Pipeline Separation Design and Installation Reference Guide

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Version 9

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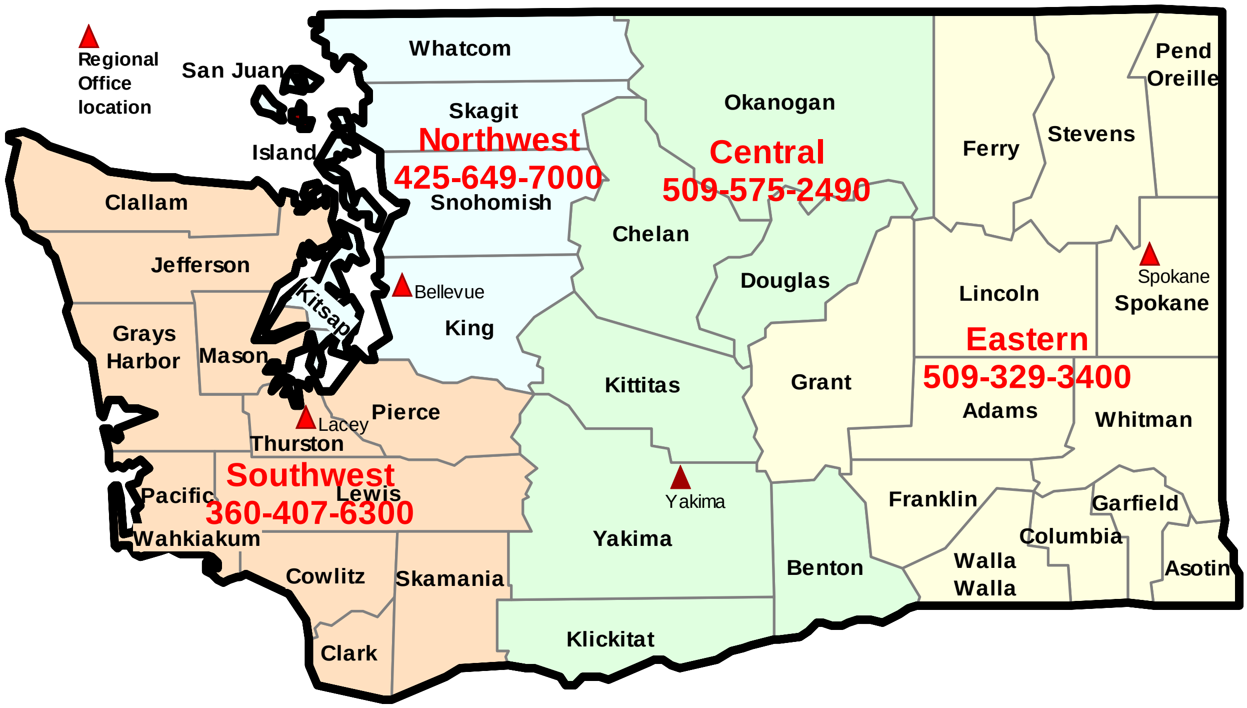

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Executive Summary

Introduction

As water reclamation and recycling assumes a larger and more important role in the management of water resources, challenges in designing and locating piping systems for the distribution of reclaimed water are daunting. Existing standards require horizontal and vertical separations between potable water, reclaimed water, storm water and sanitary sewage that are rarely available in developed urban areas. While special construction practices are allowed to overcome these obstacles, regulatory approval is required on a case-by-case basis. This process is cumbersome, and increases design and construction costs, as well as the completion schedules. The Washington State Department of Ecology and the Department of Health developed this guidance in response to the need for a streamlined process and to assist utility engineers with pipeline separation design and installation.

Pipeline separation is a necessity for protection of public health and safety, property and the quality of the pipeline contents. Pipeline failure or leaks can result in pipeline contamination that increases risks public health and safety. Pipelines do not have to rupture completely or collapse to cause concern. Even the process of excavating one pipeline to repair a leak creates the risk of complete failure of adjacent pipelines.

Separation Standards

The current pipeline separation standards are based on accumulated field and design experience, and the *Ten State Standards.*[1] These standards generally require a minimum horizontal separation of 10 feet between parallel pipes, and 18 inches of vertical separation. Many states have adopted these standards as guidance or regulation.

In 1968, engineers at Utah State University investigated the effects of trench excavation on separation distances from a buried parallel pipe. Their work resulted in a relationship between the distance from the trench face to the parallel pipe [sidewall thickness, X] necessary to prevent trench wall failure, the *critical* trench depth [Z], which depends on soil strength characteristics; the depth of bury [H] of the parallel pipe; and size of the parallel pipe [D]:

$$\frac{X}{D} = 3 \cdot \frac{H}{Z}$$

An analysis using this relationship shows that, in some instances, distances less than the standard horizontal separation distance can be justified. However, this distance is highly dependent on site and soil conditions. In almost all conditions, a minimum sidewall coverage depth of 2 to 3 feet is necessary to allow sufficient room for maintenance and repair efforts in the trench, the minimum pipe-to-pipe separation should be 3½ to 4 feet.

[1] Great Lakes Upper Mississippi River Board of State Public Health and Environmental Managers – Recommended Standards of Water Works, Criteria for Water Works, Section 8.6.

Separation-the Final Protection

Pipeline separation provides the final barrier of protection in the multi-barrier approach to pipeline protection. Other barriers include: 1) the selection of the pipe material, 2) pipe jointing method, 3) pipe bedding procedures and 4) thrust restraint or blocking. Barriers are intended to reduce risks to public health and safety; protect property; prevent contamination of the pipeline contents; protect pipeline customers and prevent collateral damage to other adjacent facilities. Pipeline separation is the final and most important barrier because it remains in place when the other barriers fail.

Special Construction Design

Most urbanized areas do not have the space available for standard separation distances. However, special construction methods can be used to assure equivalent levels of protection. Special construction methods are necessary whenever the minimum horizontal and vertical separations cannot be maintained. There are many common methods in use today. In selecting the special construction method and design, the design engineer needs to consider design factors such as external forces, impacts of ground water, and soils-strength characteristics.

Conclusions

To streamline the design and approval process, the agencies have identified three design conditions.

- Condition A exists when adequate separation distance is available and requires no unusual design considerations.
- Condition B exists when available horizontal separation is between 4 and 10 feet, and/or available vertical separation is between 6 and 18 inches. For Condition B, special construction methods developed, presented, and approved during the engineering phase of the project and included in the construction drawings through standard details are acceptable.
- When Condition C exists, available separation is less than 4 feet horizontally and/or 6 inches vertically. Under Condition C, the agencies must approve special construction on a case-by-case basis.

Introduction

Need for this Guidance

The installation of reclaimed water transmission and distribution piping is a major portion of any water reclamation project. The cost of piping and the challenges in fitting additional buried utilities into crowded utility corridors is often a deciding factor in assessing the project feasibility. Compliance with commonly used standards for horizontal and vertical pipe separation is proving difficult for nearly every project. Currently, the Department of Health and the Department of Ecology (the agencies) have allowed variations from these standards on a case-by-case approval basis. This approach is cumbersome and time consuming for the utility and the regulatory agencies. The agencies recognized the need for a more streamlined, responsive approach.

The agencies developed this guidance to streamline the approach to pipeline separation. These guidelines:

- Provide background information regarding the basis for pipeline separation standards;
- Describe the present standards developed from experience and soils mechanics;
- Describe modes of pipeline failure, the results of pipe failure, and factors that should be considered in the design of special conditions, and
- Provide general design guidance regarding approaches that can be approved by the regulatory agencies and can be applied without case-by-case, individual location approvals.

Background

Underground utility pipes provide the core services necessary to urban life. Drinking water transmission and distribution, wastewater collection and stormwater drainage systems now share underground corridors with natural gas, telecommunications, television and electrical power. In many water-limited areas, piped irrigation water lines are common, with reclaimed water being added to the collection of buried utilities. In order to allow access for maintenance and repair, utilities must compete for precious space in increasingly congested public right-of-ways.

The design of underground utilities commonly focuses on the selection of the pipe size to assure manageable pipeline velocities and internal pressure ratings. Other design concerns include:

- Pipe materials to address service life and product quality
- Pipe wall thickness to address internal and external pressures and forces
- Corrosion control needs and methods
- Valves for isolation and drainage
- Pipe jointing methods and
- Thrust restraint and control

During the design phase, engineers may not focus on the impact of existing, adjacent pipelines. This is because a construction project focuses on isolating, protecting, and addressing these conditions on a large scale. The original design should also address the needs during maintenance and repairs. Unfortunately, many pipeline failures occur because of the lack of attention to affects on and from existing pipelines.

The Need for Pipeline Separation

Importance of adequate separation

Many people do not easily understand or recognize the role of pipeline separation in protecting public health and the environment. However, pipeline contamination can expose pipeline customers to pollutants. Contamination results from cross-connections, leaks, or complete pipe failure of adjacent underground pipes. Pipeline designers can increase pipeline reliability through the proper selection of pipe materials, wall thickness, pipe joint systems, thrust restraint systems, pipe bedding, and internal and external corrosion control. But ultimately, pipelines corrode, leak, and fail. Adequate separation between pipelines provides the final barrier of protection. This minimizes incidental damage during the repair of other pipelines and leakage effects between pipes. Adequate separation also assures sufficient room to repair leaks and replace broken sections. Finally, separation reduces the potential for pipeline failure caused by a leak or failure of its neighboring pipeline.

Figure 1: Pavement damage due to pipe leak

Leakage Damage

The benefits provided by assuring pipeline integrity are neither readily recognized nor easily quantified, until a problem arises. Underground pipelines are out of sight, and out of mind. Commonly, we are aware of problems with these buried pipes only when a water line break shuts water off at home, or a sewer backs up into the basement. But these two instances represent inconveniences compared to more common results from pipeline leaks. The following photos show graphic damage created by leaking municipal utilities. Figure 1 shows pavement damage due to a leaking sewer and the consequences of a water main break in a residential area. Figures 2 and 3 show extensive damage caused to neighborhood streets by the collapse of a water or sewer line.