State of Maine

PRIVATE WATER SUPPLIES

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RIVATE WATER SUPPLIES

DEPARTMENT OF HUMAN SERVICES
David E. Smith, Commissioner

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INTRODUCTION

Among the problems incident to the increase in the population of Maine, and its growing popularity as a summer vacation state, one of the most difficult of solution is that of providing an adequate and safe water supply. This problem is most acute in the southern half of the state, as it is there that the majority of summer resorts and principal cities are located.

Rural and semirural dwellers generally obtain their water supplies from wells situated on the property of each householder. When the population increases in density, the impossibility of preventing contamination of wells from adjacent sewage disposal systems makes it necessary to substitute some form of common water supply. This supply usually is obtained from streams or lakes, although in some few instances the supply is obtained from deep wells, or from springs which furnish practically the same quality of water as that from deep wells.

Bacteria of a presumably dangerous character seldom are present in deep well waters in this general area, so that in most cases it is unnecessary to provide for bacterial removal from supplies derived from deep wells or springs. If bacteria are found, it is usually possible to discover the source of the pollution and to effect its removal or exclude it by properly designed protective construction.

Surface water supplies are always subject to contamination by pathogenic (disease-producing) organisms, and may contain, in addition, nonpathogenic animal or vegetable organisms which may produce unpleasant tastes or odors. Frequently such waters contain objectionable color or turbidity, the result of inert matter in solution or suspension.

For community water supplies, in order to remove undesirable and harmful substances present in many surface water supplies, the water may be treated by various methods, either singly or in combination, including sedimentation in reservoirs, addition of activated carbon, filtration through prepared filters, and sterilization by ozone, ultraviolet ray, or chlorine.

Frequently there is voiced a popular prejudice against chemically treated and filtered surface water, but this prejudice is without foundation if the treatment of the water is carried out effectively and efficiently, as it is in most water purification plants in the state.

Although there are about 160 public water supplies in Maine supplying water to over half our population, there are many thousands of private water supplies in daily use furnishing water for all domestic purposes for the balance of our people, and the larger part of our summer vacationists.

To those persons engaged in developing water supplies and to those families living in the suburban and rural sections of Maine who do not enjoy the benefits of a public water supply, the recommendations of this bulletin are offered as a guide.

GENERAL REQUIREMENTS

Ground Water Origin

In areas that are not served by a public water utility the securing of a safe and adequate domestic water supply is of prime importance. The planning of a water supply development or improvement requires a determination of the source or sources of water that are available and the quantity and quality of the water that may be obtained from available sources. A general knowledge of the factors affecting the quantity and quality of water available is essential for a proper evaluation of the possible sources of supply.

Rainfall and snow constitute the basic source of all water supplies. When rain falls or snow melts, the water seeps into the soil at a rate depending upon its dryness and the capacity of the soil to transmit water. This process is called infiltration. If the rainfall is heavy or the snow melts rapidly, or if the ground surface is frozen, only a part can seep into the soil. The rest runs over the surface and is drained away by creeks and rivers. In times of heavy infiltration, more water may seep into the soil than the soil can hold against the pull of gravity. A part of the water, therefore, moves downward through the underlying subsoil and rocks until it reaches a completely saturated zone, the surface of which is known as the water table. This process, called groundwater recharge, may occur in all seasons but takes place chiefly in winter and spring when there is little evaporation or transpiration of plants. In cold climates, the principal recharge may occur in spring when the frost leaves the ground.

There is considerable fluctuation in the level of the water table during the seasons of the year and from year to year. During periods of heavy rainfall, the water table is high. Conversely, during prolonged periods of dry weather, the level of the water table recedes to such depths as to cause failure of shallow well supplies.

The water table assumes approximately the same contour as the ground surface, and the direction of the ground water flow will, in general, be toward the valleys. After reaching the valleys, the underground flow follows the same direction as would a surface stream. If the water table is sufficiently high so that it outcrops in the valley, a surface stream which flows in dry weather as well as in rainy weather results. If the ground water outcrops at some point on a slope of the ground surface, a spring will result.

In favorable areas there may be several water-bearing strata separated from each other by impervious formations. The water in the deeper layers appears where these particular strata outcrop on the surface of the earth. The rain which enters at the outcrop flows by gravity down through the gently sloping stratum. Water of this sort may travel for many miles. These deep water-bearing strata, if tapped for water supplies, are usually more constant in output and furnish more water than the shallow ground-water wells.

Quality

Pure water is not found in nature. As rain falls through the atmosphere toward the earth, it absorbs dust and such gases as carbon dioxide and oxygen. After reaching the surface of the ground it immediately is exposed to contamination and pollution. The polluting matter may be very dangerous if it includes human fecal material, excessive amounts of barnyard manure, or commercial fertilizers. If the water runs off into a stream, it will take with it a considerable amount of suspended material, such as clay, silt and sand.

When surface water seeps downward into the soil and through the underlying material to the water table, silt and other particles held in suspension in the water are mostly filtered out so that water recovered from wells and springs is generally clear. This natural process of filtration is also very effective in removing bacteria from surface water as it passes through the soil to become ground water. However, because certain soils and rocks contain soluble minerals, ground water frequently contains more dissolved minerals than surface water. These mineral substances, although toxic or poisonous if dissolved in large quantities, are not found in objectionable amounts in the natural waters of Maine. Salts, such as the carbonates of calcium and magnesium, cause hardness in the water which is objectionable for laundry and other washing purposes because soap consumption is increased, fabrics are weakened, and deposits accumulate in hot water lines.

Water for drinking and culinary purposes must be free from pathogenic bacteria and other disease-producing organisms. Clearness, softness, freedom from objectionable tastes and odors, and low temperatures are desirable.

Turbidity is objectionable not only because it makes the water less attractive for drinking, but also because it frequently indicates inadequate protection from surface wash and possible bacterial contamination.

It may be expected that the water derived from springs and wells will generally be good and pure whenever the ground from which it comes remains in its natural or clean condition. Therefore, the problem of obtaining good water for drinking purposes from a spring or well resolves itself mostly into the necessity of keeping the ground clean around the source of supply. But when either a well or spring is in too close proximity to a privy, cesspool, manure pile, or heavily fertilized garden, it is unlikely that the quality of the water will remain good.

Water-borne Diseases

The most serious of the water-borne diseases are diseases of the intestinal tract, such as typhoid fever, dysentery, and cholera. Of these cholera has practically disappeared from the United States, so that we will be concerned primarily with dysentery and typhoid fever. Each of these various diseases

is caused by bacteria which are eliminated in the intestinal discharges of infected persons, and if permitted to come in contact in any way with sources of drinking water, may carry the infection to other persons. Other digestive disturbances may also result from drinking polluted water in addition to those of the definite diseases mentioned above.

Recent reports indicate fatal cases of cyanosis in infants (blue babies, the noncongenital type) may be caused by drinking polluted well water with a high nitrate content. In the event that any well or spring has not been tested for impurities, a special container should be requested from the Division of Sanitary Engineering, Maine State Department of Health and Welfare, and a sample of the water submitted for analysis and advice concerning its quality and proper methods of protection.

Quantity

In the development of private water supplies, it is desirable that an estimate first be made of the amount of water needed by the individuals involved, together with any special uses such as stock water requirements. An estimate is also needed if the present water supply is to be enlarged or improved for proposed additional uses.

The installation of modern plumbing greatly increases water usage over the quantity used when water has to be hand-pumped or drawn with a pail.

The following figures may be used as a guide for estimating water needs, although local adaptations may be necessary.

	Gallons per day
Domestic use (per person):	
Household having —	
1 hand pump	10
1 pressure faucet at kitchen sink	15
Hot and cold running water —	
Kitchen, laundry, and bath	50

	Gallons per day
Camps and schools (per person):	
Work camp with hot and cold running water —	
Kitchen, laundry, shower bath, and flush toilets	45
Camp with flush toilets	25
Camp without running water or flush toilets	5

	Gallons per day
Livestock:	
Per horse	12
Per dairy cow (drinking only)	15

DUG WELL - WITHOUT MANHOLE

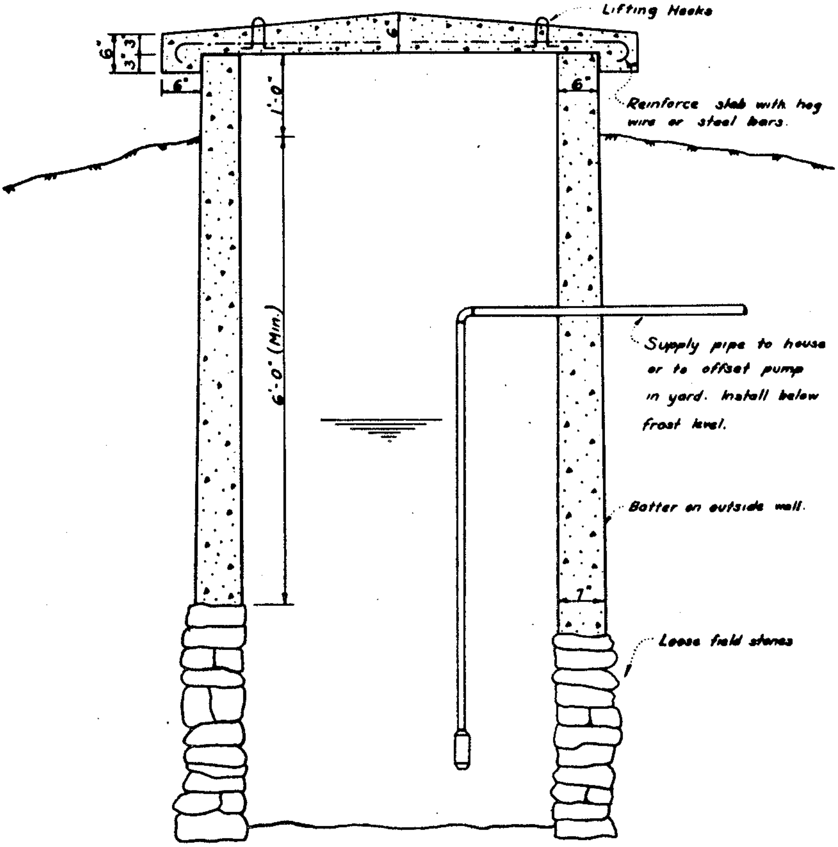


Fig. 1

Sanitary Safeguards

A. Watertight concrete cover constructed with edges overlapping well curbing.

B. Concrete well curbing extending at least one foot above surface of ground, and at least six feet below ground surface.

C. Surrounding land graded to slope away in all directions from well.

Per dairy cow (drinking and dairy servicing)	35
Per hog	4
Per sheep	2
Per 100 chickens	4
Per 100 turkeys	7

Garden and lawns:	Gallons per hour
Garden hose, ⅝ inch	200
Garden hose, ¾ inch, ¼ inch nozzle	300

Certain special uses of water may also have to be taken into consideration, such as fire-fighting and crop irrigation, although the amounts needed will vary greatly with the equipment used and the project for which a water supply is to be provided.

TYPES OF PRIVATE WATER SUPPLIES

Wells

Water wells necessarily extend into the zone of saturation of the earth, in some cases extending to great depths. With respect to methods of construction, wells may be classified into three groups: (1) dug, (2) driven and (3) drilled.

A dug well is constructed by excavating a shaft, generally by means of hand tools, and installing a lining for the walls of the shaft. Dug wells are used extensively for domestic water supplies. They are generally not very deep, usually less than thirty feet in depth, as they are necessarily large in cross section and have correspondingly large storage capacity for each foot that they extend below the water table. Because of their shallow penetration into the zone of saturation, they generally yield only small supplies of water and often fail in times of drought when the water table recedes.

A driven well is constructed by driving a pipe, usually fitted with a well point and screen, with the aid of a maul or pile driver. Driven wells are confined to areas where water-bearing sand or fine gravel lie at comparatively shallow depths and where there are no intervening hard rocks or boulders that would prevent driving the pipe. Under these conditions, driven wells can be constructed rapidly and at small cost. The pipe, usually less than 3 inches in diameter, is left in the ground to serve as the well casing. These wells are usually pumped by suction with pumps fastened to the tops of the pipes. As a rule, wells of this type are less likely to receive surface pollution than dug wells, and when located on an area of high water table may yield an ample water supply.

DRIVEN WELL

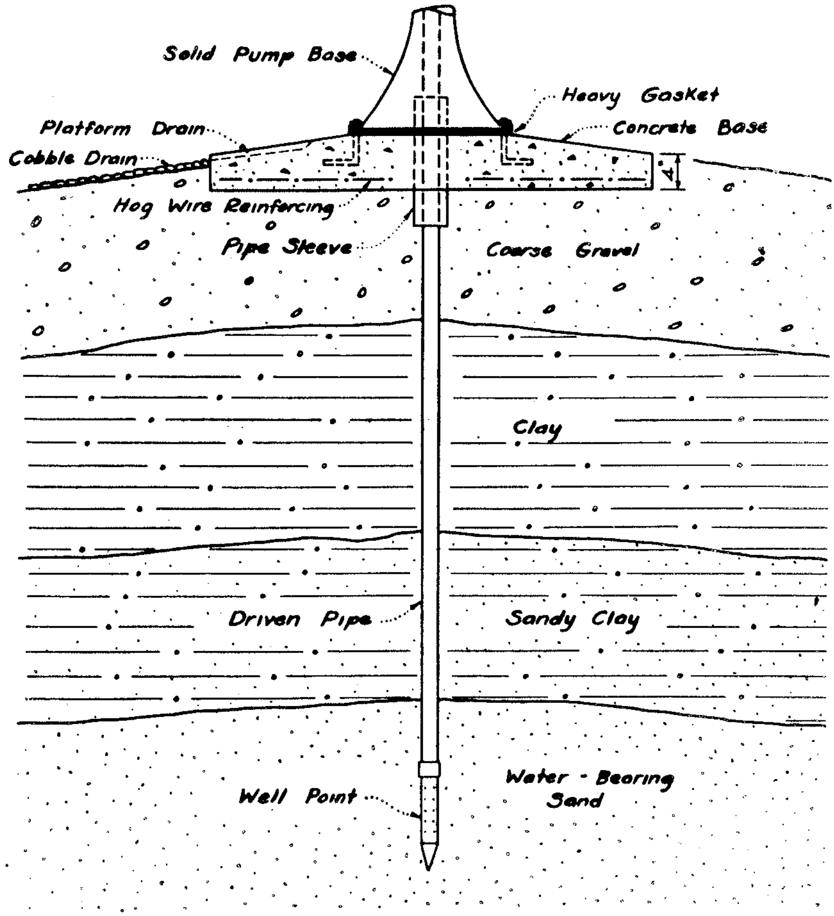


Fig. 2

Sanitary Safeguards

A. Concrete platform four feet square.

B. Pipe sleeve extended above platform and sealed to prevent entrance of surface drainage.

C. Surrounding land graded to slope away in all directions from well.

DRILLED WELL

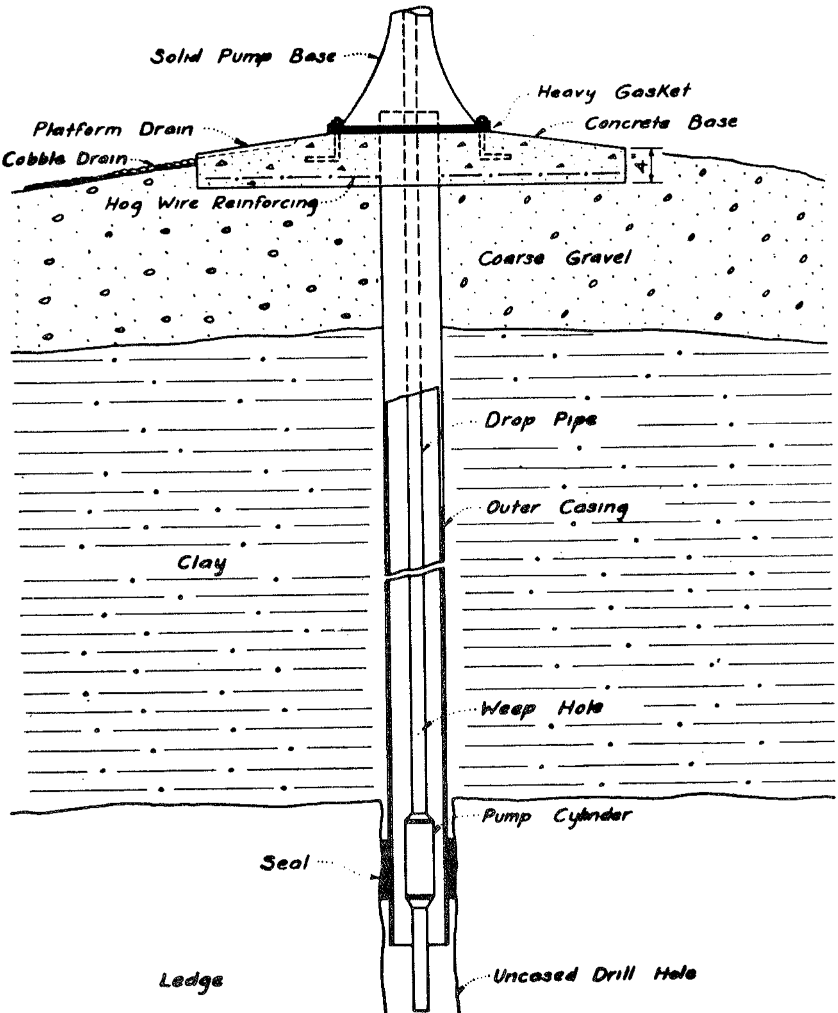


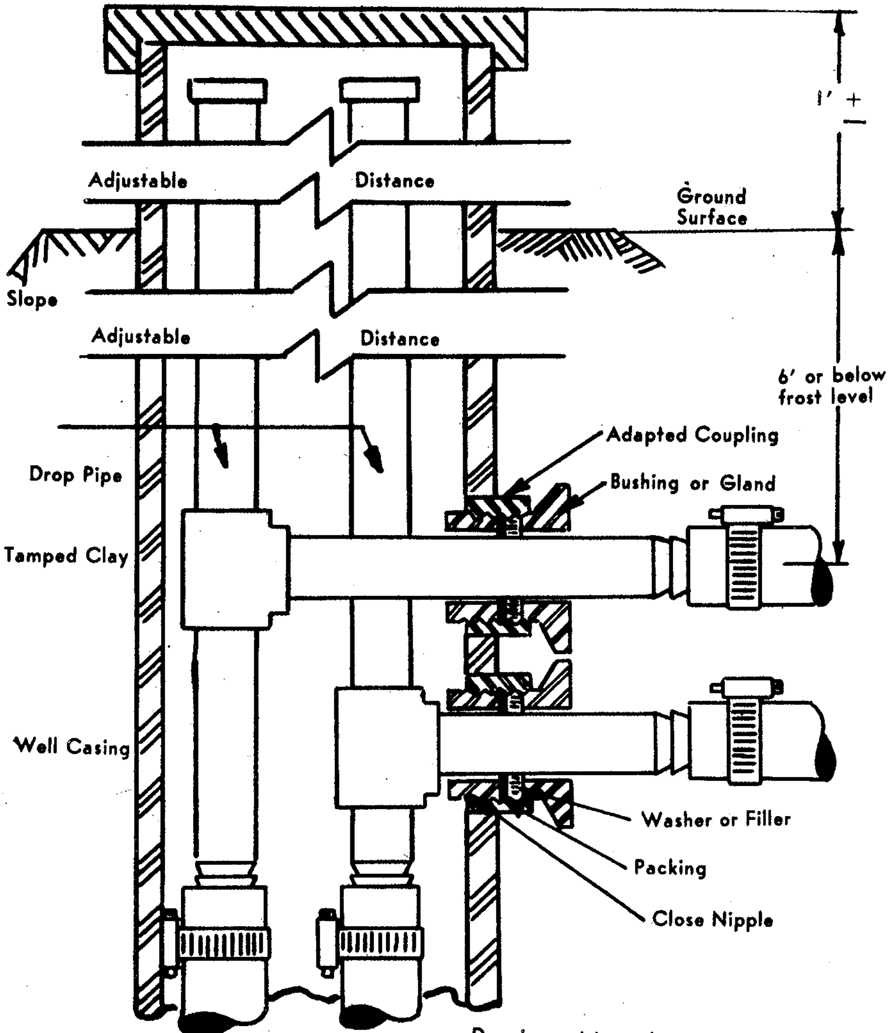
Fig. 3

Sanitary Safeguards

A. Concrete pump platform at least three feet square.
B. Watertight metal casing, properly sealed at the top to prevent entrance of surface drainage, and sealed between the bottom of the casing and the side of the drill hole by one of the following:
    1. Driving casing into clay or shale or similar sealing formations.
    2. Cement grout.
    3. Lead packer.
    4. Expanding rubber packer.
C. Solid base pump bolted to platform using waterproof heavy gasket.
D. Surrounding land graded to slope away in all directions from well.

DRILLED WELL — SANITARY PUMP CONNECTION

JET PUMP



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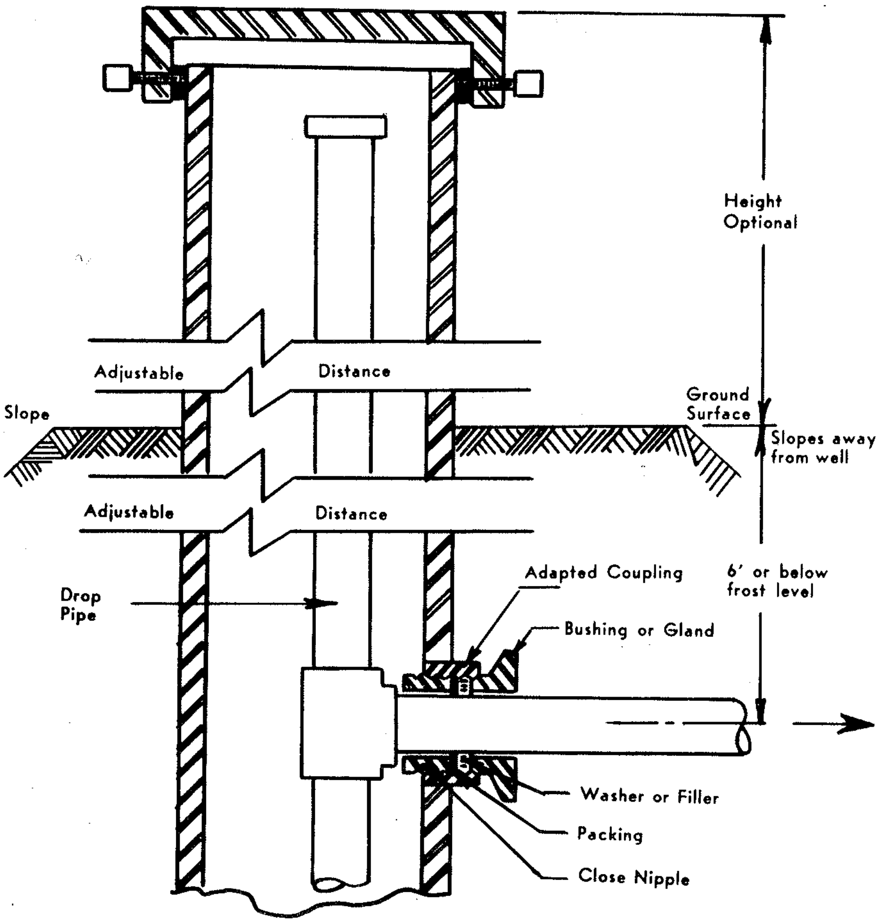
DRILLED WELL — SANITARY PUMP CONNECTION
SHALLOW WELL OR SUBMERGED PUMP



Drawing not to scale

A drilled well is constructed by making a hole with a drilling machine and installing a casing and screen where needed. Those sections of the well through soft material will require casing, as well as the upper strata, to exclude contaminated surface drainage. Drilling methods have a great advantage over digging or driving methods, in that they are adapted for sinking the holes to aquifers that may lie far below the water table. Drilled wells, therefore, tap water supplies that may not be recoverable with wells of other types, and as a rule they have larger yields and are less affected by droughts. Domestic drilled wells in Maine vary in size of the casing from 3 to 6 inches, the latter being more common. Domestic drilled wells of good construction in unconsolidated materials are generally finished with standard wrought-iron or steel well casings having threaded joints and with durable sand screens of proper mesh. For larger wells, gravel packing is sometimes used to increase the yield and to reduce pumpage of sand into the system.

Springs

As is the case of other types of ground water supplies the basic source of water derived from springs is the rain or snow that falls upon the ground.

SPRING

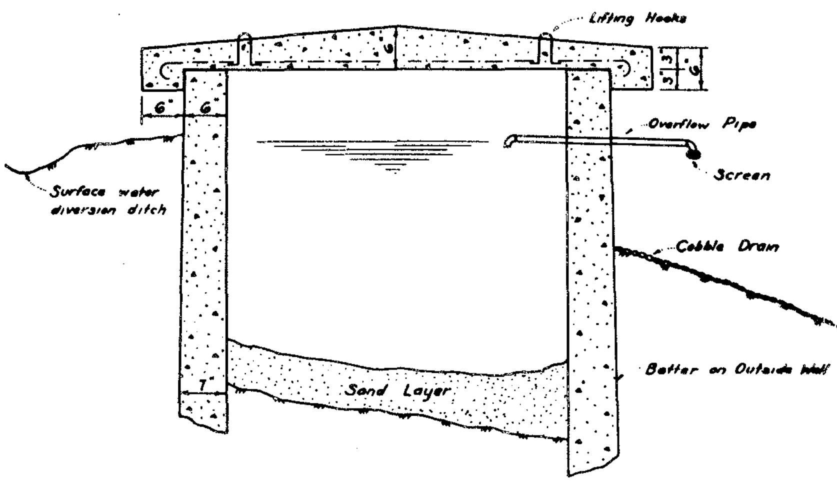


Fig. 4

Sanitary Safeguards

A. Watertight concrete cover constructed with edges overlapping spring curbing.

B. Spring curbing extending at least one foot below the bottom of the spring and at least one foot above the surface of the ground.

C. Provide a ditch so that surface water may be diverted from the spring.

This water, in seeping downward and horizontally, encounters an impervious layer of clay or rock and follows the layer until it outcrops at the surface of the ground. Springs are therefore usually situated on hillsides or gentle slopes, quite frequently at the base of such slopes.

Many people believe that all spring water is safe and better than water from wells. This belief is without foundation, however, because springs are not only subject to the same conditions of contamination as wells, but as a result of a definite flow of water may even draw from greater distances, thus requiring even greater precautions to maintain their purity.

Cisterns

Cisterns are frequently used in regions when there is insufficient ground water to provide household water demands. The water is usually obtained by collecting the runoff of rainfall from roofs.

There are two general types of cisterns in use, underground and above ground. The former are generally preferable because of economy in construction and protection from freezing in cold climates. The same factors govern the location and protection of underground cisterns that apply to dug wells. Above ground cisterns, although occasionally used, are somewhat undesirable in cold regions. Cisterns should not be located in basements because of the increased danger of contamination from such things as rodents, faulty or leaky plumbing system, dust and similar substances.

The size of the cistern will depend upon the needs of the individuals or household and may be estimated from the tabulation shown on page 7 of this bulletin.

All masonry cisterns should be allowed to cure for a month or more before being used. Occasional sprinkling with water will aid in curing the concrete and converting the free lime in the cement to insoluble compounds, so that less will be dissolved in the stored water. If immediate use of the cistern is desired, as soon as the concrete has hardened it may be scrubbed with vinegar, a 10 percent muriatic acid solution, or a solution of four pounds of zinc sulfate per gallon of water. Thorough flushing after treatment is essential. Where quantity of water permits, a new cistern should be pumped out two or three times prior to use of the water for drinking.

Asphalt or tar for waterproofing the interior of storage units is not recommended due to the objectionable taste which may result in the water and the possibility of undesirable chemical reaction with the materials used for treatment. A dense concrete is necessary to provide watertightness.

A waste connection in the supply line from the roof to the cistern is desirable, so that the first washings of the roof may be discarded. This will eliminate bird droppings, soot, and dust which have accumulated on the roof and whose inclusion in the water stored in the cistern may cause a colored and foul-smelling supply.

DUG WELL - WITH MANHOLE

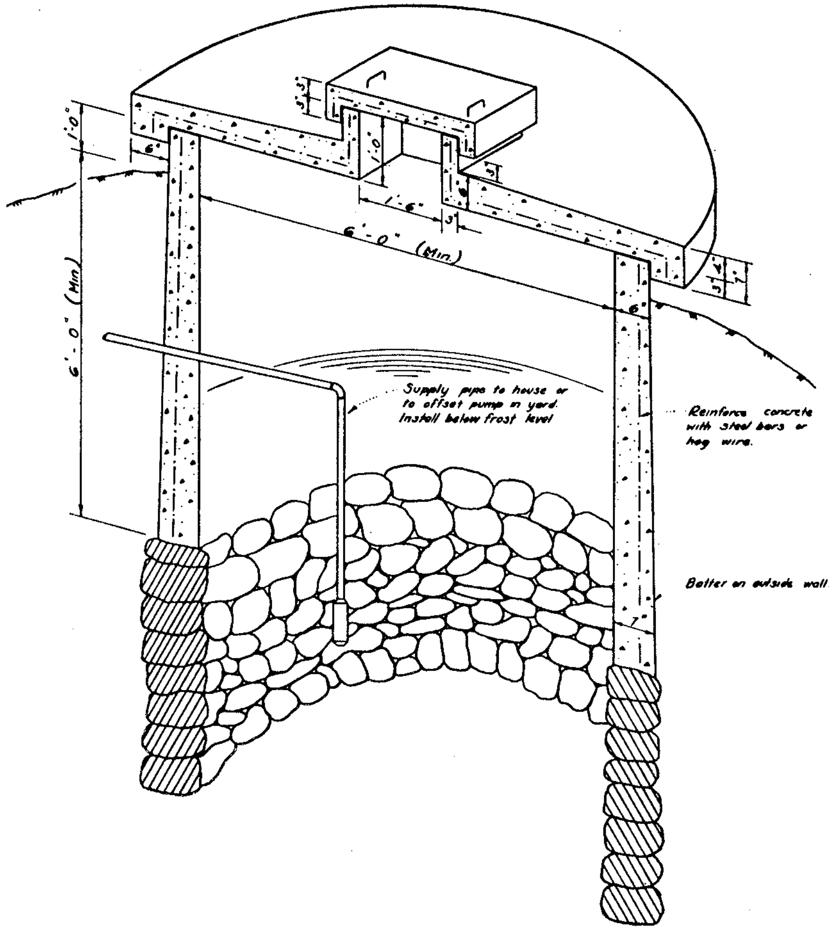


Fig. 5

Sanitary Safeguards

A. Watertight concrete cover constructed with edges overlapping well curbing.

B. Concrete well curbing extending at least one foot above surface of ground, and at least six feet below ground surface.

C. Surrounding land graded to slope away in all directions from well.

Other Water Supplies

The use of water from lakes, ponds, brooks, or similar surface supplies for private domestic purposes presents many difficulties and should be avoided if possible. The danger of contamination of such supplies and the consequent spreading of such diseases as typhoid fever and dysentery is great, especially when small streams and ponds in populated areas must be used as sources of supply. Clear water is not always safe for drinking, and the belief that running water purifies itself within any stated distance has long since been found to be incorrect.

The physical and bacteriological contamination of surface waters, except in the most sparsely settled areas, make such surface water supplies unsafe for drinking and domestic use unless a reliable purification process is provided. The treatment of surface waters, to assure a continually safe supply, is usually not practicable for rural domestic use because of the expense and labor required for operation and maintenance.

If it is necessary, however, to use a surface water supply for drinking and domestic purposes, there are machines available that will introduce into the water, as it is pumped, a sufficient amount of chlorine, sodium hypochlorite, or other sterilizing agent to destroy all bacteria. If these machines are properly operated and maintained, the water will be free of objectionable tastes and odors, yet will be safe for all domestic uses.

PROCUREMENT OF SAFE WATER

Location

Wells and springs should be located a safe distance from all sources of contamination. Because the determination of a safe distance between a ground water supply and a source of contamination is dependent on many factors including character and location of the source of contamination, type of well construction, natural slope of the water table, and type of subsoil, it is impossible to state specific distances which will be adequate under all conditions.

It has been found by experience that in sandy and gravelly soils a well ordinarily drains at least five feet horizontally for each foot in depth; consequently, cesspools, septic tanks, manure piles, privies and similar sources of pollution should be located beyond the normal drainage area of the well. Under no conditions should a well or spring be located closer than 100 feet to a source of pollution. So far as practicable, a well should not be located on the side of, or at the foot of a hill, if cesspools, privies, manure piles, or other sources of contamination are situated where they would be above the well and in the path of the ground water flow toward the well. Septic tank laterals and cesspools are actually more likely to contaminate a ground water supply than a privy in the same location due to the greater volume of liquid wastes seeping into the ground. It should be remembered these distances are

DIAGRAM ILLUSTRATING NECESSARY SEPARATION BETWEEN WELLS AND SEWAGE DISPOSAL SYSTEMS

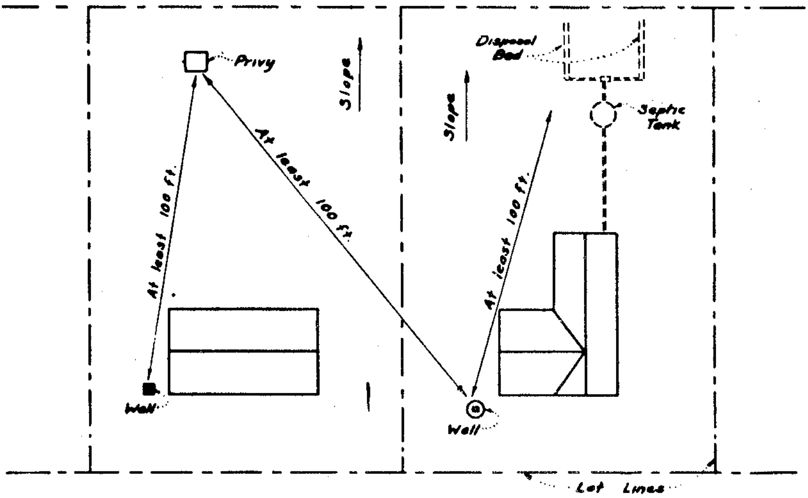


Fig. 6

HOW WELLS MAY BE POLLUTED BY UNDERGROUND SEEPAGE

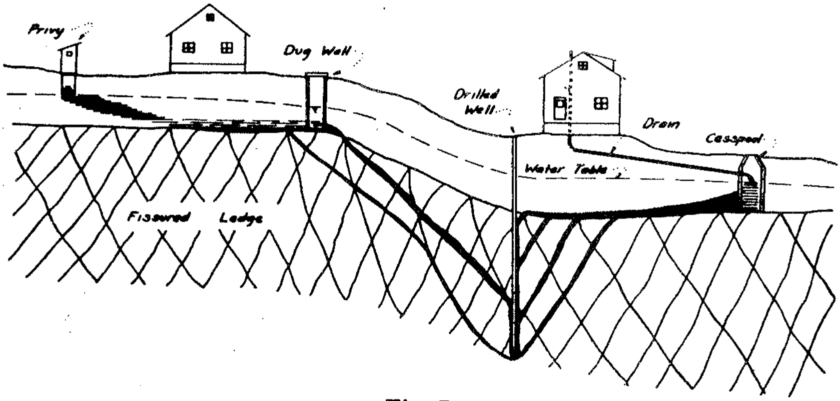


Fig. 7

considered to be the minimum and cannot be expected to be adequate under all conditions of soil and ground water characteristics.

If deep cesspools or privy vaults extend to water-bearing formations which are fairly porous, such as gravel or coarse sand, then greater separating distances are needed. A well drawing its supply from rock formations that are creviced or channeled, such as limestone, and the more common formations in Maine of shale layers at various angles, but not horizontal, should be regarded with suspicion until several analyses have shown freedom from contamination, and even then occasional analyses should be made because pollution may travel long distances in rock seams without undergoing much purification.

Protection

Once a ground-water supply has been properly located, it needs to be protected as indicated on these pages. Springs and wells should be protected from surface water by elevating the top of the spring or well above the surface of the ground. By grading the land to slope downward in all directions from the well or spring, surface water will be diverted from the water supply.

The upper portions of the well or spring should be of watertight construction to a depth of at least six feet below the top of the ground. This is accomplished by the use of tile or concrete linings.

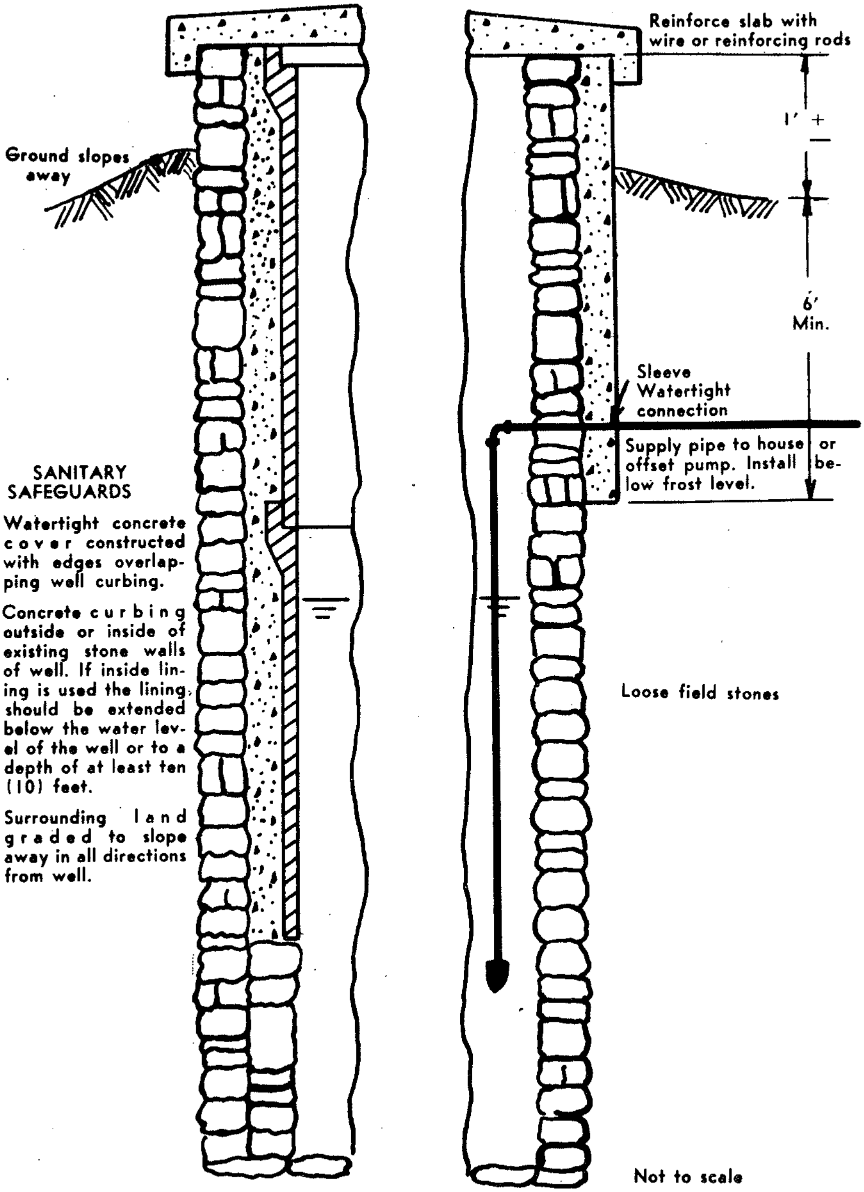
It is not enough just to provide concrete, tile, or similar tight walls. The quality and safety of the water will be endangered unless the work of protection is finished. Install a concrete or sheet metal cover over the well or spring with no ventilators or openings of any kind through which dust, light, air, waste water, or any other foreign substance may enter. Wood covers, even those of matched boards, are unsatisfactory protection for a well or spring as they warp and crack, and allow spilled water and other surface pollution to enter the supply. A good well or spring is worthy of a properly constructed, impervious cover, and the added protection that such a cover furnishes more than compensates for the slightly higher cost of construction.

Temporary Disinfection

Temporary disinfection of a private water supply is for the purpose of eliminating bacteria that may have been introduced through inadequate covers, or on account of the lack of other necessary protection, or during the process of repairing or constructing the walls around the source of supply.

After a domestic water supply, such as a new well, spring, cistern, or storage reservoir, has been located and properly constructed, and new pipes, pump, pressure tank, or other equipment installed, it is necessary to disinfect or sterilize the entire supply including such pipes, pumps, or other equipment. Such sterilization is important because the water, the pipes, and other parts of the system may have been contaminated in the process of installation.

RENOVATION OF ROCKED-UP DUG WELL



SANITARY SAFEGUARDS

A. Watertight concrete cover constructed with edges overlapping well curbing.

B. Concrete curbing outside or inside of existing stone walls of well. If inside lining is used the lining should be extended below the water level of the well or to a depth of at least ten (10) feet.

C. Surrounding land graded to slope away in all directions from well.

If repairs are made to an existing supply, such as installation of a new concrete cover, tile or concrete walls, a new pump, pump packing, pressure tank or pipes, or if the piping system has been reconnected after being out of use for a period of time, the water supply and distribution system should be disinfected or sterilized before use.

This sterilization may be accomplished by the use of any one of a number of commercial disinfectants, such as chloride of lime, high test hypochlorite, common bleach water, Dazzle, Clorox, or any similar chlorine product. These are sold by most grocery, hardware, drug, and similar stores.

If chlorinated lime or high test hypochlorite is used, add small quantities of water to the amount of powder specified in the following table and stir until a smooth paste has been formed. Add about 5 gallons of luke-warm water to the paste and stir for 10 minutes prior to allowing the solution to settle. The clearer liquid containing the chlorine in solution should be used and the material that has settled to the bottom discarded.

If bleach water, or other commercial chlorine solution containing approximately 3% available chlorine, is used, the required amount may be diluted with about 3 gallons of water and used directly.

The above solutions should be prepared in clean glass containers. The use of metal containers should be avoided, if possible, due to the strong corroding action of the chemicals.

In disinfecting a dug well, remove the manhole cover and pour in the chlorine solution, if possible washing down the walls or lining of the well. Stir the water and chlorine mixture in the well, using a clean stick, and allow to remain for not less than 12 hours; then pump it out through the entire pipe system, opening all the faucets, sill cocks, and similar outlets, until the water is free from the taste and odor of chlorine.

In disinfecting a drilled or driven well, slowly pour the required amount of chlorine solution into the well just prior to installing the pumping equipment. Proper mixing of the solution with the well water may be facilitated by running the solution into the well through a hose or pipe line as the line is alternately raised and lowered. This method should be used whenever possible. Then wash the exterior surface of the pump cylinder and drop pipe with a chlorine solution as the assembly is being lowered into the well. After the pumping assembly has been set in position, operate the pump until the discharged water has a distinct odor of chlorine. Allow the rest of the solution to remain in the well for at least 12 hours, and then pump it out through the entire piping system as in the manner for dug wells.

Springs should be disinfected by a procedure as similar as possible to that for dug wells. If the water pressure is not excessive, the overflow pipe may be plugged to allow the chlorine solution to remain in the spring for the desired interval of 12 hours.

Recommended dosages of chlorine products necessary to insure sterilization of various sized wells are shown below.

TABLE FOR FIGURING CHLORINE DOSAGE

A. Diameter of well in feet	(1)	(3)	(5)	(7)	(9)
B. Gallons of water per foot of depth	6	53	147	288	476
C. Amount of 3% bleach solution to use per foot of depth (in cups)	¼	1¼	3⅓	6	11
D. Amount of 5.25% bleach solution to use per foot of depth (in cups)	1/7	¾	2	3½	6¾
E. Amount of 24% chlorinated lime to use per foot of depth (in ounces)	0.2	1	3	6	10
F. Amount of 70% chlorinated lime to use per foot of depth (in ounces)	.07	0.4	1	2	3⅓

Size of cup: Use an 8 ounce, ordinary measuring cup.
(Two cups equal one pint. Four cups equal one quart)
An ounce of chlorinated lime is approximately one tablespoon of powder about 1¼ inches deep in the center of the spoon.

Analyses

The laboratory of the Division of Sanitary Engineering at Augusta upon request will make analyses of private water supplies and furnish a report by mail to the sender regarding the safety of the water for drinking and domestic purposes.

The analysis of water includes a physical, chemical, and bacteriological examination, performed in accordance with standardized procedure * which is universally accepted and employed in state and other laboratories throughout the country.

The physical tests relate to the attractiveness of water, and include determinations of turbidity, color, sediment, and odor. Turbidity and color are different in that turbidity is matter in suspension, whereas color is matter that has been dissolved in the water. Brownish or reddish color which remains in the water, even after turbidity caused by suspended soil particles has settled out, may result from surface water coming in contact with leaves, bogs, peat, or other vegetable matter, including the debris from dark growth forests. From a standpoint of health, the physical aspect of water is of far less importance than the chemical and bacteriological characteristics. The physical tests are of value, however, in that they are a measure of the palatability and desirability of the water for drinking and domestic purposes.

* Standard Methods of Water Analyses, A.P.H.A., Latest Edition.

The chemical tests furnish information concerning the character of a water, particularly with regard to its past history. Some of the tests are made to establish the presence or absence of nitrogen compounds. These compounds, if present in sufficient amounts, indicate that the water has at some time received drainage from an undesirable source of pollution such as a privy, cesspool, manure pile, or heavily fertilized area. As mentioned elsewhere in this bulletin under the subject of **Water-borne Diseases,** water which contains large amounts of organic nitrogen, particularly nitrate nitrogen, may be injurious to humans, or even fatal to children, and should not be used for drinking purposes. Other chemical tests which are made include hardness, pH, and chlorine as chlorides. Hardness of water is a measure of its soap-consuming properties. The symbol " pH " indicates the acidity or alkalinity of water and may be considered a measure of the corrosiveness of water. If the pH is less than 7.0, it is acid; if it is greater than 7.0, it is alkaline. The more acid a water is, the greater its corrosiveness. The chloride test is made to determine if there is an abnormally high chloride content in the water. Near the seashore this may be quite high, but normally will diminish at a regular rate as the distance from the sea increases. Sewage, especially the urine content, is high in chlorides, and an abnormally high chloride content may be an indication of sewage pollution gaining access to the water supply. Salt-treated sand piles, and applications of sodium or calcium chloride to roads in the vicinity of wells, have sometimes caused high chlorides in the water supply.

The bacteriological examination shows the presence or absence of pollutional bacteria in the sample. It serves as an indication of the safety of the water at the time the sample was collected so far as the likelihood of contracting bacterial infections is concerned, but sole reliance in determining the safety of water supplies cannot be placed on the results of a single bacteriological examination. A series of such examinations, together with the chemical analyses, and supplemented, if possible, by a field survey by a trained sanitarian, is necessary in order to judge properly the safety of a water supply.

The method of collection of the sample is extremely important in water analyses. The directions showing the proper method of collecting the sample should be followed to avoid accidental contamination of the water and a representative sample of the supply should be obtained.

The physical and chemical test results are reported numerically, generally in parts per million, as the quantities are always in relatively small amounts, and the bacteriological examination results are reported in terms of sewage bacteria (B. Coli) present or absent.

Lead and Copper Pipe — Special Tests

In areas like Maine where the normal waters are acid, lead pipes should never be used for conducting drinking water. Although lead pipe for this purpose has been prohibited for a number of years, some still remains in use.

In some locations copper pipe may not be desirable if the water is particularly corrosive. Special chemical tests for copper or lead are made when the sender indicates on the information card which accompanies the sample that copper or lead pipe is in use. If harmful concentrations of copper or lead are present in the water, the sender is so notified.

Interpretation of Water Analyses

A statement regarding the apparent safety of the water for use is furnished as a part of the analysis report. The accuracy of the opinion furnished is necessarily dependent upon the accuracy and completeness of the information which is requested on the card. Analyses, whether chemical or bacteriological, depend much for their interpretation upon a study of the source of water and its surroundings. Because it is impossible that a field survey be made by a trained observer of each supply that is being analyzed, it is highly important that information be furnished by the sender which will present as true a picture of actual conditions as possible.

If certain corrections are necessary in order to improve the quality of the supply being tested, such corrections will be listed and explained on the analysis report sheet which is furnished to the sender.

For information purposes, a few representative results of water analyses have been reproduced in the following paragraphs to illustrate the interpretation of the tests.

Dug Well — Satisfactory Quality
(Serial No. 163,764)

	Parts per Million
Nitrogen as Free Ammonia	0
Nitrogen as Albuminoid Ammonia	.012
Nitrogen as Nitrites	0
Nitrogen as Nitrates	.06
Chlorine as Chlorides	1.
Hardness	50.

pH 7.0
B. Coli .... none present in 10 cc portions

This water sample proved to be of excellent quality, relatively free of nitrogen compounds and chlorides, and free of sewage bacteria (B. Coli). Examination of the source would reveal an impervious lining and concrete cover on the well, and considerable separation from the nearest source of pollution.

Spring — Surface Pollution
(Serial No. 171,031)

	Parts per Million
Nitrogen as Free Ammonia	.044
Nitrogen as Albuminoid Ammonia	.222
Nitrogen as Nitrites	.026
Nitrogen as Nitrates	.7
Chlorine as Chlorides	10.
Hardness	56.

pH 6.6
B. Coli .... present in 10 cc portions

This particular water analysis shows nitrogen as ammonia, and chlorides that are somewhat higher than would be found in good water from a properly located and protected supply. The chemical examination, therefore, indicates pollution in rather small amounts, possibly from surface sources. This finding would be borne out by the presence of a defective curbing and improper cover over the spring. The bacteriological test corroborates the chemical analysis by showing the presence of sewage bacteria in each of the 5 standard 10 cc portions examined. This supply might well be made safe for human use by constructing concrete walls and cover around and over the spring, followed by disinfection to eliminate the bacteria already present.

Drilled Well — Badly Polluted
(Serial No. 161,585)

	Parts per Million
Nitrogen as Free Ammonia	.63
Nitrogen as Albuminoid Ammonia	.092
Nitrogen as Nitrites	.28
Nitrogen as Nitrates	25.
Chlorine as Chlorides	41.
Hardness	143.

pH 6.2
B. Coli .... None present in 10 cc portions

While this sample proved to be free of colon bacteria, the very high nitrite, nitrate, and chloride content indicate that the supply is receiving drainage from some source of organic pollution which has rendered the supply unsafe for human use. The fact that the organic matter has been so extensively oxidized indicates that the source of pollution is remote, either in distance or flowage time, from the water supply. The absence of B. Coli in this obviously

APPROVED HAND PUMP

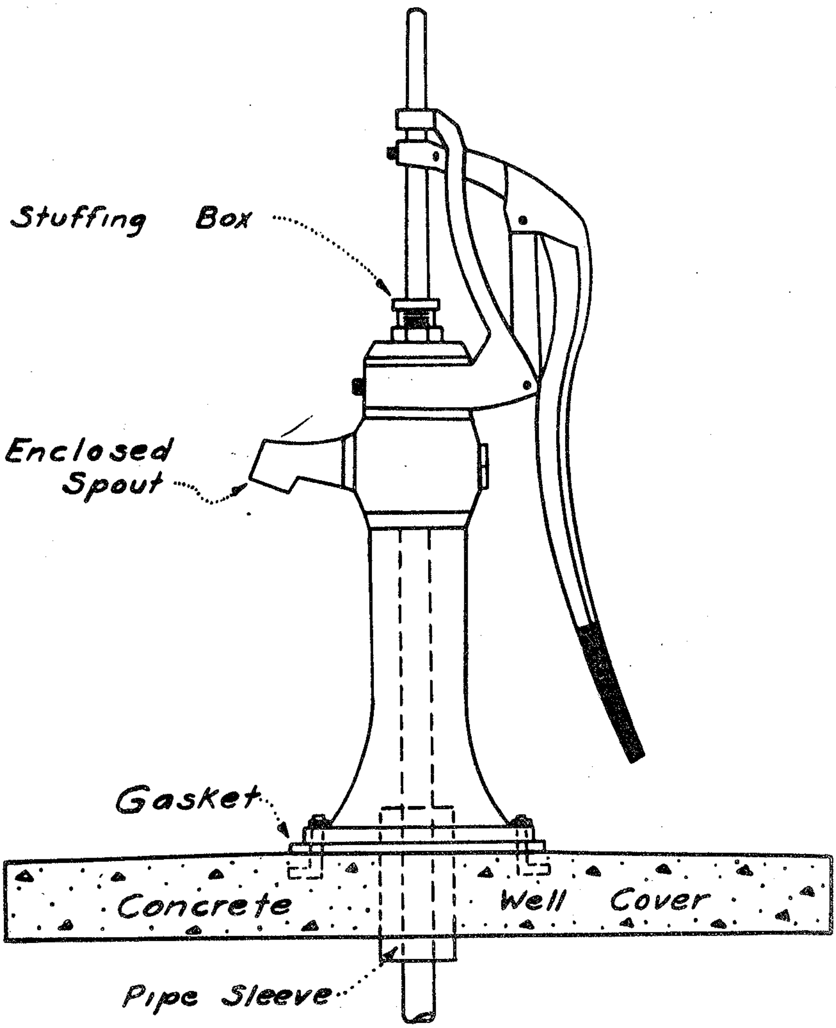


Fig. 9

Requirements of a Sanitary Pump

A. Solid one-piece base, sealed at platform to prevent entrance of surface drainage.
B. Stuffing box connection around piston at pump head.
C. Downward directed pump spout (instead of the open spout used on the so-called "pitcher pumps").

polluted sample also may indicate that the source of pollution is not in the immediate vicinity of the well, the bacteria having been filtered out as the pollution seeped for a considerable period of time through the earth.

This is the type of water which has caused many cases of sickness and deaths of infants.

DISTRIBUTION

Pumping Installations

Methods in general use for drawing or raising water from private supplies consist of bucket devices, hand pumps, and power pumps. Hydraulic rams may also be used in certain installations where the amount of water to be furnished is small and the available supply is adequate to furnish the necessary power. They are adaptable for use in hilly areas for furnishing water from springs.

Bucket devices include the simple bucket and rope method, chain bucket pumps, and chain-and-plug pumps, the latter methods utilizing endless chains which function as a means of carrying entrained water to the discharge spout. Bucket devices and endless chain methods are not recommended for use because no satisfactory method of safeguarding a supply from contamination has been devised in their installation. The hand bucket and rope method is particularly likely to cause contamination of a well or other water supply.

Hand pumps when properly installed are satisfactory for use. The pumps for hand-pumped wells and cisterns should be so constructed and installed as to make impossible the entrance of waste water, surface water, or other contamination into the supply. An approved type of hand pump with a stuffing box surrounding the pump rod and having a downward directed spout is shown in Figure 9. Ordinary lift pumps, known as pitcher pumps, having an open slotted top and an open spout should not be used in out-of-door installations due to the attendant danger of contamination of the supply.

A properly designed and installed pump should provide the following protective features:

1. The pump head should be entirely enclosed in a water- and dust-tight manner to prevent contamination by the hands, birds, flies, dust or similar sources from reaching the water chamber.
2. The pump base should be constructed to make a waterproof seal with the well cover or casing.
3. The pump cylinder should be installed below the normal water level of the supply to prevent the need for priming.
4. The pump design should provide for automatic drainage to prevent damage to the pump in freezing weather.
5. The installation should be so arranged that proper maintenance may be possible, including sufficient overhead clearance to permit withdrawal of the pump rod and pipe.

The availability of power, especially electricity, makes it possible to consider several types of power pumps for the various water supply systems. Included in the available types of pumps are reciprocating or cylinder pumps, rotating pumps, and jet pumps.

Reciprocating pumps have perhaps the widest application of use for small private water supply systems. The suction or cylinder type is capable of raising water to a height of about 24 feet in most sections of Maine measured vertically above the level of the supply.

Rotating pumps, such as the centrifugal rotary and turbine types, operate with the mechanism located at the bottom of a discharge column below water level. Well-designed pumps of these types are not likely to cause contamination of the water in the pumping process.

Jet pumps are used with both shallow and deep wells and utilize the ejector principle of pumping water into the bottom of a drop pipe through a jet which forces the water to the surface.

Power pump installations usually require enclosure in some kind of protective housing. They may be located in the basement of the house or in a separate pump room, protection from freezing being necessary in the latter instance. The pump room floor should be of watertight construction, such as concrete, and should slope away in all directions from the well or suction pipe.

The sanitary requirements pertaining to the installation of hand pumps are in general applicable to the installation of power pumps to prevent contamination of the supply.

Special information regarding the capabilities and operation of pumps may be secured from their manufacturers.

Piping

Galvanized iron or steel pipe and fittings are ordinarily used in the distribution lines for small private water systems. Copper and brass pipes have also been frequently used, particularly during recent years. Lead or lead alloy pipe must never be used for conducting drinking water due to the danger of lead poisoning.

The selection of piping materials should be made with proper regard to the character of the water being conducted. If a new water system is to be installed, or if the pipes in an existing system are causing trouble and are to be replaced, a sample of the water should first be analyzed to determine what kind of pipe is most suitable. Water taken from wells and springs in Maine is normally acid in character and has a tendency to react with any metal with which it comes in contact. Use of metal pipe with corrosive waters may result in the presence of the metal in objectionable amounts in the delivered water. If black or galvanized iron pipe is used, so-called red or rusty water may result. If pipe containing copper is used, such waters may produce green stains on enamel-ware, or cause a metallic taste to appear in the water.

The use of plastic pipe outside of the building for the conduction of cold water seems to be a solution to the difficulty mentioned above. Only plastic pipe which has been tested and approved by the National Sanitation Foundation has been accepted for use. This pipe is easily recognized by the NSF seal of approval which is stamped on the pipe. Cement-lined pipe, if it can be secured, is also satisfactory for use with corrosive water and lasts considerably longer than ordinary galvanized pipe.

Although corrosion prevention treatment is generally not feasible for a small private water system, the corrosiveness of water may be reduced by exposure to crushed limestone in a special tank. This method has the advantage of being automatic and requiring practically no supervision or maintenance.

LIMESTONE CONTACT BED

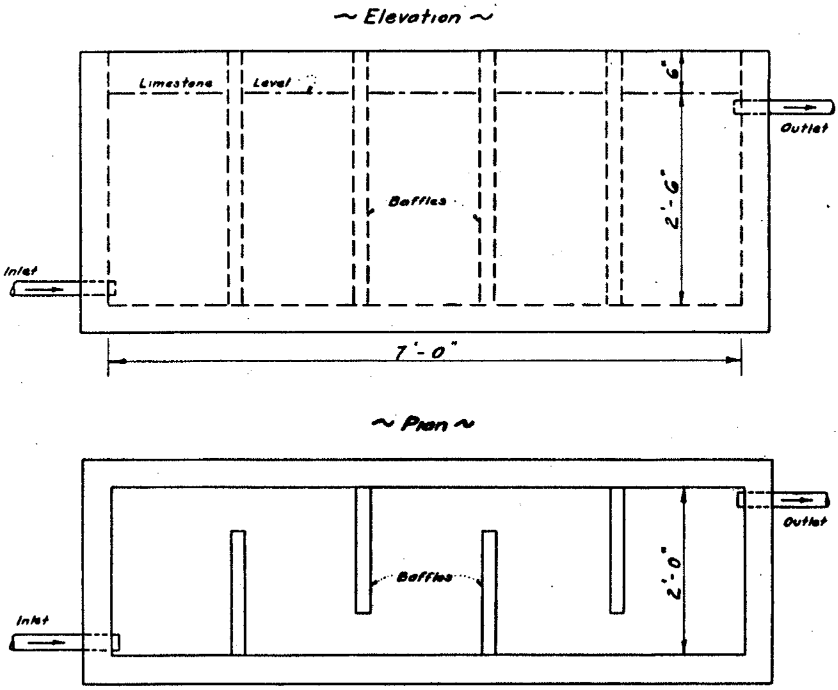


Fig. 10

Directions for Installation of Limestone Contact Bed

Construct tank with impervious cover at or near source of water supply and fill to level shown with limestone chips about ⅛ to ¼ inch in size. Approximately one cubic yard of chips are required for the initial filling of

the tank shown. Small amounts of limestone may be added as needed to replenish supply. Provide by-pass if water supply will overflow tank. Equipment for controlling the corrosiveness of water is manufactured by several companies and may be obtained through regular commercial channels.

The pipe sizes selected should be large enough to deliver the desired amount of water without an excessive loss of pressure. The following table shows the approximate discharge of water through pipes of various sizes.

Pipe Size (Inches)	Gallons per Minute
½	1
¾	3
1	5
1¼	10
1½	15
2	25
2½	50

The actual installation of piping should be made with some regard to the possibility of freezing. In houses, it is desirable to install the pipes in an interior partition or other place where there is little possiblity of freezing, rather than in an outside wall. Pipes placed underground should be at least 4 to 5 feet beneath the natural ground surface in order to be safe from freezing.

The water-supply inlet to stock-water tanks, laundry tubs, and similar installations, should be installed above the rim of the fixture to prevent the possibility of back-syphonage if the fixture overflows. There should be no cross-connection, by-pass, or other piping arrangement whereby water of questionable quality may be discharged or drawn into a supply used for drinking and domestic purposes. Any new plumbing should be installed in accordance with the provisions of the State Plumbing Code.

Water Softening

As mentioned elsewhere in this bulletin under the subject of **Quality** there may be salts present in ground-water supplies which increase the hardness of the water.

Water for home laundry purposes can be softened by the addition of ammonia, borax, or washing soda, but such home-made applications are uncertain and not recommended except for water treatment on a very small scale.

Commercial softening or water-conditioning compounds of unknown composition or effect should not be used in water intended for drinking or cooking until competent advice is obtained regarding their safety for use in order that harmful substances will not be added to an otherwise safe supply. Domestic water softeners are manufactured by several companies and may be purchased, or rented in some areas, through regular commercial channels.

Iron Removal

If a water supply is otherwise satisfactory but contains dissolved iron, it is possible to obtain iron removal units which will effectively remove iron from the water. These units are manufactured by several companies and are readily obtainable.

APPENDIX A

QUANTITIES OF MATERIAL FOR ONE CUBIC YARD OF COMPACTED CONCRETE

(Without allowance for waste) — (Sand and stone measured loose)

Proportions by Volume			Quantities of Material		
Cement	Sand	Stone	Cement (bags)	Sand (cu yd)	Stone (cu yd)
1	1	2½	9.4	0.35	0.88
1	1	3½	7.8	0.29	1.01
1	2	3	7.0	0.52	0.78
1	2	3½	6.5	0.49	0.85
1	2	4	6.1	0.45	0.90

Example: Material required for walls 7 inches thick and 6 feet deep for a cistern 5 feet square.

(Note: 27 cu. ft. equals 1 cu. yd.) Thickness of wall equals 7 in. equals 0.6 ft. (approx.)

Area of 2 side walls: (2) x 5 x 6 equals 60 sq. ft.

Area of 2 end walls: (2) x 3.8 x 6 equals 46 sq. ft.

Total Area equals 106 sq. ft.

Volume of concrete equals 106 x 0.6 equals 63.6 cu. ft. equals 2.35 cu. yds.
From the above table, 2.35 cu. yds. of a 1:2:3 concrete mix will require:

Cement: 7.0 x 2.35 equals 16.5 bags (plus about 105 gallons of water)
Sand: 0.52 x 2.35 equals 1.3 cu. yds.
Stone: 0.78 x 2.35 equals 1.9 cu. yds.

Note: Clean, well-graded gravel may be substituted for sand and stone. A proportion of 1 part by volume of cement to 4½ parts of gravel is commonly used.

For sewer pipe, tanks, cisterns, and well and spring encasements, a maximum of 6 to 6½ gallons of water should be used per bag of cement. For sealing the outside of well walls to prevent undesirable seepage of pollution into the supply, the larger openings will first have to be filled with suitable material, after which the smaller open spaces in the wall may be filled with a cement grout mixed in the proportion of 1 bag of cement with an equivalent quantity of sand and enough water to make a workable mixture. The grouting mixture must be placed in one continuous mass for best waterproofing results.

APPENDIX B — Don'ts to Remember

1. Don't use lead pipe for conducting drinking water.
2. Don't use pitcher pumps for out-of-door pump installations due to the danger of contamination of the supply.
3. Don't forget to install water pipes so they may be drained.
4. Don't fail to have a private water supply analyzed before installing new water pipes.
5. Don't use an abandoned well as a cesspool.
6. Don't permit cesspools or other pollution to remain within 100 feet of a water supply.
7. Don't forget to sterilize a water supply after construction or repairs.
8. Don't fail to have a private drinking water supply analyzed each year.
9. Don't forget to install an approved type lining and cover on a well or spring.
10. Don't forget that corrosive or hard water may be corrected.
11. Don't use asphalt compounds for waterproofing the interior of water reservoirs.
12. Don't forget to allow concrete reservoirs, or well and spring encasements, to cure properly before using.

If additional information is desired, it may be secured by communicating with the Division of Sanitary Engineering, State Department of Health and Welfare, Augusta, Maine.