

#### **4.4 General Vertical Alignment**

Design all sewers on a straight vertical alignment between structures. The current and future service needs and slope determines the depth of a gravity sewer. A pressure sewer (i.e. force main) is not as dependent on either of these factors. Force mains transport flow under pressure and are generally located at a depth less than what is required for a gravity sewer. Regardless of the type of sewer, other factors also influence sewer depth. These include local regulations, underground utilities and existing structures, general topography, and the need to protect the sewer from surface influences (e.g. traffic loads, etc.). Economy, pipe strength limitations and maintenance needs are also determining factors.

##### **Gravity Sewers**

Gravity sewers must be deep enough to provide service to all buildings and sites served.

They must also be deep enough to pass, with adequate clearance, under other existing and future utilities. Occasionally, BES allows a sewer to pass over unusually deep or large utilities, especially other sewers. They should not be any deeper than necessary to provide “unrestricted service,” protection from surface influences, and conformance to alignment requirements. The determination of the depth to provide “unrestricted service” must include reasonable allowances for unknown and unexpected conditions, such as the location and depth of future utilities.

At locations where gravity service to a building site is infeasible, BES may permit design of an individual pumped service. BES must review a proposed private pumped service before construction. The BDS Plumbing Inspection Section (Refer to [Chapter 1, Useful Contacts within the City](#)) issues the permit for constructing a private sewage pumping system.

**Force Mains**

Force mains operate under pressure, are not dependent upon pipe slope and can transport sewage over topographic barriers and over distances where the lack of slope prohibits gravity service. Because of these characteristics, a force main is installed at shallow depth below the ground surface. A primary factor dictating burial depth is the soil cover needed to protect the force main from surface loads, freeze protection as well as conflicts with other utilities and structures. A force mains’ inherent characteristic provides greater flexibility for changing its vertical location and avoiding conflicts. Do not directly connect sanitary service laterals to a pressurized pipe.

Design and construct all force mains to the requirements of the Pump Station Design Manual (Refer to [Chapter 1, Companion Documents and Internet Links](#)).

**4.4.1 Minimum Depth Determination**

BES has established minimum sewer depths and cover requirements for gravity and pressure sewers. (See table) Cover over the top of pipe is determined by the difference between the top of pipe and finished ground elevation. Factors that influence the facility depth include whether it is public or private, its location in a street or in an off-street location, and the City’s preference to serve all buildings and sites with gravity service.

Inlet lead pipes connect inlets in series or directly to a sewer main. Because of their location within a ROW, the minimum depth of cover for an inlet lead is less than that required for sewer mains and service laterals. BES developed criteria specifying the minimum cover depth required for inlet leads and alternate pipe materials when this criterion cannot be met. (Refer to [Appendix I: Inlets and Inlet Leads](#) for specific design information.)

**Table 4.3 Minimum Cover Requirements Over the Top of a Public Sewer**

PUBLIC SEWER TYPE	POSSIBLE LOCATIONS	
	a) PUBLIC ROW OR STREET	b) PUBLIC SEWER EASEMENT
Sewer Mains	6 feet	3-feet
Inlet leads	2 feet	2-feet
Force main	3 feet	3-feet

#### 4.4.2 Minimum Vertical Separation

The following requirements establish minimum vertical sewer separations.

The following criteria assume a sewer lateral being 100 feet long and placed at a 2 percent (1/4-inch per foot) slope.

- a. Provide 4 feet plus one-half the diameter of the receiving sewer separation between the lowest habitable building floor served and the invert of the sanitary lateral at the point of connection to the sewer. An allowance of 2 feet is included in the 4 feet separation for elevation losses in the sanitary plumbing systems. Those are common conditions. The actual conditions may require greater depths. BES may allow lesser depths if properly documented and justified.
- b. Provide 2 feet plus one-half the diameter of the receiving sewer between a stormwater or groundwater source (e.g. roof drain, footing drain etc.) and the invert of the storm sewer lateral at the point of connection to a sewer.
- c. Provide 1-foot separation between the outside walls of a sewer (e.g. main, lateral, etc.) and any intersecting sewer or utility (excluding water lines).

BES does not consider a request for an exception from these standards based solely on economic factors as being adequate justification to grant an exception. BES will investigate each potential connection for factors that may require greater or lesser vertical distances. (Refer to [Chapter 5, Sewer Service Laterals](#) for additional information about sewer lateral design).

BES will consider numerous factors to establish sewer depths that deviate from the standards set forth above. It is necessary for a designer to provide a complete analysis of the need for such a design and submit a Variance Request Form if conditions require deviation from these standards.

#### 4.4.3 Crossing between Sanitary Sewers and Water Lines

The vertical and horizontal separation between sewers including sewer laterals and water lines shall follow the requirements of the Oregon Health Division, Oregon Administrative Rules (OAR), Chapter 333, Division 61, Public Water Systems, 333-61-0050 (10), Crossings - Sanitary Sewers and Water lines. A copy of this OAR is in this Manual in Appendix F.

The regulations mandate a minimum separation between water and sewer pipes to assure protection of a water supply. Conformance with the regulation allows water and sewer pipes to cross and parallel one another without following any special requirements.

When construction prevents adherence to the specified separation distances use special pipe construction techniques and pipe materials.

##### Common Trenches and Sewers Parallel to the Water Line

- Do not install a sewer directly above or below a water pipe.

- Do not construct a sewer within 5-feet from the outside wall and below the invert of the water pipe.
- Locate the sewer a minimum of 1-foot away from the outside wall of a water pipe.
- Locate the top of the sewer below the invert of the water pipe. Place the water pipe on an undisturbed earthen bench adjacent to the sewer trench.

When a sewer is constructed more than 5-feet from the outside wall of a water pipe and below its invert

- No special requirements

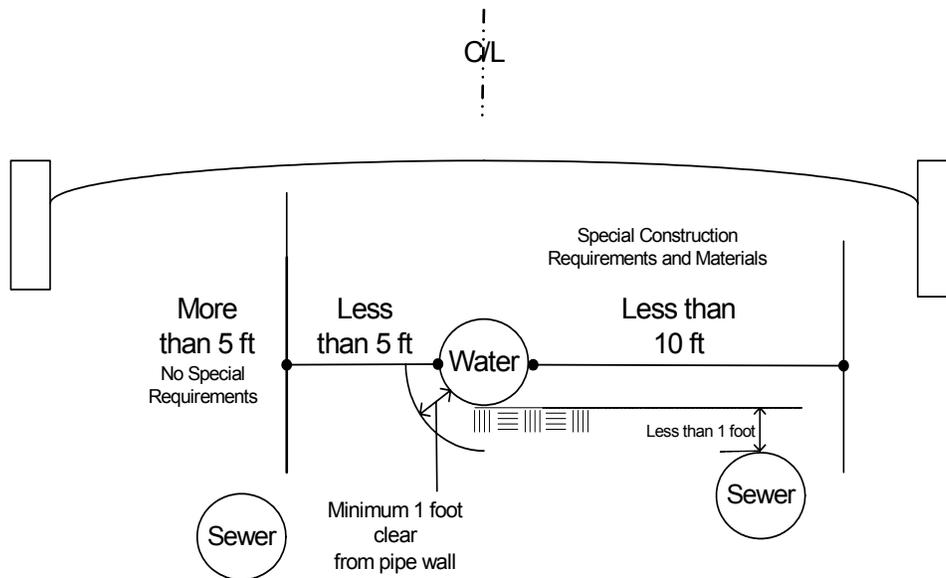
When a sewer is constructed less than 10-feet from the outside wall of a water pipe but the sewer invert is less than one foot below the invert of the water pipe.

- In this area, construct a sewer using pressure pipe materials.

Sewers Crossing Water lines

The minimum vertical separation between a water pipe and a crossing sewer main is 1-1/2-feet. Increase this separation distance to 2-1/2-feet when the crossing pipe is a sewer lateral.

Figures 4.1 and 4.2 depict the general spatial relationships between a sewer and water pipe. Departure from these specified separation distances require special construction procedures and Bureau of Water Works approval.



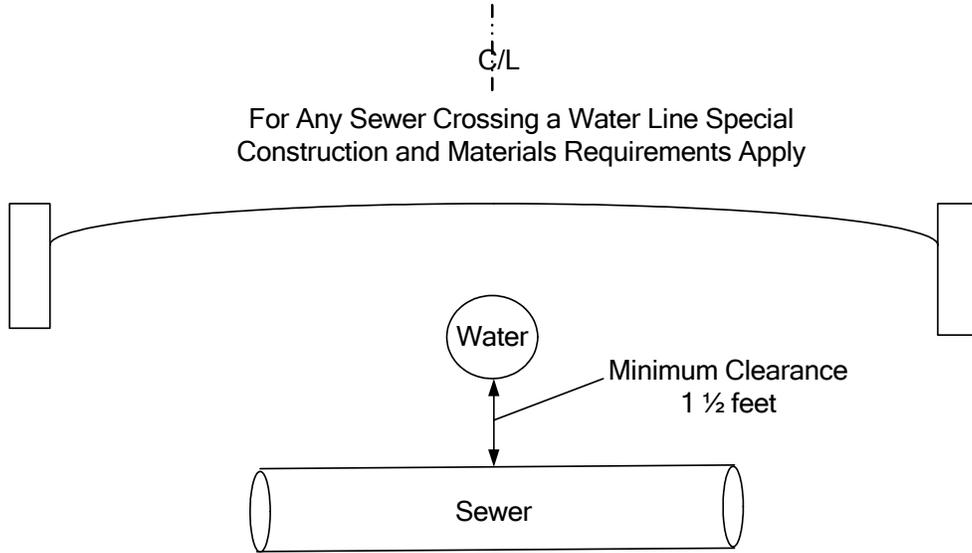
**Figure 4.1 Common Trenches and Sewers Parallel to the Water Line**

**4.4.4 Vertical Alignment - Profile Requirement**

A sewer profile (i.e. grade line) depicts the approximate elevation of the ground along the centerline of the pipe route. They are useful for identifying features that could influence design and construction decisions and to estimate excavation and backfill quantities.

For pipelines constructed within or adjacent to an existing roadway, the profile shall reference the existing roadway centerline only if the pipeline centerline is near the standard sewer location and the difference between the ground elevations is less than 1/2-foot. If a roadway is an unimproved street or does not have an established roadway grade, the designer shall contact the Office of Transportation to receive information regarding the elevation of the future roadway. The designer will be required to show the approved centerline profile and label it as being the Future Roadway Centerline.

Pipelines constructed off street shall reference the existing ground elevation over the pipeline centerline as determined from field surveys.



**Figure 4.2 Sewers Crossing Water Lines**

**4.4.5 Determining Sewer Slope between Manholes/Structures**

BES calculates a sewer slope by referencing the centerline invert elevation at the center of each manhole/structure and the total distance measured between the centers of each manhole/structure. All calculated inverts entering or leaving a manhole/structure reference the manhole/structure center. Include this information on the Plans. Refer to Chapter 4, Manhole Channel Design.

There are other techniques to calculate sewer slope, however, this method allows surveyors to efficiently field-stake a manhole location and depth to the invert. During construction, BES inspectors use the field stake information and profile data to confirm that invert elevations into and out of manholes/structures are as shown on the Plans.

Show the calculated sewer slope on the profile to four significant figures. Present the information as a percentage. Show this pipe slope on the profile.

To determine the pipe slope, subtract the downstream manhole invert elevation (I.E. In) from the upstream invert elevation (I.E. Out) and divide the difference by the total distance between the manhole centers. Multiply this number by 100 to obtain the pipe slope as a percent.