CHAPTER VIII

DISTRIBUTION SYSTEMS

A. BASIC CONSIDERATIONS

1. QUANTITY AND PRESSURE – Water distribution systems shall be designed, constructed, and operated to provide an adequate supply of water at a pressure of not less than 20 psi (140 kPa) at ground level at all points in the distribution system under all flow conditions except extraordinary conditions including unusual peak fire flow demand and major distribution system breaks (KAR 28-15-18(e)). The normal working pressure in the distribution system should be in the range of 60 to 80 psi (410 kPa to 550 kPa). It is not uncommon for systems to have a normal working pressure in the range of 90 to 110 psi (620 to 760 kPa) (AWWA, 2005b). Pressures in excess of 100 psi (690 kPa) may be necessary because of fire protection requirements, head loss associated with backflow prevention devices, or the need to serve low-lying areas. In the latter case, pressure reducing valves may be used to lower the pressure in these areas so long as their presence and operation do not conflict with fire protection requirements. Variation in pressure at any single point in the distribution system should normally not exceed 20 to 30 psi (140 kPa to 210 kPa) (AWWA, 2005b). Additional guidance regarding distribution system design and working pressures may be found in the AWWA Manual of Water Supply Practices M32 (AWWA, 2005b).

   Distribution and transmission mains for both municipalities and rural water districts should be sized to carry peak hourly flow plus fire flow; however, rural water districts commonly size to carry peak hourly flow only. In general, water treatment plants are designed to meet the maximum day demand, while the distribution system facilities, i.e., piping and storage, are designed to meet the maximum hourly flow demand plus fire flow in order to maintain adequate pressure during periods of high demand. Rural water districts typically employ proportionally larger storage facilities to meet fire flows and to reduce the size and cost of transmission lines, i.e., by sizing long transmission lines to carry maximum daily flow, with storage used to supply the maximum hourly flow to a particular service area. In the absence of meter data, peak hourly flow can be assumed to be equal to twice the maximum daily flow or four times the average daily flow. Methods for estimating peak consumer demand are provided in the AWWA Manual of Water Supply Practices M22 (AWWA, 2003).

   The minimum diameter of water mains for providing fire protection and serving fire hydrants shall be 6 inches (15.2 cm). Larger size mains may be necessary to provide sufficient fire flow while maintaining the minimum residual pressure. When fire protection is to be provided, system designs shall be in accordance with the PWSS's

designated procedure for determining fire flow requirements. One of the more widely utilized methods for calculating fire flow requirements was developed by ISO, formerly known as the Insurance Services Office, Inc. Their methods (ISO, 2003) and others are evaluated in the AWWA Manual of Water Supply Practices M31 (AWWA, 1998).

2. QUALITY – The safety and palatability of potable water should not be degraded in any manner while flowing through the distribution system. KAR 28-15a establishes water quality, analytical methods, and monitoring requirements for drinking water.

3. GENERAL PIPELINE LOCATION

   a. Use available data on topography, soil, geology, and climate.

   b. Tunneling should be considered only when it is economically justified and when there are no feasible alternate routes.

   c. Select shortest feasible route from intake to delivery.

   d. Make lines accessible for repairs and future construction.

   e. Avoid rough or difficult terrain.

   f. Special engineering evaluations are warranted where disasters such as landslides, 100-year floods, or other hazards are likely to cause breakage or outage.

   g. The use of plastic coated metal strips, tracer wire or other type of conductor should be considered, particularly where non-conductive pipe is utilized. Surface markers such as signs or posts should be appropriately located irrespective of pipe material.

   h. KDHE strongly recommends that up-to-date records of the installation of water lines and related appurtenances be maintained through the use of accurate "as built" drawings or a geographical information system (GIS) capable of storing, analyzing and managing spatial data and associated attributes. Global positioning data collection should be considered for all new construction for the purpose of accurately locating pipe lines and related appurtenances within the GIS system.

B. PROTECTION CONSIDERATIONS

1. SEPARATION OF WATER MAINS AND SEWERS

a. GRAVITY SANITARY SEWERS

1) Parallel Placements – When potable water pipes and gravity sanitary sewers are laid parallel to each other, the horizontal distance between them shall not be less than 10 ft. (3.0 m). The distance of separation shall be measured from edge to edge. The laying of water pipes and sanitary sewers shall be in separate trenches with undisturbed earth between them. Where it is not practical to maintain a 10 ft. (3.0 m) separation, KDHE will consider proposals providing equivalent protection by other methods on a case-by-case basis, if supported by data from the design engineer. Equivalent protection may require sanitary sewer construction with one of the following additional protective features: concrete encasement, vacuum sewers, or jointless pipe such as fused HDPE or cured-in-place pipe liner.

2) Crossing Placements – When a water pipe and a sanitary sewer cross and the sewer is 2 ft. (0.6 m) or more (clear space) below the water pipe, no special requirements or limitations are provided herein. At all other crossings, the sanitary sewer is to be constructed of one of the following materials (or approved equal) and pressure tested to assure water tightness pursuant to the most recent revision of KDHE's *Minimum Standards of Design of Water Pollution Control Facilities*:

a) Ductile iron pipe conforming to ASTM A536 or ANSI/AWWA C151/A21.51 with minimum thickness class 50, and gasketed, push-on, or mechanical joints in conformance with ANSI/AWWA C110/A21.10 or ANSI/AWWA C111/A21.11.

b) PVC pipe conforming to ASTM D3034 with minimum wall thickness of SDR41, ASTM F679, or ASTM F794, with gasketed push-on joints in conformance with ASTM D3212.

c) Reinforced concrete pipe conforming to ASTM C76 with gasketed joints in conformance with ASTM C361 or ASTM C443.

Joints in the sewer pipe shall be located as far as practical from the intersected water main.

Where a water main is laid across or through an area where there is an existing sanitary sewer, which is not constructed of one of the above specified materials and is 2 ft. (0.6 m) or less below the water pipe, the existing sewer shall be encased in concrete with a minimum thickness of 6 inches (15.2 cm) for a 10 ft. (3.0 m) distance on each side of the crossing or the crossed section of sewer replaced to meet the above specified construction requirements. The above requirements shall also apply where a water main must cross under an existing sanitary sewer. KDHE will consider proposals providing equivalent protection by other means on a case-by-case basis, if supported by data from the design engineer.

When a water main and a sanitary sewer must cross, it is preferred that the water main cross over the sanitary sewer, regardless of whether the sanitary sewer is new or existing.

Special provisions may be required to ensure adequate structural support for, and to maintain minimum pipe-to-pipe clearances between, a water main and a sanitary sewer at a water main and sanitary sewer crossing.

b. SEWER CONNECTIONS – There are to be no physical connections between any parts of a potable water system and building sewers, sanitary sewers, or wastewater treatment facilities by means of which it would be possible for sewage, even under exceptional circumstances, to reach a well, storage reservoir, or distribution system.

c. PRESSURE SEWER LINES – When pressure sewer lines (force mains) run parallel to water lines, the separation distance shall be as far as practical, maintaining a minimum horizontal separation distance of at least 10 ft. (3.0 m). There shall be at least a 2 ft. (0.6 m) vertical separation at crossings with the water main always crossing above the sewer force main. Where it is not practical to maintain the required horizontal or vertical separation distance between a water line and a sanitary sewer force main, KDHE will consider proposals providing equivalent protection by other methods on a case-by-case basis, if supported by data from the design engineer.

d. SEWER MANHOLES – No water pipe shall pass through or come in contact with any part of a sewer manhole. Required horizontal separation distances between water mains and manholes are equivalent to those for water mains and gravity sanitary sewers.

e. STORM SEWERS – The separation distance between a storm sewer (which is not a combined storm/sanitary sewer) and a water main should be based on geotechnical considerations. Required separation distances between water

mains and combined storm/sanitary sewers are equivalent to those for water mains and gravity sanitary sewers.

f. DRAINS – Underground drains from fire hydrants, pits, or underground structures in general (valve pits, meter pits, underground pump stations, etc.) shall not be directly connected to sanitary or storm drains.

2. SEPARATION OF WATER MAINS AND OTHER POLLUTION SOURCES – It is of the utmost importance that potable water lines be protected from any source of pollution. The following shall pertain to instances where septic tanks, absorption fields, waste stabilization ponds, feedlots, or other sources of pollution are encountered.

a. A minimum distance of 25 ft. (7.6 m) shall be maintained between all potable water lines and all pollution sources, e.g., septic tanks, septic tank absorption fields, waste stabilization ponds, sewage contamination, wastewater, landfill leachate, and all CAFO facilities.

b. Under no circumstances shall a water line be extended through an area that is a real or potential source of contamination to the water line or water supply.

c. Under no conditions shall the encasement of a water line be considered as adequate protection of a water line or a water supply for the purpose of extending the water line through a real or potential source of contamination.

3. CROSS CONNECTIONS – There shall be no physical connection between the PWSS and any pipes, pumps, hydrants, tanks, or non-potable waters supplies whereby unsafe water or other contaminating materials may be discharged or drawn into the system. KDHE approval shall be obtained for interconnections between potable water supplies. KDHE does not approve of the interconnection of any public water supply water line with any individual or independent water supply source such as a home well. Neither steam condensate nor cooling water from engine jacket or other heat exchange devices shall be returned to the potable water supply.

KSA 65-171g prohibits the contamination of water (and air) by sewage through direct connection or back siphonage and KAR 28-15-18 (f) requires each PWSS to have a formal cross-connection prevention program. KDHE must approve the program used to accomplish the control. Publications regarding cross-connection control are available from AWWA (2004a), USEPA (2003c), and University of Southern California (1993).

The water purveyor should be aware of any situation requiring an inspection and/or a reinspection necessary to detect hazardous conditions resulting from cross connections. If, in the opinion of the water purveyor, effective measures consistent with the degrees of the hazards created by the cross-connections have not been taken,

then the water purveyor should immediately take such measures as are deemed necessary to ensure that the PWSS is protected from any contamination arising from any of the cross-connections. Appropriate measures may include requiring the installation of a backflow protection device consistent with the degree of hazard or discontinuance of service.

4. LINE CROSSINGS – Special precautions should be taken to prevent possible damage to line crossings.

   a. SURFACE WATER CROSSINGS – Surface water crossings, both over and under water, present special problems which should be discussed with KDHE before final plans are prepared. Where the ground has inadequate bearing capacity, pile supports, stringers, or other acceptable methods shall be used. A pipeline crossing of a perennial stream having 50 or more square miles (130 km^2) of drainage area above the proposed project site requires a permit from DWR, except for a directionally bored crossing or a crossing consisting of a pipeline non-obstructively attached to an existing bridging structure.

      1) Above-Water Crossings – The pipe shall be adequately supported, protected from damage and freezing, and accessible for repair or replacement.

      2) Underwater Crossings – Underground pipelines shall be buried at a sufficient depth below streambeds to prevent exposure.

         a) On navigable streams, underground pipelines shall be buried at a minimum depth of 7 ft. (2.1 m) beneath the streambed.

         b) On all other streams, underground pipelines shall be buried at a minimum depth of 5 ft. (1.5 m) beneath the streambed.

         c) When crossing water courses which are greater than 15 ft. (4.6 m) in width,

            (1) The pipe should be of special construction, having flexible, restrained or welded watertight joints.

            (2) Valves should be provided at both ends of water crossings so that the section can be isolated for testing and repair; the valves should be easily accessible, and not subject to flooding.

            Permanent taps or other provisions to allow operators to determine leakage and obtain water samples should be made.

b. RAILROAD CROSSING AND MAINS NEAR TRACKS – where a water main crosses under railroad tracks, all joints lying within 10 ft. (3.0 m) of the rails shall be either mechanical joints with rubber gaskets or pipe with bell joints. Also, local requirements should be investigated. Some railroads require that the water main be enclosed in a culvert, tunnel, or conduit to reduce the effects of vibration, to provide drainage in case of leakage or rupture of the pipe, to reduce damage to the track, and to facilitate repairs.

c. MECHANICAL ENCASEMENT – Where a water line must be sleeved within a pipe in order to protect the water line, such as at road, railroad, or pipe way crossings, the water line must be sleeved with seamless, jointless pipe of equal or greater mechanical strength for distance of at least 10 ft. (3.0 m) beyond the crossing in both direction, kept separate from the sleeve pipe with plastic spacers or wooden skids, and the annular spaces formed at the ends of the carrier/sleeve pipes must be made watertight with flexible boot type end seals.

5. PRESSURE – When static pressures in the distribution system exceed 100 psi (690 kPa), pressure-reducing devices should be considered for mains in the distribution system. Pressure-reducing devices should be provided for individual service connections and set to limit the delivery pressure for individual service connections as is required by local code.

6. DEAD ENDS – Where feasible, dead ends should be minimized by the looping of distribution mains. Dead-end mains should be provided with a fire hydrant if flow and pressure are sufficient, or with an approved flushing hydrant, or a blow-off for flushing purposes. Flushing devices should be sized to provide a velocity of at least 2.5 ft/sec (0.76 m/s) in the water main being flushed. No flushing device shall be connected directly to any sewer.

   Where dead-end mains are necessary in the first stage of construction of a distribution system, the pipe layout should be designed to ensure adequate circulation in the initially installed system and to accommodate future additions and connections.

7. REPAIRS, REPLACEMENTS, AND EXTENSIONS OF MAINS – The system shall be maintained so as to prevent its contamination during necessary repairs, replacements, or extensions of mains. When pressure in any part of the distribution system becomes abnormally low, customers in the area shall be notified of necessary protective health precautions.

8. FROST – The crowns of all water pipes should be at least 6 inches (15.2 cm) below the maximum recorded depth of frost penetration in the area of installation. The minimum depth of water mains should be at least 3 ft. (0.9 m) from the ground surface to the top of the pipe.

9. PLASTIC PIPE – Plastic pipe intended for transport of potable water shall be evaluated and certified as safe for this purpose by a testing agency acceptable to KDHE. The evaluation should be in accordance with requirements for chemical extraction, taste, and odor that are no less restrictive than those included in NSF International's ANSI/NSF Standards 14 and 61. The seal or mark of the laboratory making the evaluation shall be included on the pipe.

10. PRESSURE AND LEAKAGE TESTS – Pressure and leakage tests shall be conducted on each newly installed water main in accordance with AWWA standards or KDHE's procedures for pressure and leak testing of water mains (Appendix C). The allowable leakage shall not exceed that established by AWWA standards or KDHE procedures (Appendix C).

11. THRUST BLOCKS – All tees, crosses, wyes, bends, plugs, valves, direction changes, and hydrants shall be provided with thrust blocks, tie rods, or joints designed to prevent movement.

12. VALVES – Each system shall be provided with sufficient valves to permit necessary repairs without undue interruption of service over any appreciable area. Blow-off connections to sewers or sewer manholes are not permitted.

13. SANITARY PRECAUTIONS – Sanitary precautions shall be taken in laying new pipe, especially in preventing the introduction of foreign materials into the pipe. Water should be kept out of the trench where new pipe is laid and the open ends of the pipe shall be plugged or capped overnight to eliminate potential sources of contamination.

    The selection of materials is critical for distribution piping in locations when it is likely that the pipe will be exposed to significant concentrations of pollutants comprised of low-molecular-weight petroleum products, organic solvents, or their vapors. Pipe materials such as polyethylene, polybutylene, polyvinyl chloride, and elastomers, such as those used in jointing gaskets and packing glands, may be subject to permeation by lower molecular weight organic solvents or petroleum products. If a water main must pass through such a contaminated area, materials impermeable to the particular contamination shall be used for pipe walls, jointing materials, etc., as certified by the manufacturer of the pipe for at least 25 ft. beyond the perimeter of the area of concern.

14. DISINFECTION – All water shall be properly disinfected (KAR 28-15-19) before it reaches the first (nearest) consumer on the distribution system. Water stored for prolonged periods in reservoirs may require re-disinfection upon re-entry to the system. New mains and repaired main sections shall be disinfected according to applicable AWWA standards or KDHE's procedures for the disinfection of water mains (Appendix D) before being placed in or returned to service. When connections are made to an existing system, the exposed pipe interiors should be thoroughly

wetted with a 1% (10,000 mg/L) or higher concentration chorine solution before closure.

15. DEPOSITS AND CORROSION – Corrective water treatment should be practiced where excessive deposits of chemical precipitates, biological growths, or corrosion occurs in the mains. Disinfection will control biological growths and water stabilization should be used to control chemical precipitation and minimize pipe corrosion (Section L of Chapter V, Stabilization).

    Chemicals added to the water for corrosion control shall conform to applicable AWWA standards, shall be certified to NSF International's ANSI/NSF Standard 60: Drinking Water Treatment Chemicals – Health Effects, or equivalent, shall be acceptable to KDHE, and shall protect public health and the environment (KAR 25-05-18(h)). The corrosive effects of finished water on non-ferrous metal pipe used for water service lines should be considered, including possible toxicological effects upon consumers resulting from dissolution of the metals.

    Water mains shall be protected from exterior corrosion by use of selected material for backfill or by wrapping or coating the pipe exterior with protective material. A 10-point soil evaluation procedure for predicting conditions corrosive to underground piping is provided in AWWA Standard C105.

16. PLUMBING – Water services and plumbing shall conform to all local plumbing codes.

C. MATERIALS AND INSTALLATION

1. USED PIPE – Water mains that meet the above standards may be reused but only after the pipe has been thoroughly cleaned and restored as much as possible to its original condition.

2. JOINT MATERIALS – Materials used in pipe joints shall meet applicable AWWA standards. Mechanical joints or slip-on joints with rubber gaskets are preferred. Gaskets containing lead shall not be used. Repairs to lead-joint pipe shall be made using alternative materials. Manufacturer approved transition joints shall be used between dissimilar piping materials. Solvent weld joints will not be approved for water mains, but may be used for service connections with pipe sizes less than 2 inches (5.1 cm).

3. AIR RELIEF VALVES, COMBINED AIR/VACUUM RELIEF VALVES, AND BLOW-OFF CHAMBERS – At high points in water mains where air can accumulate, provision shall be made to remove air by means of hydrants or air relief valves. Automatic air relief or combined air/vacuum relief valves shall not be used where flooding of the manhole or chamber may occur.

The open end of the air relief pipe from an automatically operated valve shall be extended to at least 1 ft. (0.3 m) above grade and provided with a screened, downward-facing elbow. The open end of the air relief pipe from a manually operated air relief valve should be extended to the top of the pit. Manual operation of an automatic air relief valve shall be possible.

The open end of the relief pipe from a manual or automatic combined air/vacuum relief valve shall always be extended to at least 1 ft. (0.3 m) above grade and provided with a screened, downward-facing elbow. Termination of the open end of the pipe from a manual or automatic combined air/vacuum relief valve at the top of the pit will not be approved. Manual operation of an automatic combined air/vacuum relief valve shall be possible.

Chambers or pits containing valves, blow-offs, meters, or other such appurtenances to a distribution system, shall not be connected directly to any storm drain or sanitary sewer, nor shall blow-offs, air relief valves, or combined air/vacuum relief valves be connected directly to any sewer. Such chambers or pits shall be drained to the surface of the ground where they are not subject to flooding by surface water, or to absorption pits underground.

Air relief and combined air/vacuum relief valves should be located as close to the pipe as possible with all interconnecting (riser) pipe to be oriented upward to the valve from the water line. Isolation valves should be the same size as the interconnecting piping and should be located between the water line and valves.

4. FIRE HYDRANTS – Because freezing temperatures are a concern for distribution systems in this region, only "dry-barrel" hydrants will be approved for installation and such hydrants shall comply with AWWA Standard C502. Hydrant drains shall not be connected to a sanitary sewer or storm sewer. Specifications for installation of hydrants may be found in the AWWA Manual of Water Supply Practices M17 (AWWA, 1989).

   Fire hydrants should be connected only to water mains adequately sized to carry fire flows, and located to permit flushing of all mains and in compliance with local fire code requirements. Generally, fire hydrants should be provided at each street intersection and at intermediate points between intersections. Hydrant spacing may range from 350 to 600 ft. (107 to 183 m) depending on the area being served and the design flow. Additional discussion of criteria for the location of hydrants can be found in the AWWA Manual of Water Supply Practices M31 (AWWA, 1998).

5. INSTALLATION OF MAINS – Installation should follow applicable AWWA standards, AWWA Manuals of Water Supply Practices, and/or the manufacturer's recommended procedures. AWWA standards include C600, *Installation of Ductile-Iron Water Mains and their Appurtenances* and C605, *Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water*. AWWA Manuals

of Water Supply Practices include M23 (AWWA, 2002) for PVC pipe and M11 (AWWA, 2004b) for steel pipe. Widely recognized industry guidelines for the installation of PVC pipe are also provided by the Uni-Bell PVC Pipe Association (Uni-Bell, 2001). Similarly, widely used guidelines for the installation of ductile iron pipe are published by the Ductile Iron Pipe Research Association (DIPRA, 2003).

Continuous, uniform bedding should be provided in the trench for all buried pipe. Backfill material should be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe. Stone found in the trench shall be removed for a depth of at least 6 inches (15.2 cm) below the bottom of the pipe and replaced with bedding material(s) having appropriate compaction and load bearing properties.

Newly constructed or repaired water distribution mains shall be flushed and disinfected prior to being placed into service (KAR 28-15-18(d)).

D. SYSTEM DESIGN

1. FIELD STUDIES – The hydraulic performance of existing systems is determined most directly and expeditiously by pressure surveys and hydrant-flow tests. Such testing should cover all typical portions of the community, and if need be, they can be extended into every block. The results obtained will establish available pressures and flow, and will reveal existing deficiencies. This information can then be utilized as the basis for hydraulic calculations of extensions, reinforcements, and new grid arrangements. Following the completion of system improvements, additional tests can be conducted to determine the extent to which the desired changes have been accomplished.

2. COMPUTER MODELING – No matter how well or complete the field study is done, hydraulic investigations of extensions and new and existing pipe networks should be confirmed using available computer analysis programs. Guidelines for performing such an analysis can be found in AWWA's Manual of Water Supply Practices M32 (AWWA, 2005b) and *Water Distribution Systems Handbook* (AWWA, 2000).

3. VALVE SPACING – Valves should be placed in numbers and locations that allow control of the system consistent with cost limitations, convenience and minimization of possible sanitary hazards. Valves in smaller mains are typically more numerous than those in larger mains. In transmission lines, valve spacing is determined by operating requirements, and thus it is a matter of individual design. Typical limits on valve spacing in distribution systems are not more than 500 ft. (152 m) in commercial districts, not more than one block or 800 ft. (244 m) in other districts, and where customers are widely scattered or where future development is not expected, such as in a rural setting, not more than one to two miles (1.6 to 3.2 km).

4. VALVE SIZING – Valve sizes are normally the same as the water main in which they are installed except that in mains 30 inches (76 cm) in diameter and larger, line valves are sometimes smaller than the main size.

   Fire hydrants should have a bottom valve size of at least 5 inches (12.7 cm), one 4.5 inch (11.4 cm) pumper nozzle, and two 2.5 inch (6.4 cm) nozzles. The hydrant lead shall be a minimum of 6 inches (15.2 cm) in diameter. Auxiliary valves shall be installed in all hydrant leads.

   Blow-off valves are usually sized to be 6 inches (15.2 cm) for mains 6 to 16 inches (15.2 to 40.6 cm) in diameter, and 8 inches (20.3 cm) for mains 20 inches (50.8 cm) in diameter and larger.

5. VALVE LOCATION – Valves are usually located on the extensions of the various street property lines involved. Where property lines are not involved, the valves should be placed so that they can be referenced with respect to certain obvious monuments. Valves should be readily accessible in the event of a main failure.

   Branch mains connecting to larger primary or secondary feeders that cross under an arterial highway or street should have the valve located close to the larger main and before the crossing.

   Blow-off valves and fire hydrant valves should be located as close to the connected main as possible.

   Buried valves normally are contained in a conventional valve box assembly. Vaults are not necessarily required.

6. METERING – Each service connection shall be metered. A routine testing program is needed to check the accuracy of all meters in the system. Inoperable or malfunctioning meters should be repaired or replaced. Abnormal water usage should be investigated to insure that service connections are not leaking or broken, especially where geologic conditions may prevent detection of leakage by observation.

   Master meters that meter water supplied to distribution systems should be checked periodically for accuracy. They may either over-register or under-register. The percentage of error as determined during an in-place test of the meter is reflective of the meter's accuracy and an indication of when it would be appropriate to replace it with a new meter. Factors such as water quality, flow rate, total quantity measured, chemical deposition and physical abrasion can adversely impact a meter's accuracy. Proper selection and installation of master meters is important.

   When planning a master meter installation, attention should be given to providing adequate lengths of straight pipe upstream and downstream of the meter to ensure

maximum uniformity of flow and hence accurate registration. Provisions for testing a master meter in place without interruption of service by use of a test plug and a comparative test meter should be included in the design of the installation. Where a single meter is installed, a bypass circuit should be provided so that meter maintenance can be accomplished without interrupting service.

Meters shall meet applicable AWWA standards. Recommended practices for the selection, installation, testing, and maintenance of water meters are provided in the AWWA Manual of Water Supply Practices M6 (AWWA, 1999b).

7. WATER LOADING STATIONS – Water loading stations present special problems since the fill line may be used for filling both potable water vessels and other tanks or contaminated vessels. To prevent contamination of both the public supply and potable water vessels to be filled, the following requirements shall apply to the design of water loading stations.

   a. A backflow prevention assembly, device, or method shall be utilized to prevent any backflow to the PWSS. Preventing backflow into a loading station by providing a mandatory air gap between the receiving tank, vessel, or container and the discharge end of the potable water supply pipeline of not less than 2 times the diameter of the water delivery spout opening is preferred. Alternatively a backflow prevention device or a vacuum breaker device that meets KDHE requirements may be installed.

   b. The piping arrangement shall preclude the transmission of any type of contamination from a hauling vessel to other hauling vessels that subsequently utilize the fill station.

   c. Hose lengths shall be restricted to prevent contamination through contact with the ground.

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