COLD CLIMATE HOUSING RESEARCH CENTER
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Promoting the development and advancement of healthy, durable and economically sound shelter for Alaskans and circumpolar people.

Best Management Practices for Rainwater Catchment Systems in Alaska

A publication of the Cold Climate Housing Research Center Feb. 2003

Applications for Domestic Water Use

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Many families throughout Alaska depend on water catchment systems to provide water for washing, cleaning, cooking and drinking purposes. The high quality of rainwater is one reason to use rain as a primary drinking water source. However, once rainwater comes in contact with materials in the catchment system, contaminants can be introduced that adversely affect human health.

UAF was funded by CCHRC through a grant from AHFC to evaluate best management practices (BMPs) for rainwater catchment systems in Alaska. The study included the impact of roof, gutter, reservoir, pump, pipe, and filter materials on the suitability of water for human consumption. This was accomplished through literature research with particular attention to building materials in common use in Alaska. This study is not limited to a specific region of Alaska and makes suggestions as to which material(s) would best reduce the risk of drinking water contamination by water catchment systems.

DISCUSSION ABOUT CURRENT DRINKING WATER STANDARDS:

Products that come into contact with drinking water can be tested and certified to ensure that they do not leach chemicals into the drinking water. Several non-profit organizations specialize in testing and certifying such products. The leader in this field is the National Sanitation Foundation which is now called NSF International (http://www.nsf.org/). Together with the American National Standard Institute (ANSI), NSF International has created testing/material standards widely used and accepted for drinking water.

NSF/ANSI Standard 61, 'Drinking Water System Components-Health Effects,' is the most important drinking water standard. It covers many materials from the tank to the faucet. The standard addresses crucial aspects of drinking water system components: such as contaminants that leach or migrate from the product/material into the drinking water. (http://www.nsf.org/)

NSF/ANSI Standard 53, 'Drinking Water Treatment Units-Health Effects,' applies to filters. This standard has similar requirements as Standard 61, plus the added requirement that it may be effective in reducing substances, such as microbiological, chemical or contaminants, under the appropriate flow rate. (http://www.nsf.org/)

NSF Protocol P151, 'Health Effects from Rainwater Catchment System Components,' deals only with products used in rainwater catchment systems. This Protocol evaluates Environmental Protection Agency regulated contaminants which could leach from materials used in rainwater catchment systems, such as roofing materials, coatings, paints, liners and gutters. Products meeting the requirements of this protocol are required to maintain contaminate levels below those specified in the latest version of the EPA's Drinking Water Regulations and Health Advisories. (http://www.nsf.org/)

ROOF:

Potable Water Use: There are a wide variety of roof materials found on Alaska homes. The most common are asphalt based shingles, painted calume steel, wood shingles, and painted and unpainted aluminum. In general, metal roofs are the recommended roofing material in rainwater catchment systems[1, 2]. They are smoother, cleaner, more impervious and more durable than other types of roofing materials[1, 3].

Currently, there is no roofing material certified for potable water. Therefore, a coating, or membrane applied to the top of the roofing material is the best practice. Of the several coatings certified under NSF 61 or NSF P151, only one is rated for freezing temperatures (SEALPRO, http://users.rcn.com/sealproinc/protective_coatings.htm).

Non-Potable Water Use: If a rainwater catchment is going to be used for purposes other than drinking or cooking use, many roofing materials can be considered suitable for catchment surfaces. When considering non-potable uses for rainwater, the roofing material and use compatibility should be considered. For example, wood and asphalt roofs tend to collect bacteria. In addition, organic and inorganic chemicals, such as asbestos can be leached from asphalt roofing [3, 5, 6]. Aluminum roofs could react with acidic rainwater and lead to increased levels of aluminum in the water. Any contact with lead paint or copper and lead flashings could lead to an unacceptable concentration of heavy metals in the water[1-3, 5, 7-9]. Galvanized metal roofs are a controversial material because zinc and other metals could be leached into the water, however, in most cases the zinc concentration is below the maximum concentration limit set by the World Health Organization (WHO)[1, 8, 10]. Some sheet metal materials may contain lead and caution is needed when considering this roofing material in catchment systems[6, 10].

ROOF WASHER/LEAF SCREENS:

Roof washer systems are used to discard the first flush of rain at the beginning of a rain event. The purpose of a roof washer is to reduce the concentration of containments, including bacteria and other debris by discarding the first flush of rainwater collected from the roof [1-3, 5, 9, 11]. A roof washer minimizes the amount of leaves, twigs, insects and other matter in the reservoir. This, in turn, improves the taste, color and odor of the reservoir water.

Currently there are no leaf screens made from material certified for potable water. However, screens could potentially improve the quality of the water by keeping leaves and other debris out of the reservoir[1, 2]. They are installed along the entire length of the gutter, or they could consist of wire baskets at the heads of the downspouts. A course leaf filter can also be installed anywhere from the gutter to the entrance to the tank. The most popular positions are in the gutter, at the beginning of the down pipe or in the down pipe. These leaf filters must be cleaned and maintained on a regular basis to prevent blockage to the reservoir[1, 2]. Trees surrounding the roof can be strategically removed to decrease the amount of pine needles, leaves and small twigs that might fall on the catchment surface[1, 4].

GUTTER:

There are no approved or certified potable water gutters currently available. For catchment systems intended for potable water, a membrane approved for potable water could be applied over the gutter material to prevent leaching of chemicals. Certified membranes can be used to cover aluminum, galvanized steel and plastic gutters. Aluminum is sunlight-resistant and naturally resistant to corrosion [1, 3]. Galvanized steel is widely used because of its pliability [3]. Copper and iron gutters could leach metals into the drinking water when exposed to acidic rain water. All gutter materials should be free of lead[1, 3, 5, 7-9].

Careful attention to the shape and angle at which the gutters are placed on the house can improve the flow rate into the reservoir. Water should not be allowed to remain stagnant in the gutter where it provides an excellent breeding ground for mosquitoes[1].

RESERVOIRS:

Types of Reservoirs:

Underground: Underground tanks are best for year round use[1-4, 12]. Appropriate measures should be taken to protect the tanks from freezing[3, 4, 12]. Underground tanks have less chance for contamination and evaporation[13]. However, care and maintenance are needed to ensure the structural integrity of the tank.

Concrete: Although concrete tanks have the reputation of being strong and long-lasting, they are subject to cracking, especially underground and should be checked for leaks yearly[3]. They are more permanent than other types of tanks because they are heavy and cannot be easily moved[3, 12]. Concrete tanks can be poured into different shapes and sizes giving them an advantage over other tanks[4, 12].

Fiberglass: Fiberglass tanks are popular because they are lightweight, reasonably priced, long lasting, prefabricated and certified in many different sizes and shapes[3, 4, 12]. They are easy to transport[3]. Fiberglass tanks should include a coating to prevent sunlight from penetrating the tank[3].

Poly-plastic: Poly-plastic tanks have similar benefits to Fiberglass tanks and they are readily available from several manufacturers in Alaska.

Galvanized Steel: Galvanized steel tanks are noted for their strength and for being lightweight and moveable[3]. Like roofs and gutters made from the same material, they are known to leach zinc when exposed to acidic rainwater[1, 3]. For use in potable water systems, a certified inner membrane or liner is required.

Redwood: Redwood tanks have a reputation as a durable water storage tank with an average life expectancy of approximately 50 years[3]. Redwood has a natural preservative which makes it resistant to insects and decay[3]. Redwood does not tarnish or decay and requires no paint or protective outside coating[3]. However, redwood tanks will eventually leak due to fluctuations in water levels throughout the years. Therefore, for potable water, it is suggested that a certified inside liner be installed.

Liners, Bags and Membranes: Liners, bags and membranes can be installed or applied inside reservoirs to prevent leakage or provide a low-cost, temporary collection tank or surface[3]. They also prevent leaching of chemicals from tanks such as zinc from newly galvanized tanks or lime from concrete tanks[1]. All liner materials should be certified for potable water by an appropriate source, such as NSF International.

A Must if Potable: All materials used in the reservoir system (membranes, liners, sealant, paints and the actual reservoir) should be certified for potable water by an accredited source[2, 3, 12]. All reservoirs should have a tight fitting cover which will prevent evaporation, mosquito breeding and will keep insects, birds, and animals from entering the tank[2, 3]. All tanks should have an overflow [1, 2, 12]. The tank should not only have adequate structural strength to withstand wear and tear but should have easy access for cleaning[1-3, 12]. Finally all potable water tanks should be located at least 10 feet away[14] from sources of pollution, such as septic tank fields,[3, 12] and should be located in a location accessible to a water truck in case of severe drought[3, 12].

Disinfection: There are many methods in which reservoirs can be disinfected. The suggested method is ultraviolet (UV) light[3]. Ultraviolet light is an effective way to kill most bacteria and viruses. A UV system does not require that chemicals be added to the water, however the ultraviolet bulbs should be changed on a regular basis because they naturally loose their ability to transmit the proper wavelength. Ultraviolet disinfection systems can be installed with an audible and visual alarm indicating lamp failure. Ultraviolet systems should be installed with a properly sized pre-filter to remove any sediment that could potentially shadow the bacteria as the water passes the UV light[3].

Chlorine is often added as part of the final drinking water treatment process[1, 3, 6]. However, chlorine also reacts with the organic matter naturally present in water, such as decaying leaves that could pass filters. This chemical reaction forms a group of chemicals known as disinfection by-products (DBPs). DBPs are known carcinogens in animals.

Access and Cleaning: The inside of the reservoir should be thoroughly scrubbed and rinsed before the system is put into use[5, 12]. This can be done with a soft brush, water, and baking soda[4] or a diluted bleach solution (both rinsed with ample amounts of water)[5, 12]. This can be followed with annual cleanings of the reservoir when the tank can be drained and emptied of accumulated sediment[5]; cracks can be patched at this time with non-toxic sealant[4, 5]. It is important to have good ventilation when working inside of the tank[5, 12]. In general, a manhole and a vent for cleaning purposes are suggested as standards for reservoirs, and regular cleaning helps to improve the quality of potable water[5]. Multi-tank systems are suggested if rainwater is the only source of water for the family[4]. Other tanks can be used while one of the tanks is being cleaned or maintained, without a stop in water use. Incoming and outgoing pipes can also be regularly maintained and cleaned for optimal water flow[5].

After the system is completely operational, but before any water is consumed, have the water tested by a laboratory certified by the Environmental Protection Agency to ensure that the water is safe to drink.

PUMPS:

Water pumps should be approved for potable water by the Food and Drug Administration (FDA), NSF, or Underwriters Laboratories Inc. (UL). (http://www.ul.com/).

FILTERS*:*

The recommended filter size for drinking water is 1 micron. A cartridge this size will remove any particle which is 1 micron or larger. Filters should be certified under NSF Standard 53. The Alaska Department of Environmental Conservation (ADEC) has issued a list of approved filters, which can be found at http://www.state.ak.us/dec/deh/water/filtration.htm.

Activated carbon filters can be used to remove any unpleasant appearance, odor, and taste. Carbon is best at removing organic chemicals and chlorine.

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