



FLORIDA RURAL WATER ASSOCIATION

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FRWA Whitepaper Unidirectional Flushing & Superchlorinating

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Distribution Systems Represent Your Biggest Investment. Water systems are made up of four major components: source water (wells), treatment, storage, and distribution. Of these four, the distribution system represents the greatest portion of the total capital investment, somewhere between 60 and 70 percent. Yet when buried the distribution system is mostly out-of-sight and out-of-mind. Little money or attention is spent to maintain this significant utility investment.

We have entered an era of dwindling capital resources and aging infrastructure. Enormous pressure is being brought to make things last longer and do more with less. This is done by establishing and maintaining effective distribution system operation and maintenance programs.

Old Pipe and Water Quality Problems. Old and neglected pipe can and does have a negative effect on water quality at our customer's tap. What good is it to build sophisticated and expensive treatment plants that produce the highest quality water only to put in pipe full of debris and biofilm.¹ The EPA tells us that biofilm is present in almost every water distribution system; so this one of the reasons for maintaining residual chlorine to protect public health.

Old and neglected pipe degrades water quality. Require more chlorine. Water can pick up odor, color, taste and bacteria from the distribution system through chemical and biological interactions. Recently in Washington D.C. nitrification from chloramination was the leading factor in lead leaching into drinking water from the pipes. The problem is more acute at dead-ends and areas with low demand. Additionally water mains are often oversized to provide fire protection or to meet land development codes requirements.

Options. There are only a few things that can be done to remove biofilm and debris from the distribution system short of replacing the entire pipe network. First, the most expensive is to swab the lines with pigs however this is expensive and requires the line to be insulated from the rest of the system. Second and next expensive is to inject an enzyme or oxidant into the lines to dissolve the biofilm this allows the lines to remain in service (we wonder where all the "stuff" goes). Finally, unidirectional flushing and chlorinating is the least cost option and is effective for most situations. ***FRWA strongly recommends unidirectional flushing.***

If the term unidirectional flushing is unfamiliar, we will describe unidirectional flushing below.

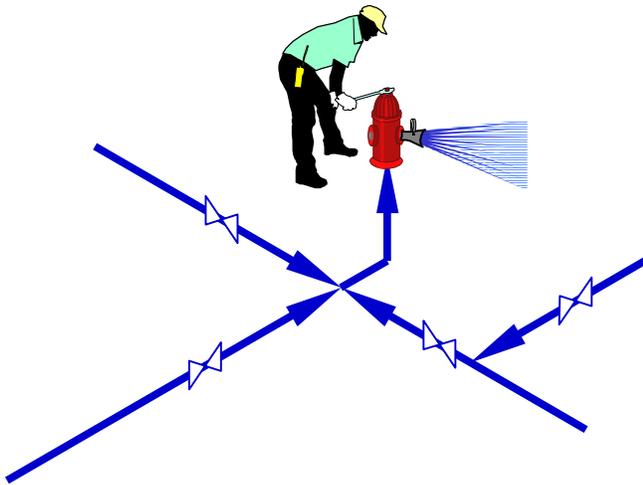
UNIDIRECTIONAL FLUSHING

Unidirectional flushing cleans the pipe, which improves chlorine residuals levels, lowers complaints, and in turn discourages the regrowth of biofilm and noncompliance issues related

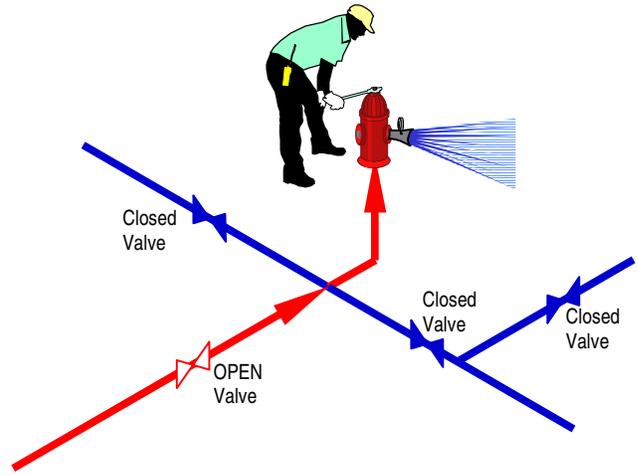
¹ Biofilm is composed of microorganisms or layers of bacteria that attach to the interior walls of water distribution pipes and to one another -- most heavily around corroded surfaces on pipes. The bacterial community traps nutrients, microbes, worms and waterborne pathogens to form an almost impenetrable material. Almost immediately after attaching itself to pipeline walls, the organism begins building upon itself, adding layer upon layer, forming a plaque-like coating.

to coliform and heterotrophic plate counts (HPC). Unidirectional flushing can be followed by routine flushing (including installing automatic flush valves at strategic locations) -- system water quality problems can be controlled without much effort thereafter.

Conventional Flushing is the traditional practice of cranking a fire hydrant open for a few minutes in response to customer complaint. Conventional flushing is reactionary. Flow comes to the fire hydrant from multiple haphazard directions. The operator cannot target flow to a single pipeline. Water and time is wasted. Random fire hydrant flushing addresses the symptom but not the problem.



Conventional Flushing



Unidirectional Flushing

Conventional Flushing	Unidirectional Flushing
<ul style="list-style-type: none"> ▪ Water flows from any and all directions ▪ Can't control flushing direction ▪ Can't fully clean water pipes ▪ Water velocities are low ▪ Less scouring and little biofilm removal 	<ul style="list-style-type: none"> ▪ Water channeled to a single line ▪ Systematic valve operation ▪ Higher water velocities ▪ More scouring and biofilm removal ▪ Better cleaning to purge system ▪ Improves chlorine residual

Unidirectional Flushing forces flow in a single direction and single pipeline, the resulting flow approaches scouring velocity (5 feet per second) the necessary to scour deposits and debris from the mains. Unidirectional flushing is a proactive controlled approach.

Unidirectional flushing is a routine process of cleaning the piping of the water distribution system. Most water providers conduct a systematic and controlled flushing program to remove sediments and stale water and to help maintain chlorine residuals throughout the system. Flushing improves the overall quality of water in the distribution system and assists in the overall system maintenance.

Other benefits of unidirectional flushing are:

- Immediate water quality improvements
 - Restoration of chlorine residuals (less demand to fight biofilm)
 - Removal of accumulated debris and biofilms
- Requires limited capital resources to develop and implement
- Reduces odor, taste and color customer complaints
- Allows for simultaneous preventive maintenance activities, such as valve and hydrant exercise
- Uses less water than conventional flushing
- Standardizes procedures which provide a uniform basis of comparison with future flushing events
- Helps systems meet increased regulatory requirements

How to Perform Unidirectional Flushing. The American Water Works Association (AWWA) has released a 20-minute DVD that explains the concepts and techniques of unidirectional flushing; how to develop a flushing plan using paper maps; how computer aided mapping simplifies the project; benefits versus traditional flushing techniques; and the benefits to consumers and the community. FRWA has a copy of this DVD and can be loaned to water systems by contacting your water circuit rider or you can purchase it from www.awwa.org.



UNIDIRECTIONAL FLUSHING STEPS

Step 1 – Pre-plan the flushing sequence using system maps and hydraulic models. Chart flow patterns, you always start at the source water and storage tanks. Flush toward system extremities, pushing the dirty water downstream. A haphazard flushing pattern is worse than no flushing at all.

- We recommend that you consult with an engineer for designing your unidirectional flushing plan.
- Use valve and hydrant locations to map out your unidirectional flushing pattern.
- Review drainage and dechlorination requirements (if flushing water will be directed to a surface water body).

Step 2 – Divide distribution system into sections and flushing sequences. These should be manageable loops / flushing runs that can be accomplished during normal working shifts. We recommend 1,500 to 2,000 segments.

Step 3 – Set targets for flushing velocities. It has to be high enough to scour the pipe and to remove biofilm and biomat. Target is 2 to 5 feet per second, but depends on pipe conditions. Low velocity flushing (under 1 fps) only wastes water without doing the job, while 7 to 10 fps is TOO high and can permanently damage pipes.

Step 4 – Develop a Step-by-Step Flushing Sequence for field crews to follow – about 10+/- Steps in how they open & close valves.

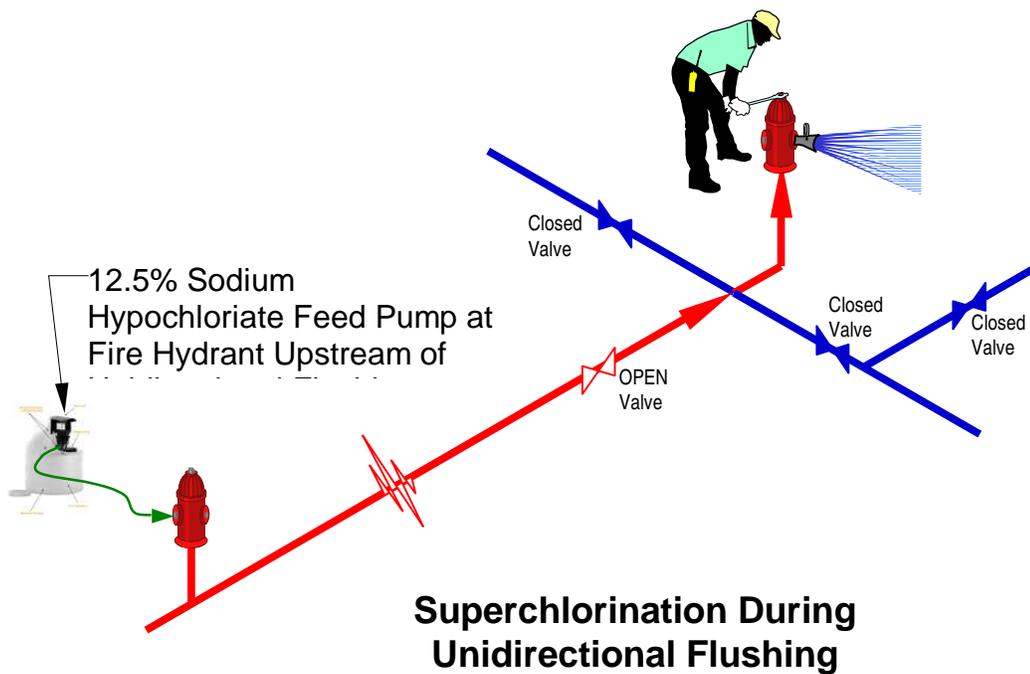
Step 5 – Create color coded and laminated maps for each flushing sequence

Step 6 – Test and exercise valves and hydrants before flushing. Complete any necessary repairs first.

Step 7 – FLUSH! Notify customers in advance of possible impacts and duration, see the sample notice below. Ensure storage is full to provide adequate amount of flushing water.

- Unidirectional flushing requires careful monitoring of pressure, flow, and velocities.
- Open hydrant for a period long enough (5-10 minutes) to scour the pipe. Flush until the water is clear.
- Assure that system pressures in other parts of the distribution system do not drop below 20 psi.
- If discharging into a drainage course, check chlorine residual concentrations to ensure that chlorine has dissipated by the time the water reaches fishery habitat, or use a dechlorinating agent to consume the chlorine.
- Collect two water samples from a flowing hydrant; the first after 2 or 3 minutes of flushing and the second just prior to closing the hydrant. Sample for chlorine residual, turbidity, and iron (where applicable).
- Document results and update records.
- Spot flush water systems at all dead ends and other locations where low chlorine residuals or failed bacteriological samples are found. If there are no facilities for this, it is strongly recommended they be installed.

Step 8 – Optional Chlorination During Flushing. Selecting areas of the water system to flush and superchlorinate (by remote injection) is appropriate if they can be reasonably isolated from the rest of the water system by valving. Superchlorinating can be accomplished during Unidirectional Flushing by remote injection using 12.5% Sodium Hypochlorite (NaOCl) and a peristaltic chemical feed pump at a fire hydrant upstream of the flushing point. Be sure to notify customers of flushing and high chlorine! You can periodically exceed the annual average Maximum Residual Disinfection Levels (MRDL) of 4.0 ppm for this type of water distribution system maintenance.



Step 9 – Recommended Installation of Automatic Flushing Valves. For those dead-ends and low usage areas that have water quality and low disinfection residuals, FRWA strongly recommends installation of Automatic Flushing Valves. These devices use 2-inch valves, the operators run on 9-volt barrettes, and can be set to operate for 15 to 30-minutes every few days at 3:00 am. This is often enough to flush out the older water and debris while improving disinfection residuals.

Utility Grade Flushing Valves are available for purchase from:

- Larry J Ruffin & Associates, phone: 407-999-5061, www.ruffincompanies.com
- Kupferle Foundry Company, Dan McKeague, phone: 800-231-3990, www.hydrants.com

Small utilities that cannot afford these commercial devices can build their own Automatic Flushing Valves, see schematic below,

Step 10 – Optional Watermain Swabbing (or Pigging). In some of the worst cases, flushing a water distribution system may not effectively improve water quality or hydraulic capacity. If there is evidence of severe pipe tuberculation or corrosion (ex: on old cast iron pipes), water treatment chemical build-up (ex: alum floc) or silt/sand build-up, watermain swabbing using a soft foam swab may be required. Swabbing is generally conducted by qualified professionals. Swabbing is normally done in phases working from the source into the distribution system.

NOTICE

Water Main Flushing

The City of _____ will be flushing the water mains in your area on:

Tuesday, November 10 and 11
Between the hours of 8:00 am to 4:00 pm

What is the purpose of flushing the underground pipes?

- To clean the water mains by forcing water through them at a high speed out of fire hydrants until the water runs clear. This water scours out sediment from inside the mains. Flushing is preventative maintenance that improves the quality and appearance of the water.

Is this flushing program designed to minimize wasted water?

- Yes, this program uses an engineered sequence of opening and closing fire hydrants to minimize the amount of water used. The utility will measure the water use and report it to the Water Management District.

Can I use my water when you are flushing the water mains on my street?

- **Please do NOT use your water or flush your toilet when we are flushing the water mains on your street.** Using your water or flushing your toilet could draw sediment into the water pipes in your building, and into water filters, washing machines, hot water tanks, etc. Please turn off any time-delayed water systems, such as dishwashers, coffee makers, and lawn sprinklers.

After you have flushed the water mains on my street, what should I do and when can I start using the water?

- Once utility vehicles and signs are no longer on your street or after 4:00 pm, perform the following steps:
 1. Turn on a **cold** water tap, we suggest a garden hose tap in front of your house.
 2. Let the water run for 5 or 10 minutes and watch for the water to run clear without sediment. A good way for you to test this is to take a sample using a large clear glass or pitcher. Look for debris that may settle. The water might have very small air bubbles or look white / cloudy -- this is okay.
 3. You can use your water if it is clear. If the water doesn't clear in 5 minutes, wait 30 minutes and try again.
 4. Do NOT choose a tap that has a water filter connected to it, or the sediment may clog your filter. Do not use a hot water tap because it could draw sediment into your hot water tank.

Questions or Concerns

If there are any questions or concerns in regards to the unidirectional flushing program please feel free to contact _____ at the City of _____ Utilities Department at telephone: _____.

Flushing Program Public Notice

The City of _____ has started an aggressive Flushing Program in your area!

What is a Flushing Program? It is a method of cleaning the water mainlines through a network of flushing sequences with the water being discharged from a fire hydrant. Flushing is preventative maintenance that improves the quality and appearance of the water. The program involves closing valves in a specific sequence to create water movement in one direction while opening specific hydrants at the end of that sequence. Maintaining the flushing sequence is important so that the water used in the flushing sequence remains clean. This technique allows higher water flow velocities by isolating certain sections of water mains. This higher water velocity allows for better scouring of pipes and will use 40% less water in the flushing process than traditional flushing. The flushing of the pipes will dislodge and remove mineral deposits, sediments and biological deposits that accumulate in the water mains.

What are water mains? Water mains are underground pipes that carry water from the pumping stations to your street.

Why are you flushing the water mains? We clean water mains to improve water quality by removing sediments and naturally occurring organics. Water travels slowly through the mains, causing sediment to settle and organics to build up over time. A change in the direction or rate of flow of the water in the mains (e.g., due to a water main break, or hydrant use for fire fighting) can disturb the sediment and discolor the water.

How do you clean the water mains? We clean the water mains by forcing water through them at a high speed and discharging it through hydrants into sewers. This water flow scours sediment from inside the mains. We leave hydrants open until the water runs clear.



When will you clean the water mains? We will clean water mains in different areas of the city each year from October to March, 5 days a week, from 8:00 a.m. to 5:00 p.m. There are about 20 miles of water mains in City of _____. It will take about 6 months to clean them all for the first time.

How long does it take to clean the water mains on each street? It takes about 1 or 2 hours to flush the water mains on each street.



Flushing Before and After

How will I know when you are flushing the water mains on my street? We will tell you before we start flushing. When we begin, we will place signs at either end of your street that say, "Water Main Flushing in This Area".

If you live in a house. We will hand deliver a notice to you one or two days before we clean the water mains on your street. The notice will contain an informational flyer and a brochure with more information on the program.

If you live in an apartment. We will let your property manager/landlord know, one or two days in advance, when the work will begin and how long it will take. We will leave a package of information, including a fact sheet on the program to hand out to tenants, and notices to post in the building.

If you operate a business. We will contact you one or two days in advance to let you know when the work will begin and how long it will take. We will contact you again to let you know when we have finished cleaning.

Can I use my water when you are flushing the water mains on my street?

Do not use your water or flush your toilet when we are flushing the water mains on your street.

Using your water or flushing your toilet could draw sediment into the water pipes in your building, and into water filters, washing machines, hot water tanks, etc. Turn off any time-delayed water systems, such as dishwashers, coffee makers, and lawn sprinklers.

Apartment Landlords/Property Managers and Business Operators. We recommend that you turn off the water supply to the entire building using the water shut-off valve at your water meter (usually found in the mechanical room). This will help prevent sediment from entering the water pipes in your building and getting into your water systems.

Will I notice anything different about my water after you have cleaned the water mains? Your water may be a little cloudy and discolored. Water is sometimes discolored after water main flushing, but this should not last long. **Do not use discolored water for any purposes that require clean water, such as preparing food and beverages, medical and dental procedures, or laundry.**

Turn on a **cold** water tap (we suggest a garden hose tap outside your house) and let the water run for a few minutes. Do not choose a tap that has a water filter connected to it, or the sediment may clog your filter. Do not use a hot water tap because it could draw sediment into your hot water tank. Catch some water in a light-colored cup or container to see if it is clear. You can use your water if it is clear. If the water doesn't clear in 5 minutes, wait 30 minutes and try again.

Apartment Property Managers/Landlords and Business Operators. Before you turn your water back on to the building, we recommend that you: Turn on a **cold** water tap near the water shut-off valve (e.g., a tap in the mop sink in the maintenance room) and let the water run for a few minutes. Catch some water in a light-colored cup or container to see if it is clear. Restore water to the rest of the building if the water is clear.



What should I do if the water is still discolored after 2 to 3 hours? If you have run the cold water for several minutes and it is still discolored, [please contact us](#).

What if someone accidentally drinks the water when it is discolored? Drinking discolored water should not make you sick, however, it may not smell, taste, or look pleasant.

What else may I notice about my water after you have cleaned the water mains? Immediately after flushing, you may notice that your water is cloudy or has a chlorine smell.

Cloudy water. Water is cloudy when air gets in it and makes tiny bubbles. These bubbles are harmless and will disappear if you let the water sit for a few minutes.

Chlorine smell. We add enough chlorine to the water to keep it safe. You can easily get rid of the chlorine taste and smell by filling a container with water and keeping it in the fridge for drinking – much of the chlorine will leave the water overnight.

Are you monitoring water quality during the flushing program? Yes, our laboratory staff will randomly collect samples and test water quality from hydrants, homes, and businesses during the cleaning program.

How can I find out when you will be flushing water mains in my area? Take a look at our 2005 Water Main Flushing Program Map to see which areas we are cleaning.

Why can't you clean the water mains at night? It is safer for staff to work on the streets in daylight. Also, it is easier in the daylight to see when all the sediment has been flushed out and the water is running clear.

Is water main cleaning a waste of water? No. We are using a unidirectional flushing technique, which uses 40% less water than conventional flushing.

What is unidirectional flushing? During unidirectional flushing, water system valves are operated to create one-way flow to the water main to be cleaned. A hydrant connected to the main is then opened to remove the built-up sediment. This high speed flushing produces a scouring action in the mains, removing sediment deposits. The flushing starts at a clean water source (e.g., the water pumping stations) and moves towards the outer limits of the city. This ensures that clean water is always used to flush the mains.

What is conventional flushing? In conventional flushing, the water used to flush the main does not always begin at the clean water source (the water pumping station), and the speed of the water is much lower than during unidirectional flushing. As a result, more water is required to thoroughly clean the water mains.

Do other cities have similar water main cleaning programs? Many cities have some type of flushing program to clean their water mains (e.g., conventional flushing or unidirectional flushing). This is considered the best way to improve water quality and increase the reliability of the water distribution system.

Will the water main flushing program become a permanent program? Yes. We plan to continue the two-year cycle of cleaning all the water mains as a long-term, regular maintenance program.



How will you pay for the water main flushing program? The water utility operating budget funds this program. Water rates will not be increased to pay for this maintenance program.

Questions or Concerns

If there are any questions or concerns in regards to the unidirectional flushing program please feel free to contact _____ at the City of _____ Utilities Department at telephone: _____.