

PS/T&E COMMITTEE #1
September 9, 2013

Briefing

MEMORANDUM

September 5, 2013

TO: Public Safety Committee
Transportation, Infrastructure, Energy & Environment Committee

FROM: *KL* Keith Levchenko, Senior Legislative Analyst

SUBJECT: **Briefing** – Washington Suburban Sanitary Commission (WSSC) – Chevy Chase Lake Water Main Break

On April 8, 2013, WSSC provided an initial briefing to the T&E Committee on the March 18 water main break at the intersection of Connecticut Avenue and Chevy Chase Lake Drive in Chevy Chase.

Since the April briefing, WSSC has completed a forensic analysis of the water main break. A briefing of the results of the forensic analysis was provided to Commissioners on July 17, 2013. Updated presentation slides are attached on ©1-24.

Officials from WSSC expected to participate in this briefing include:

- Commission Chairman Gene Counihan
- Jerry Johnson, General Manager/Chief Executive Officer
- Gary Gumm, Chief of Engineering and Construction
- JC Langley, Acting Chief of Plant Operations
- Derrick Phillips, Acting Chief of Customer Care
- Dave Burke, Technical Services Group Leader

Chris Voss, Manager of the County's Office of Emergency Management and Homeland Security and Fire Chief Steve Lohr will also be available to provide their perspectives on the emergency response to the incident. *NOTE: Agenda Item #2 (immediately following this item) is a discussion regarding broader emergency preparedness and coordination issues involving County Government and WSSC.*

Chevy Chase Lake Water Main Break Incident Summary

On Monday, March 18 at approximately 8:00 PM, a 60-inch Pre-Cast Concrete Cylinder Pipe (PCCP) water transmission main broke at the intersection of Connecticut Avenue and Chevy Chase Lake Drive in Chevy Chase. The pipe was manufactured by the Interpace Corporation at the Perryman Maryland Plant in 1977 with Class IV Wire, which WSSC has found to be the most problematic pipe of this type. The main was constructed in 1978 and was last inspected, and acoustic fiber optic monitoring equipment installed, in 2010.

Fortunately, there were no reported injuries or major property damage resulting from the break. About 200 homes temporarily lost water service but were restored by Tuesday afternoon. The break resulted in the loss of approximately 60 million gallons of water. As a result of this break, and other lines being out of service as a result of previously scheduled maintenance of other transmission mains in the system, WSSC put in place mandatory water restrictions to reduce water demand and ensure sufficient water pressure for fire suppression needs and to help restore water storage capacity. These restrictions were lifted on Saturday, March 23, when the pipe was put back in service.

Connecticut Avenue was also closed in both directions Monday night between Jones Bridge Road and Dunlop Street. By the Tuesday afternoon (March 19) rush hour, all southbound lanes and all but one northbound lane had been reopened. On Wednesday night (March 20), WSSC began its replacement of a 20 foot section of the 60-inch pipe. Some northbound lane closures on Connecticut Avenue were required during this repair. The repair was completed on Thursday, March 21, and the pipe was put back in service on Saturday, March 23.

Results of the Forensic Analysis

The forensic analysis was performed by DACCO SCI, INC., with assistance provided by a subcontractor (Lewis Engineering and Consulting). The major findings of the analysis are presented on Slide 18 (©18). Three pipe conditions were noted, which combined to result in the catastrophic failure of the pipe. These conditions included: inadequate wire pre-stress in a key section of the pipe, a slow leak in the gasket from the bell end, and chemically weakened pipe joint mortar caused by the slow water leak. This kind of failure is the first of its kind found in the 70 year history of WSSC's PCCP inventory.

Slide 22 (see ©22) notes the lessons learned from this event, including:

- Pipe sections with a lack of adequate pre-stress can fail without being detected by WSSC's AFO monitoring system.
- The current AFO monitoring system is not designed to detect broken pre-stress wires within the area between the steel saddle plate and the end ring for pipe sections with a factory fabricated outlet if the area between these components is two feet or less.

Given that the section of pipe that broke on March 18 had been inspected relatively recently (2010) and had been equipped with AFO monitoring, it is important for the Council to

better understand the limitations of the AFO monitoring in terms of providing an early warning of a potential pipe failure.

WSSC notes that there are 234 pipe sections (similar to the pipe section in Chevy Chase Lake which failed) in 48 inch or larger mains. WSSC is currently reviewing technologies that can identify defects in the areas not designed to be monitored by AFO so that these suspect pipe sections can be excavated and repaired as needed. Slide 24 (see ©24) notes a pilot testing effort to be done on the 48-inch PCCP Montgomery High Zone Main.

Other Issues

In addition to the lessons learned in the forensic analysis, Council Staff suggests that WSSC describe how it prioritizes its responses and repairs to reported water leaks.

In the Chevy Chase Lake case, seven hours before the catastrophic failure, bubbling water was reported nearby. WSSC responded quickly to investigate and, within 1.5 hours, a WSSC crew had concluded a valve was leaking and a repair was scheduled for the next day. What, if anything, could the crew have done differently to have identified the imminent failure of the pipe? Assuming that WSSC investigates water leaks quite frequently (many of which turn out to be relatively minor issues), what was learned from this incident that might help WSSC distinguish small routine leaks from leaks which portend a more serious issue?

Also, were there any specific issues that arose during WSSC's emergency response to the incident and its coordination with other utilities (Pepco and Washington Gas) and governmental departments (such as Fire and Rescue and DOT)? What improvements in coordination would help with the next major incident?

Another issue of concern is that WSSC issued mandatory water restrictions after this pipe break, because of concerns about water supply as a result of other large transmission lines being out of service. Both the Montgomery and Prince George's Councils have been fully supportive of WSSC's large diameter pipe inspection, AFO monitoring, and maintenance efforts. However, given the results of this and previous breaks, Montgomery County officials have asked WSSC to provide more pro-active communication with regard to short- and long-term system vulnerabilities so that the County can be better prepared when pipe breaks occur. *This issue is discussed in more detail as part of the Joint Committee's Agenda Item #2.*

Attachments

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**Washington Suburban
Sanitary Commission**

**Forensic Results of 60-inch PCCP Water
Main Failure in Chevy Chase**

September 9, 2013

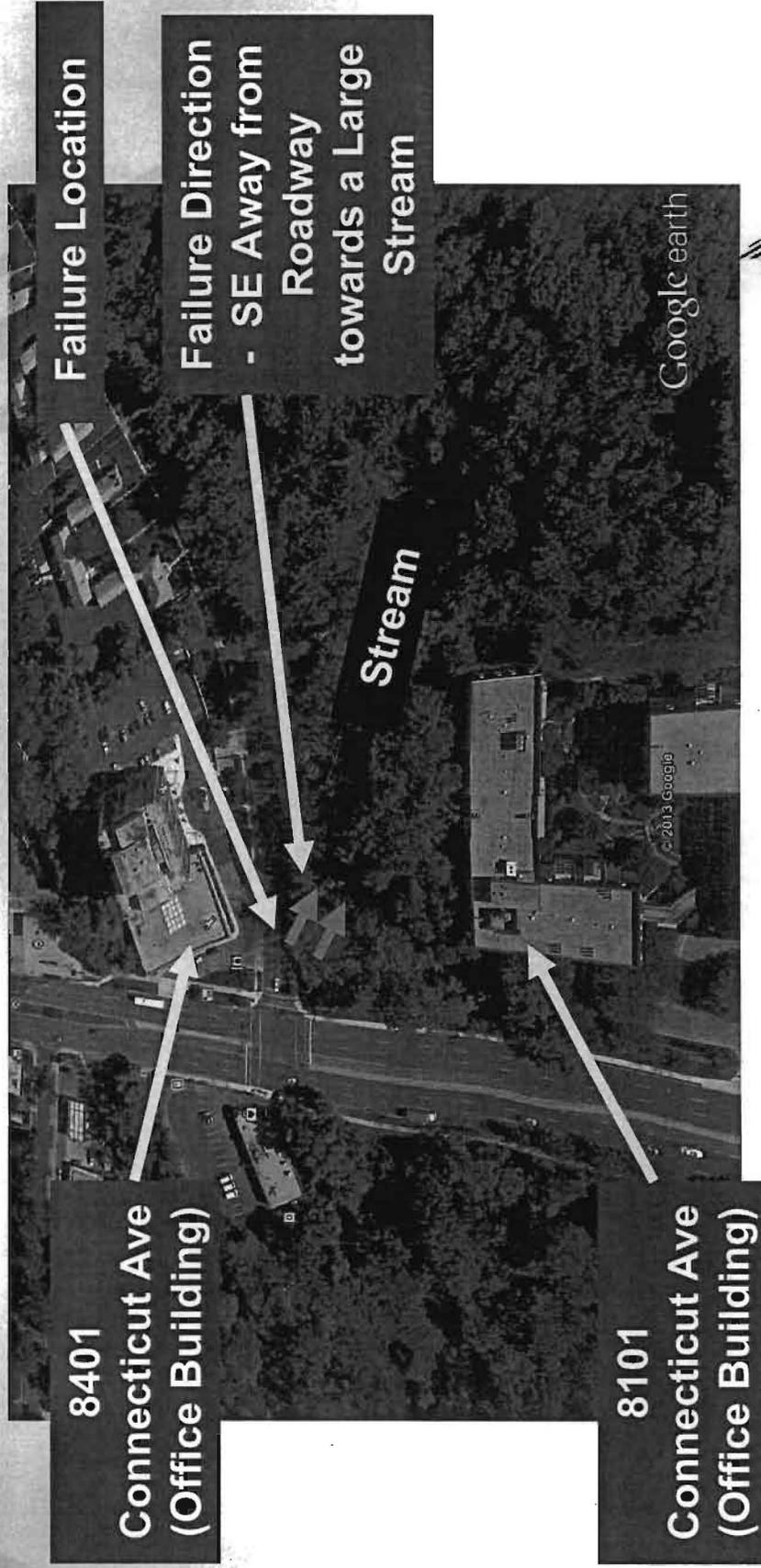
The Pipe Failure

- 60-inch Water Main Failed on March 18, 2013, Reported Approx. 8:00 P.M.
- Failure Site is Located along Chevy Chase Lake Drive Near the Intersection of Connecticut Avenue in Chevy Chase.
- Estimated Loss of 60 Million Gallons of Potable Water.
- Failure Direction was Away from the Roadway in the South Embankment of Chevy Chase Lake Drive and Caused a Large Crater Approximately 90 Feet in Length and 45 Feet Wide.
- The Water Flowed into a Large Stream which Helped to Minimize Flooding and Further Damage.



Failure Site

Failure Site Conditions



Timeline

Monday, March 18

- **13:03 Citizen Reports Water Bubbling Near 8101 Connecticut Avenue**
- 13:20 Information Relayed to Inspector
- 13:50 Inspector Determines Water Coming from 24-inch Valve Vault
- **14:30 Crew Arrives, Pumps Out Vault, Concludes Valve is Leaking – Decided to Repair Next Day**
- 19:40 Montgomery Main Zone Tanks Began To Empty
- **20:01 WSSC Received Police Report of Failure**
- 20:30 Crew Dispatched to Isolate Main
- 21:00 MC Fire Board Notified to Expect Fire Flow Issues
- 21:30 Gas & Electric Utilities Arrived
- 22:18 Alert Montgomery Sent Message About the Break
- 22:30 PGC Fire Board Notified of Impending Fire Flow Issues



Timeline

Tuesday, 19 March

- **02:00 Isolated Water Main (6 hours after failure was reported)**
- 03:25 WSSC Notification of Water Main Shutdown
- 04:00 Montgomery Main Zone Tanks Began Refilling
- **04:49 WSSC News Release About Water Use Restrictions**
- 05:30 Alert Montgomery Sent Message About Water Use Restrictions
- 07:00 Issued NTP to Emergency Contractor
- 09:00 Damaged Electrical Overhead Line Relocated
Damaged Gas Line Relocated
- **14:00 Excavation of Water Main Began (18 hours after failure reported)**
Installed New 10" Valve on 10" Main to Renew Water Service



Timeline

Wednesday, 20 March

- **18:00 Failed Pipe Removed** – Began Installing New Section

Thursday, 21 March

- **18:00 Repair Completed** – Awaiting 12-hour Cure Time for Grout

Friday, 22 March

- 04:00 Began to Refill Water Main
- **09:00 Water Main Charged – Began Flushing**
- 21:00 Water Samples Taken for 18-hour Bacterial Test

Saturday, 23 March

- 16:00 Water Approved for Use – Began to Open Valves
- **20:00 All Valves Open and Pipeline Returned to Service – (5 days following Police Report of Failure)**



Timeline

Monday, 22 April

- **Completed Final Paving**

Wednesday, 22 May

- Completed Stream Bank Restoration

Tuesday, May 28

- Completed Grass/Sod Restoration

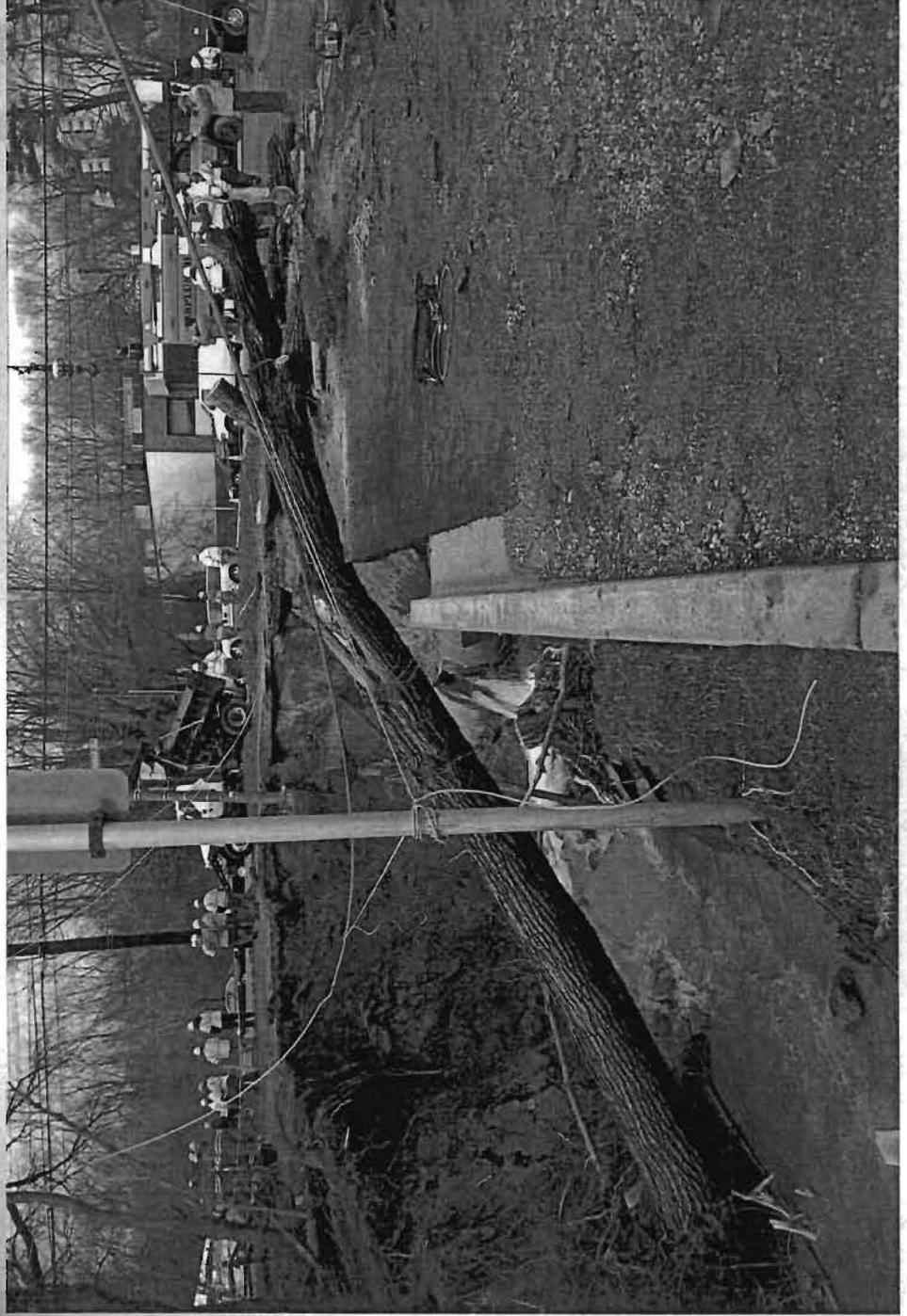
Friday, 21 June

- **Completed Final Stream Planting/Restoration**



60-Inch PCCP Failure - Chevy Chase

Before Excavation on March 19, 2013



60-Inch PCCP Failure - Chevy Chase



54/60-inch Water Main
Runs Approximately
Parallel to Connecticut
Avenue – Large Sections
of the Asphalt Pavement
from Chevy Chase Lake
Drive Were Damaged
and 24-Inch Valve Vault
Exposed.



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Failed 60-Inch - Rupture Side

Close-up Following Main Shutdown



24-Inch Factory Installed
Outlet is Located on the
Opposite Side of Pipe
(Buried)



The Failed Pipe

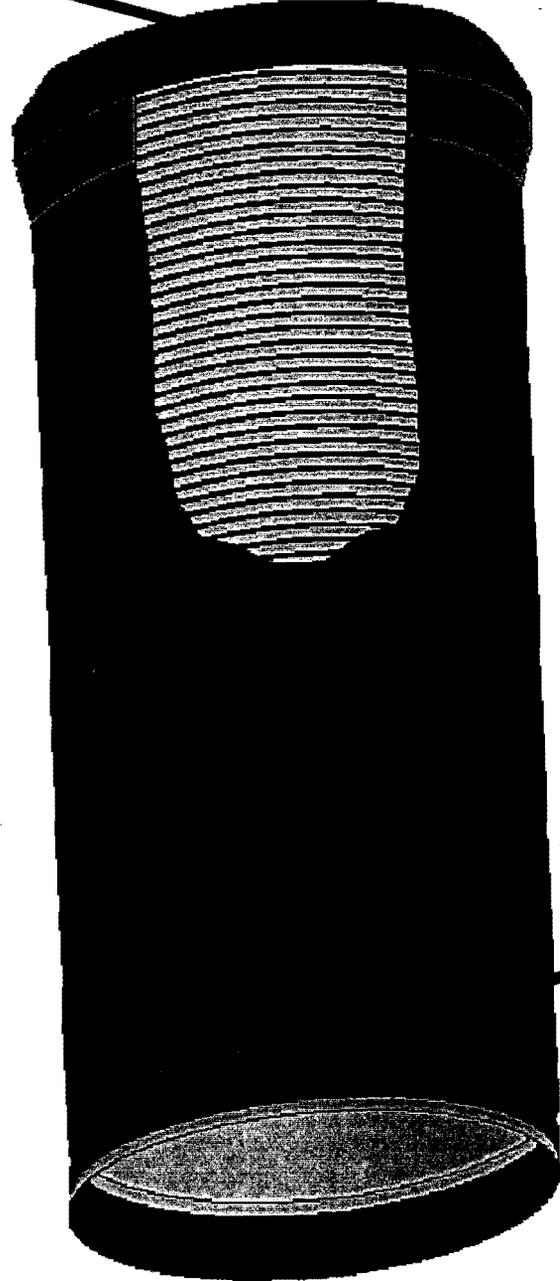


- 20 Foot Section of 60-inch Diameter SP-12 Embedded Cylinder Pre-stressed Concrete Cylinder Pipe (PCCP).
- The Water Main was 35 Years Old, Constructed in 1978.
- Failed Pipe had 24-inch Factory Installed Outlet Centered 3.82 Feet From Face of Bell End with a 13-inch Clearance from the Steel Saddle Plate to Steel Bell End Ring.
- Pipe Was Manufactured by the Interpace Corporation at the Perryman Maryland Plant in 1977 with Class IV Wire, Known to be Most Problematic.



Typical PCCP Pipe Design

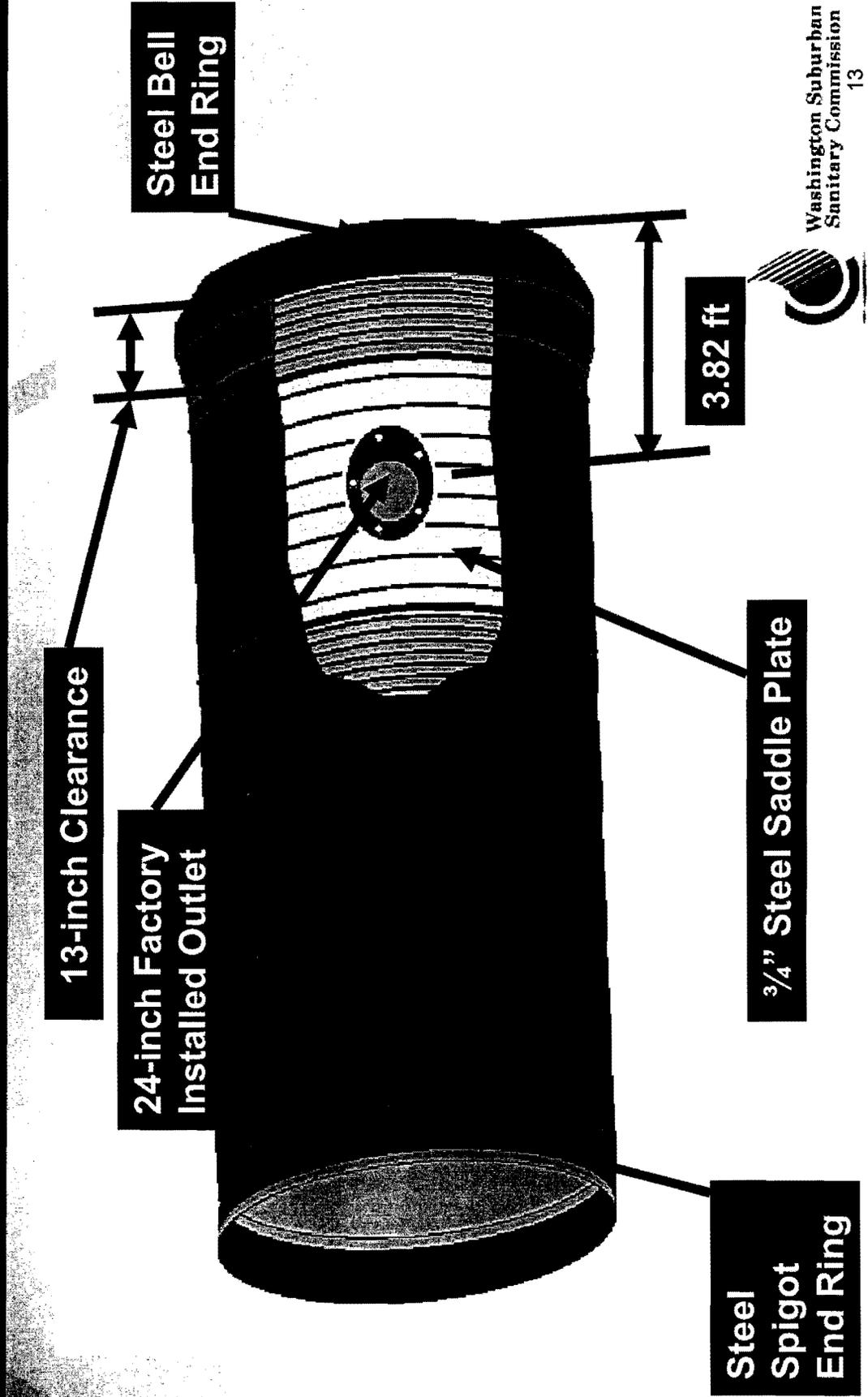
Steel Bell
End Ring



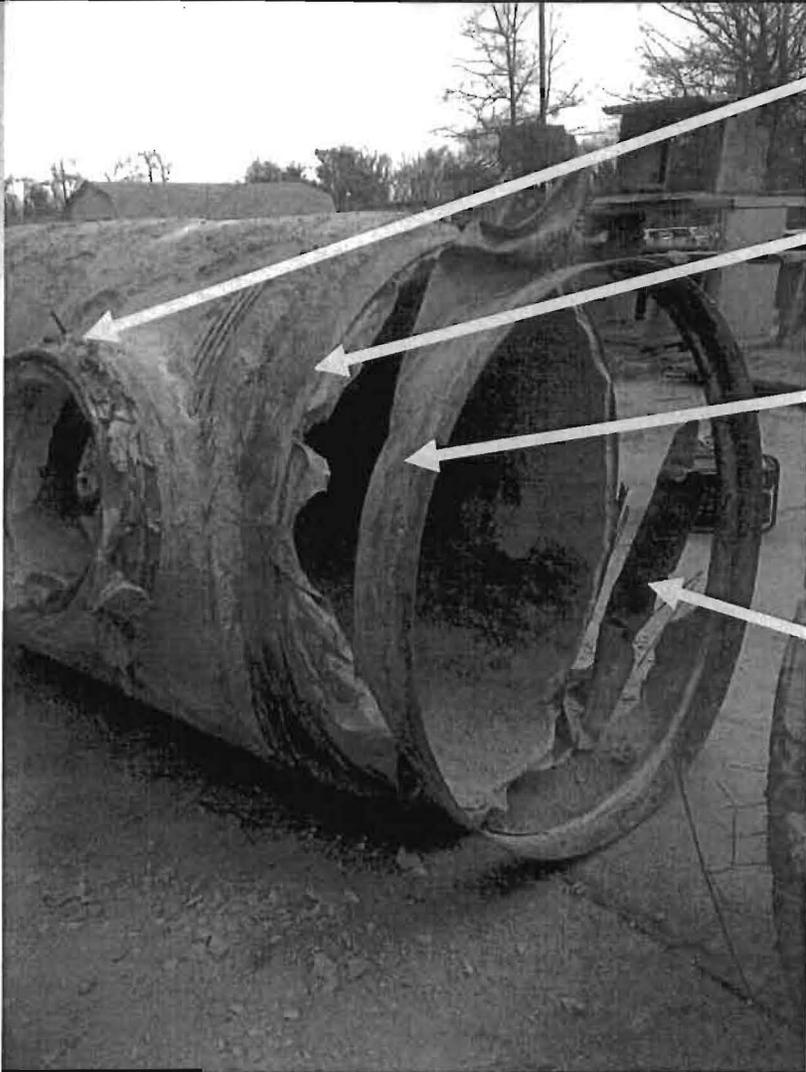
Steel
Spigot
End Ring



Failed Outlet Pipe Design



Failed 60-Inch Pipe



**24-Inch Factory
Installed Outlet**

Steel Saddle Plate

Steel Bell End Ring

Failure Area

Failure Occurred in the Area
Between the Steel Saddle Plate
and the Steel Bell End Ring on the
Opposite Side of the Pipe
From the Outlet



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What Do We Know About This Failure?

- The Pipeline was Last Inspected in the FY'10 Program.
- AFO was Installed in the FY'10 Program.
 - Since Then There Have Been Six Wire Breaks Recorded – All on Opposite Pipe End From Failure.
 - Recorded Wire Break Activity was Not a Concern.
- Failure Occurred Without AFO Warning - No Prior Wire Breaks Recorded at Failure Location.
- A Leak Was Reported Surfacing at This Location.
- The Pipe Failed Catastrophically.
- The Pipe Geometry is Atypical.



Acoustical Fiber Optic Monitoring

- What Does it Do?
 - Monitors Acoustical Pre-Stressed Wire Break Activity.
 - Coupled with Baseline Determines Rate of Deterioration.
 - Used to Prioritize/Adjust PCCP Inspection Schedule.
 - Provides Advance Notice of Pending Pipe Failure Allowing for Proactive Response.
- What Does it **Not Do**?
 - Prevent Deterioration.
 - Monitor for Pipe Leaks.
 - Guarantee a Pipe Will Not Fail.



Forensic Analysis

- WSSC Hired DACCO SCI, INC. with Subcontractor Lewis Engineering and Consulting to Perform Forensic Analysis.
- Forensic Analysis Began Immediately Following Failure by Extensive Photographic Documentation of Site Conditions and Sample Collection.
- Forensics Included a Laboratory Analysis of Failed and Intact Pipe Materials.
- Laboratory Analysis Verified that Materials Met Manufacturer Specifications and ASTM Material Specifications in 1977 at Time Pipe was Manufactured except 6-gage wire with 19 wraps per foot was used in lieu of the specified 8-gage wire with 23.8 wraps per foot.
- Forensic Analysis Found that Failed Pipe Section had Inadequate Wire Pre-stress Between the Steel Saddle used to Attach the Factory Installed Outlet and the Steel Bell End Ring.



Significant Forensic Findings

Three Principle Conditions Caused the Pipe Failure:

- 1) Inadequate Wire Pre-stress Found Between the Steel Saddle Plate Used to Attach the Factory Installed Outlet and the Steel Bell End Ring Compromised the Composite Structure of the Pipe Section;
- 2) A Slow Leak From the Gasket at the Bell End;
- 3) Chemically and Physically Weakened Pipe Joint Mortar Caused by the Leaking Potable Water (More Corrosive To Steel) Allowed Water to Enter the End of the Compromised Composite Structure and to Corrode the Wires and Steel Cylinder;

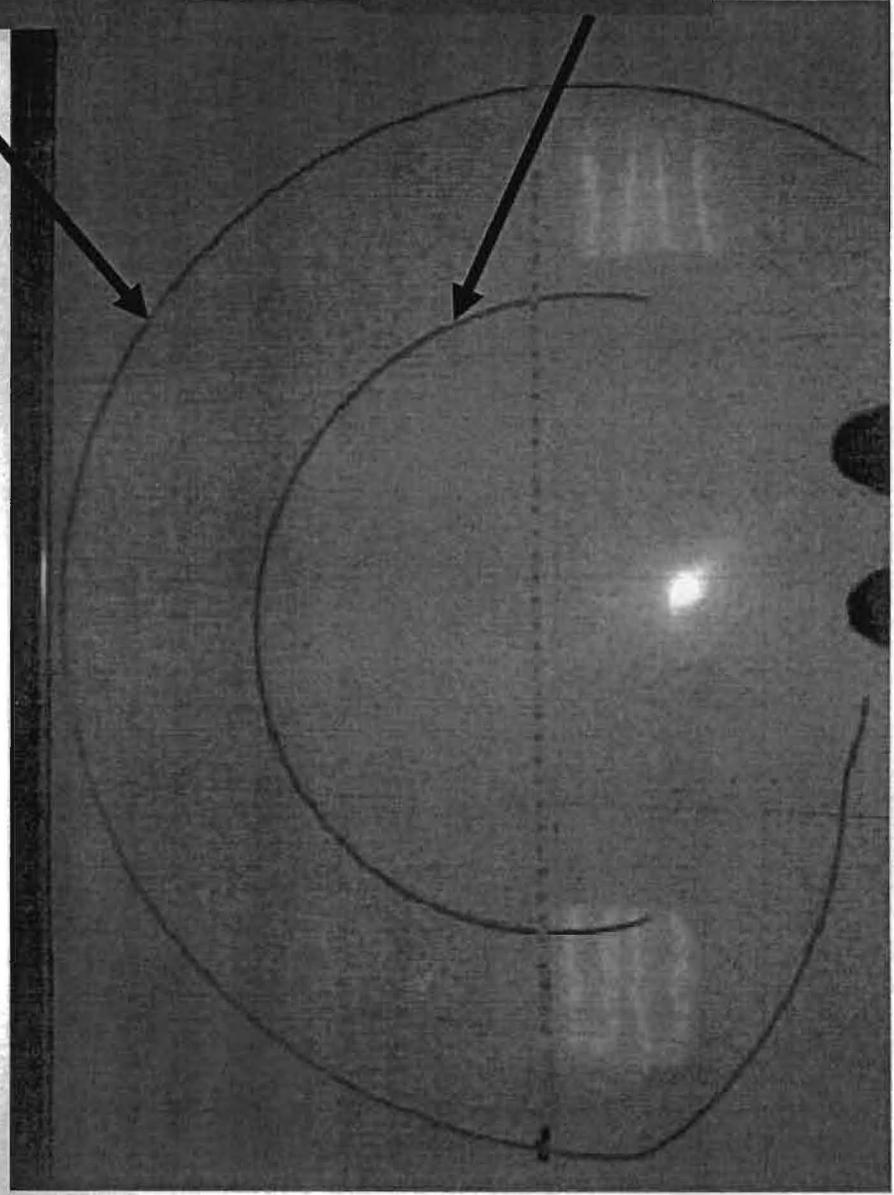
Absence of Any One of These Conditions and the Pipe Likely Would Not Have Failed at This Time. This Outlet Pipe Failure was the First to Occur in the WSSC 70 Year History for PCCP Water Transmission Mains.



First Contributing Cause – Lack of Adequate Pre-Stress at Failed End of Pipe

4' - 8" Diameter –
Pre-Stressed Wire
Hoop From Spigot
End – Adequate
Pre-Stress

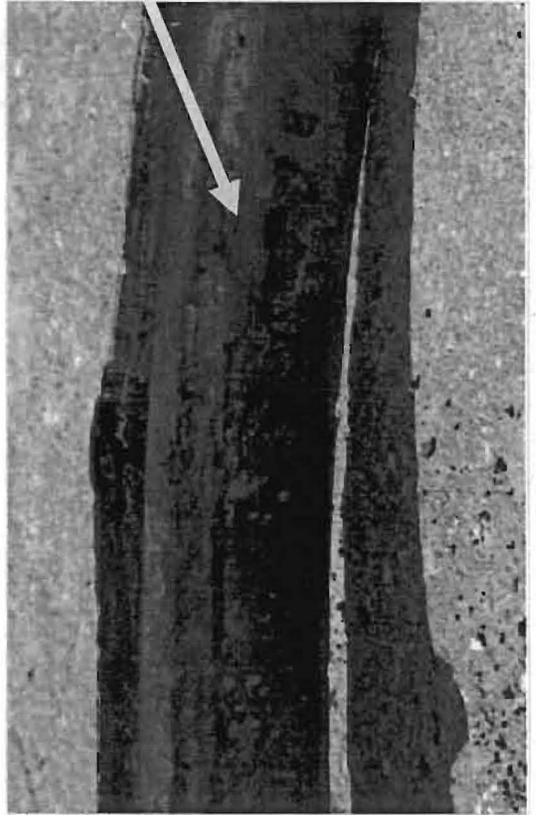
2' - 8" Diameter –
Pre-Stressed Wire
Hoop From Bell
(Failed) End –
Inadequate Pre-
Stress



Second Contributing Cause – Slow Leak at Bell (Failure) End



Dark Gray Color Shows Smooth Consistent Gasket Seal Impression on Interior of Bell End Joint Ring



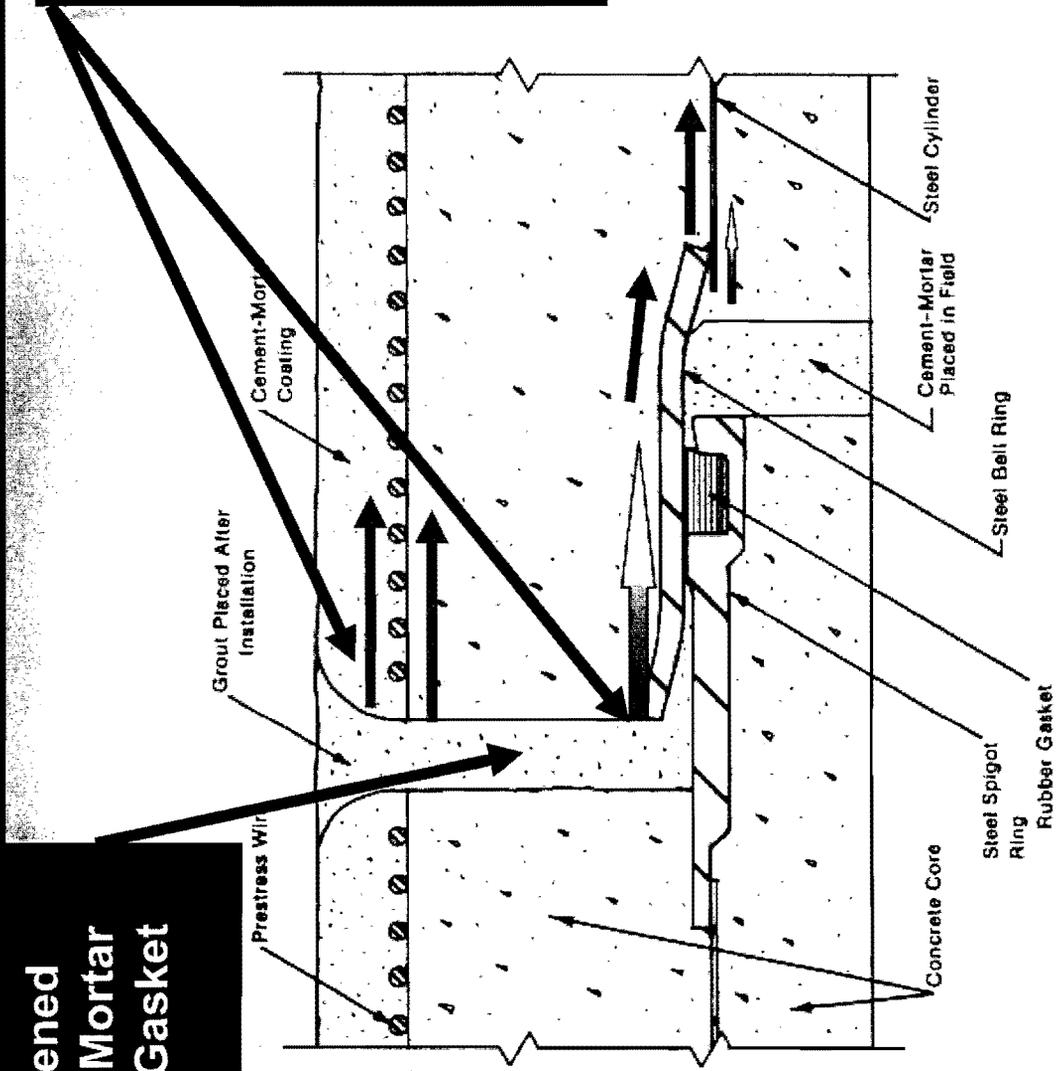
Corrosion Patterns Across 2' - 6" Length of Interior of Bell End Joint Ring at Pipe Invert Indicate the Lack of a Good Seal



Third Contributing Cause – Weakened Joint Mortar From Leak

Weakened Joint Mortar from Gasket Leak

Potable Water (More Corrosive to Steel) Entered End of Compromised Pipe Section Due to Lack of Adequate Pre-Stress and Corroded Steel Cylinder and Steel Wire



(2)

Lessons Learned – Action Plan

Lessons Learned

- PCCP Pipe Sections With the Lack of Adequate Pre-stress to Generate an Acoustical Wire Break Noise Can Fail Without Being Detected by the Acoustic Fiber Optic (AFO) Monitoring System.
- The Current State-of-the-Art PCCP Inspection Technology And Methods Cannot Detect Broken Pre-stressing Wires in the Area Between the Steel Saddle Plate and the End Ring for Pipe Sections With a Factory Fabricated Outlet if the Area Between These Components is Two (2) Feet or Less.

Action Plan – The Road Ahead

- Identify and Map Similar Pipe Sections in Mains 48-inch and Larger – This Task is Complete and a Total of 234 Similar Pipe Sections with Outlets Have Been Identified.
- Perform a Study Prior to the Start of the FY'14 PCCP Inspection Program to Investigate All PCCP Condition Assessment Technologies Both Existing and Emerging to Evaluate Techniques to Identify Defects in the Area Between the Steel Saddle Plate and the End Ring for Pipe Sections with a Factory Installed Outlet if the Area Between These Components is Two (2) Feet or Less.
- Utilize the Techniques Found in the FY'14 PCCP Inspection Program and Excavate Suspect Outlet Pipes to Validate the Results. Continue Research to Identify Nature and Extent of the Problem.
- Repair All Sections of PCCP with Outlets that are Found Suspect.



Questions



FY'14 PCCP Inspection Program Response

- In Response to the Chevy Chase 60-inch Water Main Failure, New Testing Techniques will be Piloted to Test Pipes with Factory Installed outlets similar to the pipe section that failed.
- These techniques will be used on the first PCCP manned inspection under the FY'14 Program which is the 48-inch PCCP Montgomery County High Zone Main.
- The pipeline is 6.18 miles in length beginning at Route 355 heading east through Rock Creek Regional Park and ending at Georgia Avenue.
- We have identified and mapped 17 factory installed outlets similar to the one that failed.
- A number of the outlets on the pipeline are in areas where excavation is possible so this pipeline should provide us the opportunity to validate pilot testing methods.
- Any suspect outlets pipes will be excavated and repaired if needed.

