CISTERN MAINTENANCE

Dear Member:

As each of you know, the members of the Pine Grove Community Water Association are required to have cisterns as part of their residential water system. Cisterns are an important aspect of our system and assure that we all have water when we need it. Cisterns also require maintenance. The information attached is provided by the South Dakota Dept. of Environment and Natural Resources Office of Drinking Water, as a public service to the citizens of South Dakota with cisterns. The Board of Directors feel that this information will aid you in properly maintaining your cisterns.

If there are any questions, please give one of the board members a call.

Sincerely,

The Board of Directors:

Gerry Broer	605-390-1967
Ken Bruns	605-430-2778
Jim Rensch	605-484-9425
Paul Fauss	605-342-8755
Janice Helgeson	701-770-2886
Keith Jackson	605-390-6347
Gereth Stillman	605-390-9508

South Dakota
GREAT FACES. GREAT PLACES.

DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES
JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE SOUTH DAKOTA 57501-3181

May 17, 994

RE: 5.4 Pine Grove Water (EPA ID#0948)

KURT SLENTZ DIRECTOR
ENERGY LABORATORIES INC
PO BOX ~~1587~~ 2470
RAPID CITY SD 57709-~~1587~~ 2470

Dear Mr. Kurt:

I did some searching of our files and found very little on the maintenance of cisterns that fits what you are looking for. I am enclosing a few photo copies that at least will give home owners an idea of the disinfection process and some schematic details of cisterns. The following are points that are considered important for all types of ground storage reservoirs and apply to cisterns and other underground reservoirs.

1. Cisterns should be inspected at least once per year under normal operating conditions. The annual inspection should include looking into the cistern (not entering) to determine if the cistern is intact structurally and to determine if there is excessive sediment or floating material. The interior of the cistern can be illuminated using a hand mirror or a powerful flashlight. The person making the inspection should not place their head in the hatch to the cistern for this inspection. Without the proper instrumentation, there is no way to determine if there is sufficient oxygen for breathing.

2. The cistern should be drained and cleaned every three years. Repairs to the cistern should take place at this time if repairs are necessary. Cleaning amounts to physical removal of soil and sediment on the floors and walls of the cistern. Non-toxic cleaners should be used. All cleaners should be rinsed out of the cistern after use. Cleaning should be followed by disinfection with chlorine following the procedures listed in the enclosed material. Please keep in mind that cisterns are confined spaces not designed for human occupancy. Force air ventilation should be provided when working in a confined space. There should always be a person observing the person working in the confined space and they should have a rescue plan in mind before the cistern is entered.

3. If the cistern's interior is to be painted, sealed or coated, homeowners should consider contracting this type of work and there should be a warranty to something that gives some assurance that the coatings are compatible with drinking water systems. Also, vapors from many of the proprietary coatings require the use of self contained breathing apparatus. Portland cement coatings can be safely applied by the home owner using forced air ventilation.

I hope this gives you the type of information that you are seeking. The regulations do not specifically state that reservoirs must be cleaned and inspected at a given frequency but we do encourage this practice during the sanitary surveys of public water systems. If you require additional information, please contact me.

Sincerely,

Michael J. Baker

Michael J. Baker
Natural Resource Scientist
Drinking Water Program
Phone: 773-3754

enclosures

RECEIVED
MAY

South Dakota Department of Environment and Natural Resources
Office of Drinking Water
523 E. Capitol Ave., Foss Bldg.
Pierre, South Dakota 57501-3181

RECOMMENDED PROCEDURE FOR CHLORINE DISINFECTION OF WATER WELLS
(Reference - AWWA A100-6, Standard for Deep Wells

Introduction

A water well should be thoroughly cleaned and disinfected with a strong chlorine solution after:

1. ORIGINAL CONSTRUCTION
2. ANY REPAIR OR MAINTENANCE
3. FLOODING
4. A PERIOD OF NON-USE
5. TWO OR MORE "UNSAFE" BACTERIOLOGICAL WATER SAMPLES ARE TRACED TO THE WELL

Adequate chlorine requires a certain chlorine dosage for a minimum contact time - 100 parts per million for 2 hours, or 50 parts per million for 8 hours, or 25 parts per million for 24 hours.

Chlorine for disinfection for these water systems can be either 5.25% sodium hypochlorite solution or 65% calcium hypochlorite powder. A 5.25% hypochlorite solution is common house-hold bleach such "Hilex", "Clorox", or "Purex" available at grocery stores and supermarkets. The 65% calcium hypochlorite powder is available from chemical supply houses and is known commercially as "HTH", Perchloron", or "Pittchlor".

Recommended Procedures

1. Determine the chorine dosage for the desired contact time from the following table:

AMOUNT OF CHLORINE NECESSARY PER 10 FEET OF WATER IN WELL													
Inside diameter of well casing		5.25% Sodium Hypochorite (Bleach)						65% Calcium Hypochorite					
		100 ppm* for 2 hrs		50 ppm* for 8 hrs		25 ppm* for 24 hrs		100 ppm* for 2 hrs		50 ppm* for 8 hrs		25 ppm* for 24 hours	
1¼	inches	1/8	fl oz	---	--	---	--	---	--	---	--	---	--
2	inches	1/2	fl oz	1/4	fl oz	1/8	fl oz	---	--	---	--	---	--
3	inches	1	fl oz	1/2	fl oz	1/4	fl oz	---	--	---	--	---	--
4	inches	1½	fl oz	3/4	fl oz	3/8	fl oz	---	--	---	--	---	--
6	inches	4	fl oz	2	fl oz	1	fl oz	1/4	oz	1/8	oz	1/16	oz
8	inches	7	fl oz	3½	fl oz	1 3/4	fl oz	1/2	oz	1/4	oz	1/8	oz
10	inches	10	fl oz	5	fl oz	2	fl oz	3/4	oz	3/8	oz	3/16	oz
12	inches	2	cups	1	cup	1/2	cup	1	oz	1/2	oz	1/4	oz
18	inches	4½	cups	2¼	cups	1 1/8	cups	2½	oz	1¼	oz	5/7	oz
24	inches	7½	cups	3 3/4	cups	1 7/8	cups	4½	oz	2¼	oz	1 1/8	oz
36	inches	17½	cups	8 3/4	cups	4 3/8	cups	10	oz	5	oz	2½	oz

* ppm = parts per million   1 heaping tablespoon of 65% chlorine powder = 1/2 oz.   8 fluid ounces = 1 cup

2. Prepare a chlorine solution, lift well pump, and pour the chlorine solution into the well.
3. Lower the pump and operate until a chlorine odor is noticed at all discharge points.
4. Leave the chorine solution in the unit for the recommended contact time. Do not use the water.
5. At the end of the contact time, pump the well to waste until the chlorine odor cannot be detected. DO NOT ALLOW THE WATER TO ENTER A RIVER, LAKE, OR STREAM.
6. Pump the well for considerable period of time and collect a bacteriological water sample and submit it for testing.

DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCES
OFFICE OF DRINKING WATER
523 EAST CAPITOL AVENUE #412
PIERRE, SOUTH DAKOTA 57501-3181

RECOMMENDED PROCEDURE FOR DISINFECTION OF SMALL QUANTITIES OF DRINKING WATER

Many occasions arise which require the disinfection of small quantities of drinking water. Disinfection may be necessary because of temporary contamination of a supply which is satisfactory under normal conditions. It may be necessary to disinfect water that is contaminated during transportation.

Boiling is a very effective means of disinfecting drinking water, but the process is so bothersome that it is seldom used. Chemical disinfection of small quantities of water for human consumption is much more popular, and if carefully accomplished is as effective as boiling.

Four items must be considered if chemical disinfection is to be effective: (1) the water must be free of turbidity or dirt, (2) the chemical must be applied in a sufficient amount to guarantee disinfection and must be uniformly distributed to contact every particle of water, (3) at least 30 minutes of contact must be provided between the chemical and water to allow time for the chemical to destroy any disease germs, and (4) the water after treatment must be protected from further contamination.

The most widely used chemical for water disinfection is chlorine. This chemical is used by most municipal water systems and effectively destroys disease germs when applied in dosages far below the amount harmful to humans. The chemical can be purchased in the form of chlorine gas, chlorine powder or chlorine liquid. Household bleaches such as Clorox, Hilex, Purex and Zonite are chlorine liquids. This form is best for treatment of small quantities of water because no equipment is required and the liquid can be easily measured by a dropper, spoon or measuring cup.

The household bleaches do not all have the same strength or in other words do not contain the same amounts of chlorine per unit volume. A larger amount of the weaker compounds must be used whereas a correspondingly smaller amount is necessary if a stronger solution is used. The strength or amount of chlorine in each of the commercial products is indicated on the label as % available chlorine. The household bleaches vary in strength from 1% available chlorine for Zonite or 5.25% available chlorine for Clorox, Hilex and Purex. The first step in disinfecting drinking water is to determine the % available chlorine in the solution obtained at a drug or grocery store.

The next step is to determine the amount of chlorine to use in properly treating a quantity of water. The following table gives the amount of chlorine necessary to treat given quantities of water with several commercial chlorine liquids of two different strength solutions. By knowing the amount of water to be treated, and either the name or strength of the chlorine solution purchased, the amount of the solution required can be determined from the table.

Strength of Solution	Trade Name of Solution	Amount of Solution for Disinfection of Drinking Water				
		1 gal.	2 gal.	3 gal.	4 gal.	5 gal.
1%	Zonite	15 drops	30 drops	45 drops	60 drops	75 drops
5.25%	Clorox, Hilex, Purex	3 drops	6 drops	9 drops	12 drops	15 drops

The water to be treated should be placed in a clean container. After the chlorine solution is introduced into the water, it should be agitated slightly to mix the chlorine and water. The container should then be covered and the water allowed to stand at least 30 minutes before using. An odor and taste of chlorine should be apparent. These will disappear with time, are entirely harmless to humans and are your guarantee of safe drinking water.

Roof Management

Rain water picks up dust, soot, bird droppings, leaves, and other foreign materials that are on a roof. These materials add objectionable bacteria, sediment, color and odor. Avoid overhanging trees. The equipment detailed below can help make rain water more acceptable.

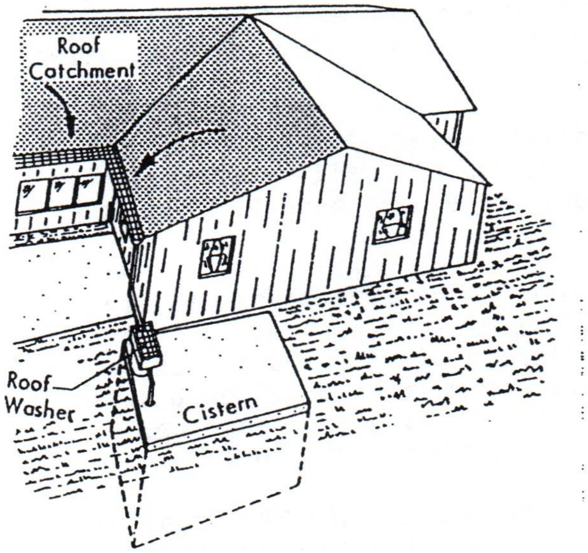

Fig 13. Roof catchment and cistern.

Gutter Guards

Gutter guards ¼" to ½" hardware cloth screens over the gutters to keep out leaves and twigs.

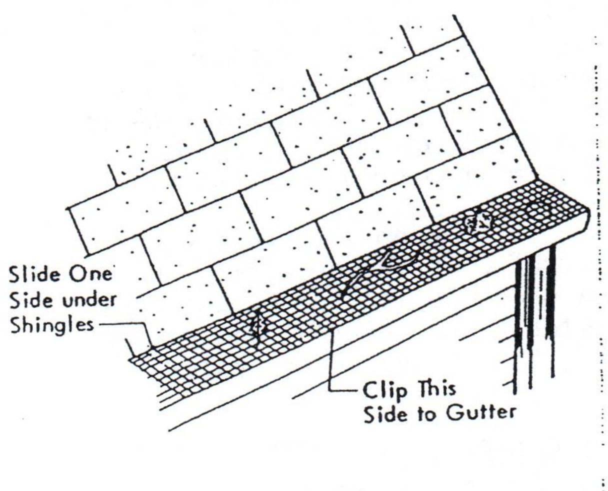

Fig 14. Gutter guard.

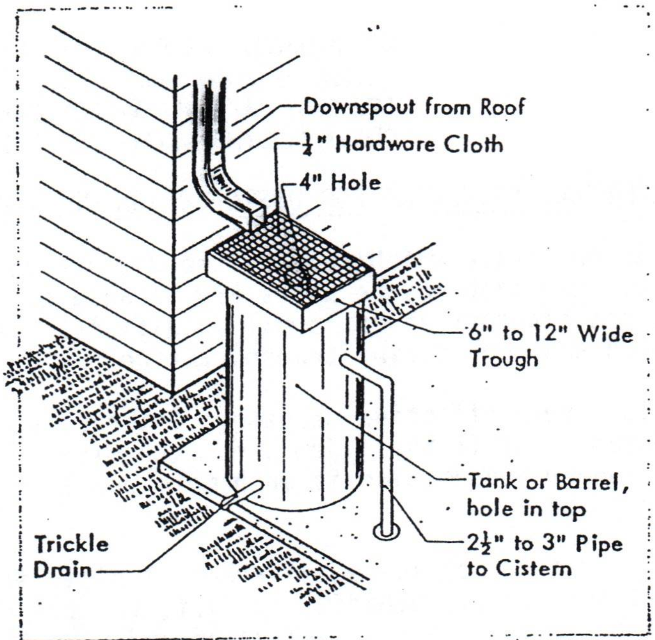

Fig 15. Homemade roof washer.

Roof Washers and Filters

Sand, gravel and charcoal can filter water before it enters a cistern or reservoir. But these filters require frequent maintenance and shortly become highly contaminated.

Roof washers are cheaper to construct and require less service. A roof washer traps the first flow of dirty water off the roof. Provide a washer capacity of about 10 gal for each 1,000 sq ft of catchment. A trickle drain (⅛" hole) empties the barrel between rains. Figs 15 and 16.

Commercial roof washers are available.

Cisterns

Floating Intake Within a Cistern

A floating intake takes water from a cistern below any floating scum and above any dirt collected on the bottom. Fig 16.

Cistern Size

Size a cistern to supply the family during extended periods of low rainfall. A 3-month's water supply (or ¼ of the annual yield of the catchment area) is usually adequate, but install a larger cistern where rainfall is poorly distributed throughout the year.

Locate a cistern where the surrounding area can be graded to prevent contamination from surface water.

Capacities of various sizes of cisterns are listed in Table 34, in the Data section.

Construction

Good cisterns are watertight and have smooth interior surfaces. Reinforced concrete, steel, and plastic are common materials. Concrete block cisterns are difficult to keep watertight.

Tightly fitted manholes or other covers keep out light, dust, surface water, insects, and animals. A watertight curb around manhole openings projects at least 6" above the cistern lid. The manhole cover should overlap the curb and project downward at least 2". Lock covers to minimize the danger of contamination and accidents.

Apply water sealant to the exterior of tanks.

Supply good screens on inlet, outlet, and waste pipes. Do not interconnect cistern drains with waste or sewer lines because of possible contamination.

Caution: Provide positive ventilation while working in a cistern—there may be hazardous gases present or insufficient oxygen.

Disinfection

After construction, cleaning, or maintenance, flush the cistern thoroughly with water to remove sediment. Use a stiff brush or broom to thoroughly wash all inside surfaces. One recommended disinfecting solution is ¼ cup 5.25% chlorine laundry bleach in 10 gal water.

Maintenance and Repair

Keep gutter guards, gutters, downspouts and roof washers free of leaves, twigs and other foreign material. Keep manhole covers sealed. Repair leaks promptly with sealants approved for drinking water —check container labels. Portland cement paints, epoxy resins and plastic liners are available for sealing cisterns.

Sediment In Cistern Water

If a good roof catchment, gutter guards, roof washer, floating intake, automatic chlorination and proper maintenance do not result in clear water consult a qualified water treatment equipment retailer about equipment and processes that can solve problems of sediment and other suspended matter.

Ponds

Use surface water from a farm pond in a home or milkhouse only if ground water sources are inadequate or unacceptable. If pond water must be used:

- Locate and select the pond site and watershed to yield the cleanest water possible.
- Size and construct the pond properly.
- Manage the pond and watershed to yield the cleanest water.
- Beware of applying farm chemicals to the watershed. Read package labels.
- Remove only the cleanest water from the pond.
- Correctly plan, install, and operate filtration and distinfection equipment.
- Keep livestock away from the pond.

Location

It is best if the pond's entire watershed is owned by the pond owner. No public or private roads should

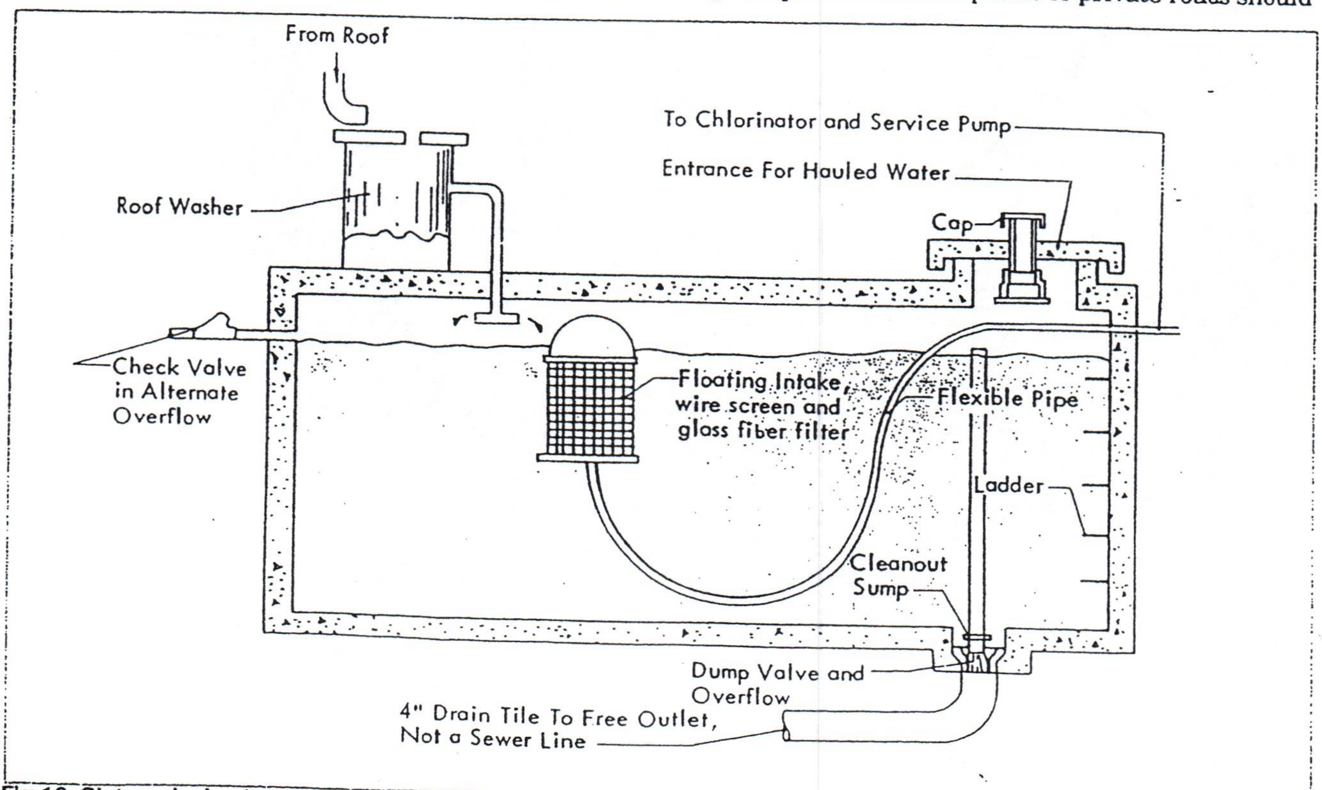

Fig 16. Cistern design features.
If no drain is provided, use a 12" diam. x 12" deep sump and a sump pump.

cross the watershed because they may be sources of pollution. The watershed must contain no septic tank, feedlot, or other source of human or animal wastes.

Put the pond where you can maintain a protective buffer strip of dense grass 100' or more wide around the pond.

Consider the following when locating a pond:

Soil type. Locate a pond over soils that minimize seepage; clay and silty clay loams are best. Avoid areas underlain with sand, gravel, and fractured rock which require pond sealing measures.

Topography. Locate a pond in a natural depression or ravine to maximize the pond's surface area.

Proximity to points of water use. Locate a pond as close as practical to points of use to minimize cost of piping, electric wiring and pumping.

Storage Capacity

Needed pond size depends on the anticipated annual water uses, rainfall, amount of reserve water desired, evaporation rate in your area, and the soil seepage rate. Estimate yearly water needs from Tables 1 and 2.

Minimize evaporation losses with small-area, deep ponds, rather than large-area, shallow ones. Make farm ponds at least 8' deep, and deep enough in northern areas that ice during winter does not cause the intake system to malfunction.

A pond should hold one year's supply if it can be refilled each year from springs or other sources. But it should hold a two or three year supply if it is the only source of water and can be filled only with watershed runoff.

A pond volume of at least 200,000 gallons (about ⅔ acre-feet) is recommended for average household uses. Volumes of farm ponds are in Tables 35 and 36, in the Data section.

The watershed area should be adequate to maintain the pond volume. If the watershed is too small, runoff will not fill and refill the pond; if too large, an expensive spillway and extra flood storage are necessary and sediment shortens the life of the pond and complicates water treatment.

General recommendations for watershed area for each acre-foot of water stored in a pond are in Fig 17.

Construction

Contact your local soil conservation district office for assistance in designing and building a farm pond. Recommended construction features include:

- Avoid shallow water. Deepen pond edges to 3' or more to discourage water weed growth.
- Prevent wave erosion with stone or concrete rip rap or adapted grasses on pond banks.
- Construct a fence at least 100' from the shoreline to exclude livestock from the pond area.
- Plant the earth dam and all land within the pond area to adapted grasses. Keep trees and shrubs 100' or more from the water line.

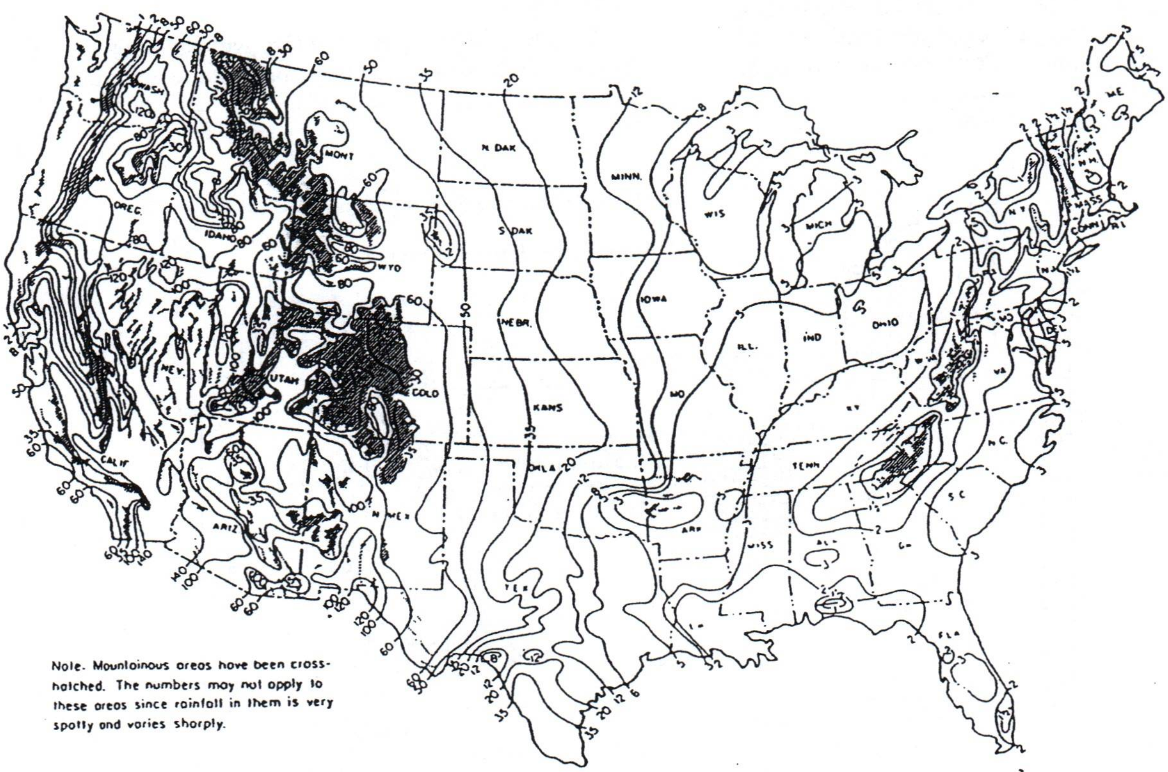

Fig 17. Acres of watershed area for each acre-foot of water stored in pond.

Interior piping, fittings, and accessories should conform to the minimum plumbing requirements of the *National Plumbing Code*[8] or the applicable plumbing code of the locality.

PROTECTION OF DISTRIBUTION SYSTEMS

The sanitary protection of new or repaired pipelines can be ensured by close attention to certain details of construction. All connections should be made under dry conditions, either in a dry trench or, if a dry trench is not possible, above the ground on a dry surface. Soiled piping should be thoroughly cleaned and disinfected before connections are made. Flush valves or cleanouts should be installed at low points where there is no possibility of flooding.

When not properly designed or installed, frostproof hydrants may allow contamination into the water system. Such hydrants should be provided with good drainage to a free atmosphere outlet where possible. The drainage from the base of the hydrant should not be connected to a seepage pit that is subject to pollution, or to a sewer. The water-supply inlet to water tanks used for livestock, laundry tubs, and other similar installations should be placed with an air gap (twice pipe diameter) above the flooding level of the fixtures to prevent back siphonage. There should be no cross-connection, auxiliary intake, bypass, or other arrangements that would allow polluted water, or water of questionable quality, to be discharged or drawn into the domestic water supply system.

Before a distribution system is used, it should be completely flushed and disinfected.

DISINFECTION OF DISTRIBUTION SYSTEMS

General

The system's distribution system should be disinfected if untreated or polluted water has been in the pipe, upon completion and before operating the new system to insure water of satisfactory quality, and after maintenance and repair.

Procedure

The entire system, including tanks and standpipes, should be thoroughly flushed with water to remove any sediment that may have collected during construction. After flushing, the system should be filled with a disinfecting solution of calcium hypochlorite. This solution is prepared by adding 1.2 pounds of high-test 70 percent calcium hypochlorite to each 1,000 gallons of water, or by adding 2 gallons of ordinary household liquid bleach to each 1,000 gallons of water. A mixture of this kind provides a solution of at least 10 mg/L of available chlorine.

The disinfectant should be left in the system, tank, or standpipe, for at least 24 hours, examined for residual chlorine, and drained out. If no residual chlorine is found, the process should be repeated. Next, the system should be flushed with treated water and tested for coliform. After coliform test results are satisfactory, the system, tank or stand pipe can be placed into operation.

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[8] Obtainable at the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, N.Y. 10017.

DETERMINATION OF STORAGE VOLUME

Three types of storage facilities are commonly employed for individual water supply systems. These are pressure tanks, elevated storage tanks, and ground-level reservoirs and cisterns.

When ground water sources with sufficient capacity and quality are used, only a small artificial storage facility may be needed, since the water-bearing formation itself is a natural storage area. However, if the well is not able to meet peak water demand or treatment is required, additional storage volume will be needed.

If water demand doesn't change, and treatment or well capacities can be increased, the amount of storage required will decrease. Therefore, there is a balance between providing a larger treatment process or well capacity and providing additional storage.

Pressure Tanks

Pressure in a distribution system with a pneumatic tank is maintained by pumping water into the tank. This pumping action compresses a volume of entrapped air. The air pressure is equal to the water pressure in the tank and can be kept between desired limits by using pressure switches. These switches stop the pump at the maximum setting and start it at the minimum setting. The capacity of the pressure tank is usually small when compared to the total daily water consumption. Only 10 to 40 percent of a pressure tank volume is usable storage. For this reason, pressure tanks are only designed for peak demands. The maximum steady demand the system can deliver is equal to the pump capacity.

The usable storage of a pressure tank can be increased by "supercharging" it with air when it is installed, or by recharging at the factory. Recharging can only be done in tanks in which the water space and air space is completely separated by a diaphragm or bladder. Consult your dealer for design details and characteristics.

Use the figures in Tables 11 and 12 for the selection of pumps and pressure tanks for various size homes. The pump capacity from Table 11 can be used to find the right tank size for the type (precharged, supercharged, or plain) and pressure range needed. These tabulated values are recommended by the Water System Council[9].

When a pressure tank is part of the distribution system, there will be no problem with "water hammer". Otherwise, it may be necessary to provide an air chamber on the discharge line from the well, located near the pump, to minimize water hammer.

TABLE 11. - *Seven-minute peak demand period usage.*

Number of baths in home:	1	1½	2-2½	3-4
Normal 7-minute peak demand (gal.)	45	75	98	122
Minimum size pump to meet demand without using storage	7 gpm	10 gpm	14 gpm	17 gpm

NOTE: Values given are average and do not include higher or lower extremes.

[9] Water Systems Council, 221 North LaSalle Street, Chicago, IL 60601

TABLE 12. - *Tank selection chart - gallons (Based on present industry practice)*

Pump capacity		Minimum Draw Down	Switch setting pounds per square inch								
			20-40			30-50			40-60		
gpm	gpm	(gal)	*A	*B	*C	*A	*B	*C	*A	*B	*C
240	4	4	15	15	20	15	20	30	20	20	40
300	5	5	15	20	30	20	25	40	25	25	50
360	6	6	20	20	35	25	25	45	30	30	55
420	7	7	20	25	40	25	30	55	30	40	75
480	8	8	25	30	40	30	35	65	35	45	85
540	9	9	30	30	50	35	40	70	40	50	95
600	10	10	30	35	55	40	45	80	45	55	105
660	11	12	35	40	60	45	50	95	55	65	125
720	12	13	40	45	70	50	60	105	60	70	135
780	13	15	45	50	80	60	65	120	70	80	155
840	14	17	55	60	90	65	75	135	75	90	175
900	15	19	60	65	100	75	80	150	85	105	195
960	16	20	65	70	110	75	90	160	95	115	205
1020	17	23	70	80	120	90	100	185	105	125	240
1080	18	25	80	85	135	95	110	200	115	140	260
1140	19	27	85	95	150	105	120	215	125	150	280
1200	20	30	95	105	160	115	130	240	140	165	310

*A - Precharged bladder or diaphragm tank.
*B - Supercharged, floating water tank.
*C - Plain steel tank.

Elevated Storage

Elevated tanks should have a capacity of at least two days of average consumption. Larger storage volume may be necessary to meet special demands, such as firefighting or equipment cleanup.

Ground-Level Reservoirs and Cisterns

Reservoirs that receive surface runoff should generally be large enough to supply the average daily demand over a dry period of the maximum length anticipated. Cisterns are usually designed with enough capacity to provide water during periods of less than one year.

PROTECTION OF STORAGE FACILITIES

Suitable storage facilities for relatively small systems may be made of concrete, steel, brick, and sometimes wood (above the land surface). Such storage facilities should receive the same care as system installations in the selection of a suitable location and protection from contamination. Waterproofing the interior of storage units with asphalt or tar is not recommended because of the unpleasant taste imparted to the water, and the possibility of chemical reactions with materials used for treatment. Specifications for painting water tanks are available from the American Water Works Association.[10] Appropriate federal, state, or local health agencies should be consulted about acceptable paint coatings for interior tank use.

All storage tanks for domestic water supply should be completely covered and so constructed to prevent pollution by outside water or other foreign matter. Figures 34 and 35 show some details for manhole covers and piping connections to prevent pollution by surface drainage. Concrete and brick tanks should be made watertight with a lining of rich cement mortar. Wood tanks are usually constructed of redwood or cypress and, while filled, will remain watertight. All tanks require good screening of any openings to protect against the entrance of small animals, mosquitoes, flies, and other small insects.

Tanks containing water to be used for livestock should be partially covered and constructed so that cattle will not enter the tank. The area around the tank should be sloped to drain away from the tank.

Figure 34 shows a typical concrete reservoir with screened inlet and outlet pipes. This figure also illustrates the sanitary manhole cover. The rim should be elevated at least four inches above the ground with the cover extending two inches beyond the edge of the rim. This type of manhole frame and cover should be designed so that it may be locked to prevent access by unauthorized persons.

An emergency water supply, that has been polluted at its source or in transit, should not be added to storage tanks, cisterns, or pipelines used for drinking water.

Disinfection of storage facilities after construction or repair should be carried out in accordance with the recommendations given under "Disinfection of Water Distribution System" in this part of the manual.

It can be seen from this example that fitting losses are not particularly important for fairly long pipelines, say greater than about 300 feet. For pipelines less than 300 feet, fitting losses are very important and have a direct bearing on pipe selected; therefore, they should be calculated carefully.

Globe valves, which produce large pressure losses, should be avoided in main transmission lines for small water systems.

Interior piping, fittings, and accessories should conform to the minimum plumbing requirements of the *National Plumbing Code*[11] or the applicable plumbing code of the locality.

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10 American Water Works Association, 6666 West Quincy Avenue, Denver, Colorado 80235.

11 Obtainable at the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, N.Y. 10017.