

Chapter 3

Pipeline System Types

CHAPTER 3 PIPELINE SYSTEM TYPES

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Chapter 3

Pipeline System Types

3.1 GENERAL

There are several types of stockwater pipeline systems that we need to know how to design. More than one of these system types may be incorporated in a single system.

3.2 GRAVITY SYSTEM

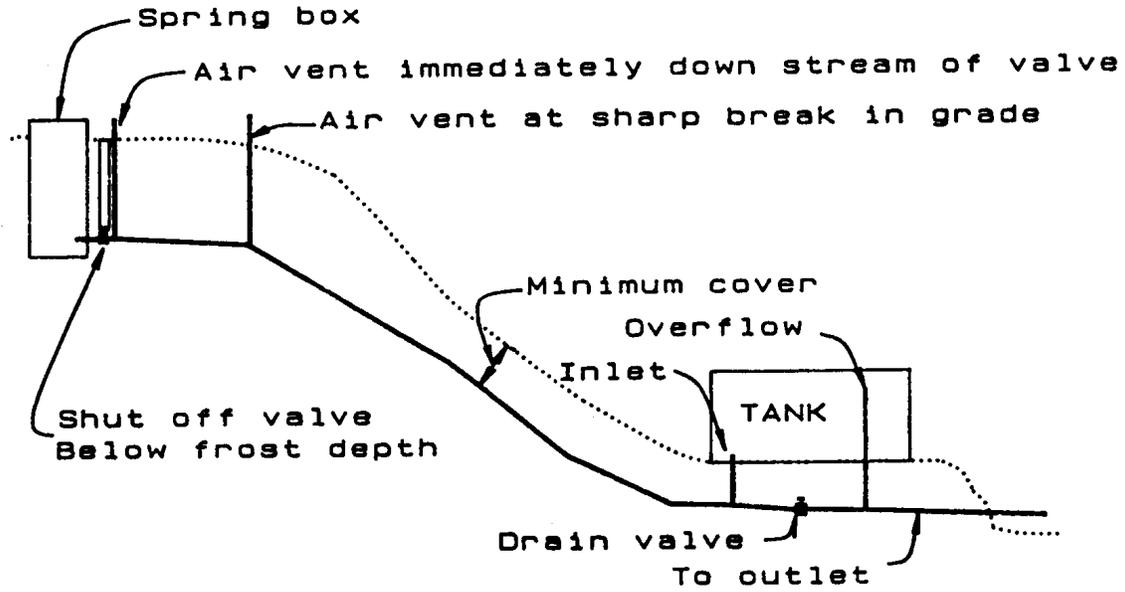
A gravity pipeline system is one in which the water supply surface is higher than all points in the pipeline and no pump is required. This type of system can generally be subdivided into two subtypes: (1) The low head gravity system and (2) the high head gravity system.

3.2.1 Low Head Gravity System

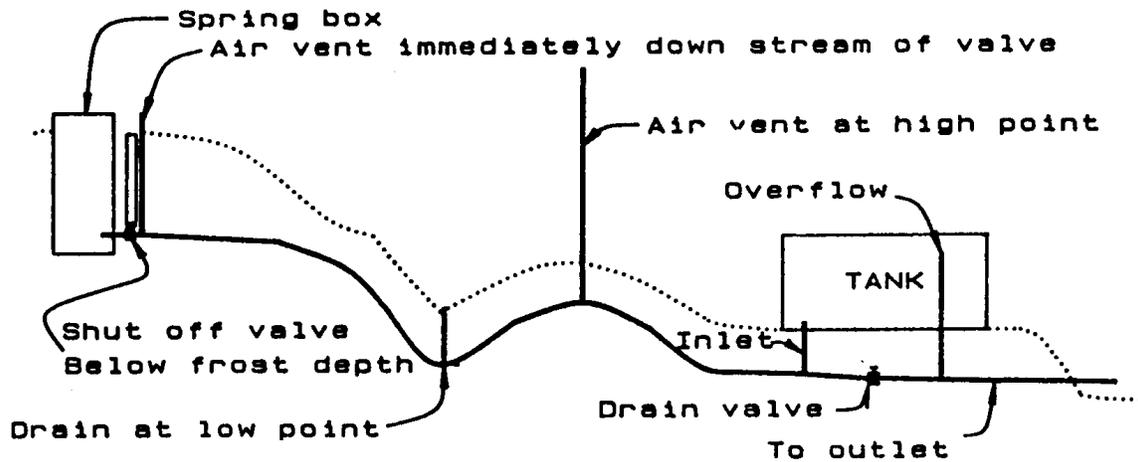
Low head is loosely defined as below 20 psi at all points in the line. An example of a typical low head gravity pipeline is shown in Figure 3.1. In this type of system the flow rate is usually whatever the spring or other water supply will provide.

It is important to make sure there can be no air locks in the system, and since the pipe is usually shallow, design the pipeline so that it freely drains when not in use. A low head gravity system is usually characterized by being installed on a positive grade in the direction of flow for its entire length. There is not enough pressure in the system to properly operate air valves, although stand pipes may be used.

Figure 3.1
TYPICAL LOW HEAD GRAVITY SYSTEMS



System With Downhill Grade in Direction of Flow



System With Undulating Grade

3.2.2 High Head Gravity System

Figure 3.2 illustrates a typical high head gravity system. This type of system is often located at the end of a pumped pipeline, starting at a storage tank at the top of a hill. Float valves are used on all tanks to control flow. Air locks at significant high points in the pipeline are prevented by installing air valves or vents.

3.3 AUTOMATIC PRESSURE SYSTEMS

Pumped flow in an automatic pressure system is controlled by a pressure switch. A pressurized tank stores water between cut-in and cut-out cycles. Figure 3.3 illustrates a common configuration for this type of system. The advantages of an automatic pressure type system is that it does not take constant attention and a minimum amount of power and water are used.

3.4 TIMED OR MANUAL PRESSURE SYSTEMS

A timed pressure pipeline system is one which uses a pump to pressurize the system and a timer to turn the pump on or off. A manual system is one in which a manually operated switch is used to turn the pump on or off.

Both of these systems operate in the same way and are illustrated in Figure 3.4. There is an overflow at the high point in the system which wastes excess water. At all other tanks, float valves or manually operated hydrants are used to keep the tanks full.

Timer or manually operated systems are usually used where high pressures make it impractical to use an automatic pressure system. Water waste is minimized by observation of stockwater usage and adjusting the pump operating times during the season. As a safety measure, it is usually advisable to provide additional water storage at various points in the system.

A large storage tank is usually located at the high point in the pipeline. Water flows from the storage tank back toward the pump during the periods when the pump is off.

3.5 FLOAT SWITCH OPERATED PRESSURE SYSTEM

A float switch operated pressure system is a pumped pipeline system in which the pump is turned on or off with a float switch located at the highest tank in the pipeline.

This type of system requires that an electric control wire run between the pump and storage tank. The wire can either be an overhead or buried line. A control wire is sometimes buried in the same trench as the pipeline.

The switch operated system is used instead of an automatic pressure system where pressures are too high for pressure tanks. The advantage of this system is that it does not waste water and power. The disadvantage is that an electric connecting wire and switching equipment can be costly.

Figure 3.5 shows a typical switch operated system. Switches are low voltage and telephone wire can be used as connecting wire. Used overhead telephone wire and poles could also be used.

Figure 3.2
TYPICAL HIGH HEAD GRAVITY SYSTEM

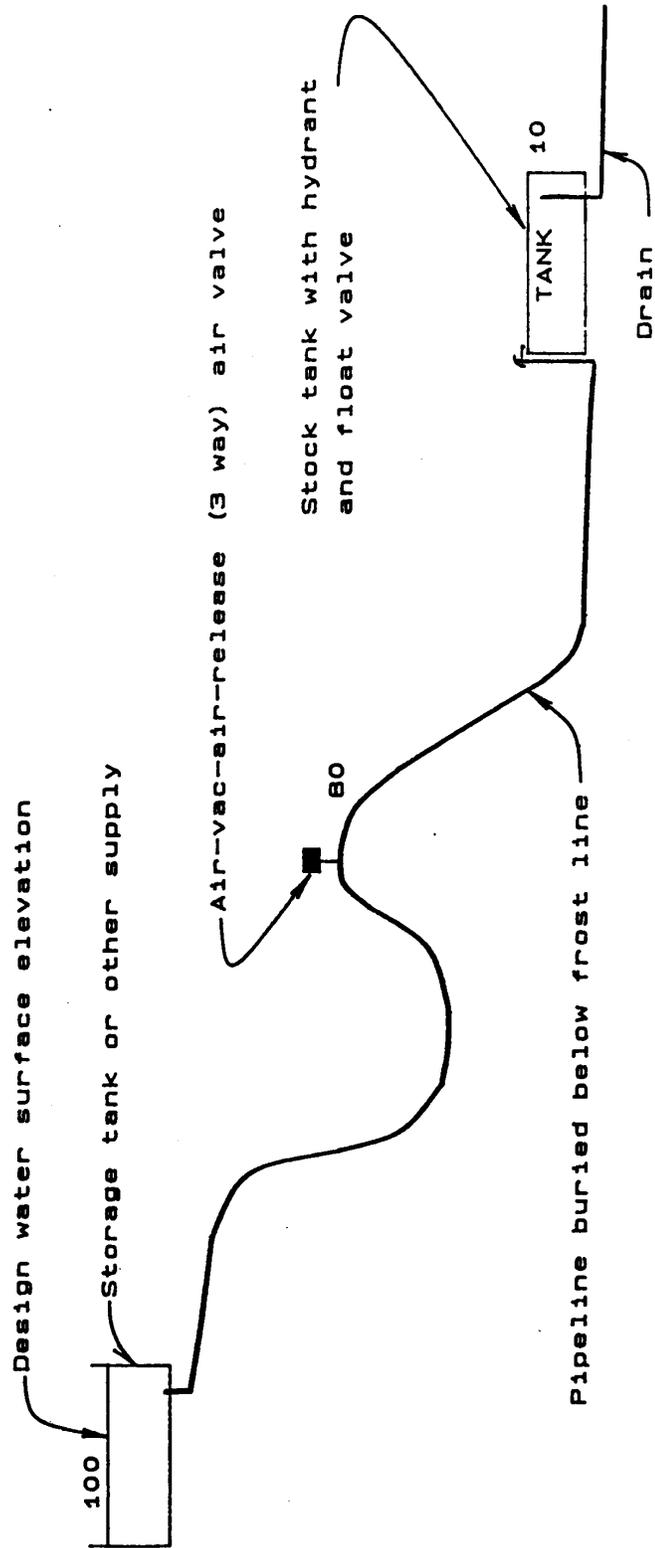


Figure 3.3
TYPICAL AUTOMATIC PRESSURE SYSTEM

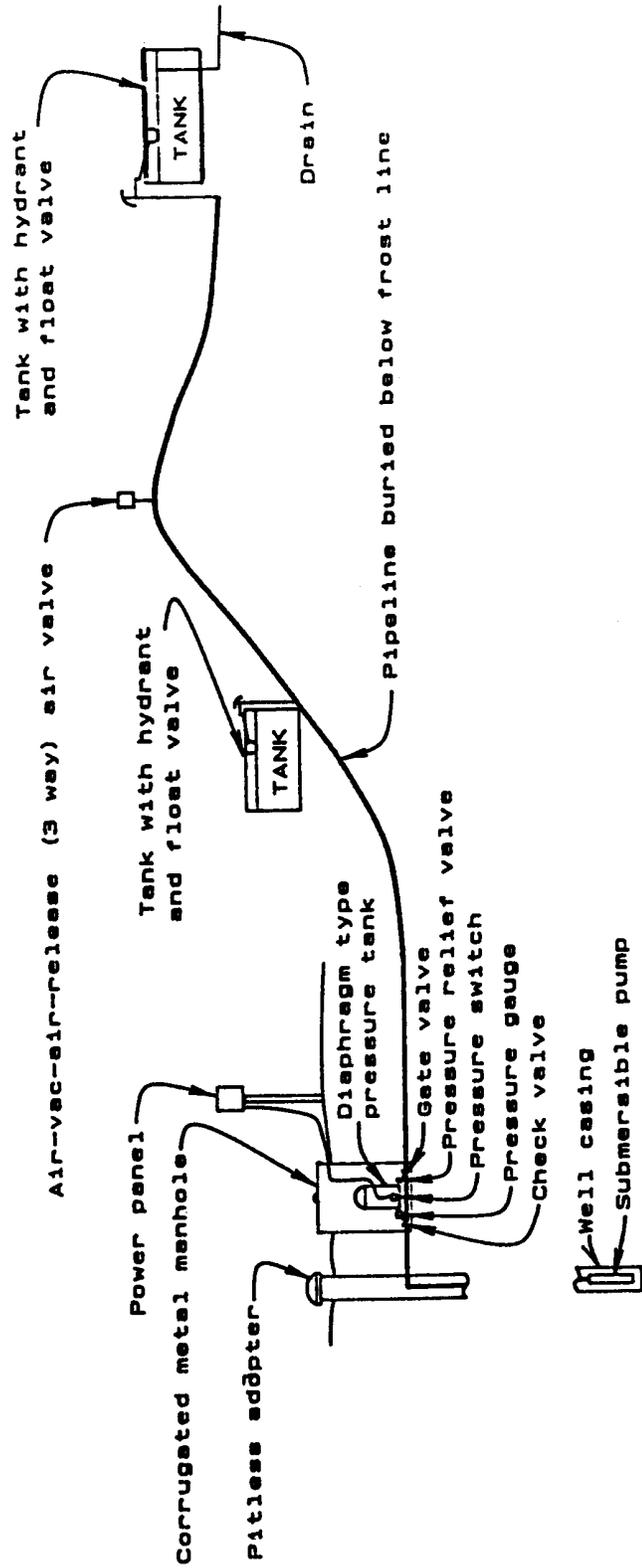


Figure 3.4
TYPICAL MANUAL OR TIMER OPERATED SYSTEM

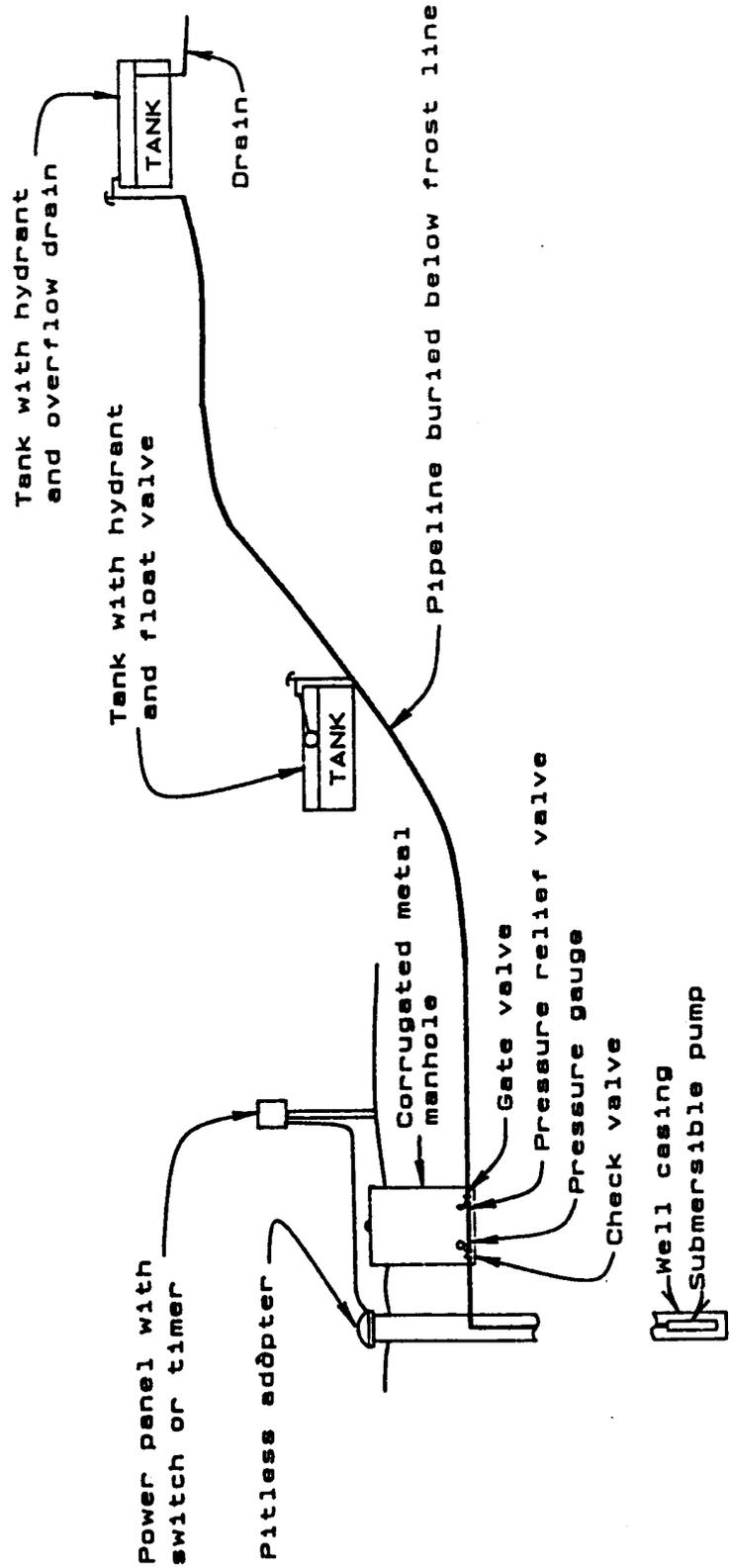
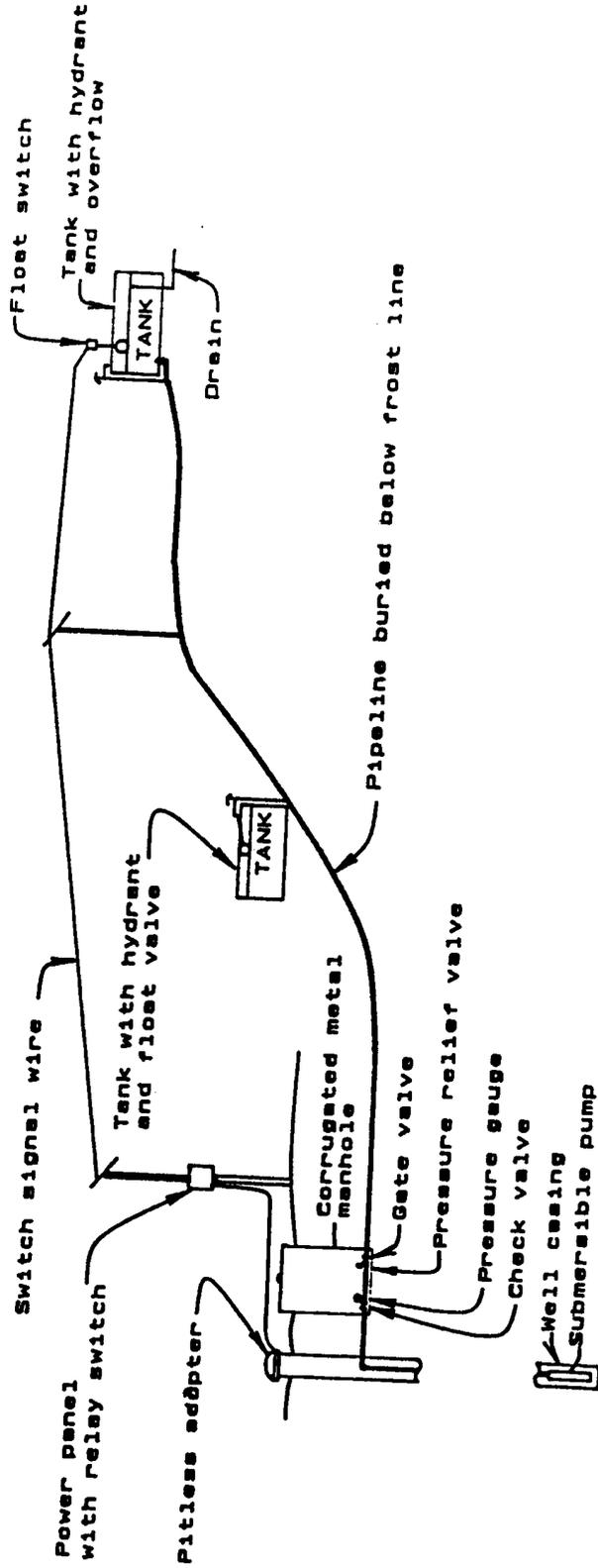


Figure 3.5
TYPICAL FLOAT SWITCH OPERATED SYSTEM



3.6 ALL YEAR VERSUS SUMMER PIPELINES

A pipeline that is only used in the summer can be buried at a shallow depth and drained during freezing weather. Such pipelines are usually buried 24 to 30 inches deep. By contrast, all year pipelines are buried below frost depth, which is five feet or more in Montana.

3.6.1 Summer Pipeline

The decision as to whether or not to use a shallow buried pipeline is most often dictated by how deep the soil is in a given area. Shallow soil over bedrock and cobbly soil, make it difficult or impossible to bury a pipeline below frost depth.

It is usually advantageous to bury a pipeline below frost depth in terrain that will allow this, even if the line is only going to be used in the summer. A deep line will not require draining every winter and is not as critical with respect to installation grades.

Shallow lines must be laid to a grade which will allow draining at low spots. Gravity, pumpout, or seepage pit-type drains must be installed at all low points.

Because of the necessity of draining shallow pipelines, more care must be taken during their installation. The pipe must be laid to grade at a tolerance such that low points in the pipe are not more than about 3/4 of a pipe diameter below grade.

Shallow lines are often buried by the "Pull-in" method. This is done with a large tractor and ripper with flexible pipe on a reel attached to the ripper and fed out behind. Flexible polyethylene pipe is usually used in this type of installation.

Where shallow pipelines cross watercourses, they are often suspended in air rather than buried. Suspended lines are usually made of steel pipe.

3.6.2 All Year Pipeline

For a pipeline to be operational during both summer and winter, the pipe must be buried below the frost line. The actual anticipated frost line and how deep a pipe should be buried depends upon several factors which include:

- Maximum low temperature and number of freezing days in a year
- Soil type and cover
- Sun exposure
- Moisture content of overlying soil
- Whether there is continuous flow in the pipeline
- Temperature of water source.

It is difficult to quantify and determine the actual effect of some of these factors. For situations where there is not continuous flow in the pipeline during the winter months, a pipeline should be buried at least five feet deep in Montana. North slope exposure, high altitudes, and moist soils are factors indicating the need for burying the pipe deeper. Even though the pipe is buried to these depths it could still freeze up in some portions of the line.

Because of equipment limitations it is difficult to bury a pipeline deeper than six feet. Therefore, the choices are to bury the pipeline a minimum of five feet in most normal conditions and six feet or deeper where exposure, elevation, long periods of stagnant water and/or moist conditions exist.

Appurtenances for all year pipelines must be designed in a way that will reduce the chance of frozen pipelines during cold weather. Valves of all kinds must be protected from freezing. This is usually done by installing them in a covered manhole or access hole. Frost free hydrants must be used. Float valves can be installed under a protective cover or in an insulated well.