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SANITARY WATER SUPPLY FOR THE HOME

A sanitary water supply is essential to every household and should be a prime consideration in locating and building a home. This applies of course, to rural and suburban homes, where a municipal water supply is not available. Most of the water used in our State for domestic purposes is pumped from ground water supplies. This affords nominal, though not certain protection against contamination. Water in wells even of considerable depths may be polluted through seepage; also flood-waters, filth and dust may get into open or carelessly closed wells. Water may also become contaminated after it has been pumped into tanks.

The well and surface contamination: The well should be located on high ground, preferably on a slight raise of the surface. If this is not possible the area immediately around the well should be filled in with good soil, i. e., soil free from organic matter and rubbish. The surface around a well should slope away from it—not toward it- Where necessary, the well should be protected by embankments or dams against floodwaters. Hand-dug wells are quite general in our State and if dug for a sufficient depth in the water-bearing strata and cared for afterwards they are very satisfactory. It is sometimes difficult, however, to dig far enough into the water-bearing gravel to insure a strong flow of water. Drilled wells cost more in the beginning than hand-dug wells, but if put down properly they are very satisfactory, both as to their upkeep and the amount and quality of water.

Dug wells are sometimes cased from the bottom with sewer pipe 10 or 12 inches in diameter, with dirt filled in around this to the top. This prevents foreign matter from getting in from above and renders them as sanitary as drilled wells. Occasionally dug wells are cased with iron pipe or sewer pipe from the bottom to a point a few feet above the water level. These are filled in around with gravel or sand. This provides a solid bottom to stand on when working in the well and makes possible the deepening of the well later. The expense of this is nominal.

The common practice of leaving wells uncurbed is not good, except where the various strata of rock and soil are hard and not likely to be affected by moisture and thus caused to crumble later. Uncurbed wells are usually of short duration. The writer found it necessary, a few years after digging a well, to case sections of the sides that were softening and caving in. The expense of this about equalled that of curbing the entire well at the time of digging. Concrete curbs for wells are permanent and superior to wood, though the initial expense is greater. Most wood curbs rot out soon and so have to be replaced. Redwood boards, if tarred, last well, but even these decay in time. Wooden curbs in the bottoms of wells often give to water an unsavory taste. It is far better for this purpose to use sewer pipe or iron casing.

The well should be covered securely to prevent foreign objects from falling in. It is not true that well water becomes unpalatable as a result of the top being covered over tightly. The well covering may consist of two-inch boards fitted closely. These should be treated with crude oil, creosote or tar to prevent warping, splitting and premature decay. Redwood lumber is well suited for this purpose. Concrete slabs, neatly fitted, can also be used and have the advantage of being permanent.

If precautions like the above are taken, a well will be permanent, and the upkeep will not be great. It will be impossible for storm waters and surface drainage with accompanying filth to get in from above. Likewise, a close-fitting cover and good curbing will prevent such animals as rats, mice, gophers, snakes, lizards and frogs from getting into the well from the top or digging in from the sides. These represent a large percentage of the causes which lead to the pollution of one's domestic water.

Contamination of water in wells through seepage: Contamination through seepage occurs down in the well and so is not easily detected. Often one is not aware of it until sickness occurs in the home. On this account, the greatest care should be exercised in the location of wells with reference to objects that may contaminate the water. These include cesspools, vaults for the disposal of sewage, sewer pipe lines and open sewer ditches, corrals, barnyards, hog yards, poultry yards, stockyards and manure heaps. Likewise, pools or ponds of stagnant water should not be near wells for such water may contain disease germs. Shallow wells near cesspools or outhouse vaults are always to be regarded with suspicion. In using such water past freedom from disease must not be taken as a guaranty for one's future health. The least distance that wells should be from such objects is 50 feet, and 100 feet is much better. Even then the ground may become so saturated with impurities from seepage water as to act no longer as a good filter. Naturally the character of the ground strata and the depth of the well have much to do with water purification,

Granted that all these centers of pollution do not contain bacteria injurious to the health, they may render water unfit for domestic uses through the soluble organic matter they impart to shallow underground waters as a result of imperfect soil filtration. Organic matter in any quantity in drinking water may become nutriment for the growth and propagation of disease germs and other bacteria. Brightness and sparkle in drinking water do not necessarily indicate purity On the contrary these qualities may suggest the presence of carbon dioxide and organic matter. Water that is relatively free from organic matter is not a good medium for bacteria to grow in One can be reasonably certain of a sanitary water supply if the above precautions are heeded. There should be adequate supervision of wells, the water supply of which is used by dairies and similar industries, since here the health of whole communities is concerned.

In those parts of Arizona, where the water level is at considerable depths, contamination of water in wells from seepage is less likely than where the water level is relatively near the surface, i. e., 30 feet or less. Outbreaks of typhoid fever have rarely been serious in our State. They have occurred generally (1) in mining camps where the houses too often are crowded together and where no attention has been given to surface drainage and to the disposal of sewage and garbage; and, (2) in occasional agricultural communities where the soils are loose and porous and the water level relatively near the surface. Under these circumstances the pollution of well water due to conditions like those noted above is easily possible and sooner or later it must take place. It is not difficult to find in rural communities, towns, and cities wells used for domestic water supplies that are entirely too near cesspools or privy vaults or other objects of contamination, to be at all safe for use. Such wells should be closed by community action.

Storage tanks and the pollution of water in them: A small storage tank is essential to a pumping plant. In the Southwest it consists ordinarily of a galvanized iron tank, usually open and elevated somewhat to secure pressure for domestic purposes. Cement tanks have not come into general use on account of their greater cost, and wooden tanks do not withstand our climatic conditions. The water in these open tanks soon becomes polluted from various sources. Insects and occasionally birds are blown or fall into them. A water supply naturally attracts birds from considerable distances during the hot summer season, Dust, including bacteria and microscopic animal and plant life, together with leaves and other foreign matter, also get into open tanks.

The plants described below are the commoner forms that were observed in a study of water taken from several tanks in the vicinity of Tucson. No attempt was made to study the bacteria, nor the various animal forms, among which were several species of protozoans.

1. Water Mould *(Saprolegnia)*. A small, filamentous plant forming a white fringe or halo a half-inch or so in extent about the bodies of dead insects floating on the water.

2. Water Moss *(Oedogonium)*. A small, bright green, filamentous plant growing attached to the sides of the tank and to floating objects. It is common in irrigation ditches,

3. Water Net *(Hydrodictyon)*. A small, green, net-like plant composed of slender cells joined at the ends to form hexagons. This is often abundant in irrigation ditches.

4. *Scenedesmus* Small plants made up of two, four or eight oblong cells arranged horizontally and held together loosely.

5. Diatoms (*Navicula* and others). These are minute yellowish or brownish, boat-shaped plants with distinct movements.

6. Desmids or water scum. This is a bright green, single-celled plant forming masses of easily separable gelatinous matter. It is common in streams and one of the more abundant algae in water tanks.

7. Blue Green Slimes (*Oscillatoria* and *Nostoc*). These plants form a thin layer on the sides of tanks or occur in irregular floating masses, bluish, yellowish or amber-colored. The cells of *Nostoc* are roundish and arranged in bead-like chains; those of *Oscillatoria* form slender, regular filaments or threads with oscillating movements.

8. *Euglena* Small, greenish, rounded or elongated cells with single vibrating threads or colorless flagella.

The growth of some of these algae in water in tanks is little short of phenomenal. In two or three months' time they often form a layer of gelatinous matter and slender threads several inches deep over the surface and on the sides of tanks. This growth is most pronounced during the spring and early summer season, but it is present in some quantity at all times of the year As already suggested it develops from plant spores or cells blown by the wind or carried bv insects or birds Experiments made by the writer indicate that cells of certain algae, including *Oscillatoria*, may remain in a dessicated condition for a period of ten years, after which they will resume active growth upon coming in contact with moisture and suitable temperatures.

When fresh this growth resembles a slimy, scum-like mass, bright green or bluish green in color, according to the species of plants predominant. With age it turns yellowish or brownish and dies, giving off a very offensive odor. At this time it disintegrates and settles to the bottom of the tank where it forms a layer of slime or ooze rich in organic matter. The nourishment of these plants consists essentially of carbon dioxide in the water in small quantities and certain salts necessary to their growth and existence. With this plant nutriment and with suitable temperatures these plants grow and flourish in the presence of sunlight.

This plant growth in itself is not regarded as harmful to drinking water, though most of us avoid using water that contains it. It is not poisonous, as some believe, nor does its presence suggest necessarily that the water is unfit for domestic uses.

Water taken from an open tank that has not been cleaned or washed for some time, and containing this algal growth in any quantity, contains a fine, blackish sediment and is usually slightly discolored. It has also more or less pronounced odor and taste. This results from the growth and ultimate decomposition of these plant organisms in the water. Such water is necessarily unpalatable and as it stands in the tank it has often a brackish or fish-like odor. It contains an excess of organic matter resulting largely from the decaying plant growth. For this reason it is an excellent medium for bacteria and disease germs to grow in, once they are introduced The bacterial count of samples of such water is abnormally high, which does not speak well for it as a sanitary water supply. All this pollution takes place after the water has been pumped into the tanks and results from the growth of these minute organisms.

Tank covers a simple means of preventing algal growth: The writer has tried various means to prevent the growth of these algae in storage tanks. Experiments made almost at the beginning of the work proved conclusively that none of these plants can grow in the absence of direct sunlight, and that when such a cover is put on a tank the plants in the water die within a week's time and do not reappear again. A simple means, therefore, of keeping one's supply of water for domestic use free from pollution caused by these plants, as well as by birds and insects, is to put a permanent cover on the tank.

Tank covers made of galvanized iron cost double or treble those made of wood. They are often neater in appearance, however, and they last much longer Galvanized iron tank covers can be made of material somewhat lighter than that used for the sides of the tank. They are usually constructed in the form of a low cone with a slope of one inch in three or four inches radial distance. They must be fastened securely to the rim of the tank to prevent their being blown off, and they should extend two or three inches over the edge of the rim all around. The cost of making and installing such a cover will vary from $50.00 to $90.00, according to the size and the height of the tank. On account of the present high prices for galvanized iron, it is recommended that wood be used.

Wooden tank covers are quite satisfactory and cost less than galvanized ones. The common form of wooden cover is built in place and requires the time of two men for one to two days. A framework of 2" x 4" pieces is first built over the entire top of the tank. These are 18 to 20 inches apart and should extend over the edges of the tank about three inches. Notches about an inch deep are cut near their ends on their lower sides to fit snugly over the rim of the tank. This rim usually consists of a half-inch pipe to which the top of the tank is fixed to give stability. These notches help in fastening securely the cover to the tank. A slope about one-eighth inch to the linear foot should be given to this framework to carry off rainwater. This framework of 2" x 4" pieces is made secure by several short cross pieces. Ordinary rough boards, preferably six or eight inches wide, are now nailed over this framework and the ends are cut off all around, thus giving a neat appearing circular top. A good grade of roofing paper is laid over these boards and nailed securely above and all around the edges. Light colored paper, i e., asbestos coated paper, is preferable to darker paper, as it absorbs less heat.

As made in this way an air space two or three inches wide is left at the sides. This can be closed to insects and birds and yet permit ventilation, which is desirable, by nailing a strip of galvanized wire gauze, about 16 mesh to the inch, to the cover all around and drawing the lower end closely against the sides of the tank with wire or stout cord pulled tightly over it. A strip of oiled, unbleached muslin can be used in place of the wire gauze. The lower end of the muslin should be hemmed and through this hem a stout cord or quarter-inch cotton rope drawn in advance of tacking the muslin to the cover. The ends of the cord or rope are now drawn tightly against the side of the tank and tied.

A hole large enough to allow a person to enter should be left in any tank cover as repairs have to be made from time to time. This may be closed with a trap door or with a piece of wire gauze tacked on a frame. Redwood is superior to other lumber for making tank covers, as it is less subject to decay. Notwithstanding the ventilation provided, the under surface is more or less moist much of the time. This is particularly true during the cooler parts of the year. For this reason any lumber will last much longer if treated with creosote, crude oil or tar.

In the absence of covers, tanks should be cleaned at least once in two months. Regardless of the care exercised in this, however, the plant cells left on the sides and bottom infect immediately the next lot of water pumped in, with the result that the algal growth soon reappears. Cleaning water tanks is at best troublesome and in the end more costly than covering.

Copper treatment not recommended for water in small tanks: Experiments made by the writer with copper sulphate and metallic copper, for the purpose of purifying water supplies in galvanized iron tanks of their algal growth, were only partly successful. Three tanks were used, each one having a capacity of 5,000 gallons. The water was treated every 60 days for a period of 6 months, and one part of copper sulphate was used to 1,000,000 parts of water. This required approximately two-thirds of one ounce of copper sulphate for a single treatment of a tank of 5,000 gallons. Even when all the algae seemed to be killed, a fresh growth appeared again within a period of 30 or 40 days at most. The summer temperatures were rather high, which should have made the toxicity of copper sulphate more pronounced than with lower temperatures. There are several reasons why the experiment was not more successful. The copper sulphate reacted upon the galvanized iron of the tank, with resulting precipitation of copper. Besides this, certain mineral salts in the water acted chemically on the copper sulphate and thus partly neutralized it. Finally, the water supply in the tanks changed completely every few days, and in the instance of one tank it changed every day. Thus the capper sulphate soon disappeared from the water in the tank or was changed into other compounds less toxic to plant growth. In order to kill practically all the plant cells present the tank should be full of water at the time the copper sulphate is added, otherwise resistant spores or cells adhering to the sides of the tank above the water line will not be killed.

Bundles of copper shavings also were unsuccessful in keeping water in tanks free from algae. It is possible that better results would have been obtained if more of the metallic copper had been used. These bundles were removed every three or four weeks and dipped in dilute acid for a few minutes to clean their surfaces.

It is well known that dilute solutions of copper sulphate are efficient in ridding storage water reservoirs of algal growth. In fact, the water in most reservoirs nowadays is kept pure and wholesome by occasional treatment with copper sulphate. The small amount of copper put in the water does not injure it in the least for domestic uses. To be successful in this work it is necessary for one to know the species of algae present, since some are more resistant to copper than others, and one should also know the amount and kinds of mineral salts present Not alone does copper sulphate kill the algae present, but if used in the strength of 1 part to 400,000 or 500,000 parts of water it is considered efficient in destroying typhoid germs. Water that is suspected of being contaminated with sewage may be treated in this way at small cost until such time as a better supply of water can be secured. It is also stated that typhoid germs may be killed by allowing the water to stand for 24 hours or longer in a copper vessel or similar container. In this connection it is almost unnecessary to state that water can be purified for drinking purposes by boiling, though this is often inconvenient.

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