Guide to Individual Private Home Water Supplies

Wichita Falls–Wichita County Public Health District Laboratory
1700 Third Street, Wichita Falls, Texas 76301-2113

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This Guide is provided as a public service by the
Wichita Falls-Wichita County Public Health District Laboratory,
1700 Third Street, Wichita Falls, Texas 76301-2113
Phone: 940.761.7836 Fax: 940.761.7878
Email: david.chattin@wichitafallstx.gov

Revised October 2014

Contents

Introduction

Suitable water for drinking purposes seldom occurs in nature. Rain and snow waters become contaminated quickly by dust, insects, animals, and man. Some of the organisms introduced into water by these means can cause typhoid fever, paratyphoid fever, bacillary and amoebic dysentery. The organisms causing these diseases are excreted in human discharges and if defective excreta disposal methods or a lack of safeguards around the water source allow the organisms to reach water supplies, human illness can result.

In order that we may free ourselves of these dread diseases, certain safeguards must be provided. We cannot depend on the physical appearance of water as a measure of safety for it is possible that clear and sparkling waters may be unsafe. For complete satisfaction, the water supply should be safe, pleasant to taste, clear and free of gases and minerals that impart disagreeable odors. A good water supply is one that is adequate for needs, dependable, and convenient. A minimum of approximately 50 gallons of water per person per day is required in those homes with complete plumbing facilities. In homes not equipped with plumbing, the water demand may decrease to about 10 gallons per person per day. Of course, if stock or irrigation water is to be provided from the household supply, additional allowances must be made. Table I gives water usage information that will be applicable in most farm and suburban areas.

This pamphlet is intended as a non-technical guide to the provision of safe individual water supplies in farm and suburban homes where public water supplies are not available. The protection of water supplies including; wells, cisterns, springs, and surface pools are discussed briefly along with disinfection, collection, and water testing procedures.

Table I
Water Consumption Schedule

Use	Water Consumption per Day
Household -	
Hot and cold running water, Kitchen, laundry, bath, etc.	50 gallons per person
Livestock -	
Dairy Cows (drinking only)	15 gallons per head
Dairy Cows (drinking & servicing)	35 gallons per head
Beef Cattle, horses, and mules	12 gallons per head
Hogs	4 gallons per head
Sheep	2 gallons per head
Chickens (layers and broilers)	4-6 gallons per 100 birds
Turkeys	10-18 gallons per 100 birds
Other Uses -	
Dairy Utensil washing	30-50 gallons
Flushing dairy barn	30-50 gallons
Sanitary hog wallow	100-400 gallons
Garden watering, 1-inch hose	625 gallons per 1,000 ft^2

Safe Water Supply Checklist

Well Supply

1. Is your well located at least 50 feet from any septic tank, cistern property boundary, and/or nonpotable well, 100 feet from a septic drainfield or any leach field, 150 feet from any feed storage area, pesticide or fertilizer storage area, or shelter or yard for pets or livestock, or 250 feet from a manure stack or liquid waste disposal system?

2. Is an abandoned well nearby, and if so, has it been properly sealed to prevent possible contamination of the water producing stratum?

3. Is the well located so that runoff waters are diverted from it and is the well at an elevation that will prevent its flooding by a nearby stream or drainage ditch?

4. Is a watertight, impervious covering provided to exclude contamination of the well by surface drainage, stuffing box leakage, dust, insects, small animals, and other foreign material?

5. Has your well been cased or curbed to exclude surface drainage and seepage water originating nearby?

6. Does your well have a pump that does not require priming, is the pump fitted with a turn down spout and is a stuffing box for the pump rod provided?

7. Is the seal between your pump and the well casing or concrete cover adequate to prevent contamination of the well water?

8. Have you investigated the possibility of constructing a deep well rather than using water from a shallow formation?

9. Has your well been constructed or repaired recently? If so, have the well and piping system been disinfected with a chlorine solution since the work was performed?

Cistern Supply

1. Is your cistern constructed of watertight materials and provided with a tight fitting cover, raised curbing type roof hatch, a screened vent and overflow?

2. Do you have a by-pass to your cistern so as to divert the first roof washing to waste?

3. Is your cistern equipped with a sand and gravel type filter to remove trash, debris, etc., which may have accumulated on the roof and in the gutters since the previous rain?

4. If a granular charcoal type filter has been provided, has the charcoal been replaced recently?

5. If the interior of your cistern has recently been cleaned or repaired, did you properly disinfect the cistern immediately?

Spring Supply

Is your spring water protected properly from dust, insects, surface drainage, wildlife, livestock, etc., and is the spring protected from flooding?

Surface Supply

1. Is the water from a pond, canal, lake, or lake settled in a tank, filtered, and disinfected continuously to render it safe for human consumption?

2. Are pasture improvement practices carried out on the immediate drainage area of your pond to minimize the sediment in the raw water?

3. Are livestock excluded from the pond and the immediate drainage area from which the water is obtained?

Windmills

1. Does your windmill installation provide adequate protection of the water formation from surface drainage and waste water from the hydrant which may be installed on the riser pump?

2. Have you considered the use of metal instead of wooden sucker rods? The use of metal rods will facilitate the removal of contamination that might occur during installation.

3. When new leather cups were placed in the pump cylinder, was the assembled cylinder submerged in a chlorine solution (40-50 ppm) for at least one hour? This procedure is recommended since the presence of leather cups fosters the growth of coliform bacteria.

All Water Supplies

1. Have all water storage tanks been provided with tight fitting covers to exclude contamination and to prevent the presence of “red worms” and algae growths in the water?

2. Are all stock watering tanks or troughs supplied by allowing the water to spill into them? Submerged supply lines may cause your water system to become contaminated.

3. Is there an access provided for chlorination of the water supply?

4. Have you submitted a sample of your water to a certified water testing laboratory to determine its bacteriological content? Do you repeat testing every 6 months to insure your water source stays clean?

Location of Water Wells

While the determination of a safe distance between ground water supplies and a possible source of contamination is dependent on many factors, to safeguard your well from possible sources of contamination such as stock and poultry yards, privies, septic tanks, septic drainfield or leach field, etc., it is recommended that the well be located at least 150 feet from such sources of contamination. If local conditions will not permit a distance of 150 feet between the well and the entire septic tank system, the watertight septic tank should be installed at least 50 feet from the well and an effluent line of tight joints be laid so that no part of the septic drainfield or leach field will be located within 100 feet of the well. It is also recommended that the well be located so that flooding and the entrance of surface water are prevented. For existing wells located less than 150 feet from possible sources of contamination, the construction of diversion ditches or levees between the well and potential sources of contamination might be considered.

Water producing formations located less than 10 feet from the original ground surface should be considered potentially unsafe and should not be utilized as a domestic water supply. Deeper wells drawing water from rock formations, such as limestone that are creviced or channeled, should also be regarded with suspicion until several analyses have demonstrated that the water is free from contamination. Even then, periodic analyses should be made because polluted water may travel long distances through crevices or underground channels without being purified.

Well Construction

Dug Wells

The shallow dug well is constructed with hand tools or backhoe and is only deep enough to reach shallow ground water. This well may be lined (cased) with stones, brick, tile, or other material to prevent collapse, then covered with a cap of wood, stone, or concrete. Typically 10- to 30 feet deep, this type of well generally furnishes comparatively little water, and have the highest risk of becoming contaminated. To be protected from surface contamination, a dug well must be provided with a watertight material (e.g. tongue and groove precast concrete) and a cement grout or bentonite clay sealant poured along the outside of the casing to the top of the well and a concrete cover. The casing or curbing for dug wells is usually constructed of stone, brick, tile, or metal. A sanitary pump should be installed to draw the water, and land surface around the well should be mounded so that the surface water runs away from the well and is not allowed to pond around the outside of the wellhead. Figure 2 illustrates a properly constructed dug well.

Drilled Wells

Drilled wells penetrate about 100-400 feet reaching a plentiful and more reliable water supply. A casing of metal or plastic pipe should be placed in a drilled well to prevent caving of the formations penetrated and also to insure protection of the water supply from contamination by shallow ground water. To secure maximum protection against possible contamination, the well should be cased from the top of the water producing formation to at least 18 inches above the elevation of the concrete surface slab or finished floor of the well house. The casing should also extend at least 1 inch above the top of the foundation upon which the pump or motor is mounted. It is also desirable to have the well casing pressure cemented from the top of the water formation to the earth's surface; at least a mixture of cement grout or bentonite clay should be placed around the upper 10 feet of the casing, or deeper if necessary to exclude water from shallow formations as illustrated in Figure 3. The drilled well should also be provided with a concrete cover sloped away from the casing. Submersible pumps, located near the bottom of the well, are most commonly used in drilled wells.

Bored Wells

Bored wells may be constructed with the aid of hand or machine driven augers. Casings of tile, metal, or other suitable material should be provided in the excavation and extended from the earth's surface to the water stratum to be developed. Similar to dug wells, bored wells do not tap deep sources of water and are, therefore, subject to the same difficulties of providing relatively large yields, and they may be affected considerably during periods of drought.

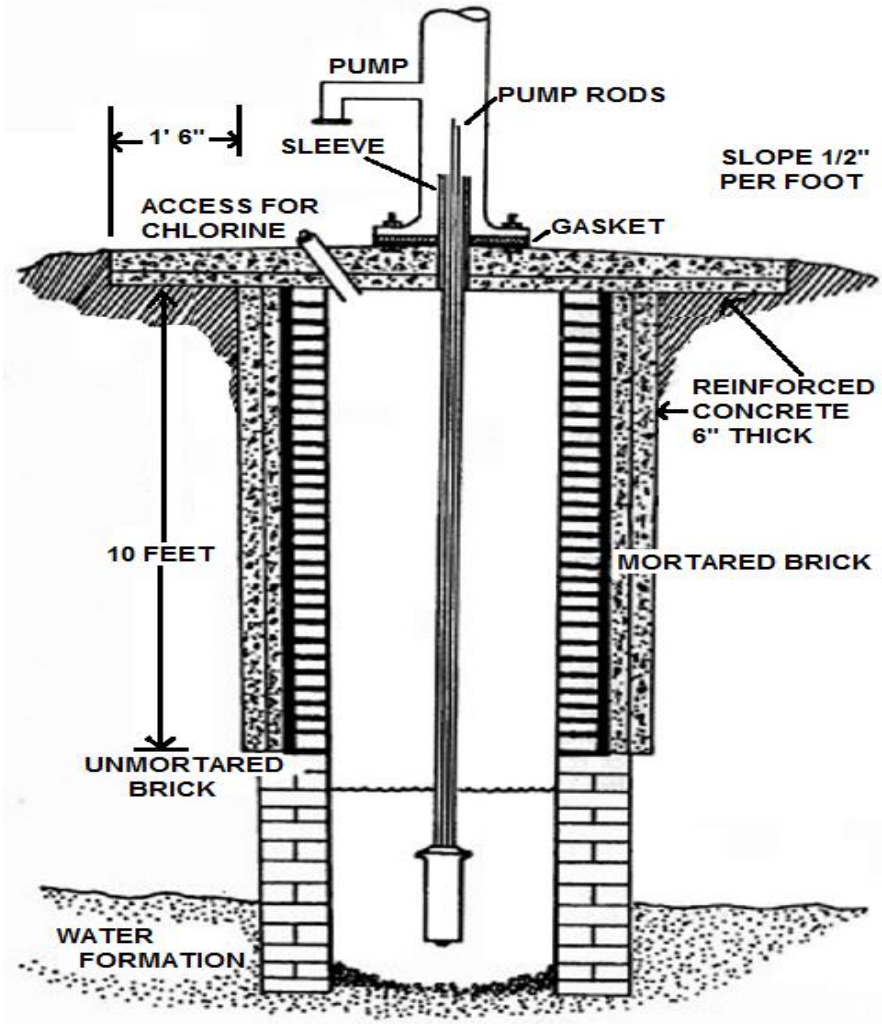
Driven Wells

A driven well is constructed by driving a pipe fitted with a well point with a pile or other driving device. A screened well point located at the end of the pipe helps drive the pipe through the sand and gravel. The screen allows the water to enter the well and filters out sediment. Driven wells are typically 30 to 50 feet deep and are usually located in areas with thick sand and gravel deposits where the ground water table is within 15 feet of the ground's surface. The pump for the well can be located on top of the well or in the house. An access pit is usually dug around the well down to the frost line and a water discharge pipe to the house is joined to the well pipe with a fitting. The well cover should be tight fitting with no cracks and should sit about a foot above the ground. Slope the ground away from the well so that the surface water will not pond around the well.

Abandonment of Wells

Permanently abandoned wells should be filled with suitable materials to protect the water-bearing formations from contamination. Wells may be deemed satisfactorily filled when: (1) Drilled or cased wells are filled completely with cement grout, concrete, or clean puddled clay, (2) Dug or bored wells are filled completely with puddled clay or its equal after as much as possible of the curbing is removed. This procedure should be carried out whether or not a new well is to be constructed nearby. Abandoned wells should never be used for the disposal of sewage, septic tank effluents, or other wastes.

Figure 2 – PROTECTED DUG WELL



Suggested Chlorination Access for Wells

In order that the protective seal need not be broken for introduction of chlorine compounds, it is suggested that a pipe be installed through the well seal to provide an access for chlorination. This pipe should either be capped or raised and equipped with an elbow turned downward and screened or capped.

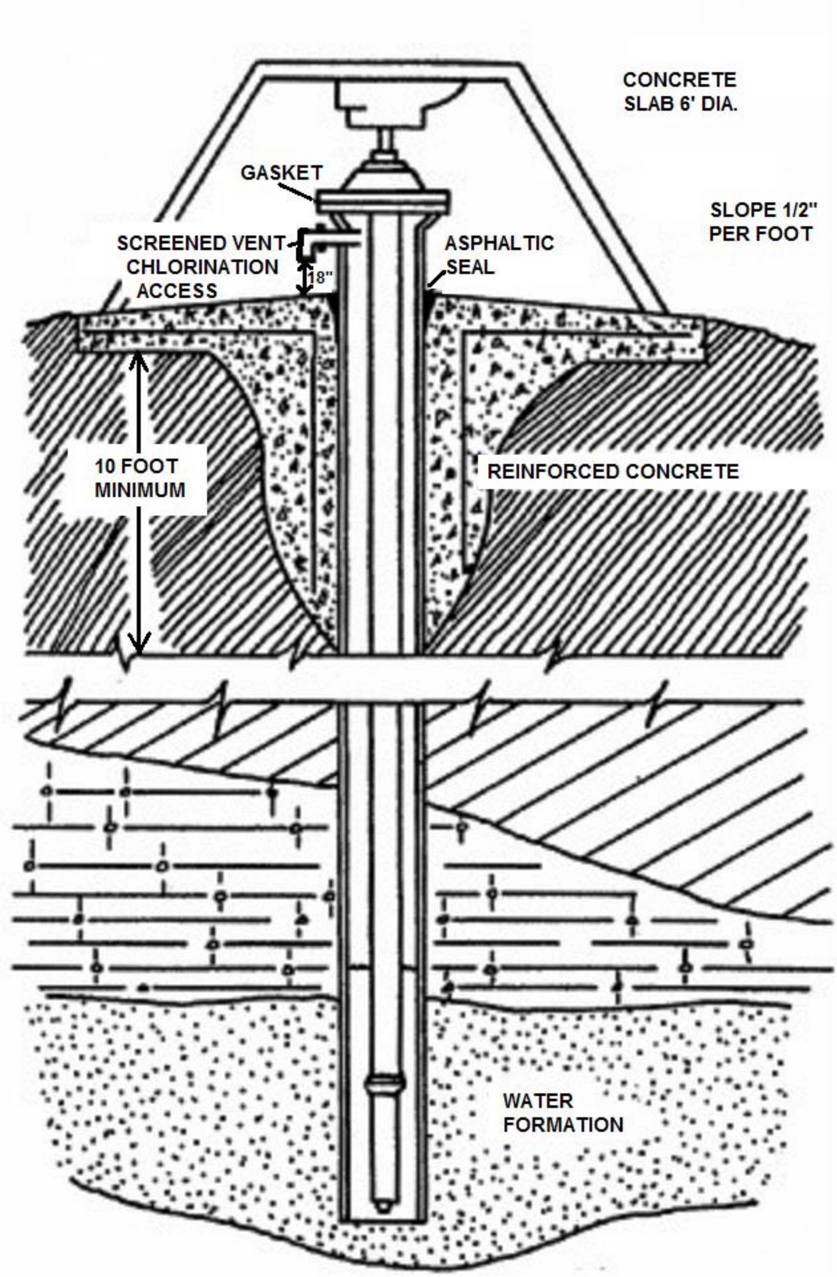


Figure 3 – PROTECTED DRILLED WELL

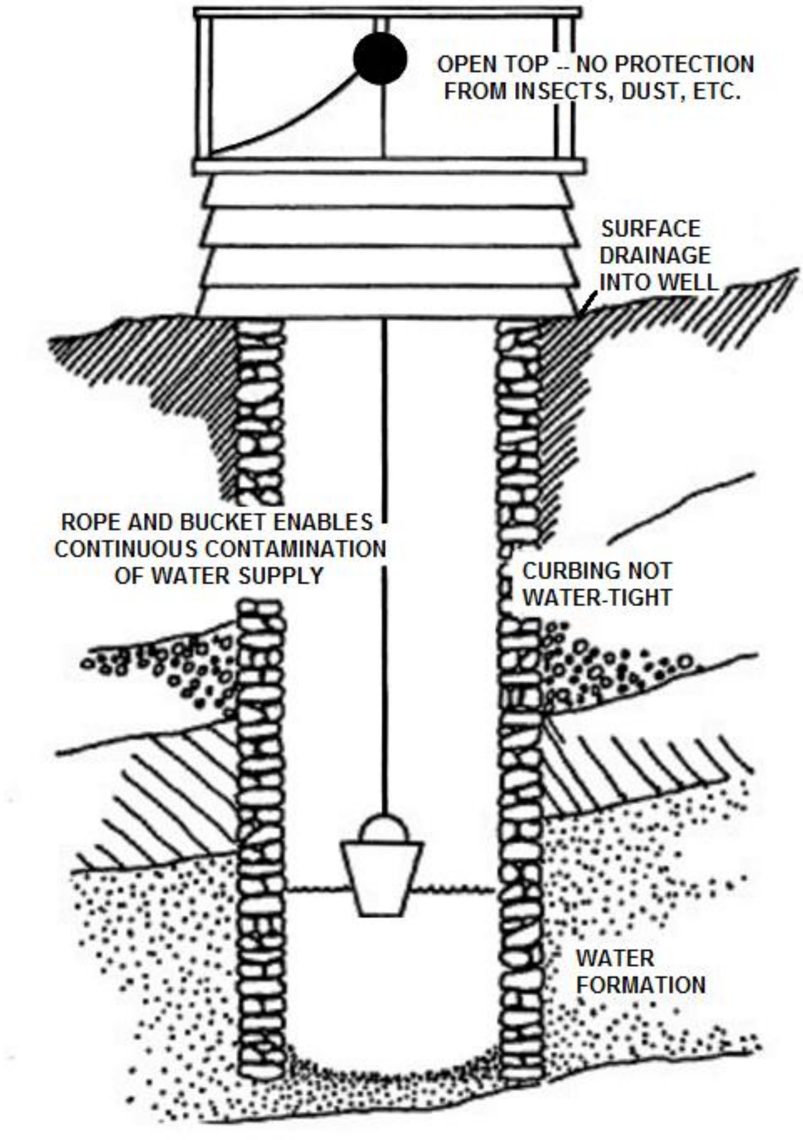


Figure 4 – UNSAFE WELL

Reconstruction of Old Wells

Figure 4 illustrates several conditions of disrepair and poor planning that will allow wells to become contaminated. Some of the deficiencies pictured are:

1. The well is not protected with a watertight, insect proof seal to prevent contamination of the water from the earth's surface.
2. Improper drainage allows surface water to drain toward the well.
3. The well lining constructed of rock is not adequate to prevent polluted waters from seeping into the well.
4. The rope and bucket method of water withdrawal offers an avenue of contamination from dirty hands, a dirty bucket, and the rope.
5. Poor construction technique is likely to allow the growth of aquatic vegetation in the well which could impart objectionable odors and tastes to the water.

The old well must be relocated if proper drainage is not available and if sources of contamination are too near; Figures 5 and 6 demonstrate the two methods by which an unsafe dug well may be converted to a protected well which will produce safe water. Figure 5 depicts reconstruction by digging out around the present well curbing to a depth of at least 10 feet below ground level and backfilling with watertight concrete at least 6 inches thick. A 6 inch thick slab is prepared as a well cover and fitted with a pump for securing water. Aquatic vegetation has been removed and clean, chlorinated gravel placed in the bottom of the well.

Figure 6 illustrates a similar method of well reconstruction that includes excavation and removal of the old well casing to a depth of at least 10 feet, the provision of a 6 inch thick concrete stab for a well cover, casing extending to the ground surface from the slab and backfilling the excavation with tamped clay. A pump has been installed on a sloped concrete slab for water withdrawal.

The Cistern Supply

Ground water supplies are not always available or production is insufficient for domestic water demands. The provision of cisterns for the storage of rainfall runoff from roof surfaces may afford a safe water supply if certain precautions are taken to prevent contamination during collection and storage.

The catchment area from which rain is collected will be normally polluted with dust, bird droppings, dead insects, and perhaps other debris. A simple method for preventing these objectionable materials from reaching the storage reservoir is to provide a by-pass in the downspout leading to the cistern and suitable by-pass mechanisms. Filtering devices containing sand and gravel and/or charcoal have been devised to aid in the removal of organic materials. Also, filtering media can aid in the removal of objectionable tastes and odors imparted to the water from various shingle stains and other roofing materials. Filter design should facilitate routine cleaning of filter media without disturbing or contaminating the stored water. A sand filter is illustrated in Figure 7.

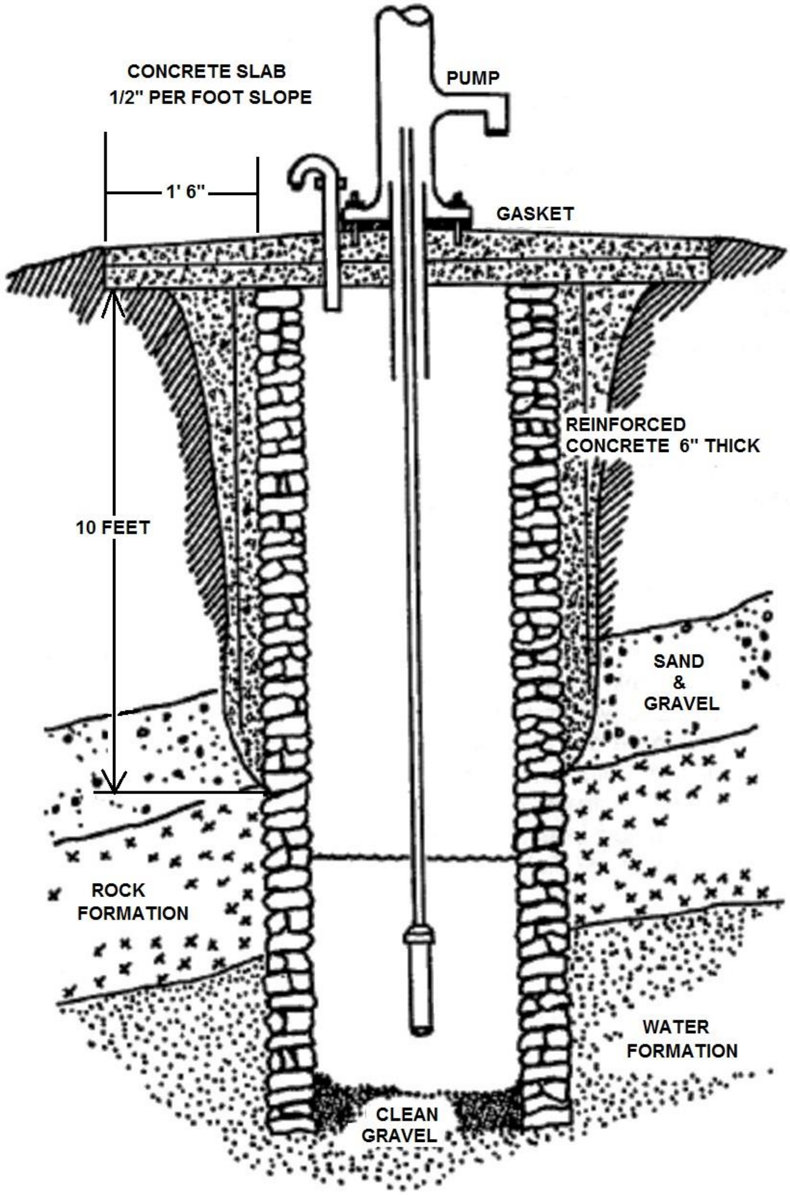


Figure 5 - RECONSTRUCTED DUG WELL – METHOD 1

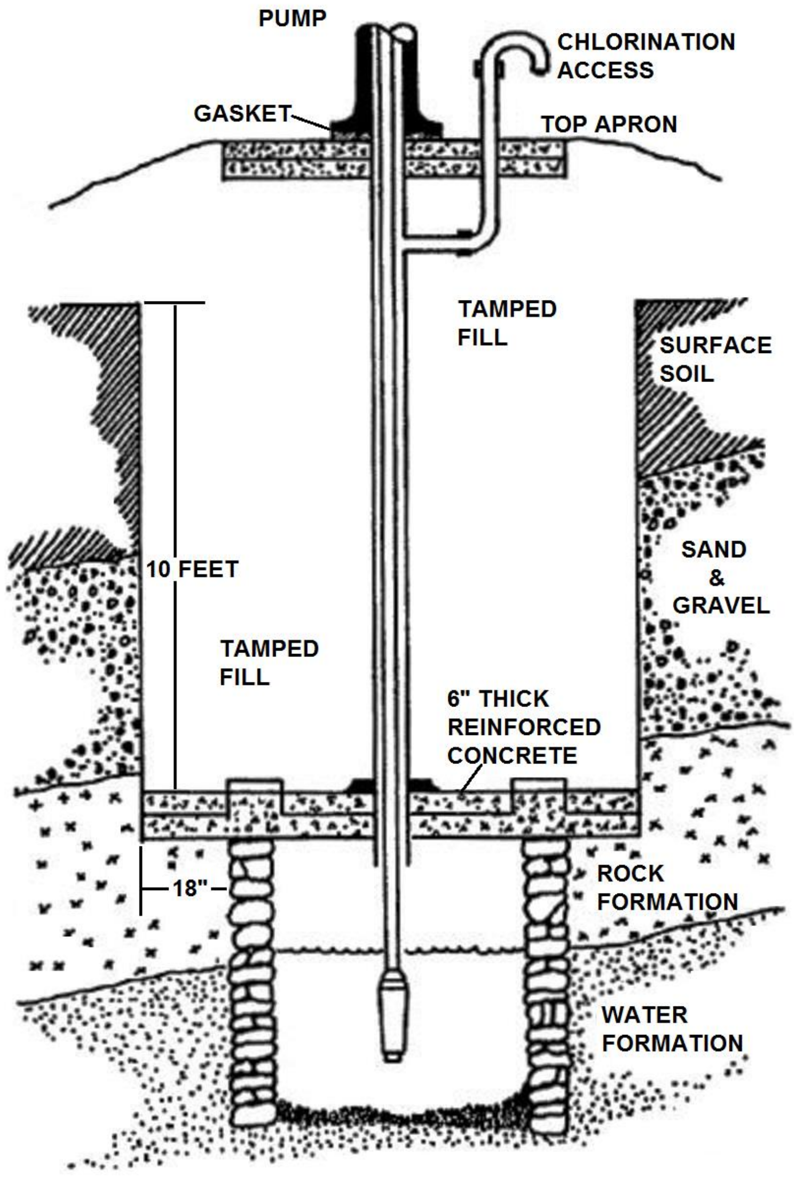


Figure 6 - RECONSTRUCTED DUG WELL – METHOD 2

Where drainage and ground water conditions are unsatisfactory and climatic conditions permit, above ground cisterns are often preferable. However, underground cisterns are preferable in some localities because of economy in construction, relatively lower water temperatures, and protections from freezing in colder climates. Both types of installation should be covered securely to prevent possible entrance of dust, insects, and other objectionable materials. Concrete cisterns should be at least 6 inches thick and protected in much the same manner as water wells with well drained surrounding surface areas and a watertight covering fitted with raised curbing and an overlapping covered manhole as illustrated in Figure 7. Inlet, outlet, and waste pipe should be screened properly.

Sanitary Development of Spring Water Supplies

Contrary to popular belief, spring water is not always of good bacteriological quality, In many instances, springs are nothing more than very shallow wells with the water supply being derived from water producing rock or sand only a few feet below the ground surface. Since it is not always practicable to determine accurately the depth from which spring water comes and whether or not the water stratum is protected from surface contamination by impervious strata, extreme care should be exercised in developing springs for use as domestic water supplies.

Spring water utilized for domestic purposes should be enclosed with walls and a cover made of concrete or other relatively watertight materials. Construction techniques should provide unrestricted admission of spring water and exclusion of surface water and other foreign materials. While the spring cover should be movable to allow access to the interior of the spring box, there should be no opening through which water might be obtained by means of cups or buckets dipped into the impounded body of water. The cover should be kept locked. Water should be taken only from discharge pipe installed in a wall.

In some locations it is necessary to construct diversion ditches to prevent the entrance of surface runoff water from higher areas nearby. It is also a good procedure to fence the immediate vicinity of the spring so that livestock or wild animals will be excluded.

Spring waters can be developed so as to secure maximum protection from contamination by excavating sufficiently to locate the true spring openings and to insure a secure foundation for the encasing structure. If possible, the water should be allowed to escape from the enclosure by gravity and collected in a tight, well protected storage reservoir, then pumped to the distribution system. This method is preferable to that of pumping directly to the distribution system from the spring enclosure. Figure 8 illustrates some of the aspects of suitable spring water supply development.

Spring water should not be used with confidence for drinking or domestic purposes until it has been shown to be safe for these purposes. Provision should be made for effective and continuous treatment of the water, unless, by a series of laboratory examinations, the water has been found to be satisfactory. And, periodic bacteriological examinations should be continued as long as the spring is used.

Sanitary Development of Surface Water Supplies

The residents of some areas of Texas are without the benefit of adequate ground water supplies to enable dependence on this source for a domestic supply. Sometimes well water is inaccessible and local conditions sometime prevail wherein ground waters are of unsuitable quality for domestic purposes. In addition, cistern supplies are not dependable in those areas subject to extended periods of drought. Such conditions have encouraged the development of surface waters for individual home water systems. Rivers, creeks, ponds, and irrigation canals usually offer fairly dependable sources of raw water; however, these waters are exposed constantly to contamination. They should not be utilized for domestic purposes until subjected to an adequate water treatment, including coagulation, sedimentation, filtration, and disinfection. Unless necessary, the use of surface water for domestic supplies should not be considered by individuals because of the complex nature of water treatment techniques necessary to assure a safe water supply.

Surface waters contain quantities of minute soil particles and other debris which result in cloudiness and/or turbidity. These materials and the disease causing bacteria in raw water must be removed prior to human consumption. Figure 9 is a schematic drawing of a suggested pond water system. Essentially the same treatment demonstrated here should be provided for water derived from other surface sources.

Where ponds furnish the water supply, it is extremely important that measure be taken to provide drainage areas large enough to afford sufficient water for minimum water needs. Drainage areas should preferably not include cultivated land. Pasture and woodland are considered the most satisfactory terrain. Less silt is present in the pond water collected from these areas which allows more efficient filter operation with less frequent cleaning, and the decrease in pond capacity as a result of silt deposits is minimized. Farm ponds used for domestic supplies should be fenced to prevent animals having direct access to the pond.

Sedimentation

Pond water requires sedimentation, filtration, and disinfection prior to use. Artificial tanks of concrete, metal, or earthen construction may be used to allow the suspended matter to settle ahead of the filters. In order to increase turbidity removal, facilities for coagulating, i.e. alum and lime feeders, should be included in the over-all plan for water treatment facilities. Following rainy periods the turbidity of pond waters may overload the filter mechanism, therefore, selective and periodic withdrawal of water from the pond to artificial settling facilities will assure the availability of the best water at all times.

Filtration

Filters remove particles that are suspended in water. Coarser solids should be removed by sedimentation prior to filtering. Coagulated water may be passed through rapid sand filters under gravity flow conditions or through filters of the pressure type, which are available from various dealers in water supply equipment. These filters should be designed so as to filter water at rates of 2 gallons per square foot of filter surface per minute. A layer of clean gravel 16-24 inches in depth, varying in size from 1/16 to 2.5 inches, should be arranged in 3-5 layers to form the lower part of the filter. Clean sand, free of clay, dirt, and other impurities, should be placed on the gravel to a depth of 24 to 30 inches. This sand should have an effective size of between 0.35-0.45 mm and its uniformity coefficient should be between 1.4 and 1.8. Since the filter materials will become dirty with use, an arrangement should be incorporated whereby filtered water from the storage reservoir may be utilized for backwashing the filters. This wash water should be discharged to waste. At least 15 gallons of water per square foot of filter surface per minute should be allowed for backwashing.

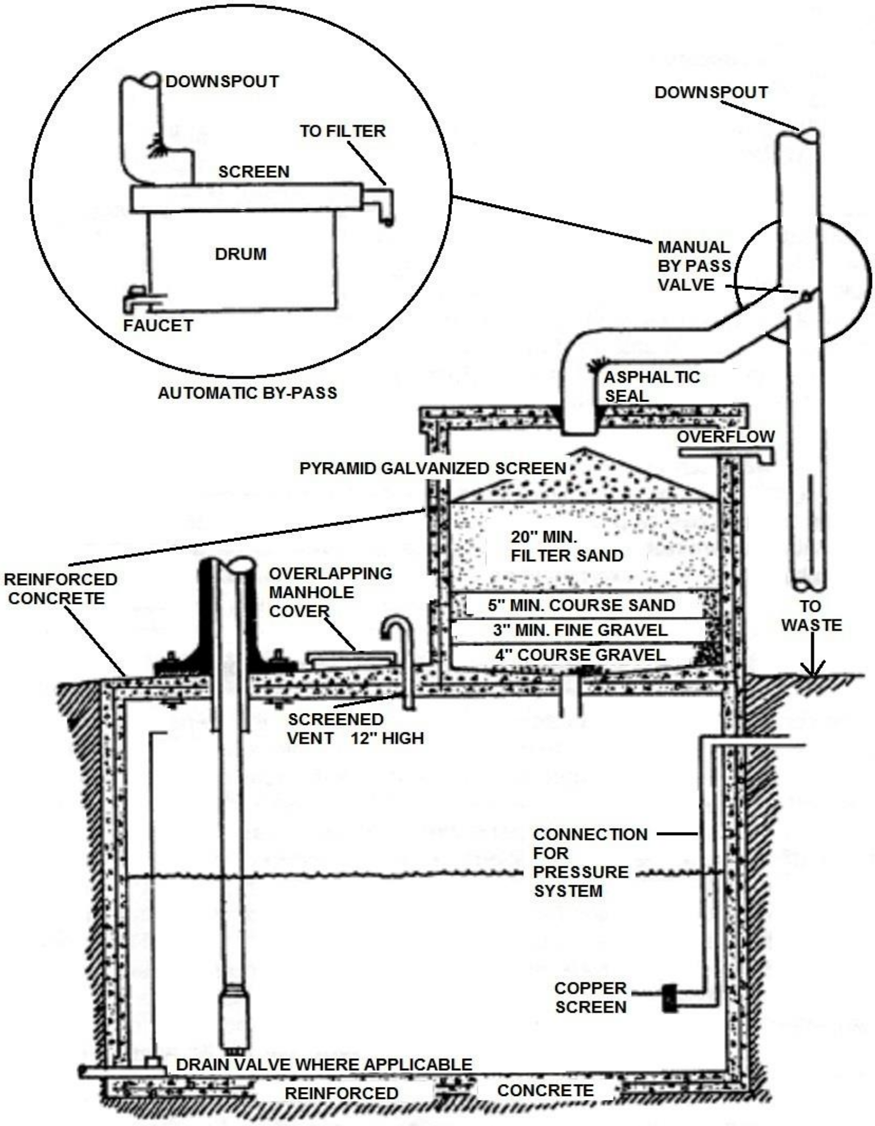


Figure 7 - CISTERN WITH SAND FILTER

In order that the efficiency of the filters in the removal of finely divided solids might be increased immediately after each backwashing the surface of the filter should be covered with a floc which is formed by the addition of alum. To accomplish this at small water supply installations, an alum pot filled with lump alum is usually used. The application of the alum solution is only required for 10 or 15 minutes prior to resuming normal filtration operation. In the treatment of certain types of surface water, a similar facility for the application of a lime solution might be needed to counteract the acidity of the water so as to minimize corrosion.

Disinfection

Chemical disinfection of all clarified surface water is absolutely essential to assure a safe supply. It is recommended that disinfection be accomplished by a mechanical type hypochlorinator. Several manufacturers offer for sale hypochlorination units which consist of a very small pump designed to inject chlorine solution into the raw water or place the chlorine solution into the water by an aspirator. The amount of chlorine solution delivered can be regulated by the hypochlorinator.

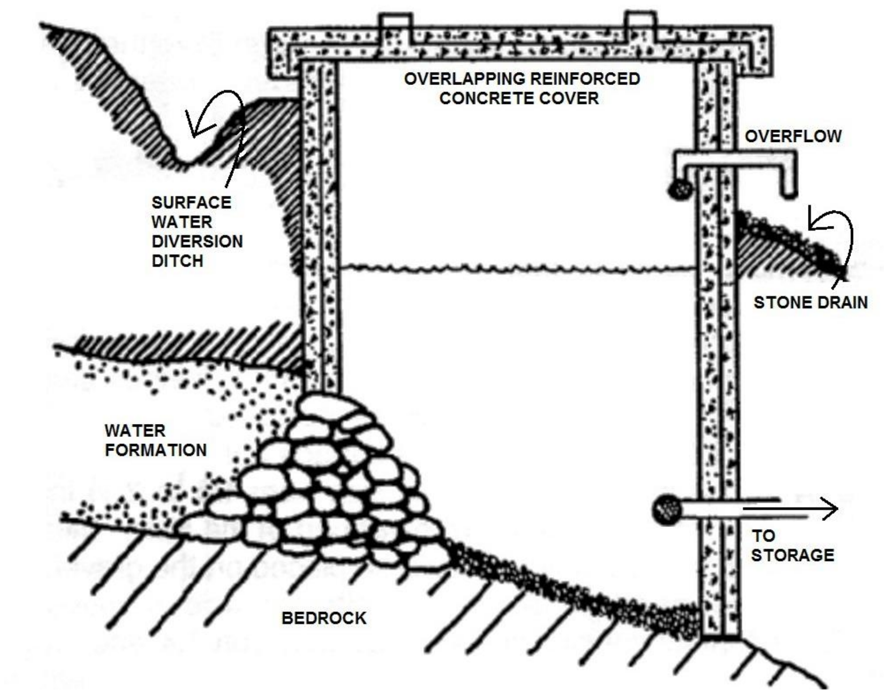


Figure 8 - PROTECTED SPRING

Pumping Equipment

Since no satisfactory solution has yet been found to the problem of safeguarding a water supply serviced by a simple rope and bucket, this method of water delivery cannot be recommended. Endless chain devices carrying small buckets to deliver water may be adaptable in some instances; however, considerable maintenance is usually necessary in keeping these devices in good operating condition and preventing contamination of the water being raised to the surface. Hand pumps, although antiquated by the availability of electric power in most areas, are sometimes used in connection with shallow dug wells and cisterns. Unless suitable elevated storage facilities are available, power driven pumps are required if a continuous supply of running water is desired, and a wide selection of such pumps are available to the developer of an individual water supply.

Pump design and installation should allow for the following sanitation specifications:

1. Pump head should be designed to prevent contamination by hands, dust, insects, birds, and similar sources.
2. Pump base should be so designed as to facilitate a waterproof seal with the well cover or casing.
3. Pump cylinder should be installed below the pumping water level in the well so that priming will not be necessary.
4. The design should provide for frost protection pump drainage within the well.
5. The installation should be designed to facilitate necessary maintenance and repair.

In general, these same sanitary specifications should apply to both hand powered and power pump installation.

The selection of a suitable pump should be guided by a determination of water needs based upon periods of peak demand. Other factors influencing the selection of a suitable pump include: depth to water, well size, pump location, pump durability, and efficiency and the availability of dealer service. Pump manufacturers furnish information regarding the capacities of their equipment when exposed to given conditions. These specifications should be followed closely in determining what type of pump is best suited for particular needs.

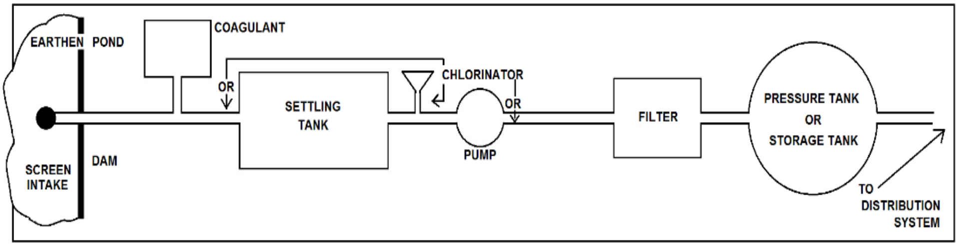


Figure 9 - WITH SETTLING TANK
Schematic layout of surface water treatment system.

Disinfection of Water Supplies

New wells and equipment become contaminated during construction and installation. Also, existing wells that have been opened for repair are subject to contamination from tools, dust, soil, hands, etc. Certainly any water supply that has been tested bacteriologically and found unsafe should not be used until disinfection is completed. However, it is not wise to assume that water will be indefinitely safe even after disinfection. For this reason, construction and location defects should be removed prior to disinfecting an existing well, and periodic samples should be submitted for bacteriological analysis after disinfection has been carried out.

An effective and economical method of well disinfection is the introduction of a chlorine solution into the well and circulating it through the plumbing system. The amount of chlorine to use in disinfection will depend upon the amount of water in the well or tank and the conditions or chlorine demand of the water. Table II enables a rapid calculation of water volume in your well or cylindrical tank.

The capacity of a rectangular well, box, or tank is found by multiplying the length by the width by the height (i.e. volume = l x w x h), all in feet, then multiplying that figure by 7½. This will give you the total gallonage of the storage container or tank.

Chlorine compounds in powder, solution, and tablet form are available at most drug, feed, pool, and grocery stores. The chlorine concentration is usually designated on the label of each product in terms of the percentage of "available chlorine." Do not use bleach that is scented or odorless- it should have a sharp chlorine odor.

Calcium hypochlorite is sold for chlorinating swimming pools. Because it contains more chlorine than bleach, it can be easier to use. Make sure the calcium hypochlorite has an NSF seals or says "meets NSF Standard 60" on the label. Get a granular or powdered form, not the large tablets. (They can be hard to break into pieces small enough to fit into the well, and slower to dissolve) When using the powdered form, be sure it's fresh; the powder can lose its disinfecting power on the shelf. Do not use disinfectants designed for hot tubs.

Table II

Depth of water in well or tank (ft.)	DIAMETER OF WELL						
	Drilled Well, Gallons			Dug Well or Cylindrical Cistern, Gallons			
	4 in.	6 in.	8 in.	3 ft.	4 ft.	5 ft.	6 ft.
1	½	1 ½	2 ½	53	94	147	212
2	1 ¼	3	5	106	188	394	424
3	2	4 ½	7 ½	159	282	441	636
4	2 ½	6	10	212	376	588	848
5	3 ¼	7 ½	12 ½	265	470	735	1060
6	4	9	15	318	564	882	1272
7	4 ½	10 ½	17 ½	371	658	1029	1484
8	5 ¼	12	20	424	752	1176	1696
9	6	13 ½	22 ½	477	846	1323	1908
10	6 ½	15	25	530	940	1470	2120
11	7	16 ½	27 ½	583	1034	1617	2332
12	8	18	30	636	1128	1764	2544

Example: A dug well 5 feet in diameter and containing 7 feet of water would contain 1029 gallons of water.

Chlorination Procedures

Recently constructed or repaired water systems, systems which have installed new equipment, and those that have been flooded or exposed in any other way to contamination require heavy doses (at least 50 parts per million) of chlorine for sterilization. Also, it is especially important that sufficient chlorine dosages be introduced into water supplies which have been shown to contain coliform organisms by a laboratory analysis.

Since chlorine will be of little value in providing safe water unless the water supply is located, constructed, and protected properly, it is recommended that the physical structure be checked thoroughly before chlorination is accomplished. After the water system has been protected properly from subsequent contamination, the water supply should be treated in the following manner:

1. Purchase chlorine (liquid, or granular- tablets can be hard to break into pieces small enough to fit into the well, and also slow to dissolve) in an amount and of sufficient strength to provide a minimum 50 ppm applied chlorine dosage to the supply. Calculate the volume of water in the supply from Table II and refer to Table III for the amounts of various chlorine compounds to provide the required dosage in given volumes of water.

2. When chlorine powders are used, a small quantity of water should be added and the material mixed into a paste. Then add 3-5 gallons of water. After thoroughly mixing, pour the liquid containing dissolved chlorine into the water well, storage tank, etc. Chlorine solutions may be added directly to the water system in the amounts indicated in Table Ill. Chlorine tablets may also be added directly to the system although considerable time is usually necessary for this material to properly dissolve.

3. For best results, it is necessary to distribute the chlorine throughout the water well and water system, by agitation and introduction into the water lines of the distribution system. Water should be pumped throughout the system until a distinct chlorine odor is noticeable at all outlets of the system.

All outlets must be opened and the water allowed to run until a chlorine odor is present, otherwise, these lines will act as a bacterial seed and recontaminate the system. The chlorinated water should then be allowed to remain in the well and distribution system for at least 24 hours. The well and piping system should then be flushed until no more chlorine odor is noted. During this time don't use this water for drinking, cooking, bathing, washing clothes, or washing dishes.

After all the chlorinated water has been removed, a water sample for bacteriological analysis should be collected in a sterile sample container, obtained from a certified testing laboratory and returned to the laboratory for testing. Home sterilized containers are not acceptable since they have no buffers or preservatives to maintain the samples integrity until analysis can be completed. Proper containers are available free of charge from a certified testing laboratory. In cases of gross contamination, the chlorination procedure may have to be repeated several times before a laboratory report indicating "no coliform organisms" found is returned, which means that the water is safe for human consumption.

During times of drought or other periods when an adequate water supply is scarce and conservation requires that no water be wasted, it is recommended that a chlorine compound in sufficient amounts be added to impart 2.5 parts per million (ppm) chlorine in the water supply, if disinfection is required. The same procedure used in treating systems with 50ppm chlorine should be followed, except that the chlorinated water should be allowed to remain in the supply and should not be flushed out to waste. If unsatisfactory laboratory results are obtained after the initial treatment, the supply should again be chlorinated with about ½ the amount necessary to provide 2.5ppm. Samples should again be tested by a competent laboratory and the chlorination procedure repeated until satisfactory results are secured.

Chlorination at a strength of 2.5ppm is most applicable to cistern water and for the disinfection of water that is transported by tank trucks even though the water is hauled from a water source that is known to be safe. Table III indicates the amounts of the various chlorine compounds necessary to provide 2.5ppm chlorine to given volumes of water.

Where pond, canal, lake, or other surface water sources are utilized for the domestic supply, it is strongly recommended that some method of continuous chlorination be provided. Several manufactures have designed suitable hypochlorinators which capably perform the chlorination process with only routine attention to assure satisfactory operation. Most of these devices include several adjustments which allow the introduction of uniform amounts of chlorine solution. Solutions containing 1% chlorine are generally desired for use with this equipment and may be prepared in sufficient quantity to supply chlorine needs for several days depending entirely upon water usage. Table III indicates the amount of various chlorine compounds that can be used to prepare 1 gallon of 1% chlorine solution. It is recommended that sufficient chlorine be applied to the water in such amounts to result in the maintenance of a chlorine residual ranging from 0.2-0.5ppm, after a minimum contact period of 20 minutes. This recommendation, of course, requires that the treated water be held in a reservoir of sufficient capacity following treatment to provide the desired detention period.

In order that a 0.2ppm chlorine residual can be maintained in surface waters, which have been clarified, it is usually essential that a chlorine test kit be obtained and routine tests be made on the treated water. Also, the amount of the 1% chlorine solution necessary to supply a 0.2ppm residual will vary from time to time, depending on the characteristics of the raw water.

TABLE III

	Chlorine Solutions *5.25% Available Chlorine	Powders 3% AC	Solutions 15% AC	Powders 15% AC	Powder 25% AC (chlorinated lime)	Powders 50% AC	Powders 70% AC	Tablets 70% AC
Amount required to make 1 gal. of 1% chlorine solution	3-1/4 cup**	3 lb	1 cup 1 tbsp	10 oz	6 oz	3 oz	2 oz	12 tablets
Amount required to provide 2.5 parts per million chlorine in water volumes of:								
100 gals	1/8 cup	1-1/4 oz	1 tsp	1/4 oz	3/20 oz	3/40 oz	1/20 oz	
250 gals	3/8 cup	3-1/8 oz	1 tbsp	1/2 oz	3/8 oz	1/4 oz	1/8 oz	
500 gals	5/8 cup	6-1/4 oz	2 tbsp	1-1/4 oz	3/4 oz	3/8 oz	1/4 oz	1-1/2 tablets
1,000 gals	3/4 cup	12-1/2 oz	1/2 cup	2-1/2 oz	1-1/2 oz	3/4 oz	1/2 oz	3 tablets
2,000 gals	1-1/2 cup	1 lb 9 oz	1 cup	5 oz	3 oz	1-1/2 oz	1 oz	6 tablets
3,000 gals	2-1/2 cup	2 lb 6 oz	1-1/2 cup	7-1/2 oz	4-1/2 oz	2-1/4 oz	1-1/2 oz	9 tablets
Amount required to provide 40-50 ppm chlorine in water volumes of:								
100 gals	1-1/2 pints	1 lb 9 oz	1/2 pint	5 oz	3 oz	1-1/2 oz	1 oz	6 tablets
250 gals	3 pints	3 lb 14-15 oz	1 pint	12-1/2 oz	7-1/2 oz	3-1/4 oz	2-1/2 oz	15 tablets
500 gals	6 pints	7 lb 13 oz	1 qt	1 lb 9 oz	15 oz	7-1/2 oz	5 oz	30 tablets
1,000 gals	1-1/2 gals	15 lb 10 oz	1/2 gal	3 lb 14 oz	1 lb 14 oz	15 oz	10 oz	61 tablets
2,000 gals	3 gals	31 lb 4 oz	1 gal	6 lb 4 oz	3 lb 12 oz	1 lb 14 oz	1 lb 4 oz	122 tablets
3,000 gals	4-1/2 gals	46 lb 13 oz	1-1/2 gal	9 lb 6 oz	5 lb 10 oz	2 lb 13 oz	1 lb 14 oz	183 tablets

*** Chlorine products are labeled to indicate the percentage of available chlorine contained.**

Note: Two heaping tablespoons contain approximately 1 ounce of powdered chlorine.

**** One measuring or tea cup contains 8 fluid ounces or 1/2 pint.**

Special Water Treatment

Iron Removal - The "Red Water" Filter

Red water results whenever water containing large amounts of iron is brought in contact with air. As long as the water is in the well, and until the oxygen of the air comes in contact with it, a gas known as carbon dioxide holds the iron in solution. Immediately upon coming in contact with the air, the oxygen reacts with the iron and causes a red sediment to appear. This red solution is iron oxide or rust.

This "red water" can be clarified through the use of a limestone filter. As the water passes through the limestone, a chemical reaction takes place that causes the iron to settle out as iron oxide. At the same time some of the carbon dioxide is eliminated because some of the limestone goes into solution. The solution of the limestone will make the treated water a little harder than the raw water, but this increase in hardness will not be enough to make a large increase in soap consumption. The resulting water is sparkling clear and will remain so indefinitely.

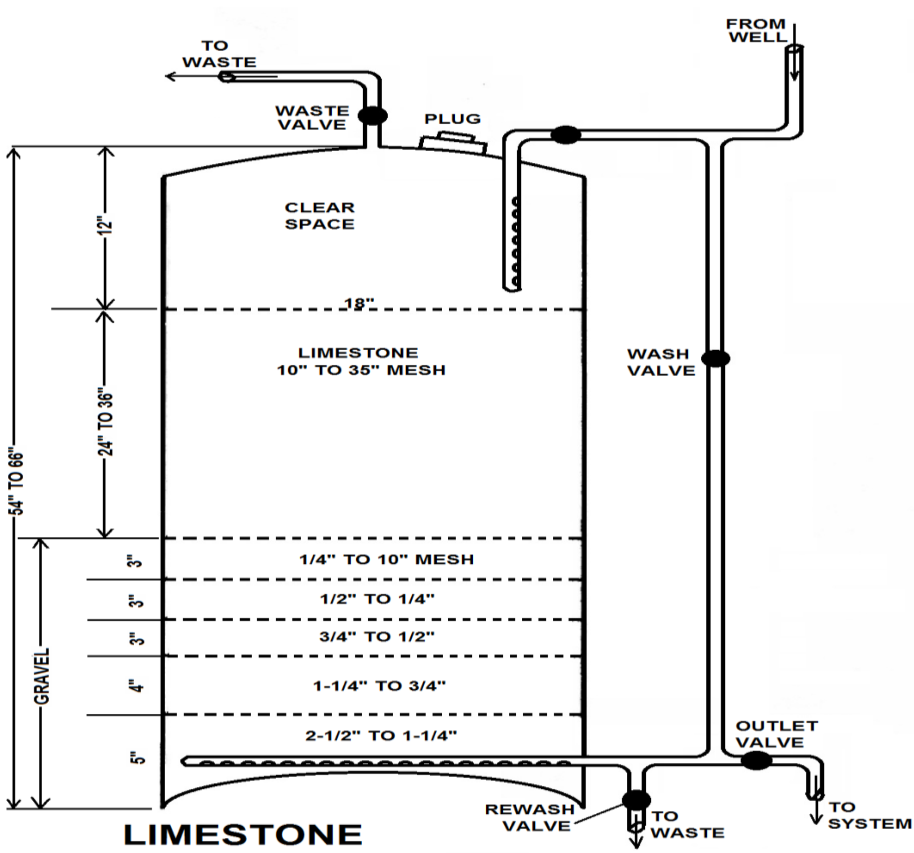
If the home has a pressure system, it is preferable to place the filter between the pressure tank and the house. If the well pumps to an elevated storage tank, the filter is best placed between the elevated tank and the house. In any case it is best to place the filter where the water will move through it at the lowest possible uniform rate, thereby requiring a smaller filter.

The limestone in the filter must meet certain specifications in order to be effective. These are listed and discussed below. The proper quality and size may be obtained from some of the commercial limestone quarries, or through a county agent.

The limestone *must*: (1) be hard; (2) pass a 10 mesh screen; (3) be retained on a 35 mesh screen; (4) contain at least 50% calcium oxide; (5) contain no more than 2% magnesium oxide; (6) contain no more than 3% silica, alumina, iron oxides, and sulfur trioxide; (7) have a medium crystal size no larger than 0.05 millimeters. A limestone of the proper hardness can be scratched by a sharp steel pocketknife, but will not rub chalky in the fingers, nor be scratched by the thumbnail. If too soft, the limestone will break up in the filter, and more frequent replacement will be necessary.

Caution—Limestone filters do not change the bacteriological quality of the water. It only clarifies the water. To purify it, supplementary methods must be employed.

Sketch and description are from Texas Engineering Experiment Station Bulletin No. 75, "Rural Water Supply and Sewerage - Part III, the Specific Treatment of "Red Water" for the Removal of Iron and Carbon Dioxide", by P. J. Alwin Zeller and J. H. Sorrels.



LIMESTONE FILTER

Softening of Water

Water hardness is usually caused by the presence of calcium and magnesium bicarbonates and sulfates. Hard water, depending on its degree of hardness, may increase soap requirements, may cause lime deposits which limit the period of usefulness of water heaters, steel pipes, and other appliances, may cause skin discomforts, and other inconveniences.

Various special filter media are available for softening water, but probably the most satisfactory method for home use is the commercial softener that connects into the supply line of the pumping system. Most commercial devices convert soluble salts of calcium and magnesium to calcium and magnesium zeolites as they come in contact with the zeolite media. The calcium and magnesium ions of the water are thus replaced during passage through the filter unit until discharged to waste during the regeneration process, and replaced by sodium ions from the salt ($NaCl$) solution.

From time to time the filter material will require regeneration, which is simply accomplished by placing salt solution in contact with the filter media. The selection of the unit capacity is based upon the quantity of water to be softened and the hardness content of the water to be treated. A unit of sufficient size to soften all water required for one week should be provided so as to minimize the frequency of regeneration and washing of the filter material. Realization of the desired results from a water softening unit requires that it be operated and maintained in accordance with the procedures outlined by the supplier of the equipment. Special consideration should be given to the removal of excess iron in the raw water prior to softening.

Correction of Tastes and Odors in Water

While bad tastes or odors in water may not be a health hazard, it may make the water undesirable for drinking and other domestic purposes. Usually bad tastes and odors can be overcome by filtering the water through activated carbon. Under normal use activated carbon will remain effective for several months and can be economically replaced. When objectionable odors are detected being discharged from the activated carbon unit, the filter media should be replaced. Frequent examinations of the unit will enable only detection of the need for fresh filter material. A device similar to the illustrated limestone filter may also be used for a taste and odor filter by substituting activated carbon for limestone.

Aeration

Aeration can be utilized to counteract the effects of excessive iron in water, to remove some odors, and to increase oxygen content of water deficient in dissolved oxygen. For individual home water supplies, aeration may be accomplished by allowing the water to flow over cascades, slatted trays, perforated pates, over a spillway, or be discharged through spray nozzles into the storage reservoir. Aeration units should be constructed so that contamination of the water is prevented.

Supplemental Water Supplies

In times of drought, it sometimes becomes necessary to haul water from outside sources to supplement individual supplies. If possible, supplementary water should be taken from a public water system and transported in clean, covered containers. Every precaution should be taken to prevent possible contamination of the water during filling or withdrawal of the water from the container. In order to overcome the contamination which might occur during handling operations, the previously described chlorination procedures should be followed.

Bacteriological Analysis of Drinking Water

To be sure that individual home water supplies are safe for those that use the water for drinking purposes, samples should be collected regularly and examined for bacteriological content. These samples should be collected from various points in the distribution or piping system. Sterile sample collection bottles for bacteriological examination are available free of charge from the Wichita Falls-Wichita County Public Health District Laboratory, 1700 Third Street, Wichita Falls, Texas 76301.

Home sterilized containers are not acceptable for the collection of test samples. They do not contain the proper buffering agent and preservative required to keep the sample stable until analysis can be performed, therefore, only sterile, pre-buffered bottles obtained from the Health District Laboratory are acceptable for sample analysis. The current fee for water testing is $15.00 per sample, however, this fee could change at any time, so to be sure, check with the laboratory.

Specimen Requirement

Beginning June 1, 2009, all samples submitted to the Wichita Falls–Wichita County Public Health District must be maintained between 0ºC and 8ºC from the time of collection until delivery to the laboratory. Samples brought in on ice or blue ice should not be allowed to freeze.

If you have any questions, please contact us at (940) 761-7835.

Samples are accepted for analysis, Monday through Thursday, from 8:00 a.m. to 3:30 p.m. Samples are not accepted on Fridays, or days prior to major holidays, since the test requires 24 hour incubation and the laboratory is closed on weekends and major holidays. If you have any questions, please contact the laboratory before you start to your trip. Results will normally be available the day after the sample is submitted after 4:00 p.m.

Procedure for Collecting Water Samples

The sample is to be collected in a sterile sample bottle containing buffering agent and preservative, and every precaution is to be taken to prevent accidental contamination. The following procedures are to be observed carefully.

1. Samples are to be submitted only in appropriate containers obtained from the laboratory. Home sterilized containers are not acceptable.

2. Samples are to be submitted only from properly constructed water systems. Water systems constructed in such a manner as to prevent entrance of dust, insects, snakes, small animals, surface drainage, pump packing gland leakage, etc. Laboratory examinations in most instances will reveal the presence of contamination in samples collected from streams, ponds, unprotected springs, open storage tanks, unsealed wells, and water wells equipped with rope and bucket, or pumps which require priming. When new wells are constructed, when existing wells or tanks are cleaned, when repairs are made to well pumps, or when the piping system is altered or repaired, the system should be chlorinated to remove contamination which may have entered the system during construction or repairs and the water should be checked again for suitability. Wash hands thoroughly before collecting the sample.

3. The inside surface of the faucet or tap should be flamed with a cigarette lighter, propane lighter, or other flaming device to sterilize it. If the connection is PVC type pipe, disinfect it with a concentrated bleach solution and allow to air dry before collecting sample. The samples are not to be collected from faucets which have leaky washers, vertical pipes, drinking fountains, kitchen sinks, rubber hoses, water heaters, or any other well access point that cannot be properly sterilized.

4. After sterilizing the faucet, the water should be turned on and allowed to run freely for five (5) to ten (10) minutes to clear the water lines and bring in fresh water. Then reduce the flow to a pencil stream to prepare for sampling.

5. Open the sterile collection bottle that you obtained from the Health District laboratory. Unscrew the cap, taking care not to touch the inside of the cap or the inside of the sterile bottle. Carefully, fill the sample bottle to the 100ml fill line, taking care not to go over the shoulder of the sample bottle. This is the ideal sample size and should not be exceeded, since the buffer and preservative contained in the bottle are pre-measured for this amount. After you have replaced the lid, close it tightly and gently tip the sample back and forth to mix the buffering agent. Do not reopen the bottle after replacing the cap and mixing. Label the sample bottle with the owner's name, point of collection, and the collection time. Refrigerate the sample until transported to the laboratory. ***Attempt to keep samples less than 8°C but not frozen during transport to the laboratory using ice or blue ice.***

6. With the sterile sample bottle is a Water Bacteriology request form (FORM-QA-008), which must be submitted to the laboratory with your water sample. Please fill this form out as completely as possible, typing or printing the information in ink. Since this form is also used for municipal water systems, there may be some information on it that is not applicable to private well systems. One of these is Water System Number, etc. Fill out all the possible information, especially name, address, phone number, date collected, time collected, point of collection, type of sample, and depth of well.

7. Return both the sterile sample bottle, clearly labeled so it can be identified (this is especially important if you bring more than one sample) and the accompanying Water Bacteriology request form (FORM-QA-008) to the laboratory. ***Samples must be received by the laboratory within 30 hours of collection and must be cooled.*** Any sample received after the 30 hour limit, samples received overfilled, or samples not refrigerated will be rejected as "unsuitable for analysis." The sample will need to be recollected.

Interpretation of Bacteriological Findings

Figure 10 shows a copy of a sample Water Bacteriology request form (FORM-QA-008), properly filled out and showing the test results possible in the area below the line indicating "LABORATORY REPORT - Do Not write in this space."

WATER BACTERIOLOGY
Form-QA-008, Rev.2 (31 Oct 2011)

Wichita Falls/Wichita County
Public Health District Laboratory

Date Reported:

PLEASE Print Below with BALLPOINT Pen

Water System ID No.: NA
Name of Water System: NA

Point of Collection or Source Water Code: WELL TAP
County: WICHITA

Submitter Phone No.: 940-761-7835 Submitter Fax No.: 940-761-7688

SEND RESULTS TO
Name: Jane Doe
Street Address: Box 1 FM South
City, State, Zip: Wichita Falls, TX 76301

TYPE OF SYSTEM: ___ Public ✓ Individual/Private

SAMPLE IS: ___ Routine ___ Raw ___ Repeat ___ Replacement ___ Construction ___ Special ___ Pool ___ Spa ___ Bottled

WATER SOURCE: ___ River ___ Lake ___ Both River and Lake ✓ Well: 75 ft Depth

Chlorine Residual: Free: ________ Total: ________

Other Special Information:

Collection Date & Time 05/20/11 (Month - Day - Year) 08:00 (Time) ✓/ (AM - PM) JD (Collected by:)

Received for Delivery by ___/___/___ (Month - Day - Year) ___:___ (Time) ___/___ (AM - PM) ________ (Received by:)

Received at Lab by ___/___/___ (Month - Day - Year) ___:___ (Time) ___/___ (AM - PM) ________ (Received by:)

Sample Temperature: **Sample on Ice: YES NO**

CHLORINE: Free ______ Total ______

LABORATORY REPORT (Do Not Write in this Space)

Water of satisfactory bacteriological quality **MUST** be free from Coliform organisms.

COLIFORM ORGANISMS: Test Method: Colilert

_____ None Found/Negative

Found/Positive for: _____ Total Coliforms

_____ Fecal Coliforms (E. Coli)

_____ Repeat Sample **REQUIRED**

_____ Unsuitable for Analysis - **PLEASE** Resubmit Reason:

Wichita Falls/Wichita County Public Health District Laboratory
1700 Third Street, Wichita Falls, Texas 76301-2113
Phone: 940-761-7835 - Fax: 940-761-7878

Figure 10 – WATER BACTERIOLOGY REQUEST FORM

There are four possible laboratory responses. These are indicated below:

1. If the laboratory report form is marked as “**None Found/Negative**”, your water sample is free of harmful bacterial contamination and is suitable for drinking. No further action is required on your part, however, we do recommend periodic re-sampling to insure your water supply stays safe for drinking. *CAUTION: A negative bacterial report merely indicates that your water is free of bacterial contamination. It does not, however, insure that there is not chemical contamination in the form of high nitrite levels (not good for nursing mothers and infants under 1 year), excessive hardness, heavy metals, pesticides, etc. Should any of these contaminants be suspected, contact a certified laboratory for further testing.*

2. If the laboratory report form is marked “Found/Positive for:” section, then it will also be marked to indicate “**Total Coliforms**”, then the water supply is not of good bacterial quality and may not be safe to be used for human consumption. It does not mean that there is fecal contamination, but there is bacteria in sufficient numbers to render the water unsuitable for human consumption.

3. If it is marked “**E.Coli**”, then your sample is contaminated with fecal coliform bacteria and is, therefore, definitely unsafe for human consumption. E.Coli or Fecal contamination indicates the water contains organisms that can cause such diseases as typhoid, salmonella, shigellosis, dysentery, etc. When these findings (positive for either Total Coliforms or Fecal Coliforms) are received on a properly collected water sample, additional samples should be collected and analyzed in order to eliminate the possibility that the sample was accidentally contaminated during collection. In the meantime, the water should not be used for human consumption unless it is boiled or otherwise sterilized. When contamination is present in apparently protected supplies, a careful survey should be made of the supply and the system should be properly chlorinated following the procedures listed under “Chlorination Procedures” elsewhere in this pamphlet, which covers the procedures to disinfect and chlorinate your water supply depending upon the type of system you have.

4. If the sample is marked in the “**Unsuitable for Analysis — Please Resubmit**” box, then for some reason, indicated in the area “Reason”, we were unable to process your sample and it must be recollected. Reasons for rejecting samples are over-full collection bottles, under-filled bottles, excessive residual chlorine levels, turbid or milky samples with interfere with reading, samples received after the 30 hour deadline, etc. This indicates that you will need to repeat the sample to receive a proper and correct analysis of bacteriological content. The laboratory will make every effort to contact the submitter via the information on the sample request form.

Time Required for Analysis

Complete bacteriological examination requires 24 hours to complete. Water samples are analyzed using IDEXX’s Colilert® procedure and will take 24 hours from set-up to complete. Ask the laboratory when the results will be available when submitting your sample for testing.

Aquatic Life in Individual Water Supplies

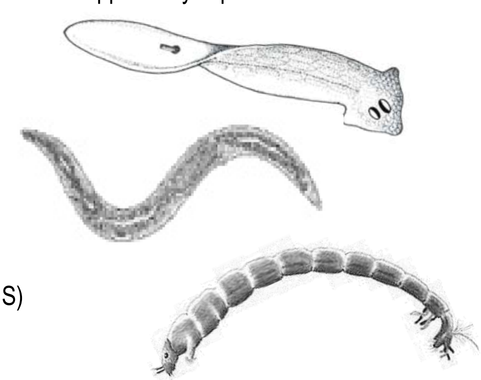
Water deposited on the earth in the form of rain is pure except for minute amounts of materials leached from the atmosphere. However, flowing over the ground and through the soil it picks up chemicals as well as plant and animal life. Surface waters in ponds, lakes, and slowly moving streams are usually rich in living plants and animals.

The lower or simpler forms of plants and animals living in water are easily dispersed. They have hard shelled resting stages or eggs which are resistant to drying and are carried on the feet of water birds or other animals or are blown about in the dust; upon reaching water, a new cycle is begun. Often, these animals turn up in unprotected wells, cisterns, or unfiltered surface waters. Some of the more common ones are free-living (non-parasitic) flatworms, free-living roundworms, water fleas, and fairy shrimp. Some common forms of aquatic life are illustrated in Figure 11.

Although most flatworms are parasitic, there are free-living forms that spend their entire life cycle in water. They are white, gray, or black and commonly measure a half inch or less. They are flattened and creep very slowly along on the undersides of stones or plants in their natural environment. Most of these animals produce eggs but reproduction by simple division may also occur.

The roundworms or threadworms are common parasites of animals and plants. However, the majority are harmless, free-living inhabitants of soil and water. The aquatic forms are usually less than a half inch in length, slender, transparent, without segmented bodies or defined head regions, and with no appendages. They are active, lashing their bodies to and fro. The roundworms lay eggs.

Hairworms are relatives of the roundworms but are much larger than the aquatic roundworms. Adult hairworms may be a foot or more in length. Their eggs are laid in long strings on submerged plants. Upon hatching, the larvae bore into aquatic insects or climb upon emergent vegetation where they may be eaten by such insects as grasshoppers or crickets. The hairworms mature within the insects and burrow out to re-enter the water if the opportunity is presented.



A. **FREE-LIVING FLATWORM**
(PLANARIA GONOCEPHALA)
DARK REDDISH-BROWN TO
GRAYISH-BROWN IN COLOR

B. **FREE-LIVING ROUNDWORM**
(RHABDOLAIMUS MINOR)

C. **LARVAE OF MIDGE FLY** (CHIRONOMUS)
COMMONLY CALLED “BLOOD WORM”

Figure 11 – COMMON FORMS OF AQUATIC LIFE

There are myriads of small crustacea in fresh water, many of which are microscopic or just visible to the naked eye. Some of them such as the common fairy shrimp and water fleas can be seen without magnification. These animals lay eggs, which withstand freezing and drying. Eggs of fairy shrimp kept in dried mud for 14 years are reported to have developed when put into water.

Aquatic insects breathe air in the adult stage and many of them leave the water, returning only to lay their eggs. This is true of the non-biting midges, the immature stages of several of which are often called bloodworms because of their red coloration. The larvae are from an eighth of an inch to an inch in length and many cover themselves with soft dirt tubes. The adult midges lay their eggs on water surfaces. An assortment of non-aquatic insects may live in the algae and other plant growths along the sides of uncovered wells and occasionally fall upon the water surfaces.

The control of aquatic insects in stored water may be accomplished by properly protecting the supply so that the entrance of adult insects is prevented. If a cistern or similar stored water supply is affected, it is suggested that the water be drained to waste, organic residues removed, and that the container be thoroughly cleaned prior to refilling. After this procedure, chlorination of the container as described previously should be accomplished.

Frequently Asked Questions

How common are water problems?
"Pure" water does not exist- all natural water contains some gases and minerals and is likely to contain some microbial organisms. Most water bacteria are harmless and many are actually beneficial.

What are coliform bacteria?
Coliform bacteria originate as organisms in soil or vegetation and in the intestinal tract of warm-blooded animals (fecal coli). The many sources of bacterial pollution include runoff from woodlands, pastures, and feedlots; septic tanks and sewage plants; and animals (wild and domestic).

Will coliform bacteria make us sick?
Maybe, maybe not. Most coliforms are harmless residents of soil and will not make people sick. Some strains of E.Coli, the most common fecal coliform bacterium, may be pathogens. Some found in food have been lethal. Their presence should be taken very seriously.

If my water is clear and smells OK, is it safe?
You cannot really directly smell unsafe bacteria or protozoa. They can only be detected using tests designed for that purpose. You should check your water quality regularly. Some sources of odors are bacteria or septic, or the presence of chemicals. It is good idea to take your nose seriously. Have your water tested.

What is the "iron bacteria" problem?
Better described as iron biofouling, the problem popularly known as "iron bacteria" is both complex and widespread. Iron and other biofouling consists of biofilms, which include living and dead

bacteria, their sheaths, stalks, secretions and other leavings, and embedded metal hydroxide particles. "Iron bacteria" is one type of biofouling among several, including the characteristic white sulfur slime of sulfur springs. Manganese and even aluminum biofouling is also found in groundwater systems. These biofilms are natural and usually harmless. Natural iron biofouling often acts as a preliminary iron filter in wells and therefore can serve a positive function as well. Biofouling can be a nuisance, however. Generally, iron biofouling is the cause of iron buildup in wells and pipes.

If there are bacteria in my well, where do they come from?
Many types of bacteria are native or adapted to saturated sediments and rock, and are present in significant numbers in most water supply aquifers, even deep formations. Given the time and a route (soil and rock give plenty of both), bacteria will migrate into and take up housekeeping in an aquifer. "Non-native" coliform bacteria or "protozoa" of potential health concern, such as *Giardia* and *Cryptosporidium*, are most likely introduced from the surface.

What's the best way to maintain a good water supply?
Have your water tested annually, even if you do not perceive a change in your water. Have your water tested by a certified laboratory. The question of whether or not to have your water tested is a serious one that concerns the health of you and your family.

For More Information

Texas Well Owner Network: http://twon.tamu.edu/

List of licensed well driller/pump installers: http://license.state.tx.us/License-Search/

Texas Groundwater Protection Committee: http://www.tgpc.state.tx.us/WaterWells.php

County AgriLife Extension office: http://counties.agrilife.org

For information on groundwater and water wells: www.wellowner.org

National Ground Water Association: www.ngwa.org

To find a certified testing laboratory in your area: www.epa.gov/safewater/labs/index.html

The Water Systems Council hotline for well owners: 1-888-395-1033 or www.wellcarehotline.org

American ground water trust: www.agwt.org

American Water Works Association: www.awwa.org

Centers for Disease Control & Prevention (CDC): www.cdc.gov/healthywater/drinking/private/wells

National Drinking Water Clearinghouse: www.nesc.wvu.edu/drinkingwater.cfm