Unsurpassed Solutions
in the Water Environment

Unidirectional Flushing Programs: A Yearly History Lesson

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Introduction

Water utilities today are tasked with maintaining a sufficient and safe water supply in the face of increasing demand, decreasing budgets, and the detrimental effects of climate change. As a result, it is critical that utilities find and implement proven methods of maintaining and improving water systems. Deposits on the interior of pipes in distribution systems, typically the result of corrosion or microbial activity, are commonplace and cause serious issues to both water quality and distribution system pressure. The most effective method of removing these accretions is through water main flushing. While there are two methods of water main flushing, unidirectional flushing (UDF) is superior in that it uses less water while more effectively cleaning the pipe walls.

Unidirectional Flushing — Methodology and Benefits

Tuberculation of water main

Unidirectional flushing is a unique process that not only helps to maintain a distribution system, but also provides critical information about the system, allowing utilities to improve operations and make informed decisions on future improvements. Conventional flushing methodology consists of simply opening a series of hydrants until the water runs clear. Because the water moves in all directions until finally exiting the hydrant, flow is often insufficient to adequately clean the pipe, and the flushing takes far longer — and uses far more water. In contrast, UDF takes place in one direction only, from larger, cleaner mains to smaller, dirtier mains. The benefit of UDF over conventional flushing is that UDF creates a more pressurized flow in a single, targeted direction, which discharges deposits from the pipe far more quickly and efficiently than conventional flushing. Also, because UDF requires less time than conventional flushing, it reduces the inconvenience to customers.

Flushing radiates from a clean source such as a well or tank and proceeds through the entire system in steps. Flushing series are typically grouped into flushing zones in order to maximize

operational efficiency and minimize public disturbance. Flushing lengths should be limited to an average of 1,500 feet, from larger pipes to smaller. A series of pre-determined valves are closed in the system to maintain a unidirectional flow. Water used in flushing is discharged from the system at pre-determined locations throughout the system, usually through hydrants or blowoffs. Because UDF requires a systematic approach, development of a flushing program is critical. A UDF program is often most effectively planned through hydraulic modeling software.

The primary goal of UDF is to clean water mains, removing as much sediment and loose tuberculation as possible, including biofilm, iron, and manganese deposits. Performing unidirectional flushing on an annual basis helps to avoid tuberculation and sedimentation buildup. Water mains that are not flushed on a regular, scheduled basis run the risk of building up tuberculation to the point that it cannot be removed by flushing. Removal of sediments is of critical importance, as buildup can have a significant, negative impact on water quality, fire flows, and distribution system efficiency.

While the primary objective of UDF is to clean mains, there are many secondary goals and benefits. Regular exercising of valves and hydrants helps prolong useful lives. Flushing can also help locate broken valves and hydrants, locate closed valves or other obstructions in the water mains, and help narrow down a search area when trying to determine the cause of water quality or pressure issues. Also, discrepancies with the hydraulic model can be discovered and addressed during flushing. Lastly, flushing helps to determine or disprove suspected system issues.

Development of the Program

The American Water Works Association (AWWA) has published a set of guidelines to follow when implementing a UDF program. First, a minimum velocity of 3.0 feet per second is recommended; as an example, a water main that is eight inches in diameter would require just under a 500 gpm minimum flow rate. In addition, AWWA guidelines recommend that the system pressure in the area surrounding active flushing maintain a minimum of 20 psi in order to provide fire flow. Analysis of the hydraulic model will help determine flow rates needed to maintain flushing velocities, and will assist with determining the sequence of valves to close to maintain service to customers in areas not being flushed.

Starting a flushing program from scratch provides a number of significant advantages. During development, it is important for the utility to be involved and provide as much input as possible. This allows for the most accurate hydraulic model to be used, leading to the best quality flushing program. The utility should review the draft flushing program and comment on modeling discrepancies or areas that may present flushing issues. These could include low pressures or flows, which can be attributed to a number of problems within the distribution system. Other potential flushing problems may include drainage issues or difficulties with property owners.

Low pressures or flows may result from broken valves, closed and forgotten valves, or misidentified water mains. Eliminating discrepancies between flushing maps, the hydraulic model, and the existing distribution map will help produce a more effective flushing plan and a more efficient distribution system. Identification of smaller diameter sections of main is a common occurrence during development of flushing plans. As an example, a utility may have replaced an old 6-inch diameter main with a larger 12-inch diameter main. Development of the flushing plan may reveal that a section of the old smaller main was left in the system and not identified on as-built drawings. The hydraulic model can help pinpoint areas to be investigated. Water system personnel may be completely unaware of the small section of reduced-diameter water main and the impacts on the distribution system in that area.

Execution of the Program

During the execution of the flushing program, it is paramount to gather as much data as possible to compare to the expected system flow and pressure conditions, and to data collected during prior flushing programs, if available. Flow and pressure should be recorded at key points in the system. The dates and times that valves were operated and flushing began and ended should be documented. Any broken valves or hydrants should be noted, and also which valves are being opened and closed. If there is a significant difference in flow rates from year to year, or if hydraulic issues arise after flushing, the first possibility that should be explored is whether or not a valve may have inadvertently been left closed. In addition, it is imperative to note flow rates and whether or not the flushing hydrant was throttled. Operators should be advised to note any discrepancies between the flushing plan and actual conditions. This information makes it much easier to pinpoint and correct any problem causing a specific hydraulic issue, and it also simplifies annual updating of the model and the flushing program.

After the initial flushing program has been completed, the data must be organized so that it can be reviewed and analyzed. Any required changes to the hydraulic model and/or the flushing program should be noted at this time. Once this information has been organized and reviewed, hydraulic problem areas should be thoroughly investigated. Beginning in the second year of flushing and annually after that, any changes in flow rates should also be thoroughly investigated. The more accurate the model is, the easier it will be to determine why results in the field may be different than expected, and the more information that is noted in the field, the easier it will be to compare results from year to year. Accurate recording of dates and times will assist with use of system SCADA data to troubleshoot problems.

Two examples of how a flushing program can be used to improve utility records are shown below:

Example No. 1

In this example, Figure 1 shows the piping according to the model used to develop the flushing program. The model showed a 12-inch water main on Holland Road and a 6-inch water main on West Emerson Street, both connecting at the Lynn Fells Parkway. During flushing, the recorded flows as well as valve configuration indicated that the model was not correct. After flow testing the area, it was determined that a portion of the 6-inch water main on West Emerson Street is actually an 8-inch water main, and there is an additional connection between the 16-inch and 8-inch water mains, as shown in Figure 2.

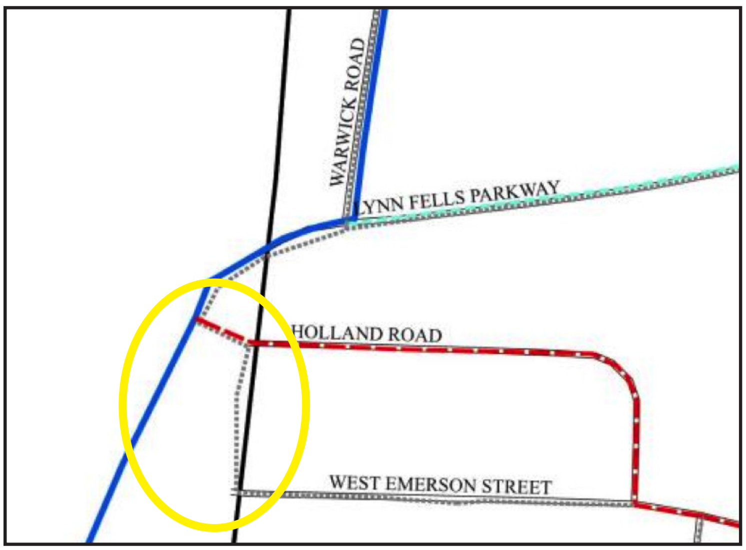


Figure 1

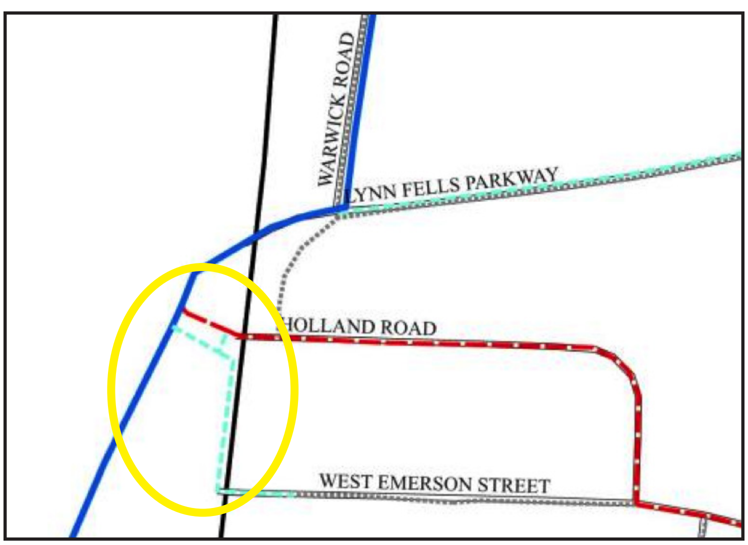
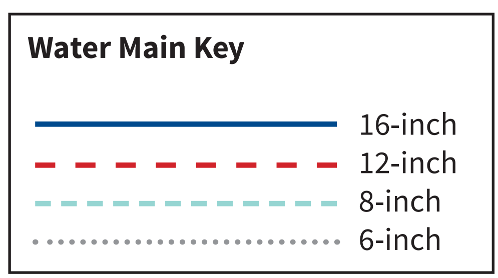


Figure 2



Example No. 2

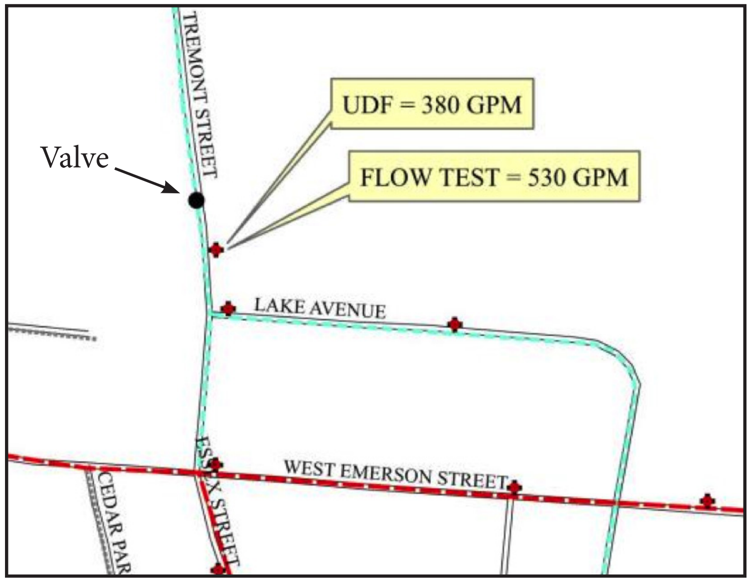


Figure 3

Figure 3 shows significantly different flows from the same hydrant on Tremont Street. During flushing, the flow was 380 gpm. A previous flow test had recorded 530 gpm, and flushing during previous years observed flows in excess of 1,000 gpm. The hydraulic model was used to determine the cause of the low flows. The model indicated that there was an obstruction on Tremont Street, and after further investigation, it was determined that a valve that was not recorded in the system maps had been closed. Since the valve was not shown on the system or flushing maps, the valve was not recorded to be opened after flushing.

Developing a Plan Moving Forward

Once a hydraulic issue has been discovered and the cause of the problem has been determined, a plan can be made for corrective action. Some solutions are as simple as performing additional flushing targeted on the problem area, or replacing broken valves. Other situations require more extensive solutions such as replacing water mains, cleaning and lining, looping dead ends, and even installing new water mains. Moving forward, the updated hydraulic model can then be used to determine the most efficient and cost-effective solutions.

Conclusion

There is a great deal of information that can be gathered during flushing, and the better the quality of data recorded, the easier it is to compare data, making it easier to determine if changes are occurring or if a problem has developed in the distribution system. Each step of the process is important, and a successful flushing program is a continuous process. The data should be compared on a yearly basis, at a minimum. If the data is not reviewed annually, small problems have the potential to become large problems, and simple system improvements run the risk of being overlooked. By receiving input from the utility and keeping track of areas of concern, the data from these areas can be compared and investigated in an efficient manner. Not only can the data indicate any new problems, but it can also evaluate the effectiveness of improvements in the system. Implementing a flushing program, and analyzing the data it provides, is an excellent way to keep a distribution system in top performance, improve water quality, and therefore, improve the overall quality of the area being served.