RURAL WATER PIPELINE HANDBOOK FOR SASKATCHEWAN

UNIT SIX (VI) -
TECHNICAL DESIGN
& OPERATIONAL GUIDE

April 2009

Section 1 Rural Pipeline Overview

1.0 General/Objective

The objective of rural pipeline design is to economically provide as many rural residents, businesses and small communities as is practical with a continuous Low Volume water supply that meets or exceeds the Saskatchewan's Drinking Water Quality Standards and Objectives.

1.1 Characteristics of Rural Pipelines

The following is a list of design parameters that are employed in rural pipeline design that are not typically used in municipal design:

- ✓ Delivery is based on an average flow over a 24 hour period;
- ✓ Fire flows are not included in the design plan
- ✓ The layout is based on branch design. Loop design is preferred but is generally not considered because of cost.
- ✓ Most rural pipelines are designed with in-house storage (cistern) systems which increases the reliability of water supply.
- ✓ In the event of loss of flow from the supply line, the subscriber relies on the reserve water from their storage tank until flow is restored.
- ✓ Storage tanks help to reduce the instant demand on the water source especially in peak periods during the day, thereby making the pipeline safer and more economical.
- ✓ The client is expected to install their own in-house pressure system to provide the desired pressure that they want. In some circumstances, in-house treatment systems are also installed by the client.

1.2 Flow and Pressure Requirements

Rural pipeline designs are generally based on the assumption that each client would simultaneously receive a predetermined design flow if each of the subscribers were to draw water at the same time. A design flow target of 0.038 l/s (.5 igpm) is often used, but some pipelines are designed with higher flows of 0.076 l/s (1.0 igpm). The flow must represent a balance between cost, client need, and experience based on the operation of previous rural pipelines. Design flows should:

- ✓ Result in an economically viable project;
- ✓ Meet the client's current and future in-house average daily requirements; and
- ✓ Provide additional capacity for future expansion (an important consideration given the investment of public funds).

1.3 Storage Requirements

Most rural water pipelines are designed so that in the event of an interruption of water flow, the impact of pressure demand and flow is reduced because of in-house reservoirs, which allow subscribers to draw water from their holding tanks until the system resumes flow and the reservoir is topped up again. Temporary shutdowns of the rural pipeline or its source may occur leaving the subscribers without water for short periods of time. It is recommended that all subscribers have in-house storage and in some cases *Pipeline Organizations* have implemented mandatory storage requirements in order to qualify for grants or funding. Also, the agreement with your water supplier may stipulate that as a condition of service, your *Organization* shall require every hook-up to include a cistern that is constructed in such a manner that a suitable air gap is maintained to prevent backflow contamination. The size of the storage should be based on the subscriber's need for an uninterrupted supply of water but consideration should be given to stagnant water and dissipating chlorine residuals. If a reservoir is sized too large, it could lead to problems due to water not being refreshed often enough. As a rule of thumb, a two day supply is recommended which may vary from household to household. Typical storage tanks range between 450 and 4500 litres (100 to 1000 ig). In some cases, subscribers may have an existing cistern they wish to use for storage, such as a buried concrete cistern or a cistern in their basement. Below ground cisterns are not recommended and some *Pipeline Organizations* do not allow them because of the inability to maintain an air gap.

Section 2 Source Development

2.0 General

Examples of suitable sources of water for pipelines are wells, rivers, lake intakes, existing pipelines and municipal systems. The source may be either raw water or treated water. The quality of the source water will determine what treatment process is required. If the source is a treated water supply, all that may be required at the tie-in location is a meter, isolation valve, sampling port and suitable backflow prevention to protect the supply source. Please refer to UNIT V - Approvals and Agreements for information regarding the regulatory and legal requirements for each type of water supply source.

2.1 Existing Pipeline

2.1.1 General Considerations

An existing pipeline must have sufficient flow and capacity to supply the new rural pipeline project without adversely affecting its existing clients. Design flow models should be used to determine the impact on the existing pipeline's pressure and flow when additional subscribers are added to it.

Assuming that the existing pipeline has enough flow to accommodate its needs and also to supply the quantity of water needed for the new pipeline, pressure requirements still have to be considered. In some situations a booster station may be required, or it may be possible to twin sections along the existing pipeline to boost the flow and pressure to meet the demands of the new line.

2.1.2 Sask Water Corporation (SWC) Utility Pipeline

Connecting to a SWC Utility pipeline may be an option for some new *Pipeline Organizations* that are in proximity of a SWC line. At the very minimum, SWC generally requires a manhole or vault at the tie-in point which would house a water meter, suitable backflow protection and an isolation valve. SWC has offices throughout the province that would likely be able to advise if the flow and pressures would meet the demands of a proposed pipeline. If a booster station is required, the above mechanical equipment could also be housed inside the pumphouse or booster station.

2.1.3 Other Group Pipeline

Connecting to an existing pipeline group's distribution system may be an option for some organizations. This would require testing and collection of data to determine line pressure, flows, peak usage rates and available water that could be supplied to the new pipeline group.

2.1.4 Municipal Systems

Municipal systems usually provide reliable sources of good quality water. The capacity and pressure available at the proposed connection point will need to be determined and may possibly be obtained from the water utility department. If the municipal system's pressure is not sufficient to meet the requirements of the rural pipeline, a pumphouse may be added to the pipeline design at the point of the supply connection to boost water pressure and flow. Booster stations may also need to be incorporated downstream to maintain pressure and flow requirements throughout the distribution system.

When connecting to an existing supply pipeline such as a municipal waterline, the municipality may request that a pressure sustaining valve be installed and set to activate if the supply pressure falls below a preset parameter. The pressure sustaining valve allows the municipality to suspend water flow to the *Pipeline Organization* when a pressure drop occurs in the supply line due to fire fighting or line breaks and prioritizes flow to meet their needs.

Supply line connection points that use below ground metering vaults or manholes are not recommended because of the problems associated with below ground systems such as potential flooding and cross contamination, confined space protocol, and inability to add post chlorination equipment. A preferred method of connecting to a supply line is to erect a building that will house the water meter, backflow protection device, isolation valve and any other equipment that may be required. Accessibility is an important issue and should be considered so that water quality and volumes can be monitored and water samples can be easily extracted for analysis. Also, a pumphouse will allow the municipality a suitable site to check the current demand on the distribution system versus the total future water demand including the new pipeline.

2.2 Wells

New and existing wells can also be used to provide a source of water for rural pipelines. Unlike purchasing treated water from an existing supply line, the cost of the raw water is minimal. The real cost however, will depend on what is required to find and develop the water supply and the operational costs incurred to maintain acceptable quality standards. If a well is chosen as the proposed water source, steps need to be taken to determine if the well is of acceptable quality and capacity and whether it could be developed as a source for the rural pipeline. Generally this would consist of extensive water quality testing and also pump testing to determine the sustainable yield. As with any water source, appropriate approvals and agreements need to be in place prior to the development of the source. (See Unit V - Section 2.2).

2.3 River or Lake Intake

River and lake intakes can be difficult structures to engineer and construct. The seasonal variations in water levels can fluctuate dramatically and the intake location may be subject to severe sedimentation. Intake structures must be able to provide a year round water supply for the life of the project. If possible, it is advisable to investigate existing intake structures rather than develop a new one. Providing there is sufficient flow through the wet well, a submersible pump could be used to retrofit an existing intake works.

River and lake intakes are only one of the hurdles that need to be overcome when using surface water. Many challenges exist in the treatment of surface water as the quality of the raw water is always changing. Each season presents new problems for the operators.

Section 3 Pipeline Design

3.0 General

The two most commonly used thermoplastics for water pipelines are polyvinyl chloride (PVC) and polyethylene (PE) pipe. Both materials are acceptable for use in the Province of Saskatchewan. There are advantages and disadvantages for using each of these thermoplastics for water pipeline installation. One of the advantages of using PVC pipe is that it is generally more economically priced than PE pipe. However, for pipe sizes of 100 mm (4 inch) or less which are most commonly used for rural water pipelines, the PE pipe can be shipped in reels and can be plowed directly into the ground which makes it the product of choice for most rural pipeline installations. Both types of pipe should be presented to the *Pipeline Organization* so that they may choose their best option.

3.1 Pipe Material

3.1.1 Polyvinyl Chloride Pipe (PVC)

All PVC pipes that are used for rural water pipeline applications must be certified suitable for potable water by the CSA testing Laboratory, and conform to the requirements of CSA:B137.3-M1990.

Rigid PVC small diameter pipe of nominal diameter of 100 mm (4 in) or greater must be manufactured in accordance with the latest edition of CSA B137.3 Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications, and also the latest standards issued by the American Water and Wastewater Association (AWWA) and the Canadian General Standards Board (CGSB).

The CSA B137.3 standard has a maximum allowable internal pressure in kPa (psi) to which the pipe can be subjected (operating or working and surge pressure) which is designed by the series number (Series 100, 125, 160, etc.) for IPS-Schedule, SDR, DR sized PVC pipe. As a rule of thumb, the maximum allowable working pressure would be approximately 62 per cent of the series rating. For example, the allowable working pressure of Series 160 PVC would be 160 x 0.62 = 100 psi.

CI-DR and SDR PVC pipe sizes may be referred to by the class system where class 100 is equivalent to 690 kpa (100 psi) DR 25, Class 150 is equivalent to 1035 kpa (150 psi) DR 18 etc. The class number (100, 150, 200, etc.) corresponds to the maximum allowable working pressure in psi (kpa) to which the pipe can be subjected. The class ratings provide for a pressure rise above the maximum working pressure caused by a surge that does not exceed that caused by an instantaneous velocity change of 0.6 m/s (2ft/s).

If the pipe is to be used at a temperature above 23° C then the effective pressure rating of the pipe must be lowered. For normal water pipeline installations, the expected internal pressures will dictate the pipe strength requirements for the PVC pipe. For water pipelines, a minimum of Series rating 160 or Class 100 or equivalent should be used.

3.1.2 High Density Polyethylene Pipe (HDPE)

All PE pipe used for water pipelines must be certified suitable for potable water by the CSA testing Laboratory and conform to the requirements of the latest edition of B137.0-1986 standards for polyethylene pipe, tubing and fittings for cold water pressure services, and the latest standards issued by AWWA and CGSB. The CSA B137.1 standard covers pipe up to and including 150 mm (6 inch) nominal diameter.

With PE pipe, the Series number (100, 160, etc.) represents the maximum allowable working pressure in psi (kPa) to which the pipe should be subjected at 23° C, with an allowance for surge pressure of approximately three times the series number. Transient or surge pressures normally experienced in pipes can be permitted to raise the total internal pressure above the pipe series rating provided the normal working pressure is below the series rating and the duration of the excessive pressure is short and followed by a period of recovery. If required, contact the manufacturers for pressure-duration specifics.

The effective pressure rating of PE pipe must be reduced if it is to be used at working temperatures above 23° C. As an example, at temperatures between 30 and 38° C, PE pipe should not be operated in excess of 80 per cent of the Series pressure rating.

Internal pressures will normally dictate PE pipe strength requirements for water pipelines. Manufacturer’s design curves can provide sufficient information to allow a designer to select the required pipe Series. Much of the pipe supplied for existing water pipelines is coiled PE pipe. For water pipelines, a minimum of CSA Series 100 PE pipe (DR17) may be used for main lines and laterals. Working pressures may be, for example, 60 psi but the pipe could be subjected to 100 psi during flushing and cleaning. Service lines should be a minimum of CSA Series 160 PE pipe.

3.2 Types of Water Pipelines

Water distribution pipelines can generally be categorized into two groups - pipelines that require their subscribers to have suitable storage or reservoirs and those that do not.

3.2.1 Pipelines with Storage

Most pipelines are designed as low pressure distribution systems that include an in-house storage reservoir. This type of distribution system adds reliability to the water supply in the event of reduced water flow due to accidents or normal maintenance. Properly designed storage facilities can also reduce the instant demand on the water source thereby reducing the cost and size of pipes, pumps and related infrastructure. For water pipelines with storage, each residential connection should have a storage tank, preferably an in-house holding tank, which is sized for at least two days of future average day demand. The typical size of water storage for in-house use with a family of three persons is 1.4 m3 (300 imperial gallons). In addition to economic benefits to the pipeline because of reduced costs in pipes and equipment, in-house reservoirs provide a means of safeguarding the distribution system from backflow contamination by installing a proper overflow below the supply inlet on the holding tank to create and maintain an air gap. Additional information on air gaps and backflow prevention can be found in Unit IV - Section 2.3.4.

3.2.2 Pipelines without Storage

If the proposed water pipeline calls for no in-house storage, then water pipelines must be sized to meet the future instant demand of the water pipeline which is considerably greater than the future peak day demand of systems with storage. The design flow of systems without storage may be more than 10 times greater than the design flow of a system with storage. In a zero storage water pipeline, the mainline, lateral and service connection pipes must be designed to have a higher flow rate than systems with storage. As an example, if 15 subscribers simultaneously opened their kitchen tap, the instant water demand may be 30 igpm (2.3L/s). A system with in-house storage in a similar situation would have a peak demand of less then 5 igpm (0.4L/s). If a water pipeline that is designed to supply water to zero-storage subscribers is not able to meet the water demands, a negative pressure event may be experienced.

3.3 Estimating Water Quantity and Flow

Many variables regarding water quantity and flow need to be considered when designing rural water pipelines. Consideration needs to be given to the terrain in which it is installed, particularly if there is severe change in elevation. The pipeline should be designed to handle the operating pressure plus surge (if applicable) as well as any pump shut off condition (if applicable).

3.3.1 Pipeline Water Demands

Pipeline water demands are to be based on evaluating the number of people living in each household, number and types of livestock, extent of lawn and garden irrigation, tank filling and other yard use. PFRA has collected data on several projects that they have been involved with and this data can be viewed at: (Appendix VI - A). Design flow for systems without storage is much higher than systems with in-house storage. Future demand growth should also be considered in design flow calculations.

Most rural farm pipelines are designed to have a peak water demand of approximately 6.5 m3/day or 1.0 igpm if no other design information is available. However, some operating water pipelines show peak water demands as low as 0.65m3/day or 0.1 igpm for household purposes only. A chart showing typical water usage can be seen at (Appendix VI - B).

3.3.2 Modeling Flows in Pipelines

The flow capacity of a water pipeline is commonly modelled by the Hazen-Williams equation http://www.saskh2o.ca/DWBinder/EPB276WaterPipelineDesignGuidelines.pdf (Scroll down to Point 9.2)

Flow calculation equations and associated computer simulation packages operate under derivations of the Hazen-Williams equation. Design velocity should be a maximum of 1.5 m/s (5ft/s), and a minimum of 0.6 m/s (2ft/s).

Most rural pipelines are designed with flow velocities that are generally less than 1.0 m/s to minimize surge problems. Pressure losses in PVC and PE pipe should be calculated using standard friction loss formulas, as recommended by the pipe manufacturer. The modified ISO formula may be used to select the pipe pressure ratings as per the manufacturer specifications. Other considerations are as follows:

- ✓ The Series rating should not change in the middle of a section of pipeline, unless elevation change is great (e.g. at coulees/river crossings)
- ✓ Changes should be made

3.3.3 Allowances for Future Capacity

Future capacity requirements should be identified by the *Pipeline Organization* as soon as possible, to ensure proper design of pipe. However, existing systems without "designed" future expansion can usually accommodate additional clients if storage is added or by adding on a booster station(s) or twinning sections of the existing pipeline. Adding more connections to an existing system may decrease the pressure and flow for some subscribers. Existing projects not currently using flow restrictors may require flow restrictors to accommodate more tapoffs.

Where the potential for future expansion exists, the pipeline should be designed to accommodate the anticipated expansion (e.g. an extra 5 igpm (0.38 L/s) for future connections at a specific location along and/or at the end of a current pipeline).

The *Organization* should consider the possibility of reasonable future expansion from two perspectives:

1) Expansion of their own system and,
2) Expansion for other user groups to tap into the existing supply.

Expansion can be built into the system through a combination of:

1) Over sizing pipe size and pressure rating and supply manifolds;
2) Designing higher capacity pump and pressure tank systems.

The *Organization* is encouraged to make every effort to provide for expansion of their system to accommodate future users.

When determining the amount of additional flow to “build” into the pipeline, a number of factors should be considered;

- ✓ Potential for additional development within the pipeline area (e.g. Acreages, subdivisions).

- ✓ Potential for additional commercial users (e.g. Livestock operations, greenhouses, custom spraying).
- ✓ Location of potential additional consumers (e.g. Clusters of houses near the pipeline vs. pasture land).

It may be difficult to incorporate additional flow into the pipeline for potential large volume users as the increase in cost vs. the possibility of a large subscriber may not be justified.

Many of these issues are best answered by the local *Pipeline Organization* or Rural Municipalities as they are often aware of development plans in the local area.

3.4 Pressure Requirements

3.4.1 Design Flow

Some subscribers require more than basic 0.076 l/s flow (large livestock operations or small communities). In these cases, the subscriber's actual average daily flow requirement is used. (Appendix VI - B)contains information on how to calculate the amount of water that a subscriber may require.

In some situations a design flow of 0.038 l/s (0.5 igpm) has been used as the basis of design. The designer should be aware of the potential future demand that may be placed on the system and ensure that the system capacity can handle future demand. Future demands may involve flows required by new subscribers and/or an increase in the flows required by existing subscribers.

3.4.2 Actual Flows

The actual flow at any given point and time along the pipeline will be different than the design flow when the system is operational. The nature of the actual water use in the system and the location of a specific user in the system will affect the flow that is available for each user. However, when flows are considered over a 24 hour period, they should be sufficient to meet the all of the subscriber's daily water requirements.

Typical usage data for a member of a rural *Pipeline Organization* show the following results: To date, the results indicate average usage rates of 800 to 1600 l/day (175 to 350 igpd). The **average** flow rates were 0.015 to 0.023 l/s/client (0.2 to 0.3 igpm) and the **peak** flow rate was 0.053 to 0.121 l/s/subscriber (0.7 to 1.6 igpm).

3.4.3 Design Delivery Pressure

The system is designed assuming that under the design flow condition (typically 0.076 l/s), the minimum water pressure at each curbstop is 98 kPa (10 m of head, 14 psi). This minimum pressure should be checked to ensure that it is sufficient to compensate for any head losses between the curbstop and the subscriber's storage tank.

3.4.4 Actual Delivery Pressure

The actual curbstop pressure may be significantly different than the pressure under the design flow conditions. The pressure available at any specific point will depend on the actual water use in the system and in most cases; the pressure will be higher than the design flow pressure. During certain operating conditions, however, the pressure at some curbstops may actually be below 98 kPa (10 m of head, 14 psi). This must be carefully monitored with accurate data to ensure a negative head is not incurred on the pipeline, which may result in damage to the pipeline.

3.5 Pipe Sizing and Series Selection

3.5.1 Line Sizing

Line sizing will be determined by the volume of water and the number of subscribers. The distance of the following points should be considered when selecting line size and series:

- ✓ The diameter of all lines shall be such that the maximum water velocity is less than 1.0 m/s.
- ✓ In general, the minimum size of mainline serving three or more connections, should not be less than 50 mm (2 in) nominal diameter.
- ✓ In general, the minimum size of lateral line should not be less than 38 mm (1.5 in) nominal diameter.
- ✓ The minimum size of pipe on the source side of the curbstop is 38 mm diameter.
- ✓ Typically 25 mm CTS PE Series 200 pipe is installed from the client side of the curbstop to the client's cistern.

3.5.2 Series Selection (Pressure Ratings)

On rural pipelines, flow velocities are generally designed to be less than 1 m/s to minimize surge problems.

The pipeline should be designed to handle the operating pressure plus surge (if applicable) as well as the pump shut off condition (if applicable). The designer should be aware that negative pressures can occur and consider the conditions that may lead to their occurrence.

Pressure losses in PVC and PE pipe shall be calculated using standard friction loss formulas, as recommended by the pipe manufacturers. The modified ISO formula shall be used to select the pipe pressure ratings as per the pipe manufacturer's specifications:

- ✓ The Series rating should not change in the middle of a section of pipeline, unless elevation change is great (e.g. at coulees/river crossing); changes should be made at defined points such as valves, tees, pumphouses etc.

- ✓ The number of pipe changes in a pipeline should be minimized to avoid confusion.
- ✓ Consideration should be given to operation and maintenance. For example, swabbing may be impeded if the pipe diameter changes in the middle of a section of pipeline.
- ✓ The Series rating of the pipe shall be selected based on the design procedures recommended by the pipe manufacturers.
- ✓ The minimum Series rating for PVC pipe 75 mm diameter and smaller, will be Series rating of 1103 kpa (160 psi).
- ✓ The minimum Series rating used for PE pipe will be 689 kPa (100 psi).

Section 4 Pipeline Mechanical Appurtenances

4.0 General

The physical location of the various pipeline mechanical appurtenances should take into account issues such as ease of access, protection from vehicles and farming equipment, surface drainage, and ground water levels.

4.1 Valves

4.1.1 Isolation Valves (Shut-Off Valves)

Where a mainline feeds several smaller lines, a valve should be placed at the beginning of each of the smaller lines so they can be isolated from the larger mainline for repairs, testing or flushing. Future connections can also be added without disrupting service on the mainline.

4.1.2 Manual Air Release Valves

Manual air release valves are not normally placed at high points along the pipeline. In some cases, air release valves are installed after the pipeline is trenched in to assist with filling, flushing and testing the new line. The number of manual air release valves should be kept to a minimum. Location of the valves requires ease of access to the land use and suitable drainage. House connections can also be used to purge air from the pipeline for filling and for testing.

4.1.3 Automatic Air Release Valves

Automatic air release valves and combination air release/air vacuum valves are not common and are only installed where a line break or other situations could create a large negative pressure in the system. These valves are required to be placed inside a manhole/pump house for frost protection.

4.1.4 Combination Air Release Air Vacuum Valves

Backflow prevention valve assemblies are required at the source connection and at all subscriber connections.

4.2 Curb Valve Shutoff

4.2.1 Curbstops

Curb valves or “curbstops” are required to isolate each subscriber connection from the main line. The location of the curbstop is determined by the *Pipeline Organization* in consultation with the engineer, unless otherwise instructed by a regulatory agency such as Ministry of Environment, Sask Health/Health Regions, Sask Water, or any other water purveyor.

4.2.2 Curbstop Location

Curbstops are typically placed at the property line and should be identified with a marker such as a painted 4x4 post, metal, plastic or fibreglass rod. Markers will offer some protection from vehicles and off-road traffic as well as warn maintenance crews of the valve placement when cutting grass and performing other maintenance duties. Markers should have reflectors or conspicuity tape on them and identifying numbers which correspond to map drawings or records. If valve placement is consistent, locating it during an emergency will be quicker, less stressful and may help to avoid further damages to equipment and property. Routine maintenance should also be quicker and easier if curbstops are easily identified and can be cross referenced with corresponding drawings to verify valve placement.

Placing the valve close to the delivery point in the subscriber's yard makes it quicker to access when isolating the house from the system to repair or replace components. Placing the curbstop too near the house, however, can result in flooded basements should leaks occur at the curbstop.

4.3 Backflow Prevention

Backflow prevention devices vary in size and shape but are generally designed for the purpose of reducing the risk of contamination entering the distribution system.

4.3.1 Dual Check Valves (DUC)

Dual Check Valves are one of the simplest forms of backflow prevention devices and are used in situations where there is a very low probability of it becoming a hazard.

4.3.2 Double Check Valves (DCVA)

Double Check Valves are the minimum standard for backflow prevention in most pipelines. They are usually part of the meter assembly and are located at the point of water delivery to the in-house reservoir. Generally, a Dual Check Valve is considered to be safe for any substance that has a low probability of becoming a nuisance or be aesthetically objectionable if introduced to the domestic water supply.

4.3.3 Testable Double Check Valves (Testable DCVA)

Testable Double Check Valves are a requirement of most source connections and are designed to be tested in place by qualified technicians. The operation and maintenance manual for your pipeline should include scheduling and procedures for regular testing of testable devices.

4.3.4 Air Gap

An air gap device is a relatively inexpensive device that is created in the subscriber's cistern or storage tank and if configured correctly, has a very high degree of backflow prevention. An air gap is achieved by ensuring that the elevation of the lowest point of the inlet or point where water is discharged into the storage tank is above the lip of the overflow. This means that if the float assembly in the storage tank fails and water continues to discharge into the tank, water in the tank will not rise above the overflow because it will take the path of least resistance and flow out the overflow and drain away. Therefore an "air gap" is created between the highest water level in the tank and the outlet. See (Appendix VI - C) See Unit IV – Section 2.2.4 for more information.

The lip of the overflow should be lower than the point of discharge into the tank by at least twice the diameter of the outlet into the tank. In other words, if the line discharging water into the tank is 1 inch, the lip of the overflow should be 2 inches below the point of discharge into the tank. The diameter of the overflow should also be a minimum of 1½ inches and configured so as to vent water away from the tank, preferably toward a floor drain. It is recommended that the overflow not be connected into the existing plumbing, as this could create the possibility of sewer gases backing up into the water storage.

See UNIT IV 2.2.4 for further information.

4.4 Other Appurtenances

4.4.1 Flush out Assemblies

Flush out assemblies generally should be placed at the end of all mainlines and at every change in pipe diameter. Flush out assemblies can be used for purging air, flushing water, or in some cases, swab retrieval during maintenance or start-up of a new line.

Flush out assemblies should be accessible, and must have the approval of the property owner if located on private property. Additionally, the facilities should be marked and protected from accidental damage caused by vehicles and/or equipment operating within the vicinity. The flush out assembly should be locked or secured to prevent unauthorized entry and to reduce the risk of contamination entering the distribution system. Also, the site should be routinely monitored for suspicious activity and possible tampering.

4.4.2 Clean out Assemblies

Most pipelines today are engineered with launch and retrieval stations for pigging or swabbing. In contrast, many older existing pipelines were not designed with this in mind and may need to be upgraded to accommodate this type of line cleaning. Although pigging or swabbing stations were not normally installed along the pipeline route in the past, pigging tees or wyes are sometimes installed in the pump stations or manholes to assist with start-up of the pipeline.

4.4.3 Tees, Caps, Saddles, etc.

Tees, caps or plugs can be used in locations of possible future expansion. A minimum length of 2 metres of pipe should be installed at the tee to facilitate locating and installing pipe in the future. It is also advisable to install tracer wire with the line to assist with locating. If it is a HDPE pipeline, future expansion can continue by attaching the new line and using heat fusion as a method of connecting the existing line.

Saddles come in various sizes and are made of different types of materials. Stainless steel service saddles can be used for 75 mm or greater size pipe.

Section 5 Pipeline Routing

5.0 General

The "Pipeline Route" is generally proposed by the design or consulting engineer and is usually based on past experience and of course data collected in the field to determine the most practical path for pipeline installation. Most often, cost will be the major influence in the route selection; however, land control may also be a factor. Population density and potential for expansion are other important considerations and will have to be weighed into the design route as well as plans to minimize and/or avoid disturbance to environmentally sensitive areas. There are other important decisions which need to be addressed as well, such as whether the pipeline should be installed in the road allowance or should easements be obtained from private land owners for the primary pipeline route. Although there will be much consultation with all of the stake holders, ultimately it will be up to the *Organization* to decide and finalize the route of the pipeline.

5.1 Road Allowances (Main Lines)

If the pipeline is to be installed in road allowances, the *Pipeline Organization* must ensure that proper approvals have been obtained from each of the RM(s) that are affected by the installation. If the line is to cross or parallel a Provincial Highway, approvals must also be obtained from Highways and Transportation or the agency that is in charge of that particular highway. See Unit V, Section 1.2 & 1.3 for more details. The *Organization* should be aware of any immediate, intermediate or long term plans that the RM or Highways have to adjust the ditch grade and plan accordingly to protect the pipeline by burying the line at a depth that allows for adequate cover. Developing previously undeveloped road allowances will result in additional costs for the group later if their pipeline needs to be lowered, so communication with the local governments is essential.

5.2 Private Property (Main Lines)

When pipelines are installed on private property, the *Organization* must ensure that easements have been obtained from each land owner. Generally, easements are obtained by the engineering firm that has been awarded the project, but regardless of who is responsible for obtaining them, it is imperative that each parcel crossed by the pipeline has the proper approvals. The pipeline route should be identified as such that a signed written easement would be adequate for land control and an interest registration should be filed with Information Services Corporation (ISC). Legal surveys are not desirable because of the higher cost, but are necessary in some cases such as pumphouses.

Unit VII - Section 11.2 (Administration) describes in more detail the easement process.

Easement widths should be kept to 10 to 15 metres if at all possible, to minimize disturbance, but must be wide enough to allow excavation of the pipeline, placement of the over burden and backfilling/clean-up operations.

If the pipeline route results in crop damage, the *Organization*, or in some cases the contractor, is responsible for compensation of damages. (Responsibility should be determined prior to tendering).

5.3 Crossings

Crossing permits may be required for some underground crossings (e.g. railway companies). In some cases there may be a cost for the crossing permit (sometimes a yearly renewal fee may be charged) to cover administration and inspection costs. Before proceeding to final design, the consultant or engineer should meet with the companies that are involved to determine these costs and obtain approvals.

Each agency will have its own set of standards and guidelines (regarding notice, method of crossing, etc.) that must be followed. These standards must be known prior to tendering so that the plans and specifications can be adjusted accordingly. It is advisable to have all approvals in place prior to construction so that there are no surprises once the installation begins. Unit IV (Approvals and Agreements), Sections 1.3 and 1.4 provides more details about crossings.

5.4 Geotechnical Information

If test-hole data is available, it should be included in the pipeline tender package for the pipeline route prior to the call for tenders. During the tender period, it is expected that contractors would familiarize themselves with soil conditions along the proposed pipeline route. Two methods are available to obtain this information.

The preferred method of providing information on soil conditions is to dig test pits at any number of locations during a pre-tender site meeting. Locations will need to be identified prior to excavation and Utility Companies must be contacted so they can locate and flag their existing utilities. This is especially important in the case of the trenchless plough methods, where traditional geotechnical information does not provide the contractors with the visual observation of the sub-surface conditions. The *Pipeline Organization* may arrange to have a backhoe on hand to accommodate this test dig.

The second method of obtaining soil information is by using a drill rig. Usually test holes are drilled every 800 to 3000 metres along the pipeline route. Where it is speculated that soil conditions may significantly affect unit prices, areas close to augured crossings such as highways, railways, and rivers may require additional test holes. This method will have a significantly higher cost than digging test pits with a backhoe.

5.5 Private Property (Service Lines)

As part of the preliminary survey, the Consultant should meet with the *Organization* to discuss procedures for installing the water service lines from the main or lateral line, to the subscriber's residence or business. It is recommended that service lines are installed with a curb valve at the property line. The service line usually is installed in the most direct route from the curb valve to the point of entry at the house or building, but this is sometimes not practical. If an excessive number of utilities (including the subscribers existing water, sewer, or other lines) are in the path of the installation, an alternative route may need to be chosen. *Pipeline Organizations* will need to determine what method of trenching will be used for the installation of the water service. If the water service is to be installed by a directional bore method, the number of utility crossings doesn't impact the installation as much as traditional open cut trenching because the water service would be pulled into place under the existing utilities and not have to be spliced and connected together at each line crossing as in traditional trenching methods.

Subscribers generally have an idea of where they would prefer the pipeline installed and where existing buried underground utilities are located in their yard site. This will help to determine the final pipeline routing.

It should also be clear who is responsible for clean-up and what the expectation is for returning the site to as near to pre-construction conditions as reasonably possible. Long term considerations may include who is responsible for maintaining the line and what the provisions are for land transfer.

Section 6 Pipeline Installation

6.0 General

This section discusses various aspects of pipeline installation and recommendations for pipe burial, suggestions for supply line connection points and tips for other pipeline considerations. To view a sample contract agreement for pipeline installation, see (Appendix VI – L).

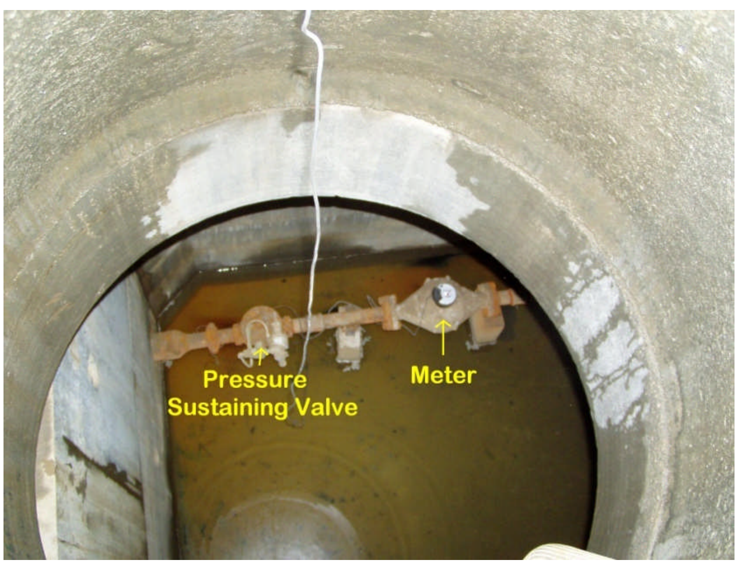
6.1 Depth of Cover

Pipelines are installed at varying depths to avoid damage from frost depending on your geographical location, but are usually buried at a minimum depth of 2.6 m (8 ft) in the province of Saskatchewan. Pipe that has a diameter smaller than or equal to 125 mm is recommended to be buried at 2.6 m to top of pipe, and pipe that has a diameter bigger than 125 mm should be 2.7 m to top of pipe. This depth should also be increased to a minimum of 2.8 m (9.2 ft) for pipe installed under grid road/highway crossings.

No pipe should be intentionally laid in water, or on frozen foundations, or when the trench conditions are unsuitable. Generally, sand bedding of the pipe is not required, except where the foundation is rocky or when backfill material consists of hard blocks of soil that are otherwise unsuitable or the engineered design has called for the inclusion of sand bedding.

6.2 Supply Line connections

6.2.1 Manhole Connection



Depending on the source of the water supply, a below ground metering vault or "manhole" may be required. If the source water is part of an existing pipeline and infrastructure, the manhole connections are often used as a starting point for the distribution system. The manhole generally includes a water meter, isolation valve, backflow prevention device, and in some cases, a pressure sustaining valve. The manhole and connection may be installed by the source utility (i.e. City of Moose Jaw) but it is generally the responsibility of the *Pipeline Organization* to maintain the connection. Manholes can be constructed of various approved materials which can include precast concrete, corrugated steel pipe or fibreglass. Consideration should be given to ground water levels and the uplift force on the manhole. Also, a drain sump should be installed to vent water from the vault should a leak occur. Frost protection of the piping and mechanical assemblies within the manhole should also be considered.

Manhole or metering vaults are quite common and although they offer a relatively inexpensive method of connecting to a water supply, the problems are they tend to fill with water, access is restricted, and they present some safety concerns (e.g. build up of gases, confined space entry). There are also some concerns about the ability to re-chlorinate and operate chemical feed pumps in a normally damp environment.

6.2.2 Pumphouse Connection

A preferred method of connecting to a supply line is by housing the connection in a building referred to as a pumphouse. Unlike a manhole connection, pumphouse buildings are user friendly and allow the opportunity for expansion.

The *Organization* should be aware of all options with regard to choices of equipment, telephone monitoring etc. so that they can make an informed choice. In general, the *Organization* wants a simple fully functional pumphouse, requiring minimum maintenance at a low cost with provisions for additional equipment, if required.

(Appendix VI – T) presents typical pumphouse plans which have been used very successfully for the last number of years. The plans include typical mechanical equipment used for a range of sizes and flows. (Appendix VI – T2).

6.3 Methods of Pipeline Installation

In general, four types of pipeline installation methods are common and are outlined below:

- ✓ **Plough method** - involves construction equipment with a plough shoe and pipe placing sleeve. This method minimizes ground disturbance. Contractors have successfully installed up to and including 150 mm diameter PE pipe.

- ✓ **Chain trencher method** - involves construction equipment with a moving chain complete with teeth. This method causes some ground disturbance, with excavated soil placed on each side of the trench. Care must be used when backfilling the pipe so that falling soil or rocks do not damage the pipe. Rocky soil conditions can hinder or prevent installation of pipe with a chain trencher.

- ✓ **Backhoe method** - this method may result in major ground disturbance, depending on the soil being excavated. Extreme care must be used when backfilling the pipe so that falling soil or rocks do not damage the pipe. Soil settlement along the trench line after construction, is more of an issue with this type of pipe installation method.

- ✓ **Directional bore method** - commonly used where access is limited and where no ground disturbance is tolerated (eg. At river/stream crossings, at large deep sloughs and sensitive areas, some farm yards with lots of utility crossings, and road and utility crossings.

6.4 Other Considerations for Pipeline Installation

6.4.1 Line Looping

Although line looping adds additional costs to the water pipeline, the benefits of line looping outweigh the costs. One of the reasons for incorporating line looping into your pipeline design would be to achieve a higher degree of safety in your distribution system. The characteristics of chlorine disinfectant are such that branch lines which are extremely long or have intermittent flow may experience dissipating disinfectant to a point that the chlorine residuals could fall below the parameters for safe drinking water. By incorporating line looping, water is refreshed quicker and is more likely to maintain proper amounts of disinfectant.

Line looping also helps to relieve some of the pressure and/or flow demands in areas of the pipeline that are experiencing marginal flow or pressure. Conditions may change as the subscriber base grows and line looping may be necessary in order to maintain the system's design requirements. It is a good idea to develop a list of priority or preferred segments of line that should be considered for line looping. Critical areas and places where it is suspected that water demands may be reaching a point where it is no longer possible to meet the flow demands should be monitored. It is important to document any complaints of low volume or flow so that they can be reviewed and addressed in a waterworks system assessment. The distribution system may be in danger of depressurising if the situation is allowed to continue unchecked. Suspected lines should be designated high priority and corrective action should be taken.

6.4.2 Grids

Grids can be created as the pipeline expands and when lateral lines are added to the infrastructure to accommodate new subscribers. Grids are quite favourable as it allows alternative routing for water distribution, thereby reducing the chance of a disruption in service.

6.4.3 Flush Outs and Cleaning

Most of the pipelines today are designed with the ability to flush lines and clean them as necessary. Pipelines that use HDPE pipe will remain relatively clean for several years and have a much higher service life than pipelines that use ductile steel or some of the other products.

6.4.4 As-Built Maps

It is essential to have accurate maps outlining the pipeline as it has been installed. The maps should include all of the information about the pipeline such as where changes in the pipe size occur, location and types of valves, location of pumphouses, manholes and booster stations. As technology evolves, new tools are readily available to use for identifying distribution lines and service connections. An example of this is the satellite imagery that is available through Google™ Maps. Computer generated images of terrain can easily be marked to show installed lines or GPS data can be overlayed into the program to show as-built construction.

6.4.5 Tracer Wire

A shielded copper wire referred to as “tracer wire” is installed with the pipe to assist with locating the line in the future. By attaching a cable or frequency locater to the end of the tracer wire and sending a signal through the wire, it is possible to locate or “trace” the signal at ground level and mark the water service line on the surface. Frequency locaters are quite expensive, however, and utilities may choose to rent them when they are required rather than buy their own. Care should be taken when installing tracer wire to make sure the ends of the wire are accessible and easy to find. If the tracer wire has been buried or cut off below the ground, it has no value and defeats the purpose of installing it. Therefore it is a good idea to run the tracer wire up the curb valve or isolation valve and attach the end of the wire to the top of the curb valve with tape so that it is readily available for use. Likewise, the tracer wire should be attached to the building at the point of entry or in a consistent manner that will be easily located by the user.

Section 7 Pipeline Maintenance

7.0 General

Pipelines that use HDPE pipe will generally remain relatively clean for several years and have a much higher service life than pipelines that use ductile steel or some of the other products.

7.1 Maintenance Records

As always, it is important to document any maintenance that has been performed on the pipeline. Pertinent information such as what type of work has been done, when it was done and by whom needs to be documented. If the work was an emergency repair, follow up documentation should also be completed and filed. Incident reports should be generated for any event that is out of the normal operating procedures.

7.2 Line Breaks

7.2.1 Line Break Reporting

Line breaks are a reality with water distribution. Generally water line breaks are brought to the attention of the *Pipeline Organization* by subscribers or concerned citizens that have noticed water pooling in areas where it normally doesn't pool or they may have noticed a sudden cave-in. It is in the *Organization's* best interest to investigate all reported water line leaks and repair them as quickly as possible. Should the distribution system develop a problem in which depressurization occurs, the potential for back siphoning contaminated water is a real concern and can jeopardize the health and safety of the subscribers.

7.2.2 Methods of Repair

Line break repair methods may vary according to each situation and the location of the break, but *Pipeline Groups* should have an action plan ready with emergency repair procedures. An action plan would include the contact numbers of available contractors and personnel needed to repair the line. The plan will also include procedures for locating other utility lines, steps required to alert downstream users of a possible water outage, and the protocol for ensuring that the line is bacteriologicaly safe before it is put back into service. All repairs must be completed in a safe, professional, and timely manner. Consideration should be given to traffic flow and detours should be planned in advance. If possible, repairs should be made when there is the least amount of traffic, and therefore the minimum amount of disruption. Attention needs to be given to sign placement as well as site and worker protection. Any excavation that has to be left open for an extended period of time must be clearly marked, and preferably enclosed or surrounded by suitable fencing. Care should be taken to keep pipes clean by covering the ends so that dirt or debris will not enter the line, and lines should be plugged or sealed when pipe laying is not in progress. Disinfection protocol must also be followed according to the guidelines set out by Ministry of Environment.

7.2.3 Types of Repair Assemblies

There is a wide assortment of repair assemblies that can be purchased as a complete package to install over a line rupture or line break. Most patches fit over the pipe and clamp together to seal the hole or rupture, but quite often the damaged or leaking section is removed instead and a new line is installed. Couplers made from various materials such as brass, stainless steel, or PVC plastic are used to reconnect the new line, or a heat-fusion fitting may also be used if the pipeline is polyethylene plastic.

7.3 Leak Detection

7.3.1 Mechanical Detection

Commercial leak detection equipment is available to assist in locating line leaks. This can include very expensive equipment such as ground penetrating radar, or relatively inexpensive equipment like a stethoscope type of listening device which is used to hear water venting from the damaged line.

7.3.2 Mathematical Detection

Mathematical detection is done by recording the volume of water that is being used by the subscribers and subtracting the volume from the supply line. If there is an excessively high amount of unaccounted water, it is possible there is a line leak. Pipelines that have an automated read system for data collection can use the system to read segments or legs of the distribution system and compare the numbers to help determine if a leak is present.

7.4 Line Cleaning

Most new lines are designed with provisions for flushing and have valves placed near the end of lateral lines and at specific locations throughout the distribution system. Flush out capability allows lines to be disinfected and cleaned by purging the system.

7.5 Line Cave-Ins

Cave-ins are usually reported by someone that frequently passes by the area in which the cave-in occurred. Quite often it is the subscriber that will report a cave-in on a line that services their residence or a mainline that runs by their property. It is a good idea to record cave-in information such as who reported the cave-in, when it was made and what action was taken. A spreadsheet can be used to record the information so that the complaint isn't forgotten and the repair work can be scheduled and completed. The spreadsheet can then be used to reference all particulars including site location, geographical coordinates, person doing the repairs and if the work was completed satisfactorily.

7.6 Line Freeze-Ups

Line freeze-ups can be a serious issue for *Pipeline Organizations* and may lead to unexpected costs that may not have been included in your budget. If the problem is re-occurring, corrective measures need to be taken. This usually involves lowering the pipe below the frost line, or in some cases Styrofoam Insulation can be placed above the pipeline to prevent the frost from penetrating. A temporary solution would be to keep the water flowing through the line during periods of low temperature by opening a tap or venting the water out onto the ground.

7.7 Valve Maintenance and Repair

7.7.1 Valve Maintenance

Valves that are not used for several years may become seized or stuck and are useless in the event of an emergency shut off. Therefore, it is a good idea to develop a schedule in which valves would be exercised to prevent them from seizing. A good preventative maintenance plan would document when and what valves have been exercised. This is particularly important for priority valves or isolation valves that may need to be closed in a hurry.

7.7.2 Valve Repair

It is not uncommon for leaks to develop at the location of a valve. This may be because of the connections made to the pipeline or it may be a failure of the valve itself. In either case the site will need to be excavated and the leak repaired. Usually the valve will be replaced at the same time, regardless of the condition of the valve.

Section 8 Pumphouses and Booster Stations

8.0 General

Pumphouses and Booster Stations can be designed in various sizes and shapes to meet the needs of the *Pipeline Organization*. Pumphouses are generally used as a starting point for delivery of water by connecting to a supply line or water source. Booster Stations are designed to extend the service area of a water pipeline. They are also used to overcome problems associated with extreme elevations by boosting working pressure to accommodate increased head.

8.1 Pumphouses

8.1.1 Site Selection

In general, an above ground building is ideal for a pumphouse, in an area that will provide good drainage. It should be accessible year-round, visible from the road and close to a suitable power source (3-phase power may be required). It is recommended that it be inspected daily to monitor equipment and temperatures inside the building. This may also be accomplished through remote monitoring. Appropriate signage should be visible and include contact information with an emergency phone number.

8.1.2 Building Requirements

Buildings should be designed so that they can accommodate the necessary equipment that is to be housed inside. There also needs to be provisions for the supply and discharge lines which should be sleeved at the point of entry into the building. A structural plan for pumps, piping and equipment can be seen at (Appendix VI – T3). It is very important to maintain the buildings in good repair so that they will continue to provide years of useful service. Consideration should be given to future expansion as well as adequate space for servicing equipment and performing regular maintenance. Buildings should have adequate lighting and proper ventilation. There should also be easy access to safety equipment such as eye wash stations. All guards, railings or items pertinent to Occupational Health and Safety Regulations must be kept in place. Blueprints of a typical building structure can be seen at (Appendix VI - T).

8.1.3 Sample Stations

Sample ports or stations should be set up at pumphouses and booster stations to monitor water quality. Data should be recorded and evaluated as determined in your Permit to Operate. It is strongly recommended that operators have a safe and user- friendly place to draw samples for analysis.

8.1.4 Building Monitoring

Buildings should be monitored routinely to ensure that all systems are functioning properly. Several companies offer monitoring services which can be programmed to notify when there is a loss of heat or power, or when it senses smoke, fire or intrusion. Equipment monitoring can also be used to protect equipment from adverse conditions and warn of potential failure or shut downs. Usually a list of contacts is provided so that the alarm company can go down the list and call out in the event of a problem.

8.1.5 Pumps and Equipment

A dual pump system is recommended and should be incorporated into the design of the distribution system. Engineers will normally design the system so that if one pump is taken out of service, the remaining pump will be able to keep up even with peak water demands. The system is also designed with all necessary equipment to deliver water safely to downstream customers, but consideration should be given to in-house water quality. Disinfection equipment may need to be added so that the water delivered downstream complies with the regulatory requirements for safe drinking water. A blueprint of a booster station with a single pump configuration can be seen at (Appendix VI – T2).

8.2 Booster Stations

Booster stations are generally used to overcome problems associated with inadequate working pressure. It may be necessary to boost the water pressure or flow to overcome a difference in elevation or to achieve longer distances in the pipeline. Boosting water pressure may also be necessary to accommodate growth of the distribution system and to expand the service area.

8.3 Building, Grounds and Equipment

8.3.1 Building Maintenance

Regular inspections of all buildings that are operated by your *Organization* are essential for longevity of the buildings and to ensure that health and safety issues are being addressed.

8.3.2 Grounds Maintenance

Care should be taken to keep the grounds accessible year round and reasonably groomed. This shows credibility and promotes the *Organization* as being responsible. It also makes routine visits easier and allows emergency repairs to be completed quicker.

8.3.3 Equipment Maintenance

Scheduled monitoring should be conducted and recorded for all buildings and property that your *Organization* owns or operates. All maintenance and scheduled visits should be documented as to when the visit occurred, what was observed, and who was present. Any repairs or changes that were made should also be documented. Maintenance records should be stored in a safe place (preferably off-site) and include the date and time repairs were made and by whom. Maintenance records could prove to be invaluable in the event of a loss or damage those results in an insurance claim. It may also be necessary to provide records to prove due diligence.

Section 9 Household Mechanical

9.0 General

This section describes some typical household mechanical system layouts.

9.1 Household Mechanical

9.1.1 Isolation Valves

Ball valves should be used as an isolation valve inside the household, preferably at the point of entry inside the house. They can be used to isolate the house downstream of the curbstop when it is necessary to replace components of the meter assembly. In-house valves offer a means of home owners to shut the water off in the event of an emergency and allow responders and maintenance personnel more time to prepare for the leak or repair.

9.1.2 Water Meters

A water meter with remote readout should be installed at every house/yard connection to monitor water consumption for billing purposes and verify water consumption. Meters must be installed according to manufacturer's specifications and should be in a location that is easily accessible. It is not recommended to install meters inside cisterns because of contamination issues and also because of the normally damp environment.

9.1.3 Pressure Reducing Valves

Pressure reducing valves are generally installed as part of the meter assembly or manifold in the house. Pressure reducing valves are normally equipped with a strainer and a pressure gauge. Leakage from household mechanical systems could result if pressure reducing valves are not installed and line pressure in the distribution system exceeds the mechanical systems pressure rating.

9.1.4 Flow Restrictors

It is advisable that flow restrictors are placed at each client's location. This will ensure that the pipeline system will operate as designed and provide each subscriber with the flow, pressure and quantity of water that it was designed for. Flow restrictors should be installed on the meter assembly or at a location that is easily accessible as they can become plugged and require servicing.

Although flow restrictors are not used on all rural pipelines, it is advisable to incorporate them into the distribution system. Pipelines that do not have flow restrictors may find it difficult to maintain the minimum pressure requirements set out in Ministry of Environment guidelines. Elevation differences along the pipeline route can result in highly variable flows at the points of delivery. This can affect the operation of the system and further complicate the design of booster stations.

9.1.5 Strainers and Filters

Most water meters and pressure reducing valves have screens built into them which prevent debris from within the pipeline to cause damage or malfunction. In-line strainers or filters are not recommended because these devises could pose a health concern by harbouring bacteria if not maintained properly.

9.1.6 Backflow Prevention Device

A backflow prevention device assembly is mandatory at every subscriber connection.

9.1.7 Pressure Gauge

A pressure gauge is recommended for every subscriber connection and is generally part of the meter assembly. Some *Organizations* install two pressure gauges so that line pressure coming into the assembly can be monitored before it is reduced by the pressure reducing valve.

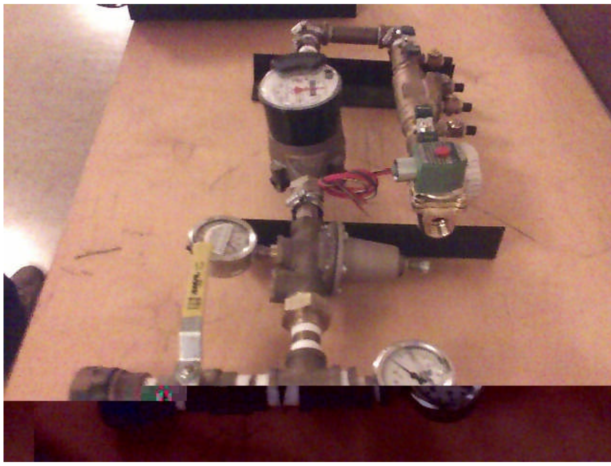
9.1.8 Storage

Storage systems come in all sizes and shapes and are available to meet the needs of the subscribers. A minimum 450 litre (100 gal) storage cistern is recommended for every subscriber connection. Although it is not recommended, existing cisterns have also been used for water storage in the past. Some examples of storage cisterns and typical house connections can be seen at (Appendix VI - U).

9.2 Meter Assembly and Maintenance

9.2.1 Meter Assembly

Meter assemblies may vary slightly from organization to organization, but generally consist of the same types of components. A typical meter assembly will include a meter with remote read, a pressure reducing valve with pressure gauge, and some type of shutoff or ball valve. Most assemblies will also have a backflow prevention device such as a Dual Check Valve and possibly an in-line flow restrictor.

9.2.2 Assembly Maintenance

Meter assemblies may require attention from time to time and could develop a leak due to fatigue or corrosion. Each of the components is subject to failure such as the pressure reducing valve which could lead to further problems. Generally, the subscriber will notify the *Organization* of any leaking or abnormal noises that they have noticed. All reported abnormal conditions should be investigated as soon as possible to prevent further damages and possibly a major line leak or flood.

9.2.3 Preventative Maintenance Plan

A preventative maintenance program should be developed to address issues that arise as your pipeline ages. For example, it is a good idea to look at replacing older meters and/or components well in advance of their life expectancy to prevent potential failures from turning into a disaster. Having said that, it is also a good idea to have a plan in place to deal with emergency clean up and repair of a water line break or leak at a subscriber's residence. Contacts and numbers of available companies that provide site restoration for floods should be kept on file and can be forwarded to the subscriber. In emergency situations, damage can be minimized by initiating the restoration as soon as possible regardless of who is responsible for the cleanup costs.

9.2.4 Maintenance Records

All maintenance and repair records should be well documented and kept for a minimum of five years. Records should be stored in chronological order as per the regulations. Original documents or record sheets should be filed for regulatory review and a hard copy version should be created to extract data for completing charts and graphs that are necessary for the organization to evaluate its position. Digital pictures can also be included in the record files if possible. Also included are the records of all data relating to water consumption, equipment run time, general conditions of pumphouses and booster stations, repair and maintenance schedules. In addition, all records of equipment failure and or replacements should be documented and filed.

Section 10 Operational Procedures

10.0 General

This section has been prepared to provide insight into the day to day operations of a waterworks distribution system and to assist start up organizations in developing an operational plan. Much of the information is based on situations encountered by existing *Pipeline Organizations* and is intended to be used as a guide to identify areas that might require further consideration and may be relevant to your *Organization*. As owners of a rural water pipeline, some important decisions will have to be made in regard to who will be in charge of the operations, how the pipeline will be staffed, and how the workload will be accomplished.

10.1 Staffing

Each *Pipeline Organization* will have to determine how the work duties will be accomplished and what will be the amount of compensation paid for the duties that are performed. Some associations depend on volunteers to carry out specific duties. Larger associations may have the resources to hire the necessary staff required to maintain the pipeline. A combination of volunteer and paid positions may be an alternative for *Organizations* that need to look at creative ways to be sustainable.

10.2 Operational Plan and Maintenance Manual

An operation plan and maintenance manual should be developed for each rural pipeline outlining all pumphouses, booster stations, sampling stations, vaults and any other part of the infrastructure. Waterworks *Organizations* are unique in design and operation and require tailoring to suit their own needs. Some *Organizations* will be sourcing and treating their own water supply, while others may be purchasing treated water from an existing water treatment facility and re-distributing to their subscribers. Therefore, operating procedures need to be developed and documented according to what works best for the *Organization* to keep the waterworks operating smoothly while still complying with current regulations.

The operational plan and maintenance manual should include system operating and maintenance instructions for all components. Daily, weekly and monthly testing procedures should be outlined for each of the components and detailed records of all equipment that is required to be tested or calibrated. A summary of household mechanical systems should be included showing various assemblies that are used in your distribution system. Also, pipeline and pumphouse design features that are incorporated into your system like backflow prevention devices and pressure sustaining valves should be included. A list of all pertinent information such as the manufacturer's data and a suggested maintenance schedule should accompany the summary of components used in your waterworks system. Other items of importance include detailed maps of the entire system, schematic drawings of pump houses, pipelines and individual subscriber's yards.

It is a good idea to document other important details in your plan such as policies that your *Organization* has adopted on operational procedures and safety protocol. Plans should be updated and reviewed regularly as new techniques or methods are developed. The successors of the *Organization* will then have a better understanding of what is required to keep the system operating smoothly and can easily modify the plan to accommodate growth or structural changes.

10.3 Subscriber Listing

A complete list of current subscribers should be readily available and may include the following items:

- ✓ addresses and phone numbers
- ✓ detailed yard maps
- ✓ start-up sample analysis
- ✓ Health Region Plumbing Permits
- ✓ subscriber agreements
- ✓ line locates and maintenance
- ✓ a copy of all correspondence

Subscriber lists are an important aspect of record keeping for the *Pipeline Organization* and should be accessible for quick reference so that all subscribers contact information can easily be retrieved in the event of an emergency. Lists should be arranged in chronological order and up-dated as new subscribers are added or whenever it is necessary to do so. Electronic files can be created so that detailed information can be easily accessed from a laptop in the field.

10.4 Meter Reading and Repairs

Each *Organization* will have to establish a method of reading the water meters so that the billing process can be initiated. One method that is used to accomplish this is to send a self read card out to subscribers so that the meter information can be collected. The subscriber enters the meter information and returns the card to the billing clerk or administrator so that that data can be calculated and the invoices prepared. Alternatively the *Organization* may elect to have someone read the meters. Because rural pipelines usually involve long distances between subscribers, meter reading can be a costly and time consuming endeavor. Some larger pipelines have incorporated automated meter reading technology into their distribution system. Some automated meter read systems have the ability to collect the water meter information by sending a signal to the water meter and triggering the meter to broadcast meter data over a radio frequency so that it can be intercepted by a mobile unit. More sophisticated units can also interface with billing software and import the data into the billing cycle.

10.5 Customer Complaints

All customer complaints should be taken seriously. It is in the *Organization's* best interest to investigate and document all reported water complaints. A customer complaint file should be established which documents the nature of the complaint, date the complaint was received and by whom, and any follow up action that was taken. The health and safety of the subscribers must be first and foremost.

10.6 Line Locates

Line locates are generally requested by subscribers wanting to know where their service line is so that they can make modifications to their house or yard like building a garage or installing a fence. Other utility companies or contractors also may need to know where the water pipeline is located so as to avoid damage to the line. Requests for line locates may come at any time but usually the peak season is during the summer months. Some requests require more precise locating which can be provided by using a frequency locator if tracer wire has been installed with the pipeline (see Section 6.4.5 – Tracer Wire). Most utilities provide line locating as a free service. The school of thought is that it is safer and more cost effective to advise of possible water line conflicts, rather than repair the line after the damage has been done.

Many commercial types of marking paint are available for line locating. Applicators are relatively inexpensive and make the task much easier. Consideration should be given to the color of marking paint used so as not to duplicate the color that other utility companies are using to identify their lines. Normally a blue paint is used to signify a water line. In addition, various colors of flags are available and once again the preferred choice is blue for identifying a water line. Customized pin-flags can be purchased through various companies but not-for-profit agencies are also located in our province.

10.7 Tools and Equipment

Tools and equipment will vary according to size and finances for each *Pipeline Organization*. A suggested list of inventory is shown below. The list may vary depending on the *Organizations* needs. A completed list of all current inventories should be kept on file for each service vehicle, piece of equipment or building and updated as necessary. Some *Organizations* choose to equip an enclosed trailer with items that they may need in an emergency. This provides a great place to keep your tools and equipment secure and out of the weather and ready to go when you need it.

10.7.1 Service Vehicle Inventory

Common items that could be carried in a service vehicle would include the following:

- ✓ Fire Extinguisher
- ✓ First Aid Kit
- ✓ Warning Devices
- ✓ Squeeze-off Tools
- ✓ Flashlight
- ✓ Maps
- ✓ Reporting Forms
- ✓ Manuals
- ✓ Communication Equipment
- ✓ Camera
- ✓ Line Locater
- ✓ Assorted Fittings
- ✓ Hand Tools
- ✓ Shovels

10.8 Personal Protective Equipment (PPE)

Personal protective equipment should be provided for all employees working in a sensitive environment, as defined by Occupation Health and Safety. PPE gear should be CSA approved and worn where required by regulation.

- ✓ Head Protection
- ✓ Hearing Protection
- ✓ Eye and Face Protection
- ✓ Foot Protection
- ✓ Reflection Wear

Section 11 Operating Requirements

11.0 General

Considerations need to be made in respect to meeting the regulatory requirements implemented by Ministry of Environment and to ensure a safe and reliable water source.

This section outlines regulatory issues that may affect your *Organization* and offers some suggestions on how to accomplish these tasks. Other sections in this manual may describe the topics in more detail and will be referred to as indicated.

11.1 Permit to Operate

The Permit to Operate is issued by Ministry of Environment and states the conditions that the *Organization* must follow in order to have authorization to operate. More information on obtaining a "Permit to Operate" and protocol can be found in the Regulatory Requirements Unit IV Section 2.2.

11.2 Certified Operator

Every group operating a pipeline that is supplying potable water to subscribers and meets the criteria that deems it to be a Ministry of Environment regulated waterworks, will require a certified operator in direct responsible charge at all times. Regulations state that a "Regional Contract Operator" (see UNIT IV 2.4.4) may be brought in from another utility or municipal system to oversee the operations. Some of the duties of the certified operator include, but are not limited to, taking water samples and tests as set out in the "Permit to Operate", preparing reports, and often performing maintenance on the pipeline. More information on Certified Operators can be found in Unit IV Section 2.4.3.

11.3 Operator Responsibilities

Pipeline Organizations that fall into the category that is governed by Ministry of Environment and have had a "Permit to Operate" issued to them, will have certain requirements for water sampling and monitoring that they must adhere to. The permit will outline the frequency in which the sampling must be conducted and the number of samples that must be submitted for analysis.

11.3.1 Chlorine Sampling

Most pipelines are required to monitor chlorine residuals on a daily basis. Chlorine monitoring can be achieved by collecting samples of water and adding a reagent to the sample which reacts with the chlorine and turns the colour of the water sample to a pinkish or purple colour. By observing the colour in the sample cell, the amount of chlorine residual in the water can be determined. A colour wheel can used to compare the colour chart to the sample cell, and thereby indicate the chlorine levels, but a preferred method is to obtain a colorimeter for a more accurate measurement. More information on Chlorine sampling and protocol can be found in Unit IV Section 2.5.3 under Water Sample Testing.

11.3.2 Bacteriological Sampling

The requirements for bacteriological sampling are defined in the "Permit to Operate". The number of samples required as well as the location and frequency of sampling will be listed in the permit. Operators must record all information relevant to the sample collection to verify compliance of sample submission and to track and record the sample analysis. All entrees need to have the date and the initials of the person making the entry assigned to them. Time of sample collection, location and sample identification also need to be documented.

A follow up file should be established to record analysis reports and assist in preparing lab reports that are to be presented to the council or board of directors. As a regulatory requirement, reports must be presented to the permittee on a monthly basis for review and to confirm that the *Organization* is operating within its parameters. An authorized official should sign the report indicating that it has been reviewed. More information on Bacteriological sampling and protocol can be found in the Unit IV Section 2.5.3 under Water Sample Testing.

11.3.3 Trihalomethanes Sampling

Trihalomethanes are basically a measurement of organic by-products in the water and are generally required quarterly, usually following the seasonal changes. Special sampling jars are sent to your administration office or designated receiving site for your operator to collect and submit the water sample. The sample location will be determined by Ministry of Environment and outlined on your "Permit to Operate". More information on Trihalomethanes can be found in the Unit IV Section 2.5.3 under Water Sample Testing.

11.4 Rechlorination

According to Ministry of Environment regulations, pipelines are required to have the ability to add chlorine to the water if chlorine tests reveal that the chlorine residuals do not meet the parameters that are defined as safe for drinking water. Typically, this would be done by injecting chlorine disinfectant into the distribution system usually at the connection point to the supply line. This is a good argument for having an above ground pump house at the connection point, as it may be too difficult to provide additional chlorine if there is only a manhole at the tie-in point.

Rechlorination may vary from pipeline to pipeline and depends on the type of product being used for disinfectant. Generally a chemical feed pump draws the product from the supply and injects it into the distribution system. All records of chemical usage need to be carefully monitored and recorded as well as equipment calibration and repair records. As always the person recording the data needs to date and initial the entry.

11.5 Start-up Testing

Testing requirement of the pipelines may vary based on a number of factors, such as number of subscribers and number of tie-in locations, length of the pipeline and potable water vs. hygienic water vs. raw water. Testing requirements are defined in more detail in Unit IV Section 2.5.1.

11.6 Extension or Alteration of Pipeline

Each segment of new pipeline must be super-chlorinated and flushed with water upon completion. The protocol for conducting super-chlorination, parameters for chlorine residual readings, and flushing requirements are outlined in the Unit IV Section 2.5.1. All bacteriological sampling must be submitted and analysis completed prior to delivery of water for subscriber usage, in accordance to Ministry of Environment's guidelines.

11.7 Reports to the Board

As stated in Section 43(2) of the *Water Regulations 2002*, all *Pipeline Organization*s must present monthly notice to council or to the Board of Directors or **permittee** of the waterworks. Reports contain detailed information regarding bacteriological sampling and compliance. The number of samples submitted, results of samples, and follow up procedures for positive samples along with results are included in the report. In addition, the sampler's name, date, time, and location must also be shown.

All data is presented for review and the signing authorities are asked to sign the data sheet to ensure that operating parameters and water quality parameters of the waterworks are being achieved.

More information can be found at:

http://www.saskh2o.ca/DWBinder.asp

11.8 QA/QC and Emergency Response Plan

As of December 31st, 2003, all waterworks in the Province of Saskatchewan were required to have a Quality Assurance and Quality Control (QA/QC) policy and Emergency Response Plan (ERP) in place. The QA/QC should contain a plan on how the *Pipeline Organization* will propose to meet its obligations to its subscribers and provide safe drinking water. It may also include a mission statement outlining how the *Organization* will conduct itself to achieve the goals set out in the statement. The QA/QC will require yearly revisions as some information may become outdated.

Emergency Response Plans are also a regulatory requirement and are essential in the event of an emergency. It is critical to have a plan in place so that important decisions are not made in haste and emergency protocol can be followed. Templates are available at:

http://www.saskh20.ca/DWBinder/EPB241BWaterworksEmergencyResponsePlanningTemplate.pdf

11.9 Waterworks System Assessment (WSA)

Under current regulations, all waterworks in the province of Saskatchewan must complete a WSA every **five** years. The WSA must be completed by a certified engineering firm and a copy must be forwarded to MOE for approval. Your Environmental Project Officer will review the document and inform your *Organization* of any adjustments. A copy of the assessment should be on file at the utility office or primary location of the *Pipeline Organization*. Also refer to Unit IV Section 2.10 for further information.

11.10 Annual Notice to Consumers

Pipeline Organizations must provide the following information to all consumers at least once per year:

a) the quality of water produced or supplied by the waterworks in comparison with the levels set out in these regulations; and
b) the Permittee's compliance with sample submission requirements described in the Permittee's permit.

A template for your Annual Notice can be found at:

http://www.saskh2o.ca/DWBinder.asp

Scroll down to Point #7 and click on Annual Notification to Consumers Guidelines for Compliance and Templates.

11.11 Regional Contract Operator

Pipeline Organizations that are unable to acquire a certified operator, may enter into an agreement with another nearby community or pipeline group so that a certified operator may be contracted to act as operator in "Direct Responsible Charge" (DRC). The Regional/Contract Operator Program allows smaller *Organizations* to meet the health and safety objectives without their own designated certified operator. Please see the following link for more information. Also refer to Unit IV – Section 2.4.4 for further information.

http://www.saskh2o.ca/PDF/Regional-ContractOperatorProgram.pdf

11.12 Annual Inspections

Pipeline Organizations must provide all records to MOE upon request. Generally, annual inspections are conducted by a MOE Environmental Project Officer (EPO) who has the authority to enter the waterworks at any time to ensure compliance to MOE regulations.