half the people in the United States use groundwater for drinking water. Californian's use about 15 billion gallons of groundwater – per day! Most groundwater is used for agricultural crop irrigation and industrial purposes.

Over 15 million Californian's get at least part of their drinking water from groundwater, from both public supplies and private domestic wells. Groundwater use in California increases during drought conditions. Over 11 billion gallons of groundwater per day are used for agricultural irrigation, helping to make California's agricultural economy one of the largest in the United States.

- Californians use more groundwater than any other state – about 15 billion gallons per day.
- Californians use approximately 20% of all the groundwater consumed in the United States.
- Californians use twice as much groundwater as the next highest state (Texas).
- Most of the groundwater used in California is for agricultural crop irrigation.



Data from "Estimated Use of Water in the United States for County-Level Data for 2000," USGS. Mgal/day is millions of gallons per day.

Revised April 2011

GROUNDWATER BASICS

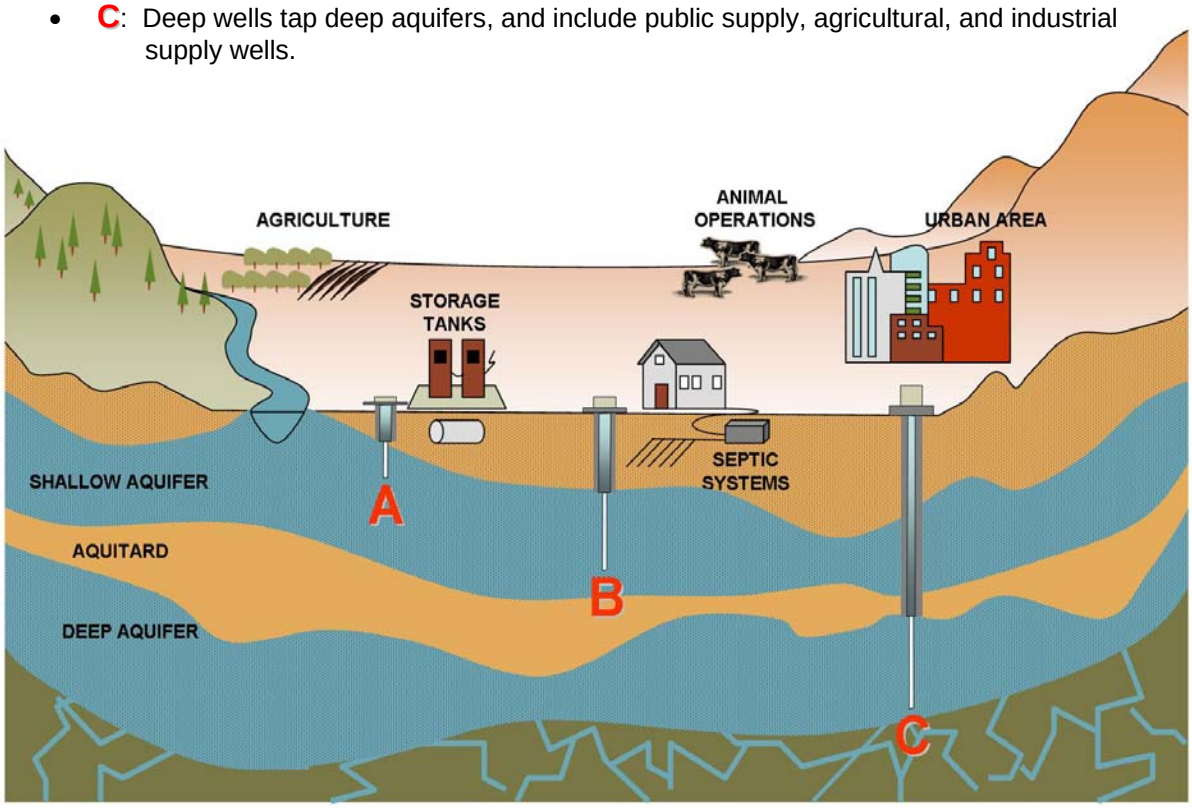
How Do We Get Groundwater?
Most groundwater is brought to the surface by pumping it from a well. There are several types of wells: public supply wells, irrigation wells, industrial supply wells, monitoring wells, and private domestic wells. Artesian wells flow without pumping.

What's In Groundwater?
Groundwater quality is related to several factors including geology, climate, and land use. Many naturally occurring chemicals in groundwater come from dissolving rocks, soil, and decaying plant material. Well water can become contaminated. Human activities can increase the concentration of naturally occurring substances like salts, minerals, and nitrate. Poor well construction or placement close to a potential source of contamination can affect domestic well water quality. Domestic well owners are responsible for testing their well water to ensure its quality.

Other compounds, such as pesticides and volatile organic compounds (VOCs), do not occur naturally in the environment. These substances can enter groundwater through spills, irrigation, wastewater percolation fields, septic systems, animal facilities, leaking underground fuel storage tanks, and other sources.

Wells draw water from different depths, and can be affected by different pollution sources. Types of wells and possible pollution sources are illustrated in the figure below:

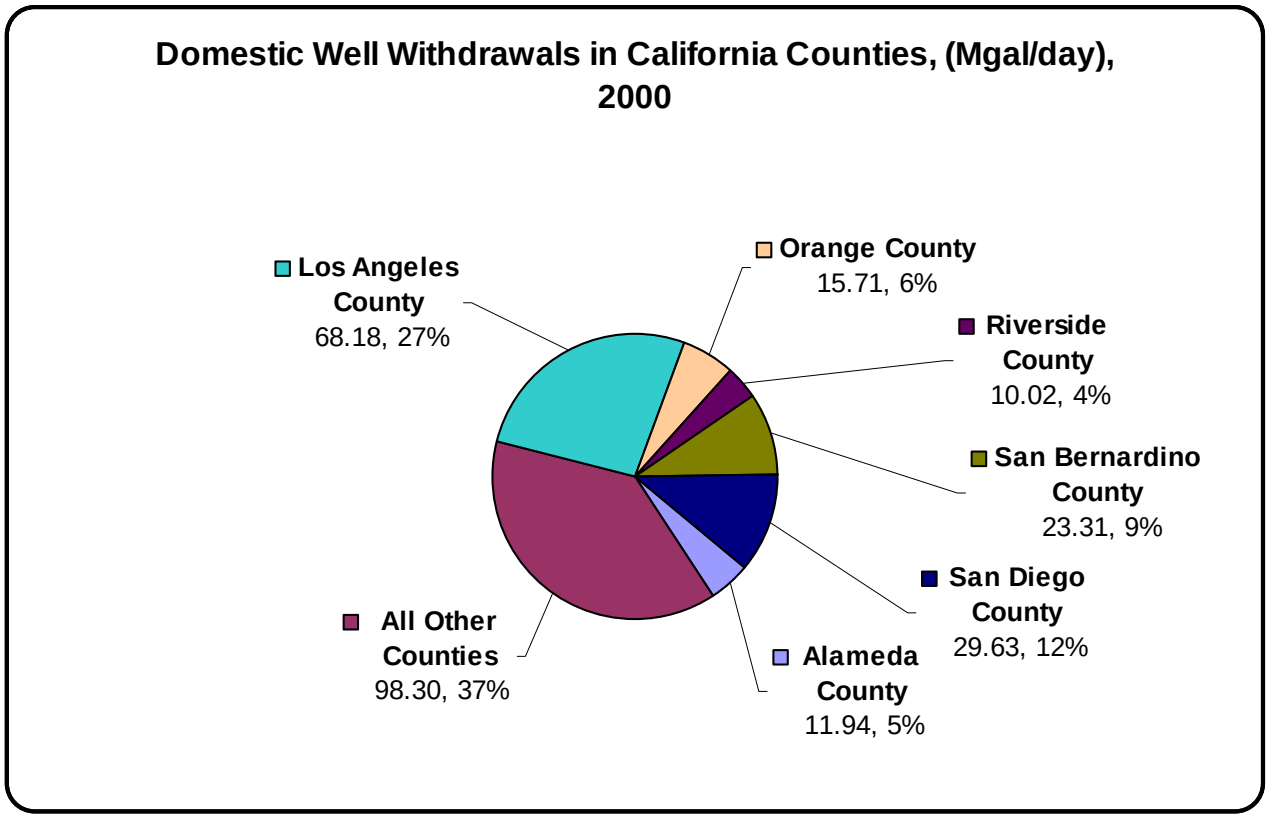
- **A**: Shallow wells capture water from shallow aquifers close to the surface. Some private domestic wells are shallow wells.
- **B**: Intermediate wells can tap either deep or shallow aquifers, and can include private domestic, agricultural, and industrial supply wells.
- **C**: Deep wells tap deep aquifers, and include public supply, agricultural, and industrial supply wells.



Revised April 2011

PRIVATE DOMESTIC WELL USE IN CALIFORNIA

As of 2010, the drinking water for about 1.4 million state residents comes from over 600,000 private domestic wells. The majority of domestic wells are located in southern California. Los Angeles, San Diego, San Bernardino, Orange, and Riverside counties account for 58% of domestic well groundwater withdrawals in the state.



Data from "Estimated Use of Water in the United States for County-Level Data for 2000," USGS

Revised April 2011

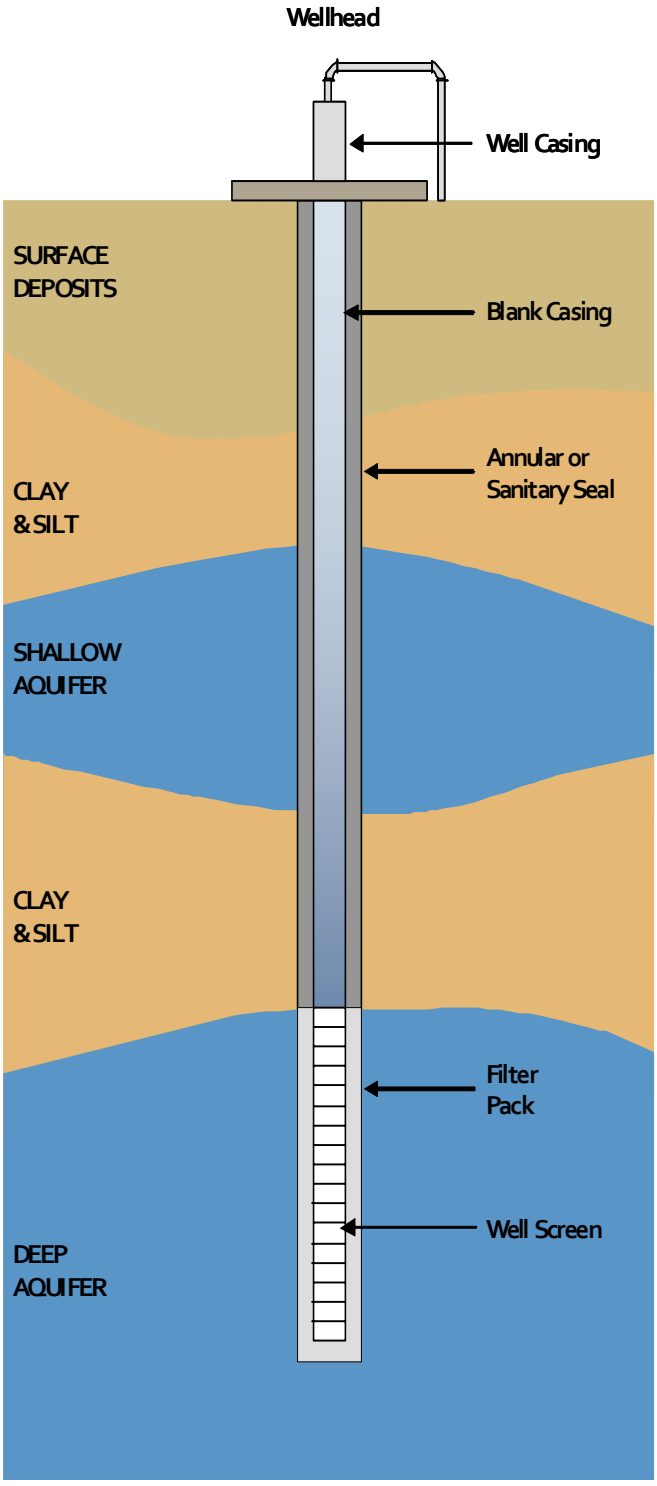
WELL CONSTRUCTION

Well owners obtain permits from local environmental health agencies or local water districts before construction, modification, or destruction takes place. The State of California does not issue well construction permits; however, the Department of Water Resources (DWR) and the State Water Resources Control Board (SWRCB) have established well construction standards (**Well Standards**). Domestic wells must be drilled by a licensed contractor, and must meet applicable local and/or state well standards. When choosing a location for a well, make sure the area is free of potential sources of contamination (see "Water Quality Protection" on page 12).

The driller will record geologic information at the drill site and will submit a copy of this information (**Driller Log or Well Completion Report**) to both the homeowner and the local permitting agency. The drill hole will intersect layers of sand or gravel that produce water (**Aquifers**). The driller may pass through upper shallow aquifers to find a deeper aquifer with better production or water quality. A length of plastic or steel pipe (**Well casing**) is installed in the drill hole. The bottom of the well casing will have thin cuts or perforations in it (**Well screen**), or can be open at the bottom (**Open Hole**) so that water can enter the well.

To keep fine sand, silt, and clay from entering the well, the driller will surround the well screen with sand (**Filter pack**). The driller must also install a concrete or cement seal (**Annular or Sanitary seal**) between the upper portions of the drill hole and the well casing. Well seal depths are generally mandated by local agencies or water districts.

The annular sanitary seal extends to the surface, where it creates a concrete pad with the well casing extending out of the middle (**Wellhead**). The casing should extend above the surface and be securely capped so that nothing – including surface water – can enter the well. The concrete pad should slope away from the well. Unless the well is artesian, a pump is placed in the well to bring water to the surface.



Revised April 2011

WATER QUALITY TESTING

How to Test a Water Well

The best way to test the quality of your well's water is to have a California State-certified drinking water testing laboratory conduct the analyses. The laboratory will supply the sampling bottles and can help you sample the well. You can also have an outside business collect a sample of your well and interpret the results for you. A list of drinking water laboratories certified by the State of California Department of Public Health (CDPH) is available and is searchable by county: http://www.cdph.ca.gov/certlic/labs/Documents/ELAPLablist.xls

What to Test For

Recommended tests and testing frequency are shown in Table 1 below. It's recommended that well owners should test for total coliform bacteria, nitrate, and electrical conductivity (EC) annually. More thorough testing should take place if you suspect contamination or notice a change in taste or appearance of your water.

Sampling Costs

Estimated sampling costs are shown in Table 1 below. Basic sampling costs can range from $100 to $400 dollars. Hiring an outside business to sample your well and interpret the results will likely cost more. Ask an accredited laboratory from the CDPH list (referenced above) for a written estimate before sampling.

Interpreting Test Results

The State of California does not regulate water quality in private domestic wells. CDPH regulates the water quality in public water systems. Comparing your well's test results to public drinking water standards can be helpful. These standards are found on-line at: http://www.cdph.ca.gov/certlic/drinkingwater/Documents/DWdocuments/EPAandCDPH-11-28-2008.pdf

Table 1 on the following page provides basic information and guidance for interpreting your test results. More information about contaminants and potential health effects can be obtained by calling the US Environmental Protection Agency's (US EPA) Safe Drinking Water Hotline (1-800-426-4791).

Commonly Encountered Contaminants

Drinking water, including bottled water, may contain trace amounts of some chemical constituents. Many are natural in origin, as water can dissolve naturally occurring minerals as it flows over or through the ground.

Commonly observed water contaminants are briefly summarized below:

- Microbes (viruses and bacteria) can come from sewage, septic systems, animal operations, and wildlife.
- Minerals, including salts, nitrate, and metals, can be naturally-occurring or can result from human activities at the surface.
- Pesticides and herbicides from agricultural, urban stormwater, and residential uses can be found in well water. Pesticides or herbicides should not be applied within 100 feet of a private domestic well.
- Organic chemicals from industry, gasoline stations, agriculture, stormwater runoff, and septic systems have been detected in groundwater.
- Radioactive elements typically occur naturally; however, human activities at the surface can release naturally occurring radioactive elements from sediments and bedrock.

The table below includes recommended tests and possible interpretations for those test results. Consult a water treatment professional for a more detailed interpretation of your test results.

TABLE 1: Water Quality Tests for Domestic Well Owners

Recommended Test			Interpreting your results	
Test	**Recommended Frequency**	**Cost***	**If the lab report shows:**	**Then you may want to consider:**
Coliform Bacteria	Test for total coliform annually; fecal if total coliforms are detected.	$20 – 50	Present	First re-test another sample to verify the results. Eliminate cause, disinfect, and retest. Increase testing frequency; if recurrent problems persist, consult a water treatment professional for more advice. Some bacteria may cause serious illness or death.
Nitrate (NO_3)	Annually	$25 – 45	$\geq$ 45 mg/L as NO_3 or $\geq$ 10 mg/L as N	First re-test another sample to verify the results. Install a treatment system or find an alternate water supply. Consult a water treatment professional for more advice.
Electrical Conductivity (EC)	Annually	$10 – 20	> 1600 µmhos/cm or significantly different from previous result.	Test for minerals, nitrate, and/or VOCs to determine the possible cause of the high EC.
MINERALS Aluminum (Al) Arsenic (As) Barium (Ba) Cadmium (Cd) Chromium (Cr) Fluoride (F) Iron (Fe) Lead (Pb) Manganese (Mn) Mercury (Hg) Selenium (Se) Silver (Ag)	Every 5-10 years or if the following significant changes occur: • EC changes • Taste, color, or odor changes • Surrounding land use changes	Package $250 – 300 Individual $20 – 30 Mercury $30 – 40	Al >0.2 mg/l As > 0.01 mg/l Ba >1.0 mg/l Cd >0.005 mg/l Cr >0.05 mg/l F >2.0 mg/l Fe >0.3 mg/l Pb >0.015 mg/l Mn >0.05 mg/l Hg >0.002 mg/l Se >0.05 mg/l Ag >0.1 mg/l	Compare to previous results. Consider retesting for any high results. Install a treatment system or find an alternate water supply. The appropriate treatment system depends on your overall water chemistry and the constituents that need to be removed. Consult a water treatment professional for more advice.
Volatile Organic Compounds	See MINERALS, above	Package $150-300	Any detection	Ask lab to re-test. If confirmed, consult a water treatment professional for more advice.

* Estimated costs as of 2009. Some labs report minerals in µg/L. 1 mg/L is equal to 1,000 µg/L. $\geq$ is greater or equal to.

Revised April 2011

Tests for Specific Water Quality Problems

Some well owners may have specific issues or problems with their well water. Table 2 outlines several common problems in drinking water, and substances you can test for. Not every problem and possible cause is a health risk. Less-frequently encountered water quality issues are not listed in Table 2; consult a water treatment professional if your particular water quality problem is not listed or for a more thorough discussion of the causes of water quality problems.

TABLE 2: Possible Causes of Common Taste, Odor, and Appearance Problems in Domestic Wells

Problem	Possible Cause
Water is orange or reddish brown	High levels of iron (Fe)
Porcelain fixtures or laundry are stained brown or black	Manganese (Mn) and/or iron (Fe) can cause staining
White spots on the dishes or white encrustation around fixtures	High levels of calcium (Ca) and magnesium (Mg) can cause hard water, which leaves spots
Water is blue	High levels of copper (Cu)
Water smells like rotten eggs	Hydrogen sulfide (H_2S)
Water heater is corroding	Water can be corrosive. Very corrosive water can damage metal pipes and water heaters
Water appears cloudy, frothy, or colored	Suspended particulates, detergents, and sewage can cause water to appear cloudy, frothy, or colored
Your home's plumbing system has lead pipes, fittings, or solder joints	Corrosive water can cause lead (Pb), copper (Cu), cadmium (Cd), and zinc (Zn) to leach from lead pipes, fittings, and solder joints
Water has a turpentine odor	Methyl tertiary butyl ether (MTBE) or other organic compounds
Water has a chemical smell or taste	Volatile or semi-volatile organic compounds (VOCs) or pesticides

Residents near landfills, industry, dry cleaners, gas stations, and/or automobile repair shops may wish to consider testing for VOCs, metals, total dissolved solids (TDS), and petroleum hydrocarbons. Well owners in agricultural and livestock areas may consider testing for pesticides, nitrate, bacteria, and TDS.

Revised April 2011

WATER QUALITY TREATMENT

Examples of domestic well treatment systems include activated alumina filters, activated charcoal filters, air stripping, anion exchange, chlorination, reverse osmosis, ozonation, and ultraviolet radiation. The type of treatment system used will depend on the type of water quality issues you are trying to address. It is important to know what your water quality issues are *before* installing a treatment system. Not all water treatment systems will work for every type of contaminant. Most treatment systems also require routine maintenance and upkeep – improperly maintained systems can cause more damage than having no treatment system at all. A treatment system, installation, and maintenance can be expensive, depending on what particular water quality problem you're trying to address. Talk to a water treatment professional, and ask for a guarantee that the system you want to install will work for your situation. A list of water treatment professionals can likely be found in a local phone book. Contact your county environmental health office for additional help in finding a water quality professional who can help you select and install an appropriate treatment system.

In some cases, it may be necessary to drill a new well that taps a less contaminated aquifer, or to obtain an alternative water supply. Treatment systems may not be successful in every situation.

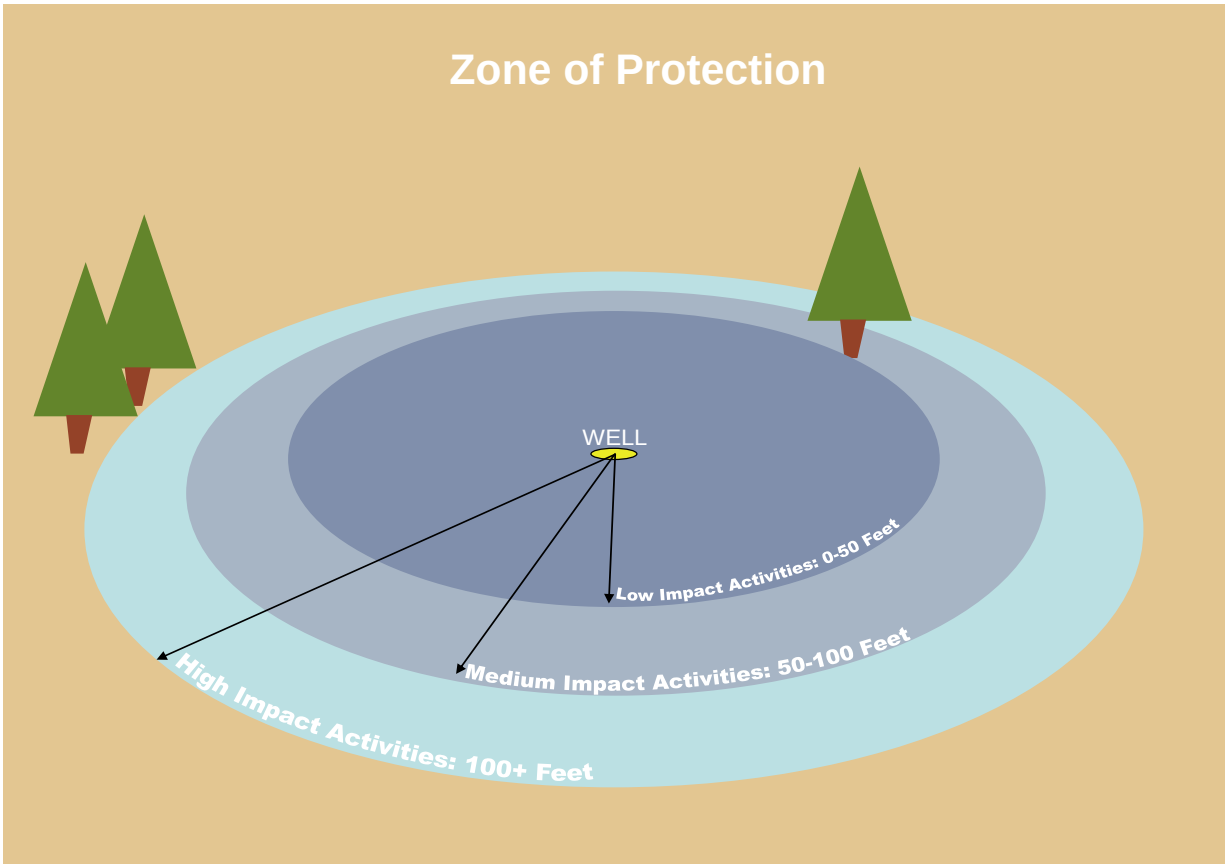
WELL DESTRUCTION

Unused and abandoned wells can allow for contamination of aquifers used as drinking water sources. The risk of groundwater contamination increases when other wells are operating, since pumping can draw poor quality water down the abandoned well and into the drinking water aquifer. To prevent unnecessary contamination, wells that are no longer being used must be destroyed.

The DWR has developed standards for well destruction. These standards are available in Bulletins 74-81 and 74-90, and can be found on-line at: http://www.dpla.water.ca.gov/sd/groundwater/california_well_standards/well_standards_content.html. Usually, the abandoned well is entirely filled with cement or similar compounds. Local environmental health agencies are responsible for specific well destruction standards and typically require well destruction permits. In some cases, local well destruction standards may be more stringent than State of California standards. The deconstruction work must be completed by a State licensed contractor.

WATER QUALITY PROTECTION

Preventing groundwater contamination is the best way to keep your well water clean. Groundwater typically moves slowly, so any contamination can take decades to naturally flush clean. The layer of ground between the surface and groundwater will provide some protection, but is not a perfect filter. The farther away possible contamination activities are from your well, the more soil is available to filter out contaminants if an accidental spill or release occurs. Local health agencies may have legally-mandated setbacks. The US EPA recommends that private well owners establish a "zone of protection" around their well. This zone should be considered off-limits for storing, mixing, spraying, spilling, burying, or dumping anything that might contaminate your water supply. Check with your local agencies to see if there are any specific ordinances requiring setbacks for animal enclosures, septic systems, and other types of facilities. The State of California does not regulate the location of private domestic wells.



LOW IMPACT ACTIVITIES

- Recreation area
- House
- Outdoor furniture and play areas

MEDIUM IMPACT ACTIVITIES

- Garage
- Boat
- City sewer lines

HIGH IMPACT ACTIVITIES

- Chemical storage
- Animal enclosures
- Manure/compost piles
- Machine/auto repair
- Septic system

Source: USEPA

Revised April 2011

Protect your well, and protect your water:

- Only low-impact facilities, such as a house, outdoor play area, or outdoor furniture should be located within 50 feet of the well. Do not mix or store any material that might contaminate your water supply within 50 feet of your well. Medium and high impact activities should only occur at safe distances.

- Animal enclosures and septic systems should have a minimum setback of 100 feet from a domestic well.

- Do not store or mix pesticides, fertilizers, lawn-care products, paint or paint cleaners, hazardous cleaning products, gasoline (including gasoline generators), or automotive wastes near the well.

- Do not dispose of hazardous materials (including some types of household cleaners, paint and paint cleaners, automotive waste, and pesticides) to a septic system – these substances are not treated in a typical septic system, and can easily migrate to groundwater. Take hazardous household chemicals to a designated collection center for disposal.

- Septic systems should be located downhill (downgradient) from a domestic well, and 100 feet from any drinking water source.

- Inspect your well at least once a year for cracks in the casing and seal, or any other types of leaks or possible sources of contamination. If issues are noted, have a State-licensed contractor repair the well.

Revised April 2011

RESOURCE GUIDE

There are many sources of information on private domestic wells. Programs that can help answer private domestic well water quality questions are provided below.

Local Government

County environmental health agencies are typically responsible for issuing well construction/abandonment/destruction permits, septic system permits, and other issues associated with private domestic wells. Consult your phone book or conduct an internet search to find the specific agency in your county responsible for private domestic well oversight. Some local agencies run hazardous household waste programs. Such programs typically offer tips for use, recycling, and disposal of these products.

State Government

The State of California does not regulate the water quality in private domestic wells. However, state agencies can be helpful in dealing with water quality issues and identifying threats to water quality.

California Department of Public Health (CDPH): The CDPH Division of Drinking Water and Environmental Management is responsible for the regulation and monitoring of public water systems (a public water system serves 200 or more homes). Visit the Division of Drinking Water and Environmental Management website at: http://www.cdph.ca.gov/programs/Pages/DDWEM.aspx

California Department of Water Resources (DWR): DWR provides groundwater level and water quality data. DWR's Integrated Water Resources Information System (IWRIS) is a web-based GIS application that allows users to access, integrate, query, and visualize multiple sets of data. Visit the DWR website at: http://www.water.ca.gov

Department of Toxic Substances Control (DTSC): The DTSC can help answer questions about hazardous materials and waste, reducing household use of hazardous materials, locating disposal and handling facilities for specific types of household materials, and where to report illegal dumping and spills. Visit the DTSC website at: http://www.dtsc.ca.gov

State Water Resources Control Board (SWRCB): The SWRCB is responsible for the adjudication of water rights and water quality protection. Visit the SWRCB website at: http://www.waterboards.ca.gov

- **Groundwater Ambient Monitoring and Assessment (GAMA) Program**: The GAMA Program is the SWRCB's comprehensive groundwater quality monitoring program for California. The main goals of GAMA are to improve statewide groundwater monitoring and to increase the availability of groundwater quality information to the public. Visit the GAMA website at: http://www.waterboards.ca.gov/gama

- **GeoTracker GAMA**: GeoTracker GAMA provides user-friendly internet access to groundwater quality data in California. GeoTracker GAMA provides water quality data for raw, or untreated, groundwater and integrates and provides tools to analyze several datasets. Visit the GeoTracker GAMA Introduction page at: http://www.waterboards.ca.gov/gama/geotracker_gama.shtml

- **Regional Water Resources Control Boards** (Regional Boards): Regional Boards develop Basin Plans for their hydrologic areas, issue waste discharge requirements (WDRs), take enforcement action against violators, and monitor water quality. To find the Regional Board for your area, visit the following website at: http://www.waterboards.ca.gov/water_boards.shtml

Federal Government: US EPA Safe Drinking Water Hotline:

The Federal Government does not regulate water quality in private domestic wells. However, the US EPA provides helpful information to domestic well owners. The Safe Drinking Water Hotline is available to help understand regulations and programs developed in response to the Safe Drinking Water Act. The hotline can be reached at (800) 426-4791. Visit the website at: www.epa.gov/safewater/privatewells/index2.html

Photo: Private domestic well water sampling.

ACKNOWLEDGEMENTS

The SWRCB would like to acknowledge and thank the Santa Clara Valley Water District and the San Diego County Department of Environmental Health for use of their informational fliers in the development of this document.

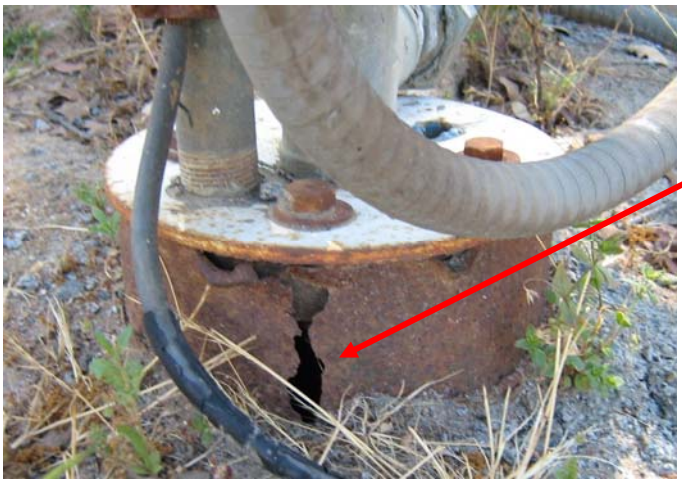
For additional information, please contact GAMA Program Manager John Borkovich at (916) 341-5779 or jborkovich@waterboards.ca.gov.

Photo: A domestic well showing the well casing, cover, and conveyance system. The well is located inside a shed with a concrete floor.

APPENDIX: Photographic Guide to Common Well Maintenance Issues

Proper well maintenance can help prevent groundwater contamination. The following are examples of commonly observed well maintenance issues and suggestions on how to minimize potential contamination at your well

Cracked Well Casing



A cracked well casing may allow surface water and contaminants into your well. One of the most common water quality issues associated with a cracked well casing is the presence of coliform bacteria. Other chemicals can also be introduced into the well through the cracked casing. Consult a water quality professional, like a licensed well driller to repair or replace the cracked casing.

Missing Plugs and Other Well Openings

Many wells have a small plug located at the top of the well casing. The plug may degrade over time and sometimes fall off. If the plug is missing, the well is directly open to potential contamination. The most frequently observed contaminant associated with a missing plug are coliform bacteria. Replacing a missing plug is an effective way to reduce potential contamination.

Well Location: Near Storage Tanks

Storage tanks for hazardous materials should be kept at least 100 feet from your well. Gasoline products, VOCs, and pesticides are the most common contaminants associated with spills or leaks from storage tanks. Keeping your fuel tanks at least 100 feet away from your well may help avoid well water contamination.

Well Location: Agricultural Areas

Locating a well close to agricultural areas – such as orchards or row crops – increases the likelihood of detecting nutrients (such as nitrate), salts and pesticides in your well water.
Your well should be located at least 100 feet from areas of pesticide or fertilizer application.

Revised April 2011

Well Location: Downhill (Downgradient) from a Contaminant Source

Avoid placing your well downhill from a potential contaminant source like a fuel tank or a septic system. Groundwater flow direction typically follows topography – so a leak from an uphill or upgradient contaminant source could potentially affect your well water quality.

Well Location: Animal Enclosures

Manure is a source of microbial contaminants (including coliform bacteria), nutrients (such as nitrate), and salts. Your well should be located at least 100 feet from any permanent animal enclosure.

Revised April 2011

Well Location: Storage of Hazardous Substances

Storing hazardous substances near your well increases the potential for well water contamination. Hazardous substances including paint, petroleum products (like gasoline), pesticides, herbicides, fertilizers, and solvents should be stored or mixed at least 100 feet from your well location.

Excess Vegetation Surrounding Your Well

Overgrowth of vegetation near your well may lead to root damage of the casing, creating a conduit for possible well water contamination.

Do not apply herbicides, pesticides, or other chemicals to vegetation near your well, as these chemicals may contaminate your well water.

Revised April 2011