T&E COMMITTEE #1
June 8, 2009

Briefing

MEMORANDUM

June 4, 2009

TO: Transportation, Infrastructure, Energy & Environment Committee

FROM: Keith Levchenko, Senior Legislative Analyst

SUBJECT: **Briefing** – Washington Suburban Sanitary Commission (WSSC) – River Road Water Main Break Forensic Report Findings

On June 8, 2009 WSSC will provide a briefing to the T&E Committee on the findings of a forensic analysis of the December 23 River Road water main break as well as the implications of these findings for WSSC's water main infrastructure funding priorities in the future. WSSC's briefing materials were not available in time for inclusion in this memorandum but will be provided to Councilmembers as soon as they are available.

Officials from WSSC expected to participate in this briefing include:

- WSSC Commissioner Adrienne Mandel
- Teresa D. Daniell, Interim General Manager
- Rudolph S. Chow, Interim Deputy General Manager
- Gary Gumm, Chief of Engineering and Construction
- Kirk Wineland, Director of Intergovernmental Relations
- Jim Neustadt, Director of Communication & Community Relations

Attachments to this memorandum include:

- River Road Forensic Analysis FAQs – May 20, 2009 (from WSSC website) (©1-2)
- Excerpts from the Report of Findings: Forensic Investigation of 66-Inch PCCP Water Transmission Main Failure on December 23, 2008 (©3)
  - Executive Summary (©4)
  - Excerpted Portion of Project Profile Drawing (©5)
  - Conclusions (©6-8)
  - Photographs (©9-10)
  - PCCP Cross Section Drawings (©11-12)

River Road Water Main Break Incident Summary

WSSC first briefed the full Council on the break on January 27, 2009. Some background information on the break, which was provided for that briefing, is reproduced below.

On December 23 at approximately 7:55 AM a 66 inch Pre-Cast Concrete Cylinder Pipe (PCCP) water main broke near the 8500 block of River Road in Bethesda, Maryland. The main runs from the Potomac Water Filtration Plant in Potomac to near the Mormon Temple in Kensington. The main was put in service in 1965 and was last inspected in 1998.

Fortunately there were no major injuries resulting from the break. However, 15 motorists and passengers had to be rescued from the flooding via swift water boats and by helicopter.

River Road is a busy commuter road connecting western portions of the County with Potomac and Bethesda. The road had to be closed in both directions between Seven Locks Road and Bradley Boulevard for more than a week. The road reopened at 3:00 AM on January 1.

About 100 customers briefly lost water completely. Water service was restored to all customers the afternoon of the break. However, all public schools were closed 2 ½ hours early on the day of the break because of reduced water pressure at many schools in the downcounty area.

WSSC contractors replaced a total of five 16-foot sections of pipe, weighing 14 tons each at a total cost of $1.5 million.

Forensic Analysis

On May 20, 2009 WSSC Commissioners were briefed on the results of a forensic analysis performed by Lewis Engineering and Consulting, Inc., of Gainesville, Florida. The Executive Summary is attached on ©4. The full report is available at the WSSC website at: www.wsscwater.com.

The analysis did not identify any defective material components. All tested materials were found to be compliant with required specifications at the time of construction. The analysis concluded that improper installation was the cause of the break:

> *"In the absence of any apparent or confirmed deficiencies in the construction of the pipe, it is concluded based upon the findings of this investigation that the failure occurred due to damage to the coating via the pipe being supported directly by rock. The installation contractor failed to remove rock and fill the trench bottom with selected material to provide uniform and continuous bearing support for the pipe in accordance with WSSC General Specifications in force in 1965."*

As part of this briefing, WSSC has been asked to not only discuss the conclusions of the analysis but also the implications for WSSC's ongoing large diameter PCCP inspection, monitoring, and repair efforts.

During prior discussions of the large diameter PCCP issue, it was concluded that a robust inspection and monitoring program was needed for all of this large diameter pipe (WSSC has 59 miles of PCCP of 54 inches or greater diameter) because of the uncertainty of where these pipes were degrading and the potentially significant public safety impacts involved with a major break. While the forensic analysis may not alter that basic premise, it suggests that a review of installation practices, in addition to potentially defective pipe material, may need to be warranted. For instance, other large diameter PCCP installed by the same contractor may need to be considered.

WSSC Budget

WSSC's inspection and maintenance of large diameter water mains (such as the main involved in the River Road break) has been sporadic in recent years. A $1.6 million FY09 budget supplement to provide additional inspection work of large diameter mains was approved by both Councils late last year.

The FY10 Budget includes $2.5 million for 12 miles of large diameter PCCP pipe inspection and installation of acoustic fiber monitoring and $1.75 million for PCCP repair work that is identified through the inspections. The Montgomery County Council supported an additional $2.1 million for an additional 6 miles of inspection and acoustic fiber optic cabling in FY10. Ultimately the Montgomery and Prince George's County Councils agreed to add $1.0 million to the WSSC budget for water main infrastructure related work to be prioritized by WSSC.

Attachments
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Washington Suburban Sanitary Commission

River Road Forensic Analysis FAQs
May 20, 2009

Q. What caused the 66-inch water main on River Road to break?

A. The company that WSSC hired to do a forensic investigation into the break (Lewis Engineering & Consulting) has determined that the contractor did not properly install the 66-inch pipe in 1965.

Q. What is WSSC doing today to make sure PCCP pipes are properly installed?

A. We have increased the amount of miles of pipe that are inspected. Techniques used to inspect pipe have vastly improved and with new technology we are better able to spot exterior as well as interior problems with large water mains such as the 66-inch on River Road.

Q. Does WSSC inspect all large water mains?

A. It costs about $100,000 to inspect a mile of large water main. Between FY01 and FY06, about four miles of PCCP pipe was inspected. In FY07, after a small rate increase, WSSC inspected 10.5 miles of pipe, and it did 8.2 miles last year. In FY'09, we are inspecting 10.8 miles of PCCP pipe that is 36-inches and larger and installing acoustic monitoring. In FY10, $3.5 million is budgeted for inspection and monitoring PCCP pipes.

Q. How many large water mains (36" and larger) does WSSC have?

A. There are about 150 miles of PCCP 36" and larger of which 55 miles are 54" and larger.

Q. Is this a safety issue?

A. Routine internal PCCP inspections are a best practice used to reduce the risk of failure by identifying any pipe sections requiring repair and to provide condition assessment for long term capital planning in an effort to ensure a safe and reliable water supply. Seventeen miles of PCCP have been equipped with acoustic fiber optic cables which help detect breaks in the wires inside of PCCP pipes. Acoustic cables are being installed in 10.8 more miles of PCCP in FY09.

Q. Will WSSC dig up the other pipes to see if they are properly installed?

A. It's not financially feasible.

Q. Were the new sections of the 66-inch pipe properly embedded when they were installed?

A. Yes. The installation of the new pipe was inspected by WSSC and found to exceed our current standards.

Q. Who originally installed the River Rd 66" pipe and did that contractor install other sections of pipe?

A. We are searching our records for the name of the contractor. These documents pre-date our computer records and have to be pulled from a storage facility.

Q. What is WSSC doing to ensure that only reliable contractors do work for WSSC?

A. WSSC approved a new contractor performance evaluation process that went into effect in March 2009. These evaluations will document the contractor's knowledge of work, quality of work, compliance with standards and requirements, timeliness and effectiveness of management. The evaluations will be an important resource when determining responsibility of a contractor for future contracting opportunities. The performance of the Prime Contractor will be evaluated per Standard Procedure ENG-09-01, which is available on the WSSC Centralized Bidder Registration (CBR) System website at www.cbr-wssc.com and the WSSC website at www.wsscwater.com. If the contract duration is 60 days or more, the Prime Contractor will be evaluated for performance at the midpoint of the contract and at contract completion. **An overall final evaluation rating of unsatisfactory will result in a one year suspension from bidding on WSSC contracts.**

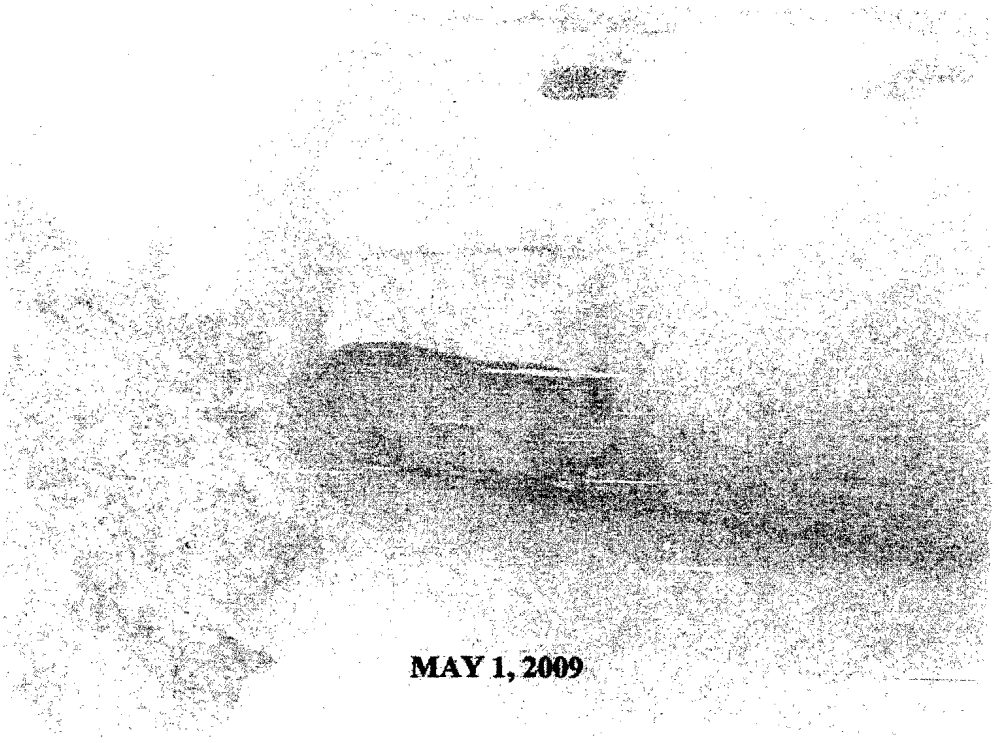
REPORT OF FINDINGS

FORENSIC INVESTIGATION OF 66-INCH PCCP WATER TRANSMISSION MAIN FAILURE ON DECEMBER 23, 2008 8500 RIVER ROAD, BETHESDA, MONTGOMERY COUNTY, MD

CONDUCTED FOR:

WASHINGTON SUBURBAN SANITARY COMMISSION

LAUREL, MARYLAND



MAY 1, 2009

CONDUCTED BY:

RICHARD O. LEWIS, P.E.

LEWIS ENGINEERING AND CONSULTING, INC.

GAINESVILLE, FLORIDA

(3)

FORENSIC INVESTIGATION OF RIVER ROAD 66-INCH PCCP FAILURE

EXECUTIVE SUMMARY

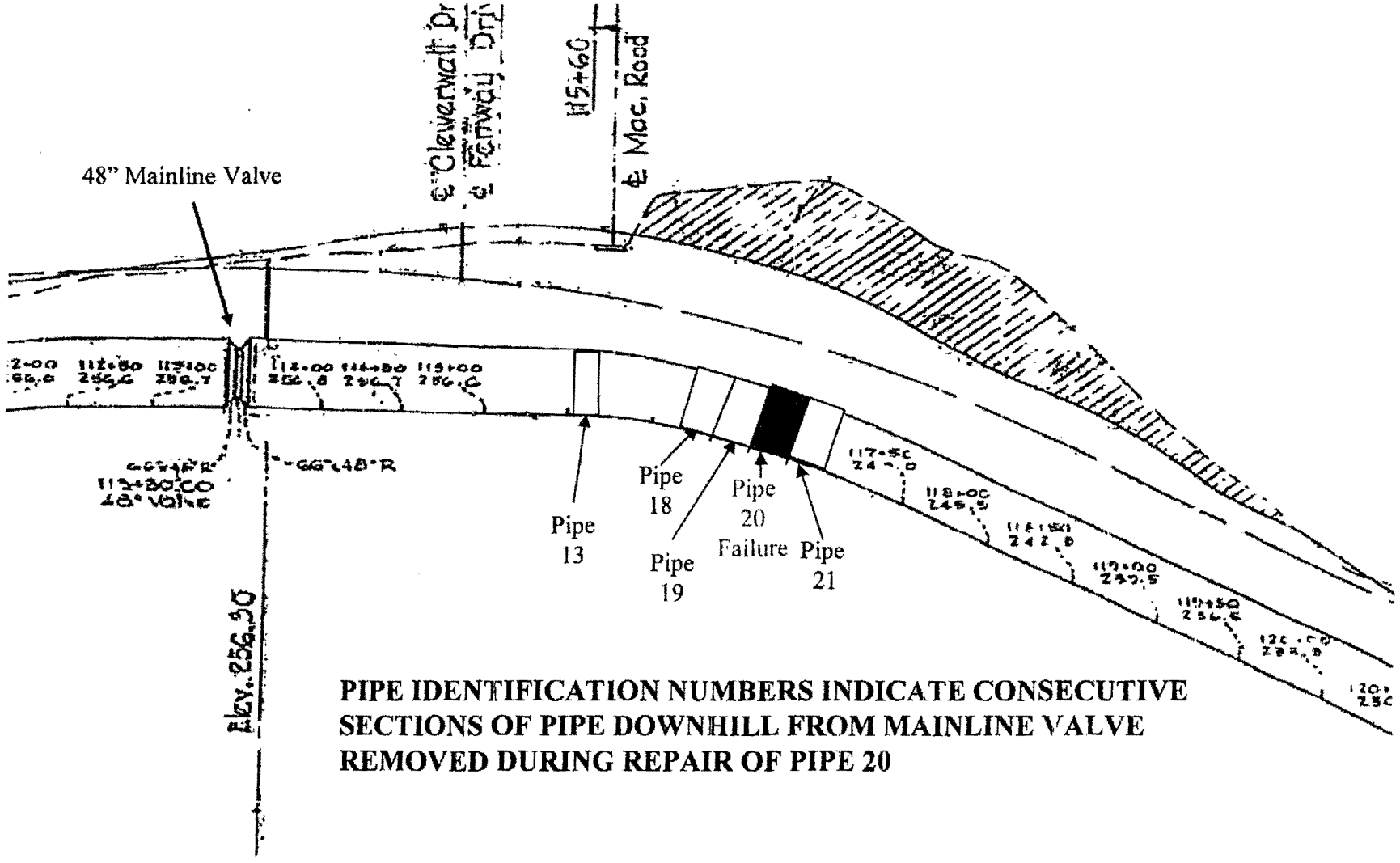
A failure occurred in the WSSC water supply system in a section of 66-inch nominal inside diameter prestressed concrete cylinder pipe (PCCP) water main along River Road on December 23, 2008. The subject PCCP was manufactured in 1965 by Interpace Corporation according to Interpace specification sheet for the water main project. Three different pressure classes of pipe, all 16 feet in length, were indicated on the specification sheet for use in the approximately 5,200 feet of the project. The section of pipe that failed was identified by the prestressing wire diameter and wraps per foot of wire on the pipe as a Class D, 165 pounds per square inch (psi) working pressure design.

WSSC staff on-site documented that a rupture of the steel cylinder had occurred beneath corroded and broken prestressing wire near the invert of the pipe at the bell end. An approximately 48 inch long tear was present in the cylinder at approximately the 7:30 o'clock orientation as viewed downhill at the site. The on-site WSSC staff noted and photographically documented the presence of large sections of rock in the pipe trench in contact with and supporting the pipe. Several pieces of concrete outer core and cast concrete coating from the immediate area of the rupture were recovered in the debris washed downstream by the torrent of water discharged from the pipe. Those pieces of coating and core exhibited cracks through the thickness of the materials that had been present for many years as evidenced by dark brown iron corrosion product stains on the crack faces. The staining resulted from migration of water through the cracks containing iron corrosion products from corroding prestressing wire and steel cylinder. Pieces of failed prestressing wire recovered from the area of the rupture were significantly corroded, but several had well preserved brittle wire fractures that indicated the failure mode was corrosion induced hydrogen embrittlement.

During repairs of the failed pipe, WSSC staff conducted an internal inspection of the 66-inch pipe uphill to the nearest mainline valve, and downhill past the rupture as far as practical. Three additional sections of pipe were identified with visible cracks indicating distress and structural integrity issues with the pipe. Removal and replacement was decided as the appropriate course of action. The sections removed, including the failure Pipe 20, are indicated on the attached pipeline profile excerpted from the original project engineering drawings. Documentation of the additional removed sections confirmed a common orientation and pattern to the distressed condition on each pipe. All exhibited cracked and damaged coating at approximately the 7:30 o'clock orientation near the invert where each of the pipe was documented to have been supported directly on rock. Corroded and broken prestressing wires were present beneath the cracked coating. *These sections of pipe exhibiting common areas of distress associated directly with rock contact similar to the ruptured pipe, were invaluable evidence of the mechanism of failure of Pipe 20.*

Laboratory testing of materials removed from the preserved intact portion of the failed pipe at the spigot end confirmed that the pipe complied with the dimensions indicated in the Interpace specification sheet and that the wire complied with the specified mechanical properties. In the absence of any apparent or confirmed deficiencies in the construction of the pipe, it is concluded based upon the findings of this investigation that the failure occurred due to damage to the coating via the pipe being supported directly on rock. The installation contractor failed to remove rock and fill the trench bottom with selected material to provide uniform and continuous bearing support for the pipe in accordance with WSSC General Specifications in force in 1965.

EXCERPTED PORTION OF PROJECT PROFILE DRAWING FOR 66-INCH PCCP RIVER ROAD WATER MAIN



PIPE IDENTIFICATION NUMBERS INDICATE CONSECUTIVE SECTIONS OF PIPE DOWNHILL FROM MAINLINE VALVE REMOVED DURING REPAIR OF PIPE 20

(2)

Paragraph 2-07 titled Preparation of Foundation, states that,

"The contractor shall use special care in the preparation of trench bottom so as to provide a uniform and continuous bearing and support for the pipe or structure at every point."

Based upon the reports of WSSC staff on site during the excavations and pipe removals, and photographic documentation of that process, it is the conclusion of this investigation that non-uniform, point load contact with discrete large sections of rock along the invert of all four sections of damaged pipe at the bottom of the pipe trench was the principal cause of coating cracking that compromised corrosion protection for the wire. Responsibility for the coating damage to the failed and companion sections of pipe lies with the contractor for failing to properly excavate rock from the pipe trench and prepare a uniformly supporting trench bottom as required by the WSSC General Specifications.

It could not be determined in the investigation whether the rock contact issue resulted in immediate cracking of the coating during installation, or if cracking developed at a later date. The fact that the 66-inch PCCP survived 43 years of service life before failing, considering the harsh bedding conditions found along that reach of the pipeline, is remarkable. Surviving 43 years under those conditions speaks to the quality of materials employed and the methods of construction of the PCCP in 1965. Those same rock bedding conditions, where also present along the route of the remaining 66-inch River Road pipeline, likely place at risk additional sections of pipe beyond those removed and replaced in December, 2008.

Based upon the findings on Pipe 20, and the supporting forensic evidence documented on Pipes 13, 18 and 21, it is concluded that the failure of Pipe 20 after 43 years of service occurred due to the coating damage and cracking by point contact with rock along the invert of the pipe. Over time, migration of groundwater through the cracks resulted in corrosion induced failure of the prestressing wire and ultimately, substantial loss in pipe wall compression that compromised the structural integrity of the pipe.

CONCLUSIONS

1. The 43 year old WSSC 66-inch PCCP water main that failed along River Road on December 23, 2008 ruptured as a result of damage to the concrete coating, loss of corrosion protection for the prestressing wire, corrosion induced failure of over 100 contiguous circumferential wraps of prestressing wire, and ultimately loss of structural integrity at the bell end of the failed pipe.

2. Evidence gathered at the failure site in the form of iron stained pieces of outer concrete core and concrete coating indicates that corrosion of both the prestressing wire and the external surface of the steel cylinder had been ongoing for many years, likely decades.

3. All PCCP materials of construction documented and tested were determined to be compliant with the material properties and dimensions noted in the Interpace pipe design Specification Sheet for the 1965 project; the results of petrographic and chemical analysis of samples of coating from the failed pipe are appended to the report.

4. A weld defect suspected of extending through the full thickness of the steel cylinder immediately adjacent to the rupture location was investigated in the laboratory, but was found to only partially penetrate the thickness of the weld; therefore, the suspect weld was not confirmed to have been a leakage path for water from inside the pipe that could have promoted corrosion of the prestressing wire.

5. The failed pipe identified as Pipe 20 ruptured at the bell end at the 7:30 o'clock orientation on the hill (north) side of the pipe; companion Pipes 13, 18 and 21 found internally cracked and distressed, all had external coating damage and corroded and broken prestressing wire in the same relative o'clock location.

6. An issue identified, reported and documented by WSSC staff on site witnessing the excavation and removal of the failed and distressed pipe was the presence of discrete large sections of rock along the invert of the pipes upon which the pipe were variably bedded.

7. The stress imposed on the coating at points of contact with the supporting rock, either during installation or subsequently in service, resulted in cracking of coating and compromise of the corrosion protection afforded to the wire by the coating.

8. In addition to Pipe 13 having been bedded on rock, prestressing wire removed from the distressed area was found to have been substantially under-tensioned during pipe manufacture resulting in compromise to the pressure capacity and structural integrity of that section of pipe; this finding is concluded to have been an

exacerbating factor in the greater extent of deterioration found on Pipe 13 as compared to Pipes 18 and 21.

9. It could not be determined from the findings of this investigation why Pipe 20 failed prior to Pipe 13, except that a larger number of contiguous broken wires (110) was present at the location of the rupture on Pipe 20 than was documented on Pipe 13 (95).

10. WSSC General Specifications for Water Mains, Sanitary Sewers and Storm Drains adopted in September, 1954 and applicable to the construction of the 66-inch River Road water main in 1965, required removal of rock from the pipe trench by the contractor and placement of selected material 4 inches deep free from rock in the trench bottom so as to provide a uniform and continuous bearing support for the pipe at every point.

11. WSSC staff witness reports and documented evidence from the pipeline repair site confirm that the pipe bedding conditions were not compliant with the WSSC General Specifications.

12. Responsibility for the pipe having been installed on incompletely excavated rock and improperly prepared bedding conditions at the bottom of the trench lies with the installation contractor.

Prepared and submitted by,

Richard O. Lewis

Richard O. Lewis, P.E.

Attachments: Photograph figure pages and Appendices A, B, C and D

MAY 15, 2009

Figure 5. Failed pipe location after removal of water but prior to excavation of rock and soil.

Figure 6. View of rupture location in pipe from north (hill) side of pipeline after partial excavation of soil and rock.

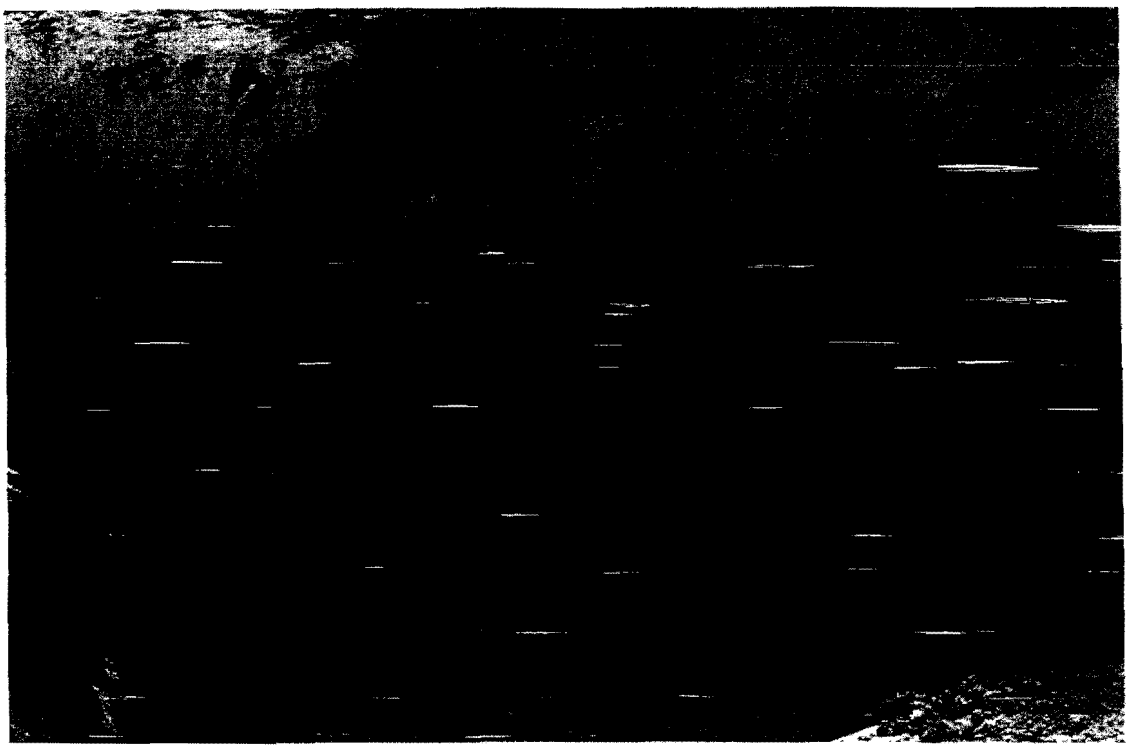


Figure 7. Closer view of cylinder rupture location on failed section of pipe.

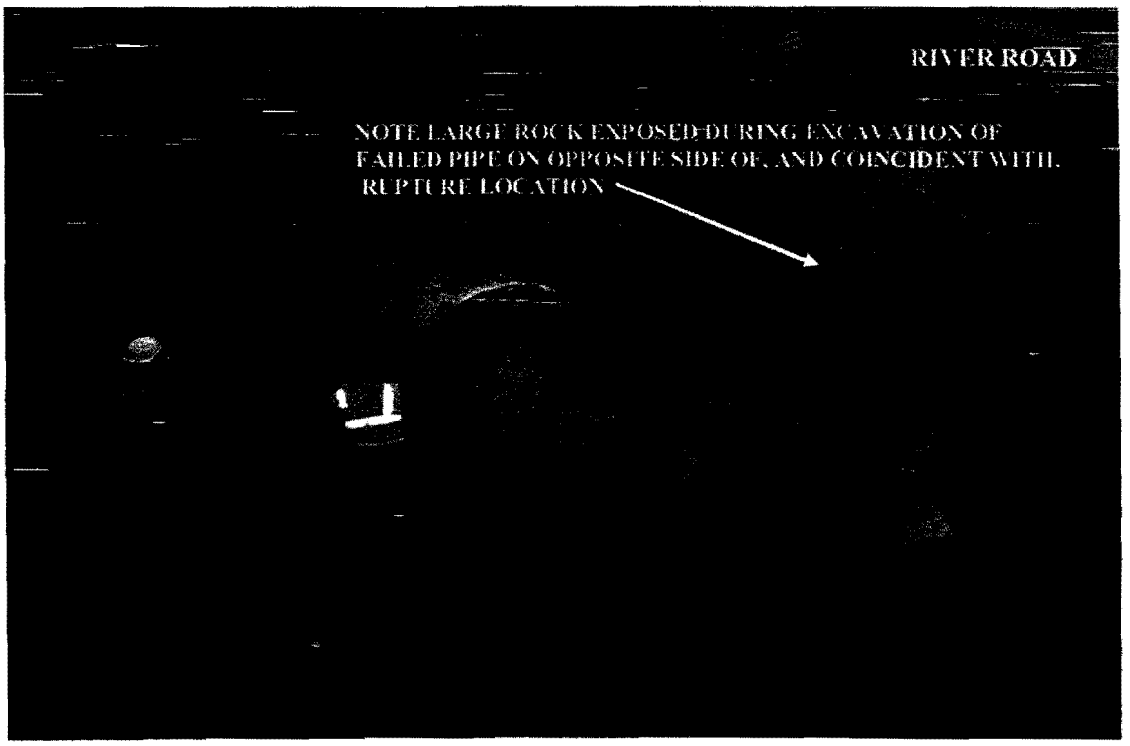
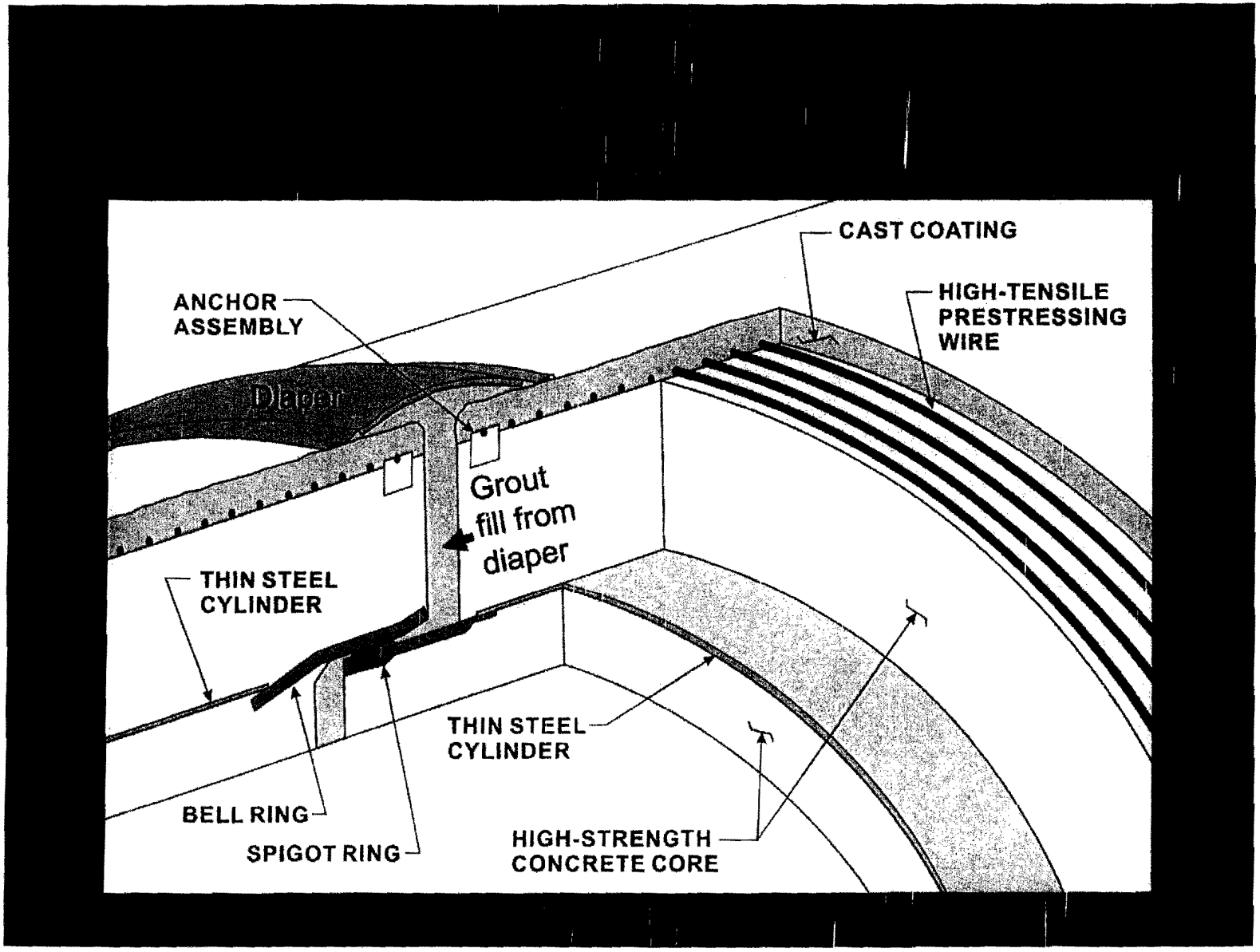
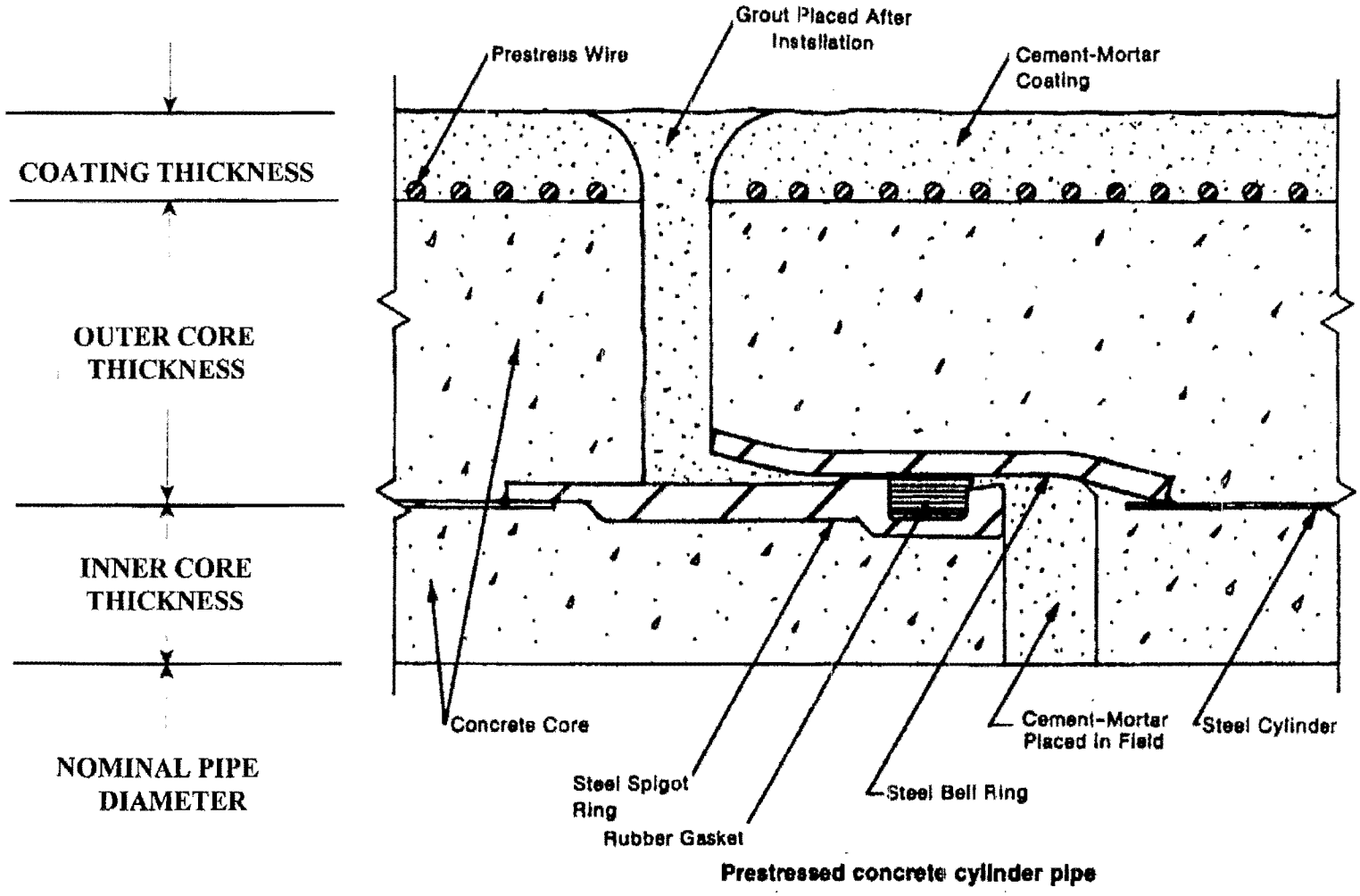


Figure 8. Failure location further excavated with bell end of ruptured pipe partially dissected for removal; note proximity of large rock projection adjacent to rupture location.

APPENDIX A-2


CAST COATING
ANCHOR ASSEMBLY
HIGH-TENSILE PRESTRESSING WIRE
Diaper
Grout fill from diaper
THIN STEEL CYLINDER
THIN STEEL CYLINDER
BELL RING
SPIGOT RING
HIGH-STRENGTH CONCRETE CORE



Prestressed concrete cylinder pipe

APPENDIX A-3