UDF Overview

A pipe’s hydraulic carrying capacity will deteriorate with age, depending on the corrosive nature of the water and surrounding soils. Deposits on the pipe walls may be formed by precipitation, microbiological activity, and corrosion. These accumulations will increase the hydraulic roughness and reduce the cross-sectional area and hydraulic carrying capacity of the mains. A loss in carrying capacity can lead to low pressures as well as the inability of the system to deliver fire flows, especially during high demand periods. Slow moving water can result in a loss of chlorine residuals at stagnant spots and create a public health risk. Problems associated with water quality degradation are particularly acute with dead-end lines and low-demand portions of the water distribution systems.

Flushing water mains is an effective tool for maintaining water quality and clarity and system capacity. Flushing can improve water quality by restoring the disinfectant residual, reducing bacterial regrowth, dislodging biofilms, removing sediments and deposits (and contaminated water), controlling corrosion, eliminating taste and odor problems, and reducing disinfectant demand throughout the system. Flushing is also performed to improve the flow of water (restore flows and pressures and fire fighting capability) through the distribution system allowing it to work at capacity. These benefits will prolong the life expectancy of the distribution system and reduce the potential for waterborne disease outbreaks.

Flushing is performed by isolating sections of the water distribution system and opening fire hydrants (or flushing valves) to cause a large volume of flow (large velocity) to pass through the isolated pipelines so that a scouring action is created that removes any material built up in the pipe. The flushed water is then discharged through a hydrant. Flushing should continue until the water has cleared and disinfectant residual has reached normal expected levels. To minimize negative environmental impacts (as flushed water may be high in suspended solids and other contaminants that can harm water bodies), flushed water is normally discharged into sanitary sewers or a storm water management facilities such as detention ponds. It is important to properly manage a flushing program as excessive flushing can waste significant volumes of water.

There are basically three flushing methods: continuous blow-off, conventional, and unidirectional. The most effective method of flushing water mains is unidirectional flushing.

**Continuous Blow-Off** – A short-term preventive strategy, continuous blow-off is used to flush areas of the distribution system with water circulation problems and stagnant water (e.g., dead ends, large water mains). Because the method forces a low-flow velocity through a small portion of the system, it may not be effective in removing sediments. It also uses large quantities of water.

**Conventional (Traditional) Flushing** – Conventional flushing generally involves opening hydrants in a specific area of the distribution system until the water visually runs clear. While effective in quickly removing loose particles, this type of flushing is usually not effective in dislodging well-attached deposits and cannot remove scales and tuberculation. Because in a looped system the water will flow to the hydrant from multiple directions and via several mains, it becomes very difficult to achieve the high-velocity flushing required to scour and remove deposits. As a result, some sediment and biofilm may not be removed and the cleanup method requires a lot of water (about 40% more than unidirectional flushing). In addition, dirty water from surrounding mains can enter the segment being flushed, thus resulting in debris being moved from one part of the water system to another.
Conventional flushing in a looped system results in water flowing toward the hydrant from all directions generating lower flow velocity and less scouring of the pipes.

**Unidirectional Flushing** – Unidirectional flushing involves the closure of valves and opening of hydrants to create a one way flow in the water mains for removing the built-up sediment. This type of flushing (i.e., high speed flushing) increases the speed of the water in the mains so that the shear velocity near the pipe wall is maximized. This high-flow velocity produces a scouring action in the mains, effectively removing sediment deposits and biofilm.

Flushing should start at a clean water source (e.g., pump station) and proceed outward in the system so that flushing water is drawn from previously flushed reaches. This step-wise approach ensures that clean water is always used to flush the mains and, thus, systematically washing out the pipes without pulling contaminants from other lines as can happen with conventional flushing.

No special equipment is needed; however, some planning is required to define the flushing zones, the valves, and hydrants to be operated, the duration of the flush for each zone, the required flow velocities, and the sequence of operation. A hydraulic model of the water distribution system can greatly simplify and expedite the planning process, especially for estimating pipe flow rates, velocities, and flushing times. In addition, the network model can be effectively used to assess the hydraulic impact of flushing sequences to avoid excessive pressure drops (e.g., below 20 psi) throughout the system while providing the required flushing velocity for the flush sequence that is sufficient for scouring solids from the pipes. The required velocities necessary to remove sediments and debris from the water pipes range from 2.5 to 6 ft/s within each pipe segment.

Unidirectional flushing results in water flowing toward the hydrant in only one direction resulting in higher flow velocity, more scouring and better cleaning of the pipes with less water use.

While more costly and time consuming (more planning needed) than conventional flushing, unidirectional flushing is more effective and requires less water. In addition, because unidirectional flushing will test almost all of the water system valves and hydrants, it implicitly identifies those in need of repair or replacement. It also helps identify other distribution system problems such as pipes with leaks and breaks. Care must be taken to open and close valves slowly and avoid high velocities (e.g., greater than 10 ft/s) to prevent the objectionable pressure surges during the opening and closing operations.

The hydraulic shear stress at the pipe wall can also be used as a criterion for flushing. The shear stress \( \tau \) (lb/ft² or N/m²) is readily calculated as:

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\tau = y R_H S_f
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Where: \( y \) is the specific weight of water, \( R_H \) is the hydraulic radius, and \( S_f \) is the friction slope. InfoWater UDF is the ultimate approach to help you develop the most effective unidirectional flushing program for cleaning your drinking water distribution system. InfoWater UDF delivers unprecedented power and flexibility in managing the systematic flushing of your distribution system to remove stagnant water along with mineral and sediment deposits that have accumulated over time — restoring hydraulic capacity.
Built atop ArcGIS, InfoWater Pro UDF seamlessly integrates advanced water network modeling with the latest generation of ESRI GIS technology. The groundbreaking application capitalizes on the intelligence and versatility of the GIS geodatabase architecture to help you develop effective flushing sequences for each flushing zone, quickly identify which fire hydrants and water main valves should be manipulated for proper cleaning while avoiding excessive pressure drops (e.g., below 20 psi), and maintaining the desired level of hydraulic performance in the distribution system. The program also computes the minimum flushing time, the total flushing volume and pipe length, the flushing velocity of every pipe in the sequence, the shear stress for every pipe in the sequence, and the available fire flow at the minimum residual pressure. The hydraulic impact of each flushing sequence is also checked to ensure that the desired minimum pressure is maintained throughout the system.

We are happy to bring you the state-of-the-art in drinking water distribution system management technology to help you sustain safer, more reliable drinking water supply infrastructures.