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Where ever a large number of people are found, making their home in close proximity to one another, a great amount of water is necessary and a supply of a sufficient quality and quantity becomes a sanitary problem of the greatest importance to every individual in the community. Early in the history of man he recognized the importance of this sanitary problem, and in many an ancient land attempts were made, successfully often, to supply water on a grand scale. In Egypt artificial lakes were made to provide water where the supply of the Nile proved insufficient. Remains of gigantic water basins have been found in Mexico and Peru. In Ceylon are found the remains of a great artificial tank some forty miles in circumference. But it was in ancient Rome that municipal water supply reached the zenith of its development. At the end of the first century A. D. there were 14 great aqueducts carrying into Rome from the distant mountains some 375 millions of gallons of water daily, or 300 gallons of water per person.

During the middle ages all sanitary measures were neglected. At the beginning of the nineteenth century only 17 water works were in existence. During the last century great progress has been made along this line, as well as in other sanitary measures, and at the present time there are in the United States over 4,000 water supplying systems, chiefly owned by municipalities.

Too much cannot be said in regard to the importance of the use of plenty of pure water in the home. The health of the family, often the health of the entire community depends almost entirely on

the water supply. Often a whole community may ward off or undergo the ravages of an epidemic of disease all because of the dependence entirely upon the purity or impurity of the water supply.

The rate of mortality has been found to be lessened greatly in cities where a supply of pure water is needed by the community at large for public baths and water closets, for flushing sewers, for cleaning the streets, for the use of animals, manufacturing purposes etc. Pure water has been installed after the use of impure water.

Some writers claim the health of an individual may depend entirely upon the amount and purity of the water he consumes. Cleanliness is more than a matter of custom, it is one of Nature's laws. Water is a vital element of our food and assists in the building up of our tissues, of which it constitutes two-thirds; it preserves the fluidity of the blood and aids in the excretion of effete matter. It is also of great importance in keeping the body at a uniform temperature under varying conditions of heat. Water is also essential for drinking purposes and cleanliness. It is hence important that the supply be abundant as well as pure. When we remember that the human body is over 70% water and that water is constantly being eliminated the need of an abundant supply of pure water is appreciated. People may use impure water but its constant use tends to the degeneration of the race. The use of impure water causes numerous ailments for which the sufferer is able to find no apparent cause.

Insufficient supply of water never fails to bring evil results. The daily amount used in the various cities depends largely on the nature of the community, whether or not it be largely a manufacturing city. The average supply for London districts in 1884 was 28 gallons per 24 hours. Varying from 25 to 37 gallons. Some towns re-

quire more, others less.

One authority has calculated the amount used per person in a fairly clean household at 12 gallons daily. He divides the amount as follows - (2-1/2 to 3 gallons for a daily sponge bath) This amount includes clothes, utensils and house washing but not a closet supply. For cooking .75 gallons, drinks .33 gallons, ablution 2-1/3 to 3.5. Share of utensil and house washing 3. Share of clothes 3 gallons. Total 12 gallons. In time of scarcity four gallons is the very least that should be allowed. There is much doubt as to whether or not wells in the rural districts yield a sufficient amount of water.

In olden times water was drawn from a farm house well by means of a bucket, from 2 to 4 gallons was the allowance. Now from 30 to 40 gallons are drawn by faucet from the town supply. A town whose citizens use large amounts of water points with pride to this fact.

Research and investigation show that the health of an individual and the general health of a community depend largely upon the purity of the water supply. Impure water is one of the most pronounced carriers of disease germs. It is possible for only a certain amount of soluble matter to be contained in water and if water when it enters the system has a portion already of its load it is the less able to dissolve and carry away the waste materials of the body.

Water rarely produces diseases which could not by proper vigilance be avoided. People live who drink impure water practically all their lives, but its constant use tends toward the degeneration of the human race. Often when a host of ailments arise from the drinking of slightly impure water, the sufferer is unable to locate the source of trouble. The evil results of impure water may be so grad-

ual as to evade observation. Observation has shown in a community where a bad water supply was replaced by a supply of pure water that the death rate not only decreased, as did also diseases, but often there was a rapid increase in the thrift, morality and degree of civilization. One author says "Those who have never drunk pure water do not realize what an effect such water has upon the kidneys, its effects is better than acetates, nitrates etc, and for people with a tendency to kidney disease there is no better drug than pure water."

Goitre is a disease most intimately connected with the mineral ingredients of water, the impurities of water which produce goitre are of inorganic nature, the latest authorities consider this impurity to be of a metallic nature, probably some salt of iron. Among the diseases caused by organic matter are cholera, enteric fever, dysentery, diarrhoea, ulcerated sore throat, low fever and erysipelas. More or less familiar diseases have been traced to the practice of bathing in impure water.

From a sanitary point of view pure water may be defined as "water that is unobjectionable for general domestic purposes and especially that which may be used for drinking with perfect safety." To most people the ideal drinking water is the clear, colorless, sparkling water of springs, refreshing by its coolness and satisfying our eye for beauty by its suggestion of purity. So strong a hold has this idea upon individuals that it is often hard to convince him that such a water may be impure or that water which does not possess these characteristics may be far more advisable for human consumption.

Purity of water means the freedom from deleterious constituents, the most dangerous constituents in water are the products of decomposition of various kinds of organic matter and the germs which

live upon the organic matters. For this reason all chemists condemn all water contaminated by sewage.

Practically all the water we use has passed, quite recently through the soil or over it, and hence is polluted to a greater or less degree.

The water draining into the creeks, rivers and lakes of a cultivated region are very liable to contamination from contact with the manure spread over the entire surface of the land as a fertilizer. Around many a barn-yard and alley there constantly exist manure piles which contaminate all the water drained from the surrounding ground. To be sure such waters are partially purified by their passage through the soil but such filtration is very imperfect.

Cess pools which are water soaked or cracked open, by allowing the escape of the contents, seriously contaminates the supply of water used by the house-hold. Faulty sewerage, drains etc, are often the cause of similar pollutions. When a filter becomes clogged and dirty its bacterial action may pollute the water to an alarming extent. Unless cleaned often a filter is better unused. Wells like-wise should receive periodic cleanings. Many cases of disease have been traced to their beginning in dirty wells.

Water passing over the surface of the land or through it is very apt to dissolve or hold in suspension certain forms of organic matter, such as small animals, both dead and living leaves, pieces of plants etc. The decomposition of such material is polluting in its effect. Pathogenic bacteria are also present in such water. Such bacteria do not find water a very congenial habitat and do not thrive in so cool a temperature, and the other organisms soon overpower these weaker ones. Danger in such water decreases in accordance with



the dilution and the abundance of the other forms of vegetable life. Under favorable conditions, i.e. almost entire absence of other forms and a sufficiently warm temperature, the danger is very great.

Surface water in low mossy ground has been found to contain from 12 to 30 grams of vegetable matter per gallon, and under such conditions it is usually of a brownish tint. Freman very happily spoke of such water as "meadow tea". In falling through the air, especially at the beginning of a rain, the water takes up large quantities of dried organic matter, such as the finely pulverized dust of leaves and the excreta of animals.

The presence of living plants in water often gives rise to extremely unpleasant, if not dangerous, tastes and odors, due to the pungent oils and other strong smelling substances formed during the process of growth. The roots of trees often penetrate the walls of improperly constructed wells and in the presence of so much moisture make an enormous growth in a short time, often the water in such a well becomes discolored, appears milky and has a very offensive odor as of decaying animal matter. That such conditions should be avoided is obvious since the results are unknown.

We have two sources of water, that which falls as rain and snow ( and gathers in creeks, lakes, ponds and shallow wells ) and that which we obtain from deep wells and springs. Subsoil water is the name we commonly give the later, and the former we term surface waters. The subsoil waters are much less liable to contamination than surface waters.

The rivers, lakes, ponds and streams serve as natural reservoirs and storage tanks for the collection of this fresh water as it falls upon the earth. The water from such sources is very easy to

obtain and where the country is unpopulated is comparatively pure and wholesome. The character of such waters is largely dependent upon the nature of the soil over which they flow and the amount of sewage deposited in them. The proximity of dwellings, barnyards and the like greatly influence the degree of contamination of all surface water. Perhaps the most impure water is that found in the shallow poorly constructed wells in small country towns where the wells, privy vaults and garbage piles are in close proximity. The same amount of impurity finding its way into a closed well produces much greater contamination than would the same amount placed in an equal amount of water on the surface of the ground where it would have the benefit of the sun, the greatest disinfectant we have. The wells in many country homes are contaminated by barnyard refuse which by slow degrees penetrates and pollutes the entire sub-surface of the soil and gradually works its way into the well from which the family's water supply is daily drawn.

A surface or shallow well is one which taps the water which rests upon the uppermost impervious stratum. Such a well drains an area which varies in accordance with the depth to which the water in the well is lowered by pumping and the nature of the ground where the well is sunk. The more porous the ground the greater the distance from which water travels toward the well, and by experiment this distance has been stated to vary from 15 to 160 times the depression which results from pumping. Whether or not these figures are correct there is no doubt that surface pollution does find its way into wells from points which one would be very apt to consider a safe distance away. Disinfectants which have been thrown into drains have been detected by the odor of the water in wells some distance away.

Too great care cannot be exercised in the construction of wells, cess pools and all drainage systems. Too great care cannot be exercised in the removal and destruction of all organic material in order that the pollution of the surface waters may be avoided as much as possible. Many of the ravages of disease would be prevented if people exercised more care in the disposal of all organic wastes of those afflicted with the disease. All such excreta should be immediately mixed with saw-dust and burned, by this means greatly lessening the pollution of the surface water in the surrounding locality.

Many large cities draw their water supply from lakes, several miles away from the town, often far up in the mountain where it is almost free from pollution, at least from organic matter.

The sub-soil waters are those which lie underneath an impervious stratum of rock. These waters reach the surface, either flowing out as springs or by means of deep wells. If the surrounding country be much higher than the spot selected for the well the pressure may be so great as to raise the water to the surface at the site of the well or even above it. Hundreds of feet may have to be pierced to reach this supply. This plan is adopted by many large towns in arranging for their water supply. Such wells as a rule yeild excellent waters, although in some cases the various salts they contain in solution are present in such quantities as to be objectionable by causing deposits on boilers. By reason of the quantity of lime contained such waters are not convenient for washing purposes, and for the same reason are considered injurious to health.

The amount of water a deep well is able to supply depends very largely on the nature of the underlying stratum of rock. Wells sunk in sand or gravel beds weild a good supply of water at ordinary

times but are very apt to have their yield lessened in seasons of drought unless they are situated considerably lower than the level of the surrounding country. Deep wells in red sand stone or chalk formation usually yield a large and constant supply because these permeable rocks are so saturated with water that they may be regarded as vast subterranean reservoirs. Preference should always be given to spring and deep well waters for domestic use, as the quality of the water is so much better than that of shallow wells.

With regard to palatibility waters may be classed under three heads, those which are very palatable, those which are moderately palatable and those which are merely palatable. Under the first heading we classify spring, deep well and upland surface waters. Under moderately palatable we classify stored rain water and the surface water of cultivated land. Those waters which are merely palatable are the river waters slightly polluted by sewage and the water from shallow well.

Spring, deep well and upland surface waters we may consider wholesome as a general rule. The danger from organic pollution is very small. This is especially true in regard to spring and deep well waters, they lie so far below the surface that the soil filtration has been nearly if not absolutely perfect before they reach the impenetrable stratum upon which they rest. Spring water is therefore necessarily pure when it reaches the surface of the earth and likewise the water from deep wells providing the wells are properly constructed, i.e. so constructed that no impurities may enter the well either around the curbing or through the wall. This wall should be perfectly tight and the well curb should be from one to two feet above the surface level. The ground immediately surrounding the well should be so grad-

ed that all the surface water will drain away as rapidly as possible.

Many of the characteristics which determine the suitability of waters for domestic purposes are due to the contamination to which the water is subjected during storage and distribution. The natural characteristics may be summarized as follows. Rain water, no matter how well aerated is flat and insipid owing to the absence of mineral matter. Especially in towns it takes up so many impurities from the air during transit and from the various collecting areas that we cannot regard it as a satisfactory supply.

In case pure well water cannot be obtained rain water, properly aerated and filtered may be used for drinking purposes. Rain water is excellent for washing purposes and being soft requires much less soap than hard water.

Waters which contain a large quantity of saline constituents are regarded as hard waters. Before a lather can be formed in hard water the saline ingredients must form with the soap a curdy material, so that a quantity of soap, varying in amount with the hardness of the water is thus wasted. There are two kinds of hardness, temporary and permanent, the former is owing to certain lime salts (usually) which are deposited in boiling. Permanent hardness is not removed by boiling, hence is not to be recommended for domestic purposes. All the salts of magnesium and calcium except calcium bicarbonate produce permanent hardness. These salts render the softening of many vegetables, especially the legumes, almost impossible when used for cooking purposes.

When the source of public water supply is a deep well filtration or purification may be unnecessary, but this is rarely the case. Public filters are sand beds; these sand beds are made of many layers

of sand, increasing the size of the sand particles with each layer until on the bottom are found small stones. The water is poured over the sand filters through the bed and is carried away by the outlet pipes at the bottom. Such a process is chiefly mechanical though due somewhat to the bacterial action which takes place. It is very important that the process be slow and intermittent to allow perfect aeration. Cities usually own a number of such filter beds and each is used periodically. One square foot of such a filter will allow from 70 - 75 gallons of water to pass through it in twenty-four hours.

The greatest ignorance prevails regarding the efficacy of domestic filters. The general opinion is that however foul the water may be to start with all deleterious matter is removed by the use of a filter. The majority of filters in common use only remove the turbidity of the water; they are utterly useless as destroyers of disease carried by the water and after they have been in use for some time they simply act as culture beds for micro-organisms and so contaminate the water passing through them rather than purify it.

In private filters the rain water filter is the one which causes most concern. It is a common practice to build an underground filter and in such cases precautions need to be taken. It is important that the cement box, especially the filtering material be impervious to the moisture of the surrounding soil. Sand and charcoal are the filtering media commonly used in filters of this class.

It is highly important that these filters be cleaned thoroughly at stated intervals, else they soon become breeders of disease germs and fully as bad if not worse than no filter at all. Charcoal is said to impart to the water a substance which favors the growth of organisms.

Among other things used as filtering media are spongy iron. Magnetic carbide of iron will remove all suspended matter and 40% of dissolved organic matter. Brick walls are often built across the center of the cistern. The water entering on one side of this wall and the outgoing pipe on the opposite, percolation through the bricks filters the water excellently so long as the bricks are new and clean. The brick box in the bottom of the cistern from which the outgoing pipe leads is exactly the same principle, that of purification by passing through the bricks. The efficiency of such filters is however short lived for the reason that these bricks soon become covered with slime and filth.

There are various kinds of smaller filters designed for household purposes. The Patent Moulded carbon filter is one of the most elaborate. "This consists of two glass vessels, the upper containing the filter block, the lower, which may be used as a water bottle, the filtered water." Tap filters suited for high or low pressure can be fitted into the water pipes and seem to act very well.

In the "Fibre Rapide" asbestos cloth and a substance called carbo calcis are used as the filtering media. All filters become clogged after use and should be either taken apart and cleaned or cleaned with a solution of permanganate or Condy's fluid. The charcoal in a filter may be cleaned by exposing it for some time to the air and light or by heating it in an oven or furnace. If spongy iron is used the media must be occasionally renewed.

The only way by which purification of water, save by filtration, is carried on to any extent is by Clarke's method. By this method a certain amount of lime water is added to a water which contains calcium carbonate, rendered soluble by the presence of carbonic

acid. In the eastern countries aluminous salts are used to purify waters. Suspicious waters should always be boiled before using. The effect of boiling is to cause certain salts to be deposited and matters in suspension in the water are carried down with them. All bacteria present are killed by this treatment, these organisms cannot withstand a moist atmosphere at 212° F. even for a short time. Thus the greatest danger from the use of infected waters is removed.

"To many the ideal drinking water is the clear colorless sparkling water of a spring, refreshing in its coolness and satisfying the aesthetic taste sense by its suggestion of purity." So strong a hold has this idea that it is most difficult to convince the average person that any water so beautiful in appearance can be other than wholesome, and on the other hand, that water which has not these characteristics may be far from wholesome and suitable for human consumption.

"Water constantly used for domestic purposes should be free from any disagreeable odor or taste, it should at all seasons of the year be well aerated and uniform in temperature; it may contain a small quantity of mineral matter in solution but should be free from poisonous salts; it should be free from suspended mineral matter, dead organic matter and contain only purifying agents."