CIRCULAR DEQ 11

MONTANA STANDARDS FOR DEVELOPMENT OF SPRINGS FOR INDIVIDUAL AND SHARED NON-PUBLIC SYSTEMS

2002 edition

This circular can be used for the development of springs for individual and shared systems. For multiple user or public systems, please refer to Circulars DEQ-1 and DEQ-3.

Springs occur where the natural flow of ground water rises to the surface. There are two basic requirements for developing a spring as a source of water, (1) selection of a spring with enough capacity to provide the required quantity and quality of water throughout the year, and (2) protection of the water from contamination. Development of the spring depends on the geological formations and hydrological characteristics of the water-bearing formation. The general geologic formations for each type of aquifer and spring are shown in Figure 1. The flow from a spring may vary considerably with changes in the water-table or artesian pressure. Some springs are very susceptible to contamination. Before developing a spring for a water supply, the owner should determine the nature of the water and the risk of contamination.

There are several types of springs. Gravity springs discharge from unconfined aquifers, which are water-bearing aquifers that rest on an impervious stratum and outcrop to the surface. Artesian springs discharge from confined aquifers, which are aquifers that have both an upper and lower layer of impermeable material that forms a barrier against contaminants. Seepage springs are where water flows or seeps out of sand, gravel, or other porous material.

When a spring is chosen for a water supply, the owner must determine that the water quality is acceptable, the quantity of water available is adequate to meet the needs of the water system, and the spring is protected from contamination. Seepage springs are very susceptible to contamination and should not be used as a water source. The quantity of water available from a spring can vary significantly due to changes in ground water storage. Depending on the type of spring, changes in ground water storage can come from seasonal variations such as dry periods and withdrawals of nearby wells.

Steps must be taken to prevent contamination of the spring during construction of the improvements necessary to supply the source water. If the spring is artesian, a vertical well is drilled or collection pipe is installed into the aquifer (either directly at the spring or near the spring). Water rises in the well or collects in the pipe due to the pressure of the artesian spring, so unlike ground water wells, a pump may not be needed to raise the water in the well or fill the collection pipe. However, pumps may be used to deliver the water to the storage tank or distribution system. If the spring is gravity driven, then a horizontal well (similar to an infiltration gallery) or collection pipe is constructed to collect the spring water before it exits at the surface. Since water from a gravity spring outcrops to the surface by gravity, pumps may only be needed to feed the water to a storage tank or distribution system.

Springs are susceptible to contamination by surface water and must be protected from surface runoff. Contamination sources include livestock, wildlife, crop fields, forestry activities, wastewater treatment systems, and fuel tanks located upgradient from the spring outlet. Changes in color, taste, odor, or flow rate indicate possible contamination by surface water. To protect the springs, the following steps must be taken:

1. Divert all surface water away from the spring and protect the spring from flooding by constructing a surface diversion ditch or berm upgradient of the spring to divert surface runoff away from the spring.
2. Fence the area at least 100 feet in all directions around the spring to prevent contamination by animals and people who are unaware of the spring's location,
3. Provide access to the storage tank for maintenance, but prevent unauthorized entrance to the tank by installing locks.
4. Avoid vehicle traffic and storage of chemicals and fuels upgradient of the spring outlet.
5. Monitor the quality of the water regularly by checking for contamination. A noticeable increase in turbidity or change in flow after storms is an indication that surface runoff is reaching the spring and possibly contaminating the water.

The features of a spring box must include:

1. A watertight basin intercepting the source which extends to bedrock or a system of collection pipes and a storage tank.
2. A cover to protect against entrance of surface water, debris, and animals or humans.
3. Provisions for cleaning out and draining the tank.
4. Provisions for overflow and venting the tank.
5. A connection to the distribution system or backup supply.
6. When more than one spring is piped to a common storage tank, each spring development needs valves and piping that can be isolated from the rest of the system.

The spring box is usually made of reinforced concrete. The spring box cover need to be watertight to prevent undesirable water from entering. The cover must be lockable, watertight, with an overlapping lid to prevent the access of unauthorized parties and contaminants and surface water from entering (Figure 2). An overflow is needed to ensure that water pressure does not build up and damage the spring box. Spring boxes need a drain to turn out the water in case the source water quality degrades. The end of the drain must have a screen to prevent entrance of animals. The intake to the water system from the tank and spring box must be located about 6 inches above the bottom and screened to minimize the amount of sludge that is drawn into the intake from the chamber. If the spring box also functions as a storage tank or is connected to a storage tank, the storage tank must meet the requirements for non-public cisterns and storage tanks, Circular DEQ-17.

A diversion ditch around the uphill end of the spring area is needed to keep rainwater from flowing over the spring area and infiltrating the ground. An impervious barrier, such as clay or a plastic liner, over the spring area will help prevent potential contaminants from entering the collection facilities. Springs must meet the appropriate state requirements for setback distances from sanitary hazards.

<u>Disinfection of Springs</u>

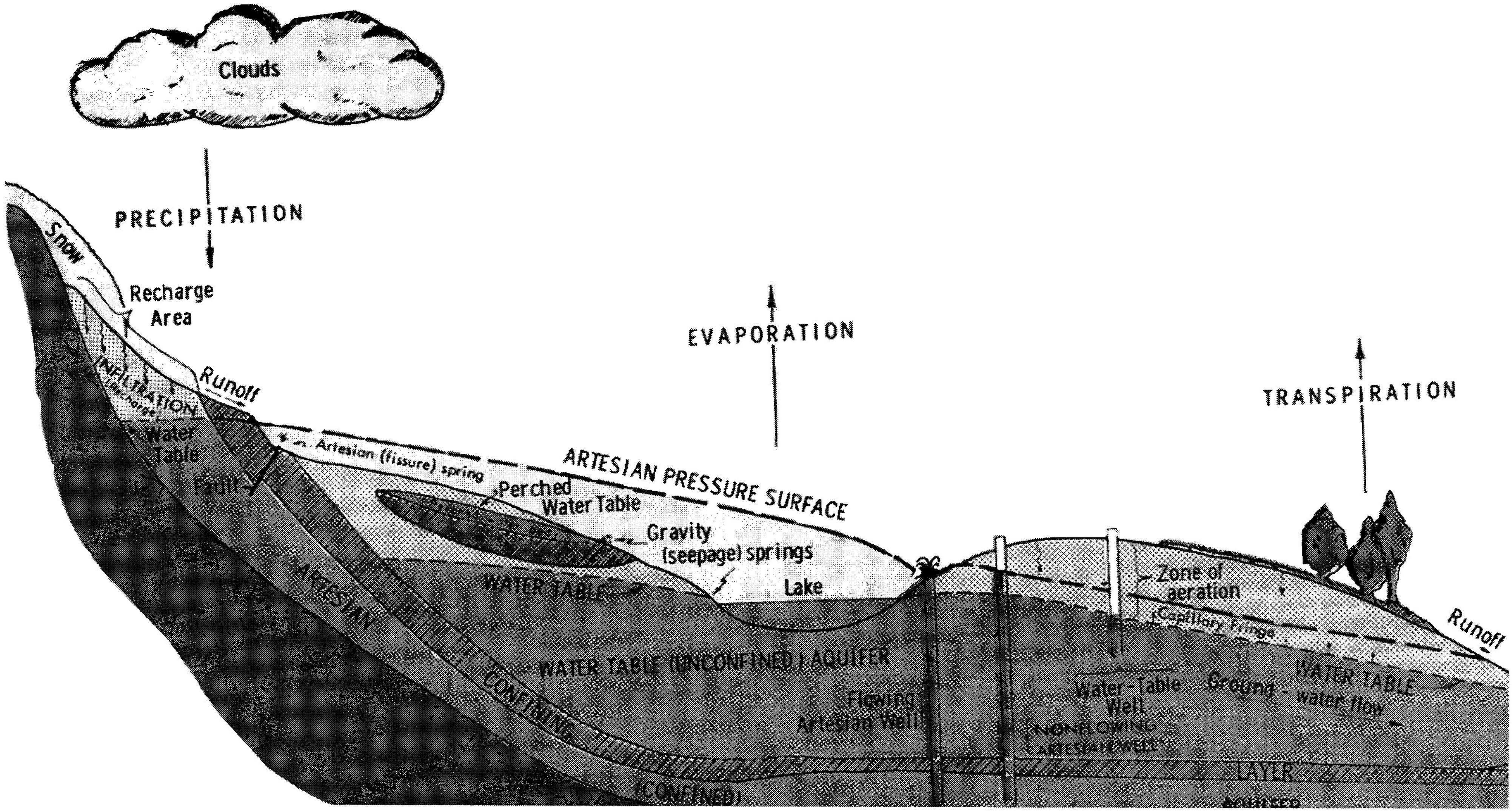
Springs are often contaminated with bacteria during construction or maintenance. All new and repaired water systems should be disinfected using *shock chlorination*. If bacterial contamination occurs on a regular basis because of surface sources entering the spring, *continuous chlorination* would be necessary. Shock chlorination requires a concentration of at least 200 parts per million (ppm) chlorine. (As a reference, 200 ppm is the same proportion as 1 pound of salt in about 600 gallons of water.) To obtain this concentration, add 3 *pints of liquid chlorine laundry bleach (such as "Chlorox," which is about 5 percent chlorine) for each 100 gallons of water* to be disinfected. Other sources of chlorine are *1 pint of swimming pool disinfectant or concentrated bleach* (at 12 to 17 percent chlorine) per 100 gallons of water or 4 ounces of high-test calcium hypochlorite tablets or powder (at 65 to 75 percent chlorine) *per 100 gallons of water. If using liquid chlorine bleach, use a new bottle because the chlorine content of the bleach deteriorates in a relatively short period of time.*
Follow these steps to disinfect spring-fed water systems with chlorine:

1. Remove debris and sediment from the spring box, storage tank and distribution system. Scrub all interior surfaces with a strong chlorine solution (1 gallon of liquid chlorine laundry bleach per 10 gallons of water). Be sure to wear gloves and other appropriate protective clothing. **Do not enter the storage tank, spring box or any confined space unless you have received training and use the proper equipment and safety precautions necessary for confined space entry.**
2. Disinfect the spring box and storage tank by first allowing it to fill with fresh spring water. If the spring flow is small, close the main line valve and the outlet pipe and add chlorine to the spring box through the vent line. Use the 200-part-per-million chlorine concentration described above. Hold the chlorinated water in the spring box and storage tank for at least 12 hours. Keep the overflow valve open. The chlorinated water used for disinfection must not be discharged to a stream, river or other waterway where damage to aquatic life may occur. Dechlorination may be necessary prior to discharge. If the flow rate is too high to retain water in the spring box, feed the chlorine solution into the spring box continuously for at least 12 hours.
3. Disinfect the water distribution system including pressure tanks, storage tanks, pipelines, valves, and faucets by pumping chlorinated water through the system. Open all faucets until a strong chlorine odor is detected at each one. Close the faucets to allow the chlorine solution to remain in the system for at least 12 hours.
4. Open all valves and faucets to allow fresh spring water to flow through the system until no chlorine odor or taste can be detected. The chlorinated water used for disinfection must not be discharged to a stream, river or other waterway where damage to aquatic life may occur. Dechlorination may be necessary prior to discharge.
5. Test the spring water for bacterial contamination 72 hours after chlorine has been removed from the spring and household system. It is important to flush the system completely because the sources of chlorine used above are not manufactured for human consumption.

Continuous chlorination is necessary if bacterial contamination continues after shock chlorinations. In this system, equipment is used to feed chorine continuously in sufficient amounts to kill bacteria. If continuous chlorination is necessary, retain the services of a qualified person to design the system. The proper chlorine feed rate depends on water temperature, pH, and pumping rate. Use a chlorine residual kit to determine if the feed rate should be increased or decreased to obtain the proper chlorine residual.

Water Testing

Spring water should be tested each year for bacteria, nitrates, turbidity, and conductivity to determine if surface-water contamination is a problem. If bacterial contamination is detected at any time in the water, properly disinfect the system and retest the water before using it. Springs are susceptible to contamination by giardia, cryptosporidium, and other microorganisms that are not detected by standard bacterial tests. Test for these microorganisms if spring water is suspected as a source of illness.



Clouds
PRECIPITATION
Snow
Recharge
Area
INFILTRATION
(Recharge)
Runoff
Water
Table
Fault
Artesian (fissure) spring
ARTESIAN PRESSURE SURFACE
EVAPORATION
Perched
Water Table
Gravity
(seepage) springs
WATER TABLE
Lake
ARTESIAN
CONFINING
(CONFINED)
WATER TABLE (UNCONFINED) AQUIFER
Flowing
Artesian Well
NONFLOWING
ARTESIAN WELL
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Well
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Capillary Fringe
TRANSPIRATION
Runoff
WATER TABLE
Ground - water flow
LAYER
AQUIFER

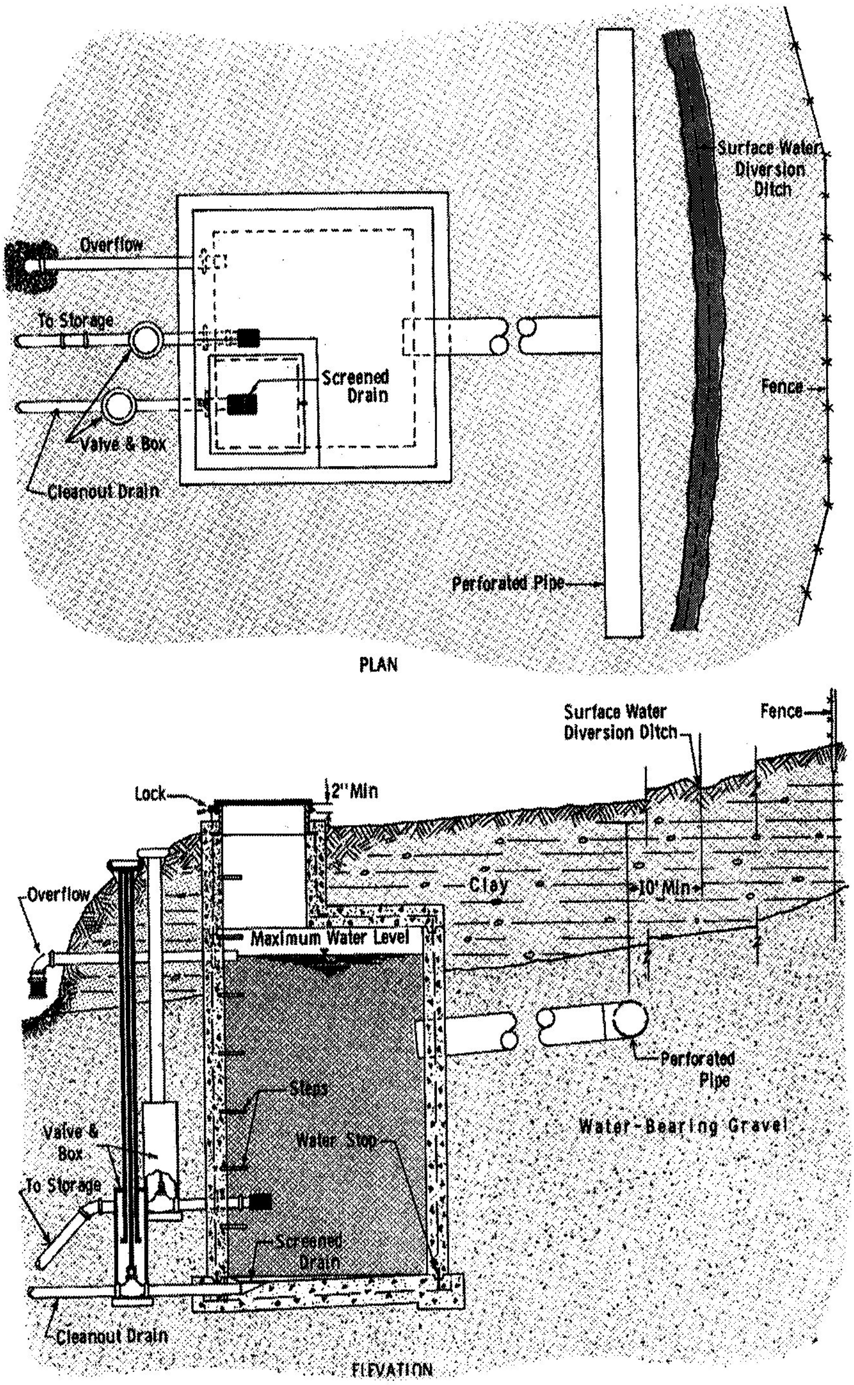

Figure 2. Spring Protection