MAINTAINING DISTRIBUTION SYSTEM
HYDRAULICS & WATER QUALITY

SFPUC and Wholesale Customers
Annual Water Quality & Technology Workshop
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Roy Martinez
Business Development Manager
Wachs Water Services
Agenda

- Distribution System Challenges
- Distribution System Control & Fire Hydrants
- SFPUC Fire Hydrant Assessment Pilot Program
- Flushing Methods
- Unidirectional Flushing (UDF)
  - Benefits
  - Program Challenges
  - Preparing for UDF
  - Executing UDF
  - UDF & Beyond
  - Before & After UDF
- Summary
Distribution System Challenges

• Pipe Condition
  – Infrastructure is Aging
  – Pipes Degrading Based on Characteristics
    • Build up of Sediments and Deposits
    • Biofilm Build Up

• Aging Infrastructure Results in:
  – Increased Pumping Costs
  – Increased Pipe Roughness
  – Reduction in Hydraulic Capacity
  – Reduction in Effective Diameter
  – Increase in Chlorine Degradation Rate
  – Nitrification
  – Increase in Taste and Odor Problems
  – Colored water

• Pipe Replacement – How do you Choose Which Ones?
Distribution System Control
And
Fire Hydrants
Fire Hydrant Use

• Used for more than fire protection
  – Source water for street cleaning
  – Construction
  – Dewatering for construction shutdowns
  – Flushing
    • Water
    • Restoration
  – Determination of overall health of distribution system
Fire Hydrant Assessment

• Develop, plan and execute a hydrant inspection, testing and rehabilitation program
• Locate, identify, access, clean out, inspect, exercise, perform minor repairs of hydrants and valves
• Flow-related testing:
  – Flop
  – M17 flow test – multi-hydrant
  – Single hydrant
  – Unidirectional flushing (UDF)
  – C-factor (head-loss)
• Minor Repairs
• Record GPS
• Document and create deliverable database
• Create work orders and analyze the results
• Traffic control
• Increased fire flow capacities
• Improved ISO ratings
• Increased efficiency and effectiveness of capital planning
• Increased efficiency of maintenance activities
• Focusing capital on critical assets
• Fire department historically maintained fire hydrants
• SFPUC took over maintenance of Fire hydrants approximately 5-yrs ago
• Industry best practice is to maintain fire hydrants yearly
• Wachs Water Services will undertake fire hydrant assessment pilot and start with:
  – College Hill pressure zone
  – Auxiliary Water Supply System - Jones Tank pressure zone
Flushing Methods
Flushing Methods to Clean Mains

- Water from all directions
- Low flow velocities
- Less scouring
- Don’t control flushing direction

Conventional Flushing

- Water channeled
- Higher flow velocities
- More scouring and better cleaning
- Systematic valve operation

Unidirectional Flushing

Can result in dirty water flushed to clean areas!

Uses up to 40% less water!
Unidirectional Flushing (UDF)
What is UDF?

• Systematic approach of closing a series of valves so as to increase system velocities and move water in one direction, thus scouring the inside wall of the pipe and forcing all debris through one hydrant.

• Primary method used to increase flows and pressures in a system without making changes to the process of which water is provided, by creating a greater opening in the pipeline.
UDF Benefits

• Improve Overall Water Quality (Flow, Pressure, Cleanliness)

• Clear out Tuberculation and Sedimentation
  – Improves Flow and Pressure
  – Increases Public Safety – Increases Fire Flow
  – Energy Savings – Pumps Don’t Run as Often
    • Saves Money
    • Provides a Green Solution
    • Saves on Replacement/Rehab costs
  – Evenly Distributes Chemicals in the System
    • Less Chemicals Used – Saves Money
UDF Benefits Continued

• Clear Out Bacteria
  – Increases Public Safety
    • Clean Water – Less Chemicals
    • Saves Money – Double Dip
• Get Air out of System
• Reallocation of Money and Funding
  – Pipe Replacement – Clean and Line
• Set you up to Have the Most Accurate and Reliable Hydraulic Model
Why do UDF Programs Fail?

...Low Operability...
Hydrant Usability Challenges

- Frozen Caps
- Caps Below Usable Level
- Operator Issues
- Closed Isolation Valves
Hydrant Usability Challenges

Frozen and Below Usable Level
UDF Program Challenges

- Hydraulic Models are Incomplete or Inaccurate
- Poor Planning of UDF Sequences
- Inexperience of Staff to Perform Project
- Not Enough Time for Staff to Perform Project
- GIS is not Populated for all Assets
- Assets can’t be found or don’t work

“We just can’t find stuff…”
“We Have Lost Control of the System…”
Preparing For UDF
Logical Flow of Work

1. Locate/Assess/Operate/Document and GPS all Valves and Hydrants (field)
2. Determine & Complete Necessary Repairs (field)
3. Complete the Water System GIS and Hydraulic Model (office)
4. Create a Unidirectional Flushing Plan (office)
   - Divide Water System into Flush Zones
   - Set Targets for Flushing Velocities
   - Develop Step-by-Step Flushing Sequences
   - Create Maps for each Flushing Sequence
5. Execute the UDF Plan (field)
6. Beyond the UDF
Execute the UDF plan

- Close valves to isolate main section
- Use diffusers to direct the flow of water away from pedestrians, traffic and property and to capture flow rate.
- Diffusers are equipped with gauges for pressure readings, static and residual
- Operate hydrants fully and slowly
- Collect agreed upon data
Pre UDF
Post UDF
Unidirectional Flushing uses 40% less water than Conventional Flushing.

...Safeguarding our most precious resource...
UDF and Beyond

- Measuring the Success of the Program
  - Where UDF Worked and Didn’t Work
  - How to Interpret these Results
    - Use collected data to spot potential issues with system

- Post UDF Testing
  - M17 Fire Flow Test
  - C-factor Test
  - Water Quality Testing

- Updating the Hydraulic Model
- Pipe Replacement Prioritization
Before & After Results of UDF
Before & After Results of UDF

The benefit of a system-wide UDF program is immediately apparent in water quality and system service

- Melbourne, FL, saw the following results:
  - Iron concentration reduced by 77 percent
  - Chlorine residual up by 15 percent
  - Turbidity decreased by 57 percent
  - But the most significant result:
    - Customer complaints were reduced from a high of 1,300 per year in 2006 (over 2.5 percent of customers) to less than 100 per year following the UDF program.
  - Melbourne's staff continue to use the UDF maps to flush sections in response to complaints.
• West Springfield, MA, the results were equally impressive:
  – Water Quality Issues
  – WWS Performed:
    • Valve & Hydrant Assessments
    • Valve & Hydrant Repairs
    • Uni-Directional Flushing Execution
  – Customer Complaints reduced:
    • 1,300 <100, 93% reduction
  – 80% Reduction in Water Main Breaks
  – Fire flows in M-17 testing showed increases in 66 percent of the locations tested.
  – C factor was increased in 77 percent of the locations tested.
  – Loss of chlorine residual was markedly reduced following the UDF flushing.
• Unidirectional Flushing uses 40% less water
• Low System Operability Increases Risks & Costs
• Successful UDF Requires Specific Steps be Taken (in order)
• UDF Provides Significant Benefits
• UDF Pays for Itself – Over Time
• For the most efficient UDF program, you need to take care of the front end and to increase the value of your investment take care of the back end
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Roy Martinez
Wachs Water Services
rmartinez@wachsws.com
720-212-4112