DAIRY FARM WATER PROTECTION HANDBOOK, JANUARY 1999

Prepared by Stanislaus County Department of Environmental Resources
In cooperation with California Department of Food & Agriculture Milk and Dairy Foods Control - Sacramento Region

Objective: Identifty Practices necessary to ensure safe water supplies on dairy farms.

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PREFACE

The United States Department of Health and Human Services' Grade "A" Pasteurized Milk Ordinance (PMO) and the California Food and Agriculture Code require, "the water supply for the milk house or room and dairy barn shall be properly located, constructed, operated, easily accessible, adequate, protected against contamination, and be of safe and sanitary quality. The bacterial quality shall conform to the standards of the State Board of Health for public supplies of drinking water".

This handbook attempts to explain these requirements and to discuss and illustrate how dairy farmers can comply. Water wells and distribution systems shall be designed, operated and maintained to supply the milk room and barn with safe water. No cross-connections between safe and unsafe or questionable water supplies shall exist. Every dairy farmer needs to be familiar with their dairy's water system and be certain that all cross-connections are eliminated or removed from the system. Beside the well(s), the water supply to the milk room/barn shall also be protected from unsafe or questionable water sources such as water troughs, flush and sprinkler tanks, sanitizer injectors, and water flush lines connected to the milk barn floor and/or elevated gutters.

Your Dairy Inspector will help you identify cross-connections and explain the options available to correct each one. Together, we can continue to help safeguard California's abundant and wholesome milk supply.

I. WELLS

A. Water Sources

Although springs, rivers, and ponds may be used to supply dairy farms with water, nearly all Grade A and Manufacturing (Grade B) dairy farms in California utilize water from wells.

B. Well Location

Water wells which supply water for milk house/room and milking operations shall be located a safe distance from all sources of contamination. The Grade "A" Pasteurized Milk Ordinance (PMO) requires wells on dairy farms to be at least 50 feet from any unpaved corral, animal enclosure or other possible source of contamination. State of California Model Well Ordinance requires all new wells to be installed at least 100 feet from septic tanks, leach lines and animal or fowl enclosures, and at least 150 feet from a seepage pit. Wells should not be located where flooding is likely to occur.

C. Well Construction (Figures 1 and 2)

Figure 1 shows a properly constructed, drilled well with a submersible pump that is typical on many dairy farms. Whenever a water well is to be constructed or modified, contact your County Department of Environmental Health (DEH) for local well requirements, and your Dairy Inspector for California Department of Food and Agriculture (CDFA) and/or PMO requirements.

To keep surface water, dust, insects and other objectionable material out of your well(s), your Dairy Inspector will verify that the following requirements are met:

- As shown in Figure 1, the ground and concrete slab around the well top should slope away from the well casing.
- A concrete slab at least 4 inches thick and extending at least 2 feet from the top of the well in all directions shall be installed around the top of the well casing. If cracks develop in the concrete slab, they shall be sealed.
- A sanitary well seal or cap shall be properly installed at the top of the well casing. See Figure 2.
- All openings around pipes, electrical conduit/wires, or other openings in the well seal or cap shall be sealed tightly.
- Well vent openings shall be at least 18 inches above grade, turned down and screened with corrosion-resistant screen of not less than 16 x 20 mesh. Mesh designates the number of openings per linear inch.
- Well seals or caps shall be accessible for inspection and the area around the well should be kept clean.

II. WELL WATER SAMPLING AND DISINFECTING

The PMO requires that dairy farm water supplied to the milk house and for milking operations be sampled and tested for coliform bacteria: (1) prior to a dairy farm being issued its first Grade "A" permit, (2) after any repair or alteration of the water supply system occurs, (3) at least every three years. Water from each well shall be tested if more than one well supplies water to the milk room and/or milking barn, unless a single water sample represents all wells.

All newly constructed or newly repaired wells shall be disinfected to counteract contamination introduced during construction or repair. Every well shall be disinfected immediately after construction, modification or repair and flushed prior to bacteriological testing. Chlorine is the most popular disinfectant, but other disinfectants may be used. Your Dairy Inspector or DEH can provide more complete instructions.

If a water supply is unable to meet the required bacteriological standards, then the water supply shall either be continuously disinfected as per PMO requirements (unless prohibited by local ordinances)or a new well shall be constructed.

III. CROSS-CONNECTIONS

Plumbing cross-connections are defined as actual or potential connections between a potable (drinkable) and non-potable water supply. There are numerous, well-documented cases where cross-connections have been responsible for the contamination of drinking water, and have caused human health problems. Dairy farm water supplies can become contaminated by feces, unsafe water in water troughs or storage tanks, and from sanitizers injected into water lines. Any cross-connection to an unsafe or questionable water supply shall be eliminated. It is the responsibility of every dairy producer to be familiar with the dangers of cross-connections and to remove them from their dairy farm's water distribution system.

Cross-connections are the links through which it is possible for contaminating materials to enter a potable water supply. The contaminant enters the potable water system when the pressure of the polluted source exceeds the pressure of the potable source. Cross-connections may appear in many subtle forms and in unsuspected places. Cross-connections on dairy farms can be found in cattle watering troughs, reservoirs below water-

cooled vacuum pumps, storage tanks for sprinklers, flush systems, sinks, recirculated "chill" water tanks, flush lines in gutters, and hose ends left in sinks, troughs or tanks. Reliable and simple air gap methods and approved standard backflow prevention devices and assemblies are available to eliminate cross-connections. Potential cross-connections are listed in the Key to Figure 13.

A. Underground Water Leaks

Water distribution systems on dairy farms usually have underground lines. An underground water leak is a cross-connection to contamination in the soil. Any underground water leak that could contaminate the water supply to the milk room or milk barn shall be repaired immediately. Underground water leaks from pipes that are down stream from an approved backflow preventer that is properly installed and operating, can not contaminate the safe water supply.

B. Submerged Supply Line (Figure 3)

A potential cross-connection exists whenever a supply line is submerged in a water trough or tank. If the supply line develops a crack or hole, unsafe water in the trough or tank may leak into the supply line when the water pressure in the supply line drops. Flowing water in the submerged water supply line can draw water from troughs or storage tanks into the potable water supply line by venturi action. Consequently, any submerged supply line shall be protected by installing a waterproof, larger line around it, unless an approved backflow preventer is properly installed upstream. Figure 3 illustrates an acceptable submerged supply line.

C. Gutters

Floor gutters under cows in herringbone-style milk barns and elevated gutters behind cows in parallel milk barns often have water lines installed and used to flush the gutter. These water lines shall end at least twice their diameter (2D) above the overflow level or rim of the gutter OR have an approved backflow preventer properly installed to protect the water supply used to wash udders or milk handling equipment from contamination.

Elevated gutters shall be flushed after each set of cows has completed milking and been released. In California, an automated flush system shall be installed to comply with this requirement. Elevated gutters and cow standing platforms (floors under cows while they are being milked) shall not be flushed or flooded with water while milking units are attached to any cows. If a milking unit would fall to the floor while the floor was being flushed/flooded, then contaminated water could be drawn into the milking unit.

D. Sanitizer Injection Pumps

Ideally, a reduced pressure backflow preventer (RPBP) would be installed immediately up stream from any chemical injection pump. However, some back-flush systems will not operate properly with reduced water pressure. If a RPBP reduces the water pressure too much, then a pressure vacuum breaker (PVB) may be installed, but a single check valve (without an atmospheric vent) shall be installed immediately up stream from the injection tee connected to the sanitizer injection pump. A single check valve shall also be installed on any lines down stream of the PVB that by-pass the injection tee.

IV. BACKFLOW PREVENTION METHODS, DEVICES AND ASSEMBLIES

A. Air Gap Methods (Figures 3, 4, 5, 6a and 6b)

The air gap is a non-mechanical backflow prevention method that is very effective. Although the use of air gaps is as old as plumbing itself, only recently have standards been established that standardize their design. The UNIFORM PLUMBING CODE states that the minimum air gap shall be at least twice the inside diameter of the supply line but never less than one inch. Air gaps are commonly used at the end of the line service such as water troughs, storage tanks, and sinks. Figures 3 through 6b illustrate adequate air gaps for several popular water valves and situations. Air gaps require inspection and measurement, but no testing is necessary. An air gap is simple, economical, non-mechanical (no moving parts), and protects against both back-siphonage and backpressure conditions.

1. Single Overflow (Figures 6a and 6b)

If an overflow hole or line is used (rather than overflowing over the rim of the water trough or tank), it shall be at least twice the inside diameter (2D) of the single largest supply line and the top of the overflow shall be at least that same distance (2D) below the end of the supply line(s). See Figure 6a. If small mesh screen or expanded metal is installed on the end of the overflow, it may

restrict the water flow and a larger overflow may be required to prevent the tank/trough from filling above the top of the overflow.

If an internal overflow is used, the overflow shall be at least twice the diameter (2D) of the single largest supply line, and the top (rim) of the overflow pipe shall be at least that same distance (2D) below the end of the supply line(s). See Figure 6b.

2. Multiple Overflows (Figure 7)

If two or more smaller overflows are used instead of one large overflow, then the total surface area of the smaller overflows shall be the same as or greater than the surface area of the required (2D) single overflow.

The surface area for commonly used water line sizes on dairy farms is presented below.

Diameter (Inches)	Surface Area (Sq In)
1/2	0.20
3/4	0.44
1	0.79
1-1/4	1.23
1-1/2	1.77
2	3.14
3	7.07
4	12.6
6	28.3

See Figure 7 for an example of overflow requirements with more than one overflow.

3. Multiple Supply Lines

Whenever a water tank has more than one supply line, the Dairy Inspector may need to verify that the overflow is adequate to handle peak flow when all supply lines are flowing at maximum flow. If the overflow is not adequate, the overflow capacity shall be increased as needed.

B. Mechanical Backflow Prevention Devices and Assemblies

Backflow preventers may be either assemblies (units that can be tested after installation) or devices (units that can not be tested after installation). The backflow preventer selected shall be appropriate for the hazard and particular application. Your Dairy Inspector will help you select an approved backflow preventer for each cross-connection. Mechanical backflow preventers may contain one or more check valves that open from the flow pressure of the safe water. The check valves seat tightly on a machined surface and when closed prevent reverse flow. All backflow preventers shall be installed so they are accessible for inspection, service, repair and protected from freezing.

1. Hose Bibb Vacuum Breaker (HBVB) Device

A hose bibb vacuum breaker protects against back-siphonage, but not backpressure. The HBVB contains one spring loaded valve and an atmospheric vent. The HBVB should be installed on the end of a hose bibb or faucet before attaching a hose, see Figure 8. The valve is spring loaded in the closed position and opens with water flow in the proper direction. When zero pressure or back-siphonage conditions occur, the spring pulls the valve closed and simultaneously pushes the diaphragm into position to form a tight seal between the valve and valve seat. The HBVB is not approved for continuous pressure conditions (water pressure on both sides of the unit for more than 12 hours) because the spring loaded valve may stick in the open position.

HBVB Use and Installation:

The HBVB is approved for HIGH HAZARDS, NON-CONTINUOUS PRESSURE and NO POTENTIAL BACKPRESSURE.

Figure 8 illustrates a properly installed HBVB. When properly installed the HBVB shall:

(1.) Have a shut-off valve installed up stream of the HBVB and have no shut-off valves or pumps down stream of the HBVB.

(2.) Be installed on each hose connected to a "Y", whenever each leg of the "Y" has a shut-off valve.

2. Atmospheric Vacuum Breaker (AVB) Device:

These devices are simple and low-cost mechanical backflow preventers. When properly installed, they provide excellent protection against back-siphonage, but do not protect against backpressure. Construction consists of a polyethylene float which slides up and down on a shaft. Water flow lifts the float, which seals against the top. When water flow/pressure stops, the float drops down venting the unit to atmosphere and opening down stream lines to atmospheric pressure.

An AVB does require servicing if there is a continuous water leak through the atmospheric vent (bonnet) during normal operation, or there is any indication that the poppet (float) does not unseat and vent to atmosphere when the unit is not in operation. For proper drainage it is recommended that this device be installed at least 12 inches above grade.

AVB Use and Installation:

The AVB is approved for HIGH HAZARDS, NON-CONTINUOUS PRESSURE and NO POTENTIAL BACKPRESSURE.

Figure 9 shows a properly installed AVB. When properly installed the AVB shall:

(1.) Be installed vertically, with the atmospheric opening at the top and the bottom of the device shall be at least 6 inches higher than the highest down stream line and the overflow level of any tank or trough down stream.
(2.) Have no shut-off valves or pumps down stream.
(3.) Not be in continuous use for more than 12 hours.

3. Double Check Valves with Atmospheric Vent (DCAV) Device

This device is approved only for Low Hazards, where only nontoxic substances (also called pollutants) could enter the potable water supply and cause a nuisance to the water users. The check valves are spring loaded for automatic closure under static (no water flow) conditions. The atmospheric vent is located between the two check valves. When water flows, the first check valve opens and simultaneously closes the atmospheric vent. Then the water flow opens the second check valve. The positive supply pressure keeps the atmospheric vent closed, but under back-siphonage (vacuum) conditions the atmospheric vent opens and relieves any vacuum on the supply side.

DCAV Use and Installation:

The DCAV is approved for LOW HAZARDS, CONTINUOUS PRESSURE and BACK-SIPHONAGE or BACKPRESSURE.

Figure 10 shows a DCAV which should be located so that water leakage will not create a nuisance. These devices are normally available for only 2 and : inch supply lines. DCAV devices can be installed horizontally or vertically, and:
(1.) Shall not be located in a pit or other location subject to standing water.
(2.) The atmospheric vent shall never be allowed to plug.
(3.) May have a shut-off valve or pump down stream.

4. Pressure Vacuum Breaker (PVB) Assembly

The PVB only provides protection from back-siphonage, not backpressure. However, the PVB is approved for continuous pressure usage and may have shut-off valves down stream. The PVB has two test cocks, two gate valves, and can be tested. If there is a shut-off valve at the end of a water line, and the air gap is not adequate (2D), a PVB may be installed to prevent back-siphonage.

A PVB has a single, spring loaded check valve (or two check valves on larger sizes) and a spring loaded air vent down stream of the check valve. A properly functioning PVB will reduce down stream water pressure from approximately 2 to 6 pounds per square inch (psi). Parts wear out and need to be replaced. Sand

in the water causes parts to wear out faster. A PVB assembly should not have water leakage through the air vent. Servicing and/or replacement becomes necessary whenever water leaks continuously or the PVB makes a "chatter" noise.

PVB Use and Installation:

The PVB is approved for HIGH HAZARDS, CONTINUOUS PRESSURE and NO POTENTIAL BACKPRESSURE.

Figure 11 shows a correctly installed PVB. When properly installed the PVB shall:

(1.) Be installed vertically with the bottom of the PVB at least 12 inches above the highest down stream line including lines to misters and in a manner to preclude all backpressure.
(2.) Be located at least 12 inches above grade where discharge will not be objectionable.
(3.) May have shut-off valve(s), but no pumps down stream.

5. Reduced Pressure Backflow Preventer (RPBP) Assembly

The RPBP assemblies provide maximum protection against both back-siphonage and backpressure conditions. They are modified double check valves with an atmospheric vent between the two check valves (with at least a 2 psi pressure differential between the supply pressure and the reduced pressure zone). RPBP devices will reduce the water pressure down stream typically from 10 to 15 pounds psi.

A RPBP assembly may have valves and/or pumps down stream. A major advantage of the RPBP assembly is that it may be installed below the level of any down stream lines. RPBP assemblies also wear out and will need to be serviced if they leak water continuously. Sand in the water flowing through a RPBP assembly will cause it to wear faster than if the water were free of sand.

RPBP Use and Installation:

The RPBP is approved for HIGH HAZARDS, CONTINUOUS PRESSURE, and BACK-SIPHONAGE or BACKPRESSURE.

Figure 12 shows a correctly installed RPBP assembly. When properly installed the RPBP shall:

(1.) Be at least 12 inches from any wall and between 12 and 30 inches above the floor or grade for drainage, and where discharge will not be objectionable.
(2.) Never have a plugged atmospheric vent port.
(3.) Be installed horizontally unless approved for vertical operation.
(4.) May have shut-off valve(s) or pump(s) down stream.

FIGURES 1-13

Figure 1. Diagram of Well with Submersible Pump

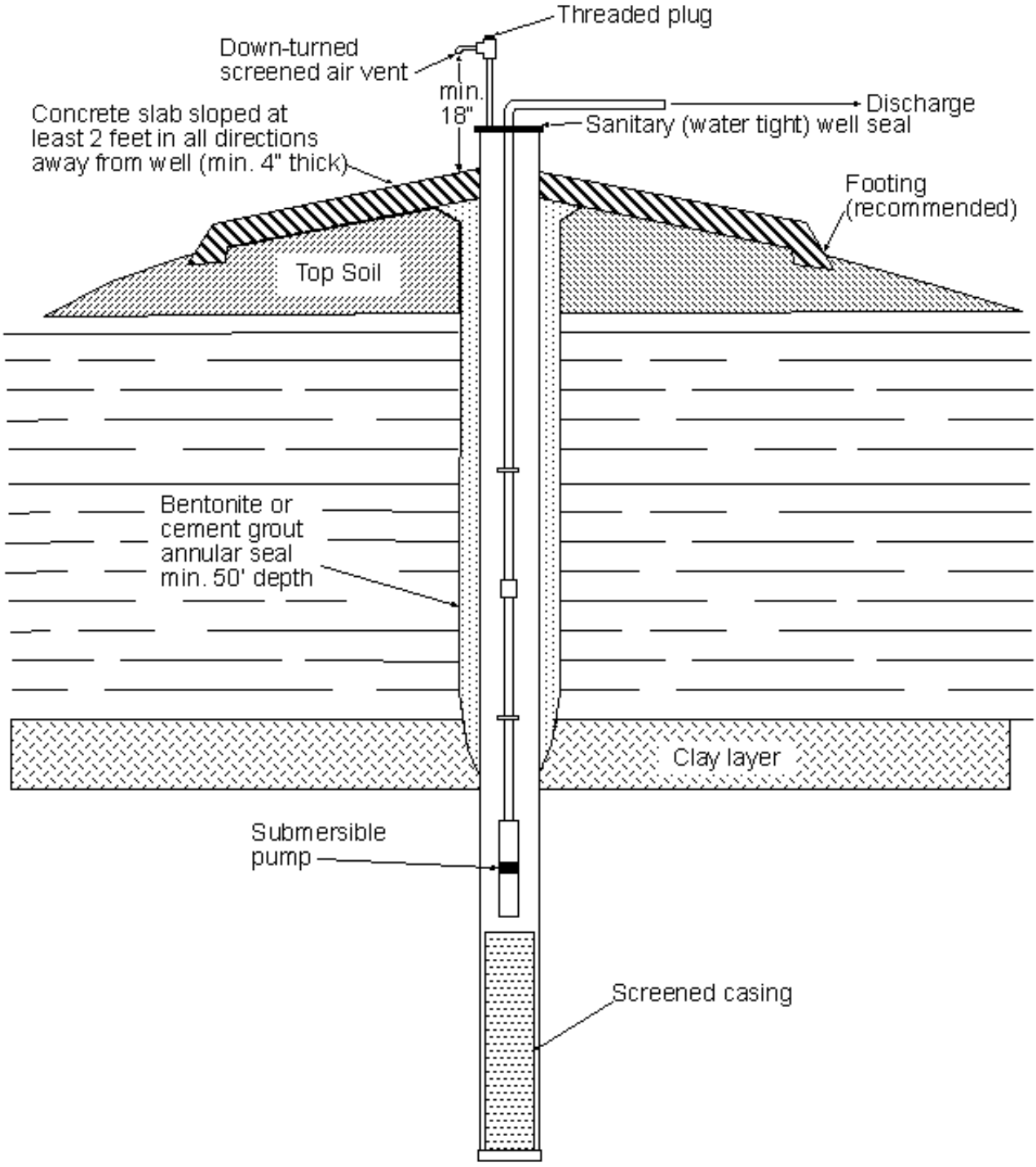


Figure 2. Diagram of Wellhead for Submersible Pump

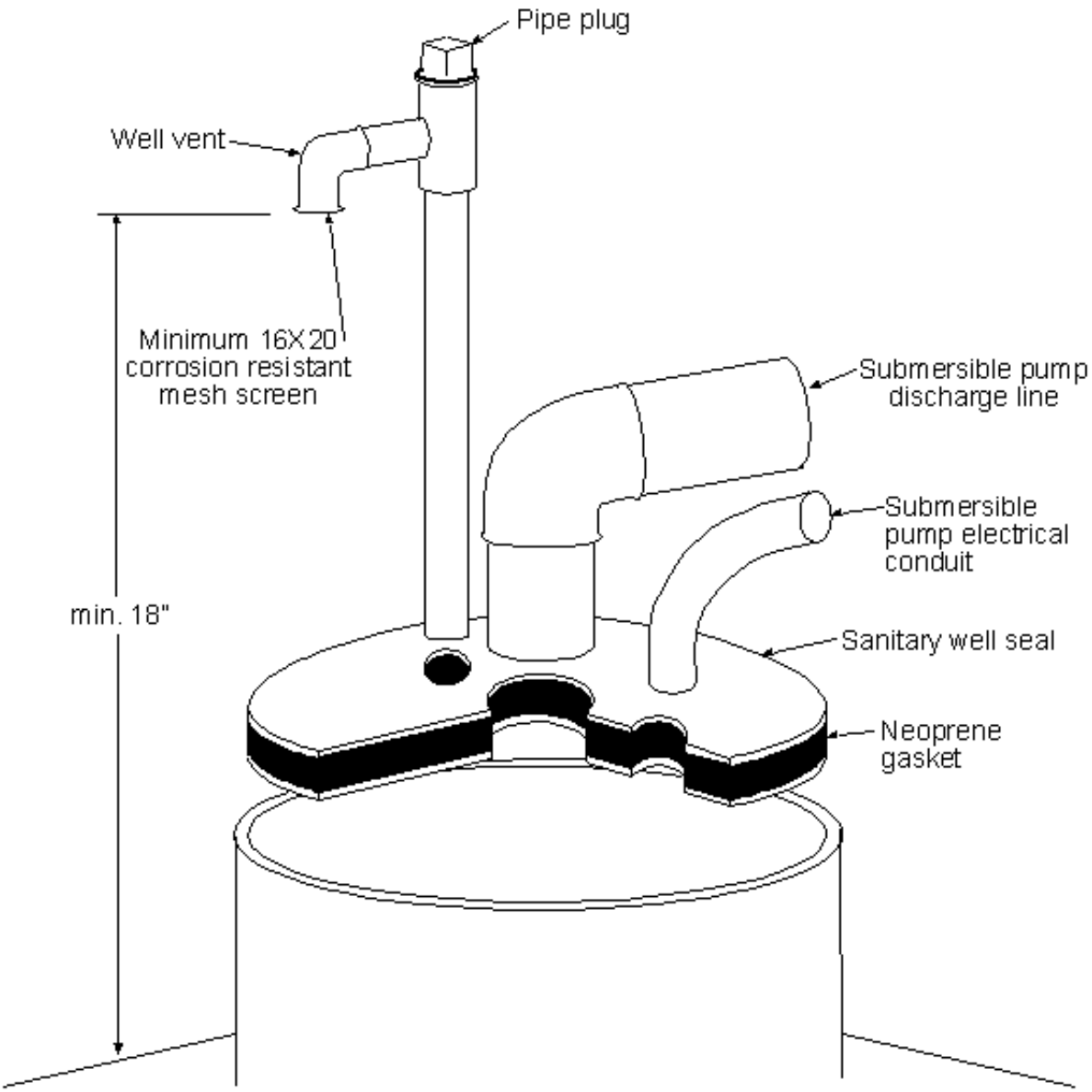


Figure 3. Submerged Supply Line

The supply line must **NOT** be submerged inside the water trough or tank without a larger waterproof line protecting it. It is recommended that the space between the two lines be filled with concrete or other watertight material.

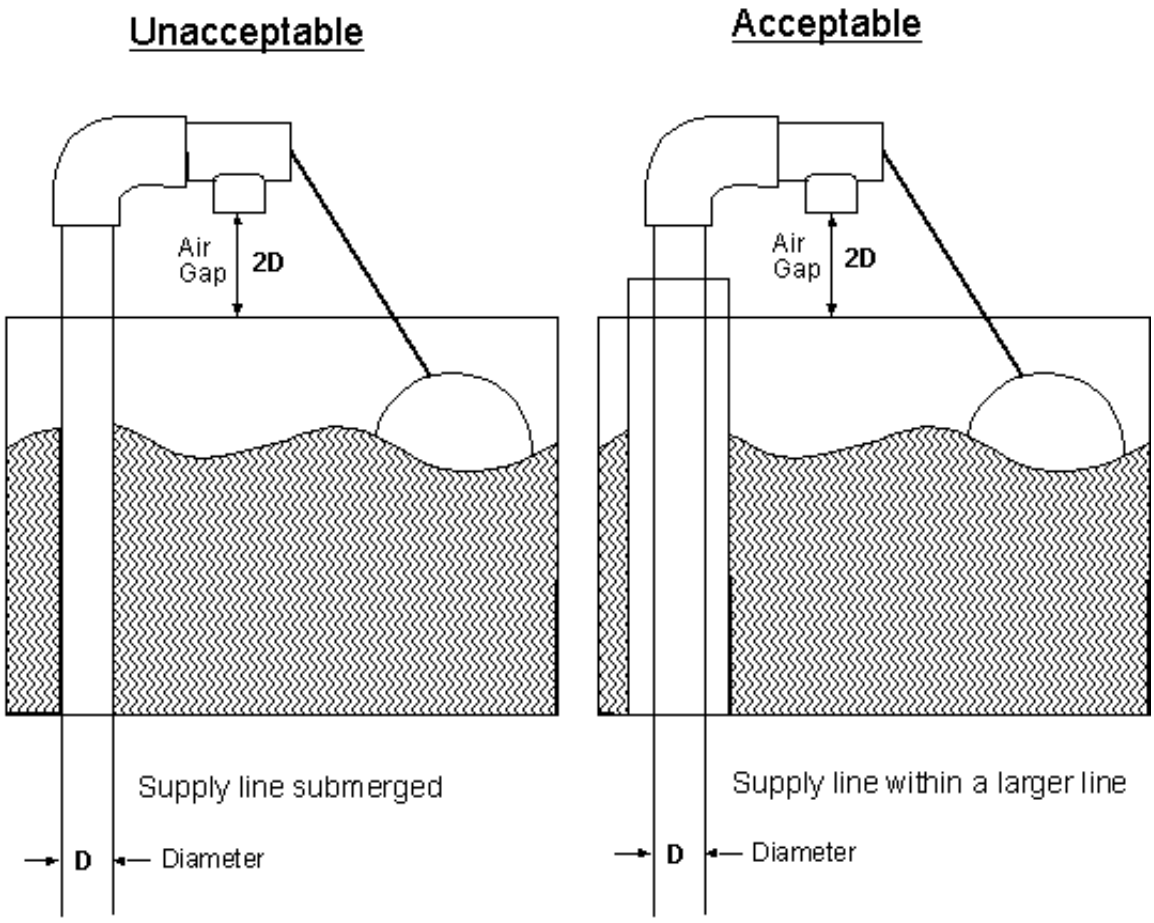


Figure 4. Air Gap for Troughs, Tanks and Sinks with Rim Overflow

The unobstructed vertical air space between the overflow level of the trough or tank and the bottom of the water inlet or valve is called the air gap. This distance must be at least twice the supply line's inside diameter (D) keeping at least one inch.

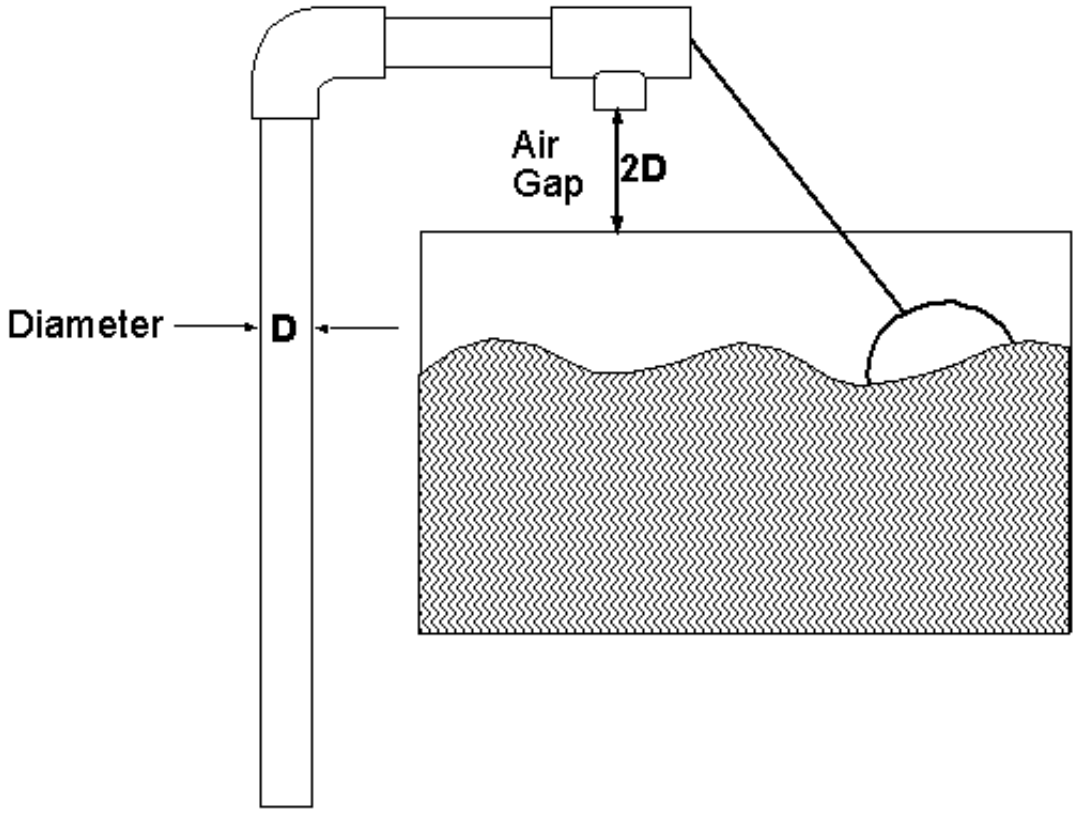


Figure 5. Air Gap for Troughs and Tanks with Rim Overflow Using an Anti-Siphon Valve

Similar to other valves, approved anti-siphon valves must be installed so their water inlet/valve is at least twice the supply line diameter (2D) above the overflow level of the trough or tank.

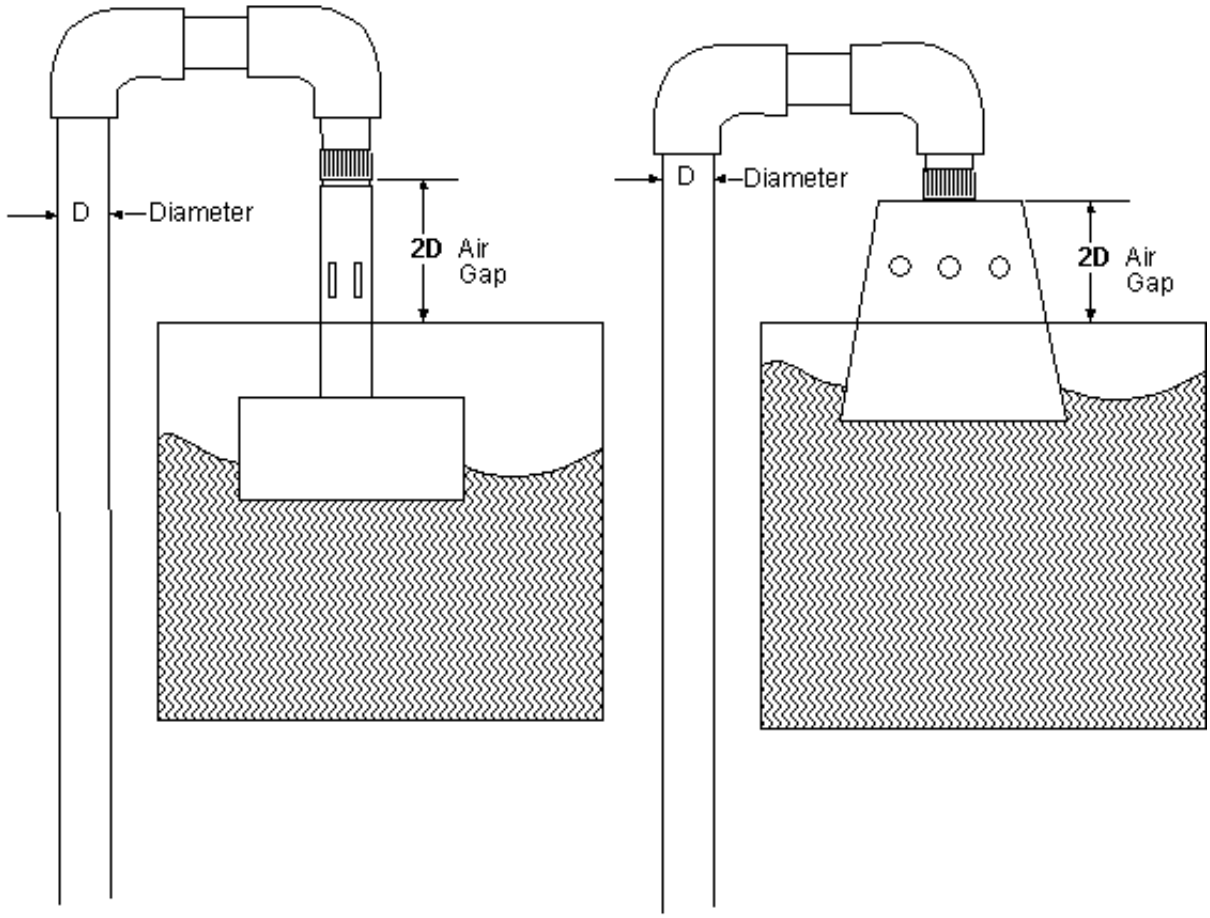


Figure 6a. Air Gap for Troughs and Tanks with Overflow Holes or Lines

If an overflow hole/line is used, it must be at least twice the diameter (2D) of the single largest fill line, and the top of the overflow must be at least that same distance (2D) below the bottom of all supply lines.

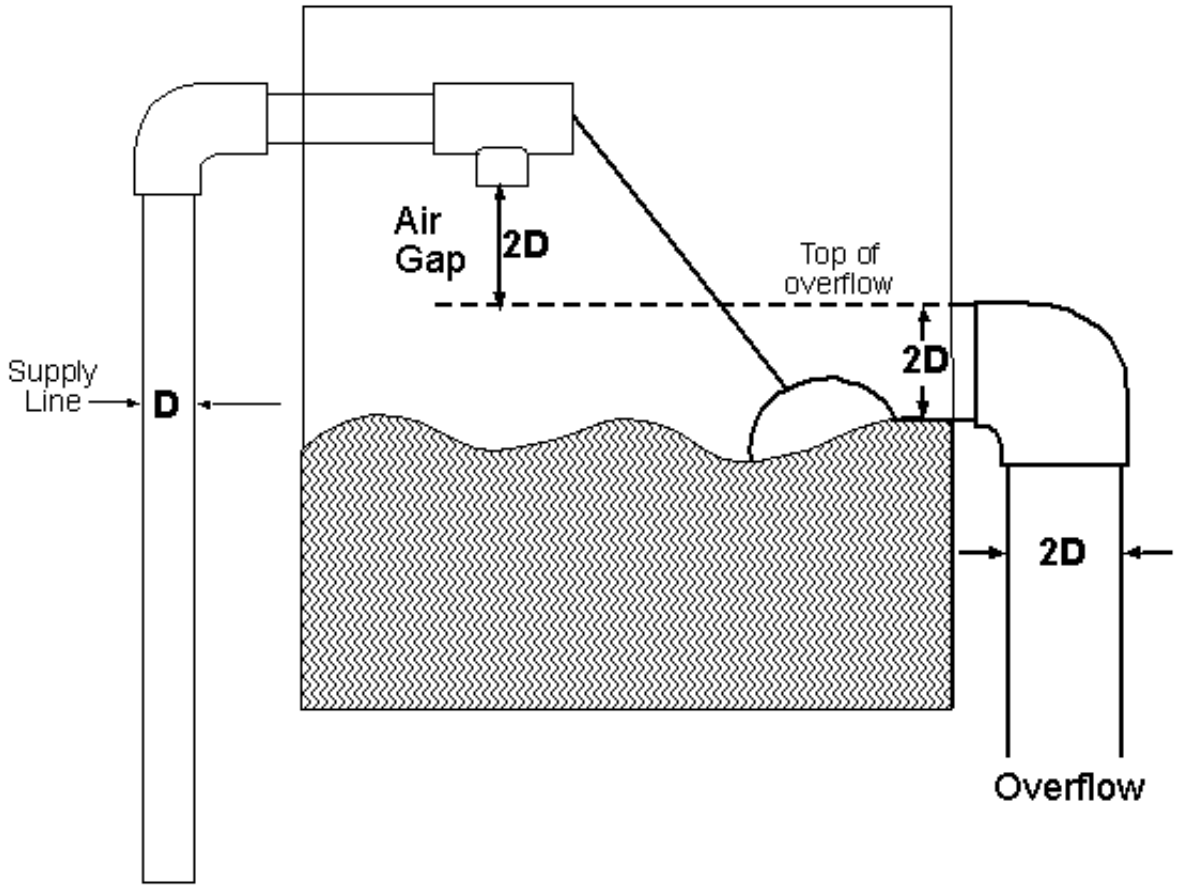


Figure 6b. Air Gap for Troughs and Tanks with an Internal Overflow

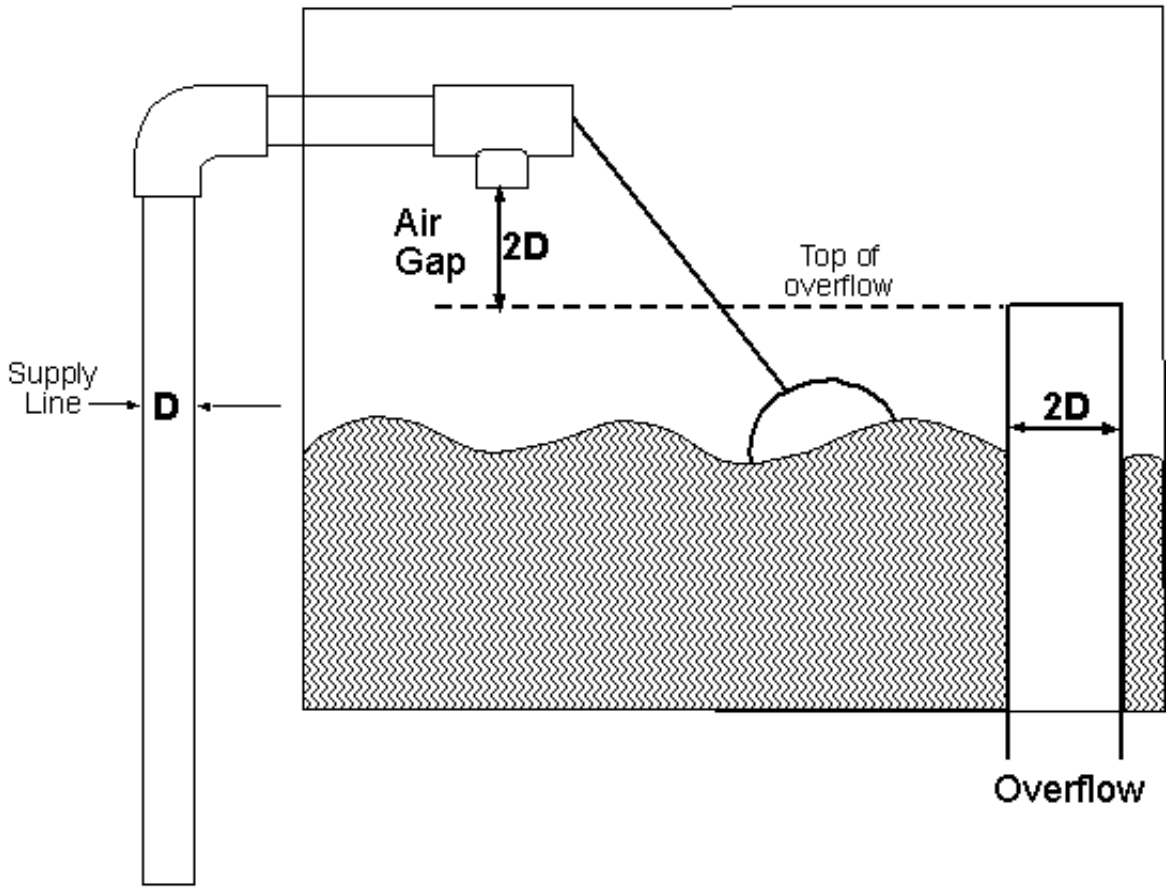


Figure 7. Multiple Overflow Requirements

If the largest supply line to a water storage tank is 2 inches in diameter, then the required overflow can be either: **a)** one 4 inch diameter overflow with 12.6 sq. in.. of surface area **b)** two 3 inch diameter overflows with 14.14 sq. inches of surface area **c)** four 2 inch overflows with 12.56 sq. inches of surface area or **d)** any combination of overflow sizes that total at least 12.56 sq. inches of surface area. The top of each overflow must be at least that same distance (2D) below the bottom of the supply lines (Figure 6a).

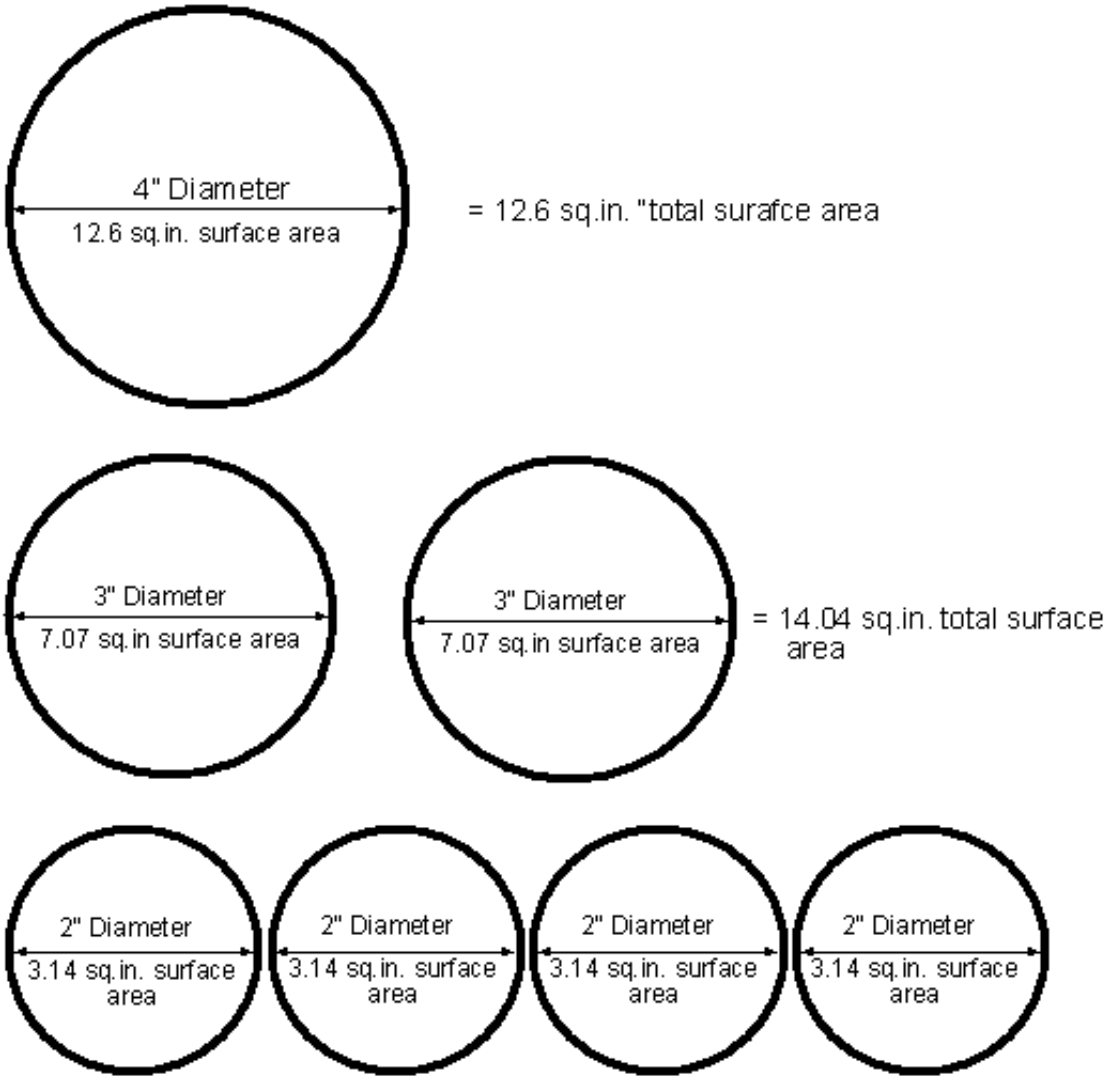


Figure 8. Properly Installed Hose Bibb Vacuum Breaker (HBVB)

Can not have a shut off valve (including pistol grip nozzle) downstream from the HBVB.

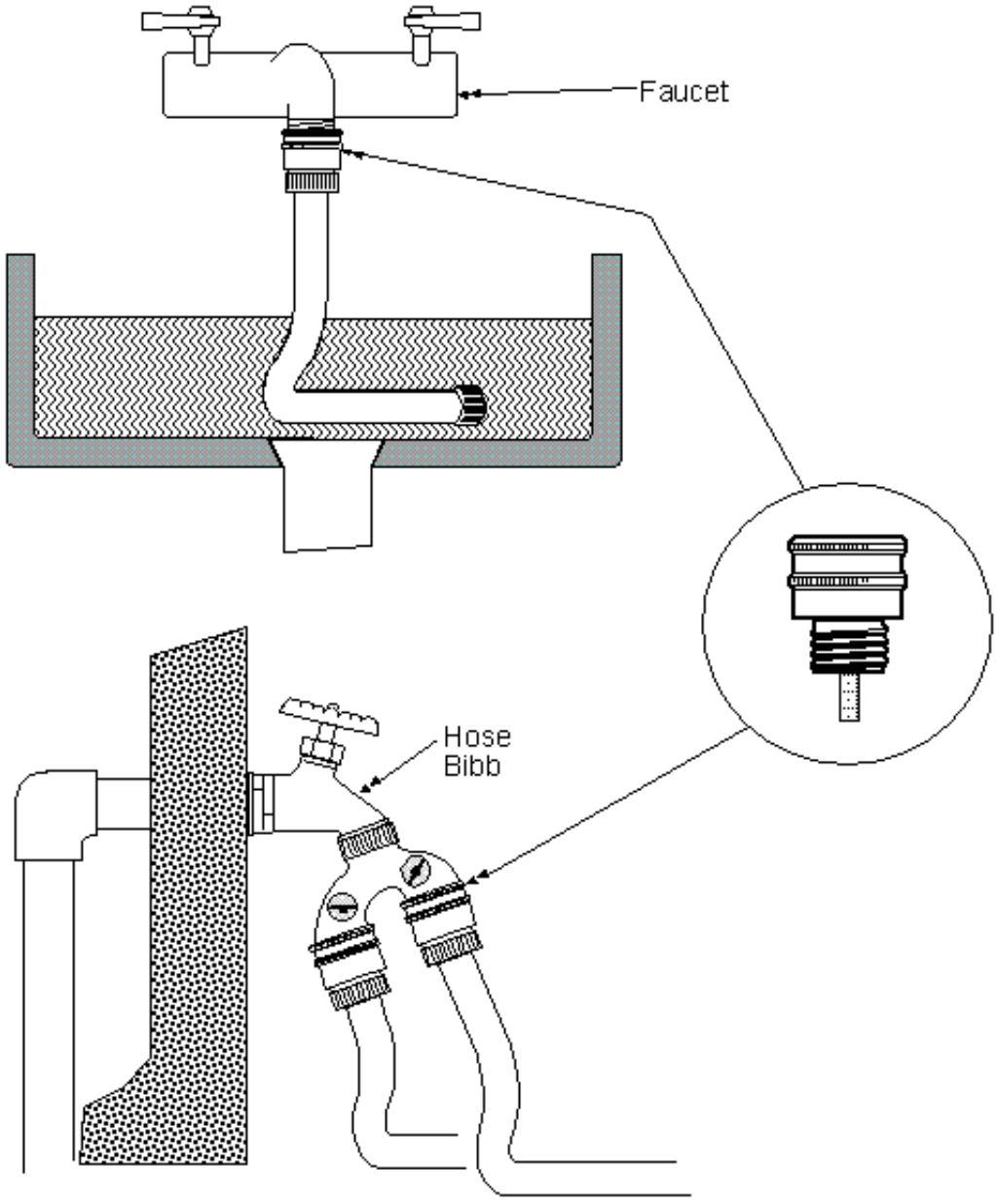


Figure 9. Properly Installed Atmospheric Vacuum Breaker (AVB)

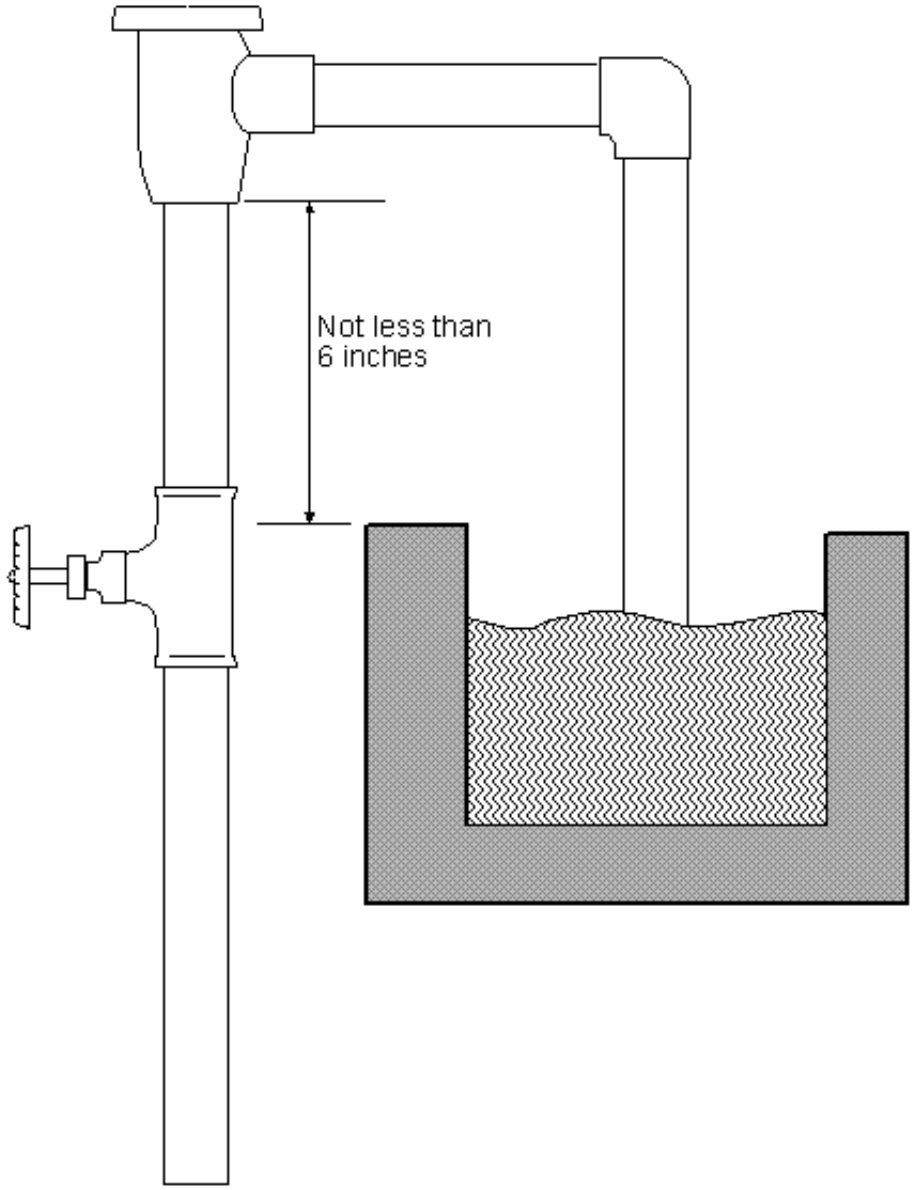
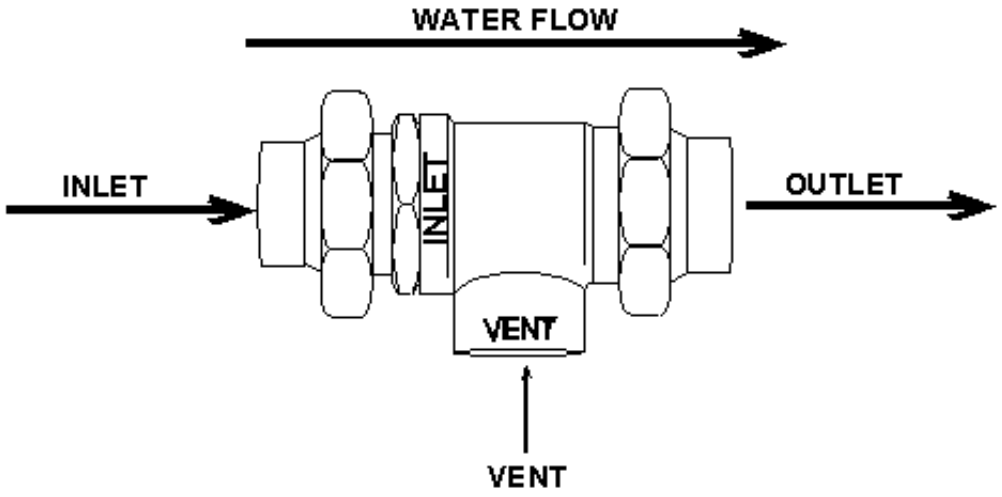


FIGURE 10. Double Check with Atmospheric Vent (DCAV).

This device has two check valves with an intermediate atmospheric vent. It is a backflow preventer for LOW HAZARD installations with CONTINUOUS PRESSURE, and may be installed either horizontally or vertically, provided the vent is not allowed to plug. Double check with atmospheric vent devices are only available in 1/2" and 3/4" sizes.



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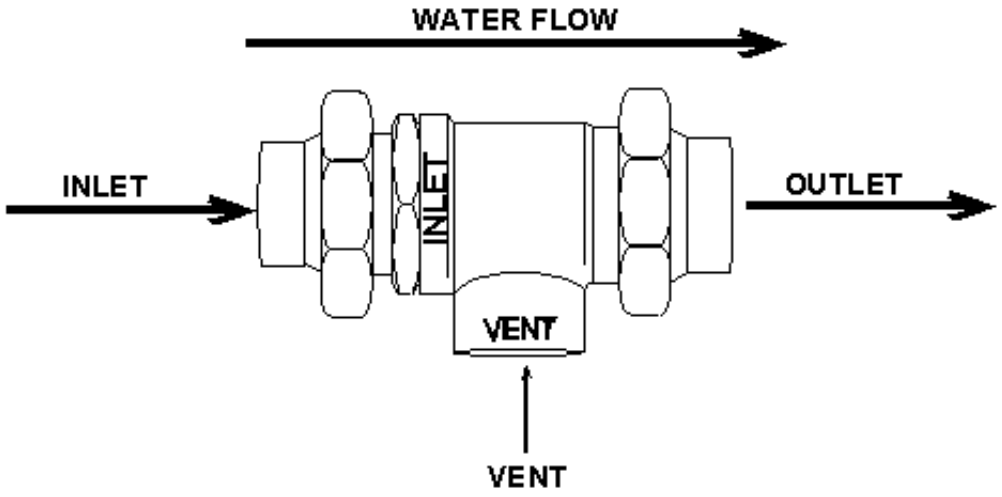


Figure 12. Properly Installed Reduced Pressure Backflow Preventer (RPBP)

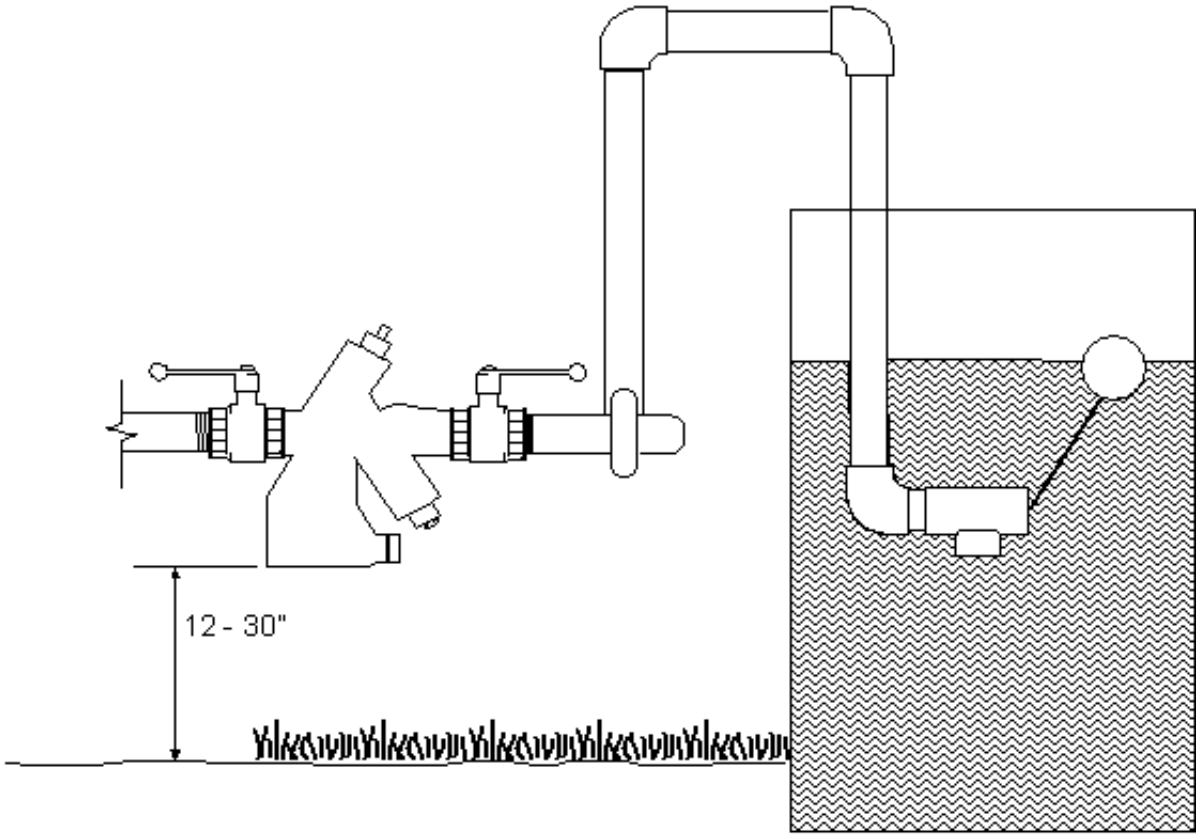
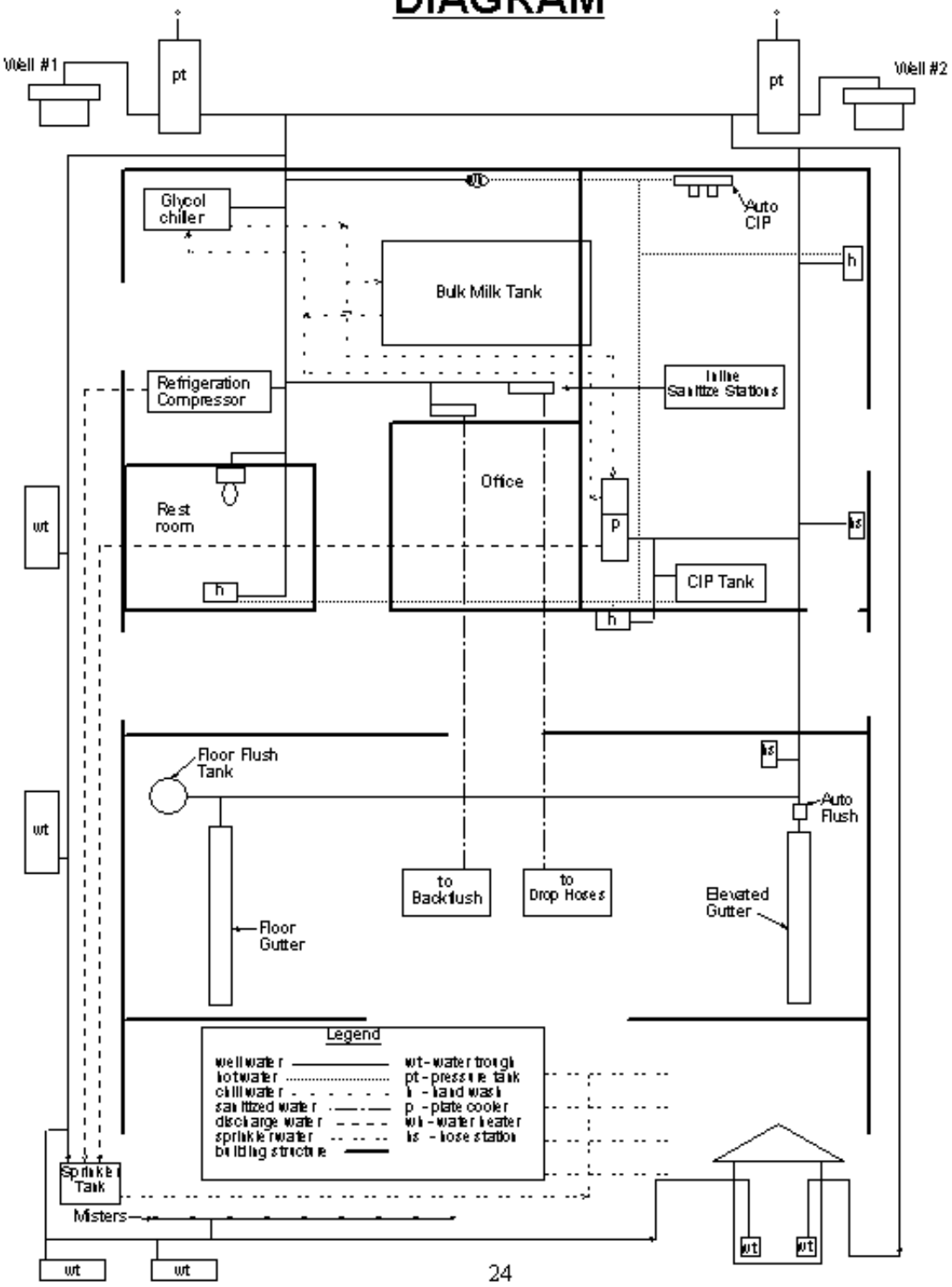


FIGURE 13. DAIRY FARM WATER SYSTEM DIAGRAM



KEY TO FIGURE 13
DAIRY FARM WATER SYSTEM DIAGRAM

Location:
Automatic Milk Tank or Pipeline Washer Unit
Elevated Gutter
Floor Gutter with Flush Line
Floor Flush Tank or Sprinkler Tank
Misters
Plate, Cube or Tube Cooler
Recirculating Water Tank (glycol/ice bank/chilled water)
Refrigeration Compressor
Sanitizer Injection Pump
(a) back flush system

(b) cow wash/drop hoses
Sinks - CIP, Handwash, Etc.
Water Troughs
Well(s)

Correction(s) for Potential Cross-Connections:

Properly install PVB or RPBP on supply lines if unit stores more than 1 gallon of chemical. Disconnect line between washer unit and milk tank or washer pump whenever there is milk in the milk tank.
Air gap supply line or properly install PVB or RPBP with an automatic valve for flushing gutter.
Air gap supply line or properly install AVB, PVB or RPBP.
Air gap supply line(s), or properly install AVB or PVB on open ended lines, or PVB, DCAV or RPBP on any supply line with a shut-off valve down stream of the backflow preventer.
If a water line to any mister(s) is down stream of an AVB or a PVB, then the vacuum breaker shall be at least 12 inches above all down stream water lines, including those to the mister(s).
Air gap discharge line or properly install AVB or PVB.
Air gap supply line or properly install PVB, DCAV, or RPBP and screen overflow.
Air gap discharge line or properly install AVB or PVB.
Properly install a RPBP OR a PVB with a check valve immediately up stream of the injection tee and on any line(s) down stream of the PVB that by-pass the injection tee.
Air gap supply lines or properly install PVB, DCAV or RPBP.
Air gap supply lines or properly install PVB, DCAV or RPBP.
Seal all openings to keep out surface water, dust, insects, etc. Vents shall be 18 inches above grade, down-turned and screened with 16 x 20 mesh corrosion-resistant screen.

GLOSSARY

AIR GAP: the unobstructed, vertical air space between the bottom of the supply valve or line of the safe "potable" system and the flood level rim of the water trough or tank (non-potable system). It is the most desirable method of backflow prevention.

ATMOSPHERIC VACUUM BREAKER: a simple mechanical backflow preventer that protects against back-siphonage, but not against backpressure. It can not have constant pressure, so no valves or pumps can be down stream.

BACKFLOW: reversed water flow, opposite to the expected or intended direction.

BACKFLOW PREVENTER: mechanical device that prevents backflow.

BACKPRESSURE: occurs when the unsafe or questionable water supply has a greater pressure than the safe or "potable" water system.

BACK-SIPHONAGE: fluid flow in reverse direction caused by a vacuum.

CONTAMINANT: any toxic or infectious substance that may enter the safe water supply.

CONTINUOUS PRESSURE: when water pressure remains on both sides of the backflow preventer for more than 12 hours.

CROSS-CONNECTION: any actual or potential connection between a safe (potable) and an unsafe or objectionable (non-potable) water supply.

DIAMETER: refers to the inside measurement of a water line/pipe from one side to the opposite side through the center.

DISINFECTANT: an approved substance that prevents the growth of harmful microorganisms

DOWN STREAM: in the direction of water flow.

HIGH HAZARD: situation when there is a potential or actual connection for a contaminant to enter the safe water supply and create a danger to the health of the water users.

HORIZONTALLY: parallel to the horizon.

HOSE BIBB VACUUM BREAKER: a mechanical backflow preventer/vacuum breaker that should be installed between the hose bibb and the hose.

LOW HAZARD: situation when there is a potential or actual connection for a pollutant to enter the safe water supply and create a nuisance to users.

MISTERS: small sprinklers that produce a fine mist (to cool cows) that are normally installed above feed mangers.

NON-CONTINUOUS PRESSURE: when water pressure is intermittent on both sides of the backflow preventer for less than 12 hours.

OVERFLOW: an outlet (rim, hole or line) through which excess water escapes.

POLLUTANT: a non-toxic, objectionable substance that may enter the safe water supply.

POTABLE: fit to drink, safe.

PRESSURE VACUUM BREAKER: a backflow preventer that can perform under constant pressure, but does not protect against backpressure. Valves, but no pumps, may be installed down stream.

REDUCED PRESSURE BACKFLOW PREVENTER: provides maximum protection (with double check valves and an atmospheric vent) against back-siphonage and backpressure under constant pressure.

SANITIZER INJECTION PUMPS: commonly used to inject sanitizers into water lines to drop hoses, back-flush units and cow sprinklers.

SUPPLY LINE: water line or pipe that supplies water.

SUBMERGED: under water.

SUBMERSIBLE: capable of operating under water.

UP STREAM: against the direction of water flow.

VERTICALLY: at a right angle to the horizon.

WATER LINES: pipes used to transport water.

WATER SUPPLY: the water (usually from wells) used to supply the milk room, milking operations and other needs on dairy farms.

WELL CASING: a tubular retaining structure (pipe) usually made of polyvinyl chloride (PVC), which is installed in the well bore to maintain the well opening.

WELL SEAL: usually two metal plates with a neoprene gasket in between which prevents contamination from entering top of well casing.

WELL VENT: a down-turned, screened opening on top of the well to let in clean air.

REFERENCES

Barclays Official California Code of Regulations

Title 3. Food and Agriculture

Extracts Relating to Milk and Dairy Products

California Food and Agriculture Code - Division 15

EPA Cross-Connection Control Manual

United stated Environmental Protection Agency

Office of Water, Office of Drinking Water

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Grade "A" Pasteurized Milk Ordinance - 1995 Revision

Water Wells... And what you should know about them.

State of California, The Resources Agency, Department of

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(December 1981)

Model Well Standards Ordinance adopted in Accordance with State Water Code Section 13801. (November 1, 1989)