CITY OF NOVI
Administrative ePacket
December 05, 2024

Council Action/Attention

Long Range Strategic Plan Update - Cardenas

People's Express Agreement Extension - Kieser

Sakura Quota Liquor License Request

MDOT Letter re: Beck Road Corridor Improvement Project Environmental Assessment

Departmental Updates

Twelve Oaks Mall Update - Cardenas

2023/24 Planting and Forestry Update - Salowich

PCCP Water Main Inspection Results - Croy

Stuff A Squad Car - Meier

The Buzz Report

For Your Information

MEMORANDUM

TO: MAYOR AND CITY COUNCIL
FROM: VICTOR CARDENAS, CITY MANAGER
SUBJECT: LONG RANGE/COMMUNITY PLAN UPDATE
DATE: DECEMBER 4, 2024

The Long Range/Community Plan/Novi 2050 Committee has been diligently meeting since its inception, making significant progress on its charge. To maintain momentum and align efforts with Council, the Committee has outlined a proposed schedule of key workshops, including their budgetary implications:

Council Workshop #1

Date: Wednesday, January 21, 2025.
Time: 5:30 p.m. (dinner) 6:00 p.m. (meeting start)
Focus: Prioritization and Direction for Transformative Projects

The goal of this workshop is to discuss and ultimately decide on the prioritization and strategic direction of projects that will shape Novi's future (previously termed "Transformative"):

- Public Safety facilities
- ITC Park, expansion/re-configuration
- Third space/Community Center
- Beck Road Widening

Council Workshop #2

Date: Late February 2025 (Exact Date TBD)
Focus: Strategic Forecasting and Emerging Trends with a Futurist

The Committee recommends engaging a professional Futurist to lead Council in a forward-thinking discussion on emerging trends, strategic forecasting techniques, and Novi's future demographic shifts. Topics will include societal, technological, economic, environmental, and political trends, providing critical insights for long-term strategic planning.

Estimated Cost: $25,000

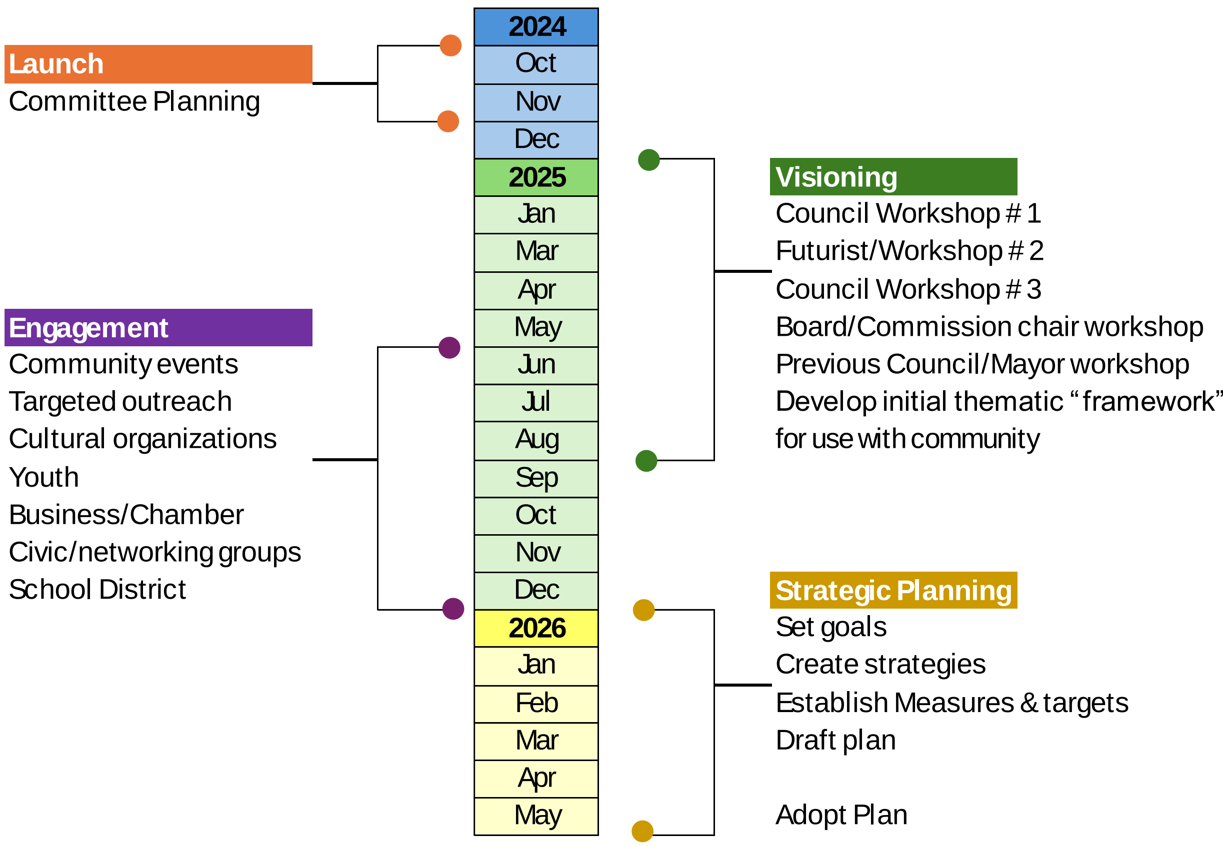
Council Workshop #3

Date: Mid-March (Exact Date TBD)
Focus: Novi 2050 Consultant Engagement

The final workshop will serve as the launch of a collaboration with a consultant (to be selected prior to this workshop) to assist in the development of the Novi 2050 Plan. The consultant will guide the Council and City in creating a comprehensive, future-focused strategic community plan over the next two years (and span two fiscal years).

Estimated Cost: $100,000

Below is the draft timeline that the committee has been working off:



These workshops reflect the Committee's commitment to developing a forward-thinking, innovative plan for Novi's future. Please let me know if you have any questions or comments on the plan that has been outlined.

Mayor and Council –

The memo below provides a heads-up on a forthcoming item on the December 16 agenda: a proposed extension of the PEX agreement with the City to remain at the Civic Center until June 2025.

- Victor

CITY OF NOVI
cityofnovi.org

TO: VICTOR CARDENAS, CITY MANAGER
JEFF MUCK, PRCS DIRECTOR

FROM: KIT KIESER, OAS MANAGER

SUBJECT: PEOPLE'S EXPRESS AGREEMENT EXTENSI

DATE: DECEMBER 4, 2024

Since July 1, 2024, People's Express (PEX) has been providing curb-to-curb public transportation services in Novi. Under an agreement with the City, PEX is granted access to 200 square feet of office space and 14 parking spaces at the Civic Center.

This arrangement was established to support the transition from Novi Senior Transportation to PEX and to ensure a local presence for PEX operations. The City initiated the setup to provide continuity for former Novi Senior Transportation staff who transitioned to PEX employment and to ensure a local presence for PEX operations through a Novi-based satellite office rather than relying solely on PEX's Whitmore Lake headquarters.

This arrangement has been essential in maintaining efficient operations and ensuring accessibility for residents who depend on these services. During this time, aside from regular operations, PEX has actively engaged in community events, reflecting its dedication to local involvement. It sponsored the Parks Foundation's Pour on the Shore fundraiser, providing shuttle services for attendees, attended the Superhero Showcase at the Civic Center, and hosted a community information session to help residents navigate their transportation services.

The current agreement expires on December 31, 2024. To ensure uninterrupted services while PEX explores alternative locations, staff recommends extending the existing agreement for an additional six months through June 30, 2025.

PEX is actively seeking alternative locations in Novi that can accommodate 50 or more vehicles and provide expanded office space beyond what is available at the Civic Center. The Community Development team is collaborating with PEX leadership to schedule a meeting and provide assistance in their property search.

The proposed extension agreement will be presented to City Council at the December 16 meeting for approval, ensuring continuity of the current arrangement into 2025.

M

Mayor and Council –

A VERY preemptive FYI on a request for one (1) of your three (3) remaining quota liquor licenses. The request is a bit pre-mature as the building has yet to be constructed. Nonetheless I wanted it to be on your radar.

- Victor

CITY OF NOVI
cityofnovi.org

TO: CORTNEY HANSON, CITY CLERK

FROM: ERICK W. ZINSER
DIRECTOR OF PUBLIC SAFETY / CHIEF

INITIATED BY: MICHAEL BENDER, DETECTIVE MB

SUBJECT: CLASS C LIQUOR LICENSE APPLICATI(
THE DANCING PINE

DATE: DECEMBER 2, 2024

Liquor License Request:

Seven York Incorporated is requesting a Class C license for a new business operating as The Dancing Pine, which will be located in the Sakura complex, near Grand River Avenue and Town Center Drive.

Applicant/Background Information:

This application is being sought by Min Kyu Kim, who owns and operates 11 restaurants in Michigan, two of which serve alcohol/liquor (Kimchi Box Plus in Northville and Azalea in Ann Arbor). Both of these restaurants serve a wide variety of wines as well as cocktails that pair with their respective menus. Because of the variety and quantity of the restaurants that the applicant operates, he has been able to develop and maintain a strong team that ensures the quality and efficiencies of the restaurants.
Dancing Pine is set to serve Korean steakhouse foods and Asian classics such as hot pot, poke, steak, sushi, and a selection of baked goods. The Dancing Pine will be in a stand alone building in the middle of the development, facing the lake.

Criminal History/Police Contacts:

The applicant was arrested for "Disorderly Conduct" in Ann Arbor on 07-31-22. Court records from the 15th District Court (Ann Arbor) revealed that the applicant was charged with "Urinate or Defecate in Public-Disorderly", however, this case was ultimately dismissed "order of nolle prosequi" on 10-28-22.

Michigan Liquor Control Commission (MLCC):

There were no violations found for the applicant's two current restaurants in which alcohol is served.

Financial Review:

Based upon the financial data provided by the corporation, no issues were found to prevent the liquor license application process from proceeding.

Summary:

Based on the information provided and the subsequent liquor investigation, I find no reason to deny the applicant's request. This request requires the approval of the Novi City Council.

C: Victor Cardenas, City Manager

Mayor and Council –

Apologies for not sending this earlier, but please see the correspondence below we sent to officials at MDOT regarding the Environmental Assessment process for the planned Beck Road work from 11 miles to Grand River. The correspondence was copied to all our state and federal representatives. In the future, we'll make sure any official communications sent to elected officials that Council will also be copied.

- Victor

CITY OF NOVI

CITY COUNCIL

Mayor
Justin Fischer

Mayor Pro Tem
Laura Marie Casey

David Staudt

Brian Smith

Ericka Thomas

Matt Heintz

Priya Gurumurthy

City Manager
Victor Cardenas

City Clerk
Cortney Hanson

City of Novi
45175 Ten Mile Road
Novi, Michigan 48375
248.347.0460
248.347.0577 fax

cityofnovi.org

Deena Woodward
MDOT Environmental Services Section
425 West Ottawa Street
P.O. Box 30050
Lansing, MI 48909

RE: JN 219309 Beck Road Corridor Improvement Project Environn

Dear Ms. Woodward,

The City of Novi is excited to begin construction on the first segment of the Beck Road Corridor Improvement Project. The project will bring much-needed improvements to a very congested minor arterial road in our community. The City has engaged with our business community, adjacent municipalities, and the public for several years while planning the needed improvements to this important corridor. We were delighted when we learned that the project received funding through the FY 22 Community Project Funding/ Congressionally Directed Spending as part of the federal Highway Infrastructure Program.

We enlisted the services of AECOM Great Lakes, Inc. (AECOM) to usher this project through planning, design, and construction, including the necessary environmental clearance. AECOM introduced the project to MDOT as early as the spring of 2021, even before construction funding was granted. At that time, we were advised that an environmental assessment (EA) would likely be needed to address National Environmental Policy Act (NEPA) requirements and obtain environmental clearance.

In May of 2023 we began in earnest to move an EA forward when we held a meeting to re-introduce the project to current MDOT Local Agency Program staff, including a desired timeline to ensure the project would meet the obligation deadline of September 30, 2025. We learned that MDOT was in the process of revamping their environmental reviews of local agency projects. MDOT shared the *MDOT ESS LAP Draft Environmental Assessment Process* flowchart to follow and indicated a MDOT Form 5323 *Local Agency Environmental Clearance Form* would be needed as a first step for MDOT to begin their review and confirm the appropriate class of action for NEPA study. A MDOT Form 5323 was submitted to MDOT on July 7, 2023. An MDOT response was received approximately seven weeks later along with several questions and requests for additional information.

AECOM and MDOT met and corresponded over the coming months culminating with submittal of a revised draft MDOT Form 5323 on October 2, 2023. MDOT reviewed the submittal over the next several weeks and provided additional comments and questions on November 9, 2023. A revised MDOT Form 5323 was submitted on December 11, 2023, which MDOT subsequently signed and submitted to the FHWA for concurrence that an environmental assessment was the appropriate class of action for NEPA study. FHWA concurrence was received on January 21, 2024, over six months after the initial submittal of MDOT Form 5323. Throughout the process, it seemed that MDOT expected a level of detail that would only be available with near-final design, rather than simply identifying the potential risks and unknowns that can be identified to help inform the class of action decision to begin the NEPA process.

Moving past the class of action decision, MDOT and the project team began to focus on initiating the EA which required FHWA action. Following independent MDOT discussions with the FHWA and AECOM through February and March, the City sent a letter to MDOT on April 17, 2024, requesting that the EA be initiated. MDOT requested additional information and a revised request letter, which was provided on July 31, 2024, and again on August 8, 2024. MDOT finally submitted a letter to the FHWA on September 9, 2024, requesting that the EA be initiated at the federal level. FHWA formally initiated the EA on September 17, 2024, approximately eight months after the class of action was decided.

Another challenge has been the cultural resources review. On August 25, 2023, MDOT notified AECOM to submit a Section 106 Application. This was in advance of the process outlined in the provided flowchart which suggests the Section 106 process should begin once the FHWA initiates the EA. A Section 106 Application was submitted to MDOT on September 29, 2023, that illustrated a “worst-case” footprint reflecting the stage the project was at in the NEPA process in which a preferred alternative had not been selected. MDOT requested additional information about six weeks later, then on December 1, 2023, MDOT sent an email stating the Section 106 Application could not be processed any further until a preferred alternative was selected through the EA. While not a schedule risk at the time, the amount of time it took to get the EA initiated (and associated confirmation of the studied alternatives) has now resulted in the cultural resources investigations being one of the controlling items of work and largest risk to completing a draft EA. The seasonality of cultural resources surveys further complicates the schedule, allowing only a small window to complete any field investigations.

Unfortunately, due to the time that has elapsed to first obtain class of action and then to get the EA initiated, we are now focused on completing the EA as quickly as possible with real risk of not meeting the federal obligation deadline. We aim to have a draft EA submitted for MDOT’s first review by December 20, 2024, a mere three months after the EA was initiated. However, challenges will remain. Meeting the obligation deadline will require cooperation from all involved parties and even working outside of accepted norms. Standard review times by MDOT and FHWA will need to be cut. This project may need to be prioritized over others. This will all be necessary to successfully deliver the project and convey the will of the congressional directed spending.

Our concerns are real as is our hope that this project will be successfully delivered. To accomplish this, we will need MDOT’s full attention and cooperation which the City respectfully requests. We also understand that MDOT is the intermediary with the FHWA, who’s cooperation is also essential. **Without full cooperation of both agencies, the City risks losing over $4 million dollars of federal funding which cannot be replaced.**

I sincerely hope that you understand the urgency and importance of this situation. We look forward to your expedited assistance and attention to this project. Should you desire to discuss any of these matters, please contact Jeff Herczeg, Director of Public Works, at 248-735-5640 or JHerczeg@cityofnovi.org.

Sincerely,

Victor Cardenas
City Manager
City of Novi

cc: Congresswoman Haley Stevens
Congresswoman Debbie Dingell
Representative Kelly Breen
Taryn Nance, FHWA
Dee Parker, MDOT
Jeff Herczeg, City of Novi
Sean Kelsch, AECOM

MEMORANDUM

CITY OF NOVI
cityofnovi.org

TO: MAYOR AND CITY COUNCIL

FROM: VICTOR CARDENAS, CITY MANAGER

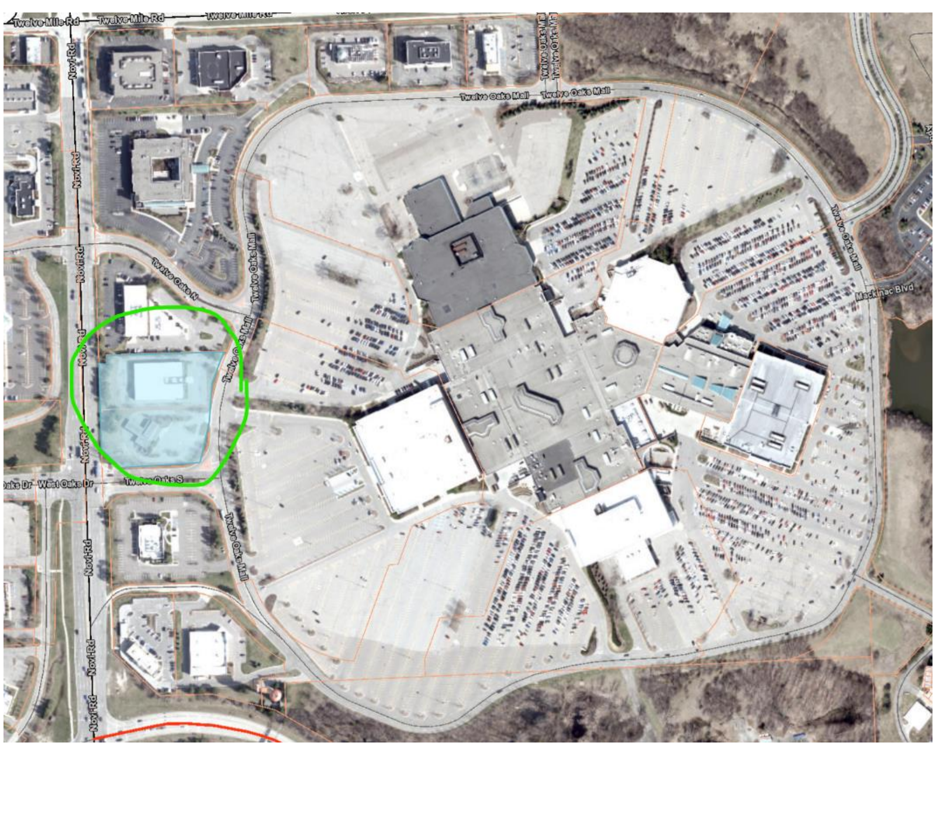
SUBJECT: TWELVE OAKS MALL UPDATE

DATE: DECEMBER 5, 2024

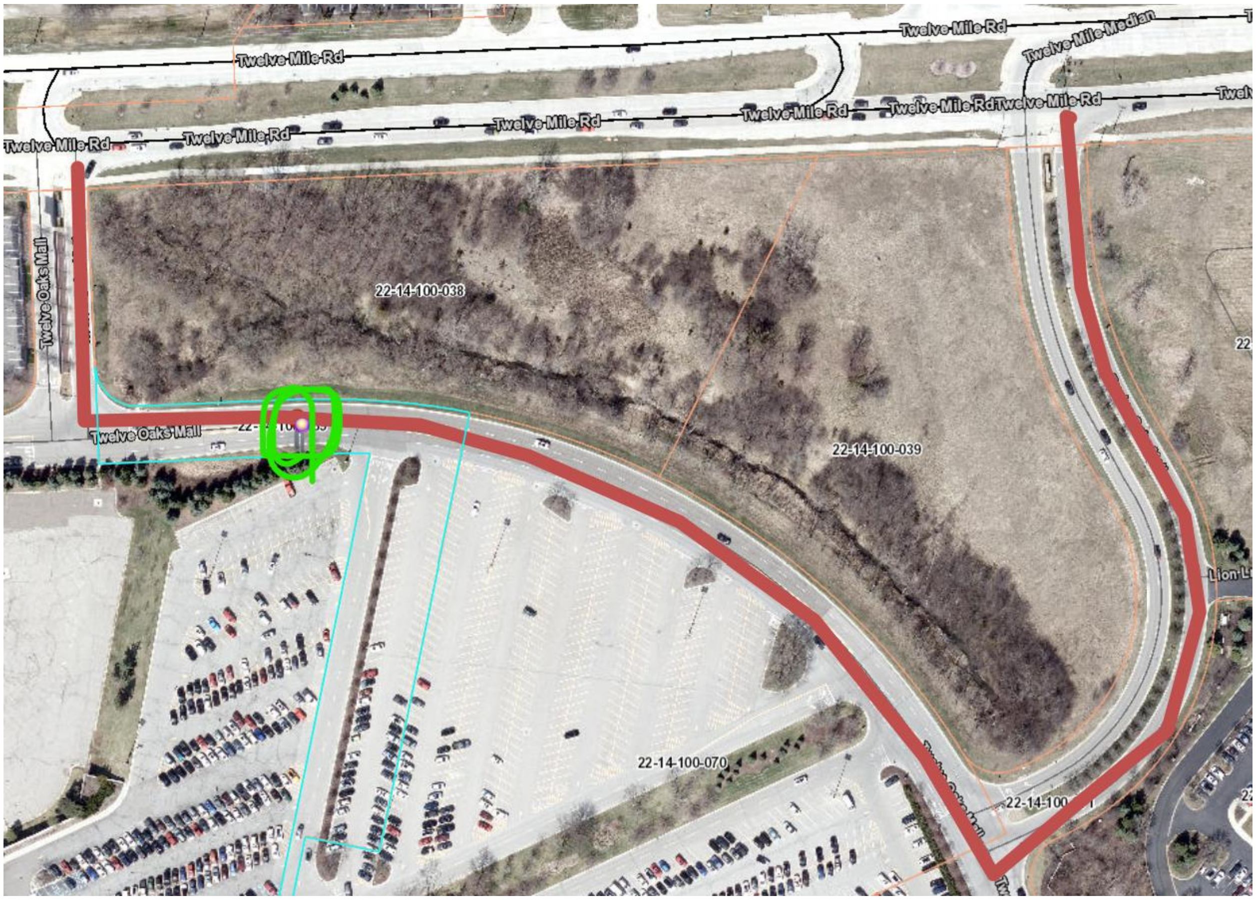
This morning, Sheryl Walsh-Molloy, Charles Boulard, and I met with Dan Jones, the retiring general manager (GM) of Twelve Oaks, and Scott Lofton, the incoming GM. Dan has been with Twelve Oaks/Taubman for 22 years. My goal is to provide a quick update on Twelve Oaks, which is quite contrary to the current narrative surrounding malls.

The holiday shopping season is in full swing. The mall is over 90% filled with limited vacancies. The large "anchor" stores Macy's, JC Penney, and Nordstrom continue to be the top performers in their respective holding companies' portfolios. Simon/Taubman does not own the vacant Sears and Lord and Taylor, but there is some movement, particularly regarding the Sears property. I have been in contact with a representative for Dick's Sporting Goods as they are investigating the possibility of building out the first floor for a Dick's House of Sport. If they do follow through with this development, we've received mixed messages about whether they will maintain their other location on the 12 mile road in Fountain Walk at 12 mile at the crossing. With respect to the remaining space, we know of a proposed Primark that would be housed on the second floor.

Community Development has received word that two long-vacant buildings on the outskirts of the mall property, again owned by a separate entity, will be demolished later this month.



Finally, Dan and Scott informed us that Simon/Taubman has worked out an agreement to allow SMART to have a bus stop on the property. The stop is near the McDonald's Mall entrance, shown below. This stop will become active later this year. The buses' route is shown in red, showing how they will enter and exit the mall property.



Again, the mall is in great shape and is thriving. We are sad to see Dan Jones leave, as he has been a great community partner for the last 22 years. We look forward to forging a new relationship with Scott and continuing to work with the mall for years to come.

MEMORANDUM

TO: JEFFREY HERCZEG, DIRECTOR OF PUBLIC WORKS

FROM: KEITH SALOWICH, FORESTER & CONTRACTS SUPERVISOR

SUBJECT: FY 2023–24 PLANTING SUMMARY AND FORESTRY UPDATE

DATE: DECEMBER 5, 2024

Trees play a vital role in Novi's environment by providing a wide array of economic, environmental, and social benefits, which far exceed the investments in planting, maintaining, and removing them. Trees reduce air pollution, improve public health outcomes, reduce stormwater runoff, sequester and store carbon, reduce energy use, and increase property value, among other benefits.

As such, the management of Novi's urban forest is multi-faceted, and includes proactive tree maintenance, reactive work in the wake of storms or resident concerns, and a focus on long-term urban forest resilience in a world of emerging threats.

PLANTING HIGHLIGHTS

The City's planting contractor, Crimboli Nursery Inc., augers a hole to plant a street tree in front of a Novi residence.

The City of Novi plants trees and shrubs annually during both the spring and fall planting seasons. Nearly all plantings are native species. Native species provide by far the greatest benefits to local ecosystems and are also well adapted to the growing conditions of the area. Staff also abides by the "right tree—right place" ethos and plants trees in sites where they can thrive for many years without posing significant conflicts with infrastructure.

The total number of tree and shrub plantings are illustrated in a table below, with some significant plantings of note:

- As part of the City's efforts to refurbish its 17 **entryway signs**, new landscape plantings were installed around several of the signs. An emphasis was placed on adding evergreen species to bring year-round interest to these sites that serve as Novi's first impression on passing motorists.

- There were eight trees, and 48 shrubs added to the City's new **Northwest Park** to enhance the landscape and add valuable wildlife habitat**.** City staff selected native species to complement that park's cohesion with the surrounding natural woodland.

- **Street trees** were planted adjacent to 121 different residences throughout Novi. Many of them were replacements for trees that had died, had fallen in storms, or were removed as part of the Neighborhood Sidewalk Program. There were also 35 new planting sites that had trees added for the first time.

	Trees	Shrubs	Total Cost
Fall 2023	179	906	$71,130
Spring 2024*	115	65	$48,035
Seedling Giveaway	873	440	$2,397

** Includes installation of large trees to provide screening along Lakeshore Park*

MAINTENANCE HIGHLIGHTS

One of the City's two tree maintenance contractors, CutMyTreeDown.com, chips debris from an invasive species removal effort in Lakeshore Park.

City forestry contractors continuously remove dead/dying/damaged/diseased trees, grind stumps, and prune trees year-round. The City Forester also assesses, diagnoses, and monitors public trees to form management decisions.

- Proactive maintenance pruning is performed on every City-owned tree in every Novi neighborhood as part of the City's block pruning program. This ensures that sidewalks and roadways remain clear of low-hanging branches, removes hazardous dead or damaged branches, and aids in scouting for pests, diseases, and dead trees that should be removed. Two block pruning crews worked in Barclay Estates, Taft Knolls, Creek Crossing, Cedarspring Estates, and all phases of Island Lake during FY 2023-24.

- There were 18 relatively small City-owned trees in harm's way due to construction projects in FY 2023-24, which were able to be saved through transplanting to a different site rather than removing and replacing them. For example, seven trees were transplanted to a different area on the Meadowbrook Commons property to allow for the pickleball court construction. These efforts saved trees and saved the City money on tree work costs.

- A City contractor removed invasive woody species, most notably buckthorn, from Rotary Park. Invasive species cause great harm to the environment by crowding out native species, thus drastically reducing species diversity, while providing minimal benefits for wildlife. The contractor cut the woody invasive species and treated the stumps with an herbicide concentrate to ensure long-term eradication.

MISC. HIGHLIGHTS

- City of Novi Forester/Contracts Supervisor Keith Salowich was appointed to a three-year term serving on the board of directors for the International Society of Arboriculture (ISA)'s Michigan chapter in December 2023.

- The City of Novi received the prestigious ISA Gold Leaf Award for Outstanding Arbor Day Activities at the 2024 ArborCon conference in February.

- Urban forestry efforts in Novi earned recognition by the Arbor Day Foundation's Tree City USA (TCUSA) program for the 32nd time. Novi also earned its 14th Growth Award through the TCUSA program by going above and beyond the program's regular standards.

- Davey Resource Group prepared an updated Tree Management Plan for the City, and prepared Novi's first-ever tree canopy coverage report. These findings will help guide the direction of future management decisions. A memo highlighting the key findings of those reports is forthcoming.

MEMORANDUM

TO: JEFFREY HERCZEG, DIRECTOR OF PUBLIC WOR
FROM: BEN CROY, CITY ENGINEER
SUBJECT: 2024 PCCP WATER MAIN INSPECTION
DATE: DECEMBER 5, 2024

Mayor and Council –

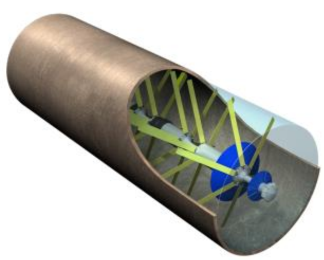
FYI, only

- Victor

cityofnovi.org

The City of Novi's water distribution system has approximately 4.5 Miles of large diameter (24" and larger) Prestressed Concrete Cylinder Pipe (PCCP), a common pipe material for large diameter water mains. However, PCCP pipe can develop defects resulting in catastrophic failures and water main breaks. A break of this nature occurred in the GLWA distribution system in October 2017 on 14 Mile, east of Novi, impacting service of seven communities and taking five days to repair.

Following the 2017 water main break, the Great Lakes Water Authority recognized the need to inspect the remainder of the PCCP in their water system. This inspection method involves the use of specialized insertion equipment that can identify specific defects within the pipe. This inspection is a proprietary method conducted by Xylem (Pure Technologies) which sends two pieces of equipment (**Smart Ball** for leaks, and **Pipe Diver** for structural integrity) through the live water main. In 2019 (see attached presentation) staff initiated the same inspection process on Novi assets to identify specific areas of concern and estimate the criticality of any defects.



Pipe Diver Cross Section

The inspection of the PCCP pipe was completed in two events. During the initial inspection in 2020, the Smart Ball completed the southern 2.2 miles of PCCP pipe (the northern section insertion point was problematic), and the Pipe Diver inspection was only completed on 1.8 miles of pipe. The Pipe Diver equipment was impeded by a damaged valve and Xylem had to perform an emergency extraction of the Pipe Diver. The remainder of the Pipe Diver/Smart Ball inspection was completed in 2024 following assessment/repair of valves in the inspection path, along with the installation of a new structure for the insertion of the Pipe Diver.

The inspections resulted in two major findings; the Smart Ball did not identify any detectable leaks, and the Pipe Diver identified four segments of pipe exhibiting distress to the extent repair was recommended. The repairs of the four pipe segments (Novi Road and 13 Mile Road) were completed in March of this year. The City's contractor, LGC Global, hired

Structural Technologies to perform an internal repair method called Carbon Fiber Reinforced Polymer (applied by hand inside the pipe) to strengthen the pipe segment. The same repair method was used on GLWA's water mains on 14 Mile Road.

Following the completion of all inspections and repairs, Xylem provided a summary report, including analysis and recommendations for future rehabilitation to proactively manage the PCCP pipe. No further repairs are required; however, additional inspection in 7-10 years is recommended. The attached Condition Assessment Report shows Novi's PCCP water main exhibits a distress rate of approximately 0.7 percent, which is well below the average of four (4) percent observed by Pure Technologies in similar inspections.

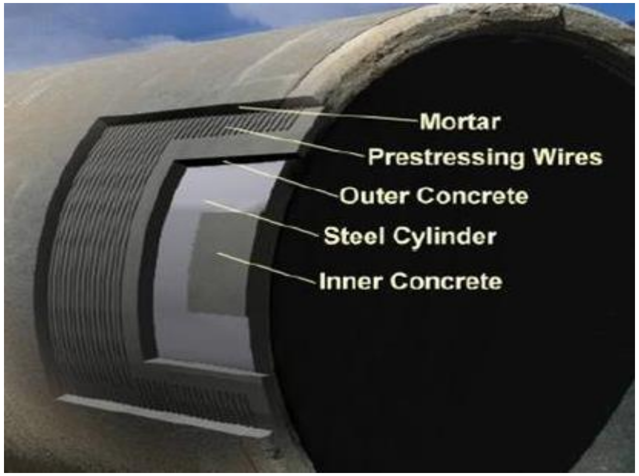
The attached map shows the PCCP water main inspected along Novi Road and the location of the repairs. It should be noted that approximately 1,483 feet of pipe north of the Novi Rd/Old Novi Rd intersection could not be inspected due to the pressure reducing valve which regulates pressures between districts. Staff will continue to monitor and inspect Novi's PCCP assets as needed.

Department of Public Works
Water and Sewer Division

Pre-Stressed Concrete Pipe Assessment and Inspection Program 2019

Pre-Stressed Concrete Cylinder Pipe from GLWA Break 14 Mile Main Break

PCCP Overview



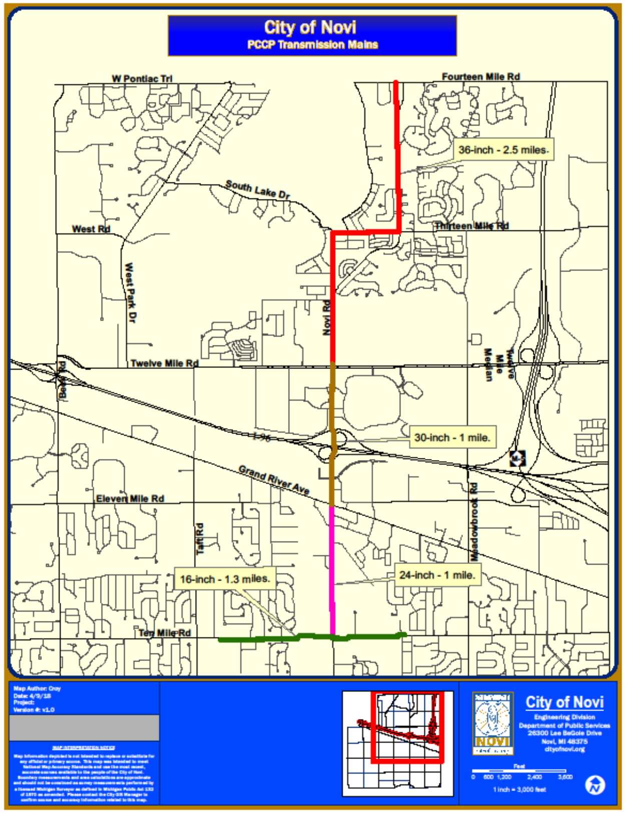
- PCCP is commonly found in water mains
- PCCP can range in size from 16” to 20’ diameter
- A prestressed wire is wrapped helically around the pipe providing resistance to internal pressure and external loads
- Designed to handle high pressures

Types of PCCP Failures

Corrosion

Hydrogen Embrittlment

City has 2.5 Miles of 36”, 1 Mile of 30”, 1 Mile of 24” and 1.3 Mile of 16” PCCP water main. This is the primary water service for the majority of Novi.

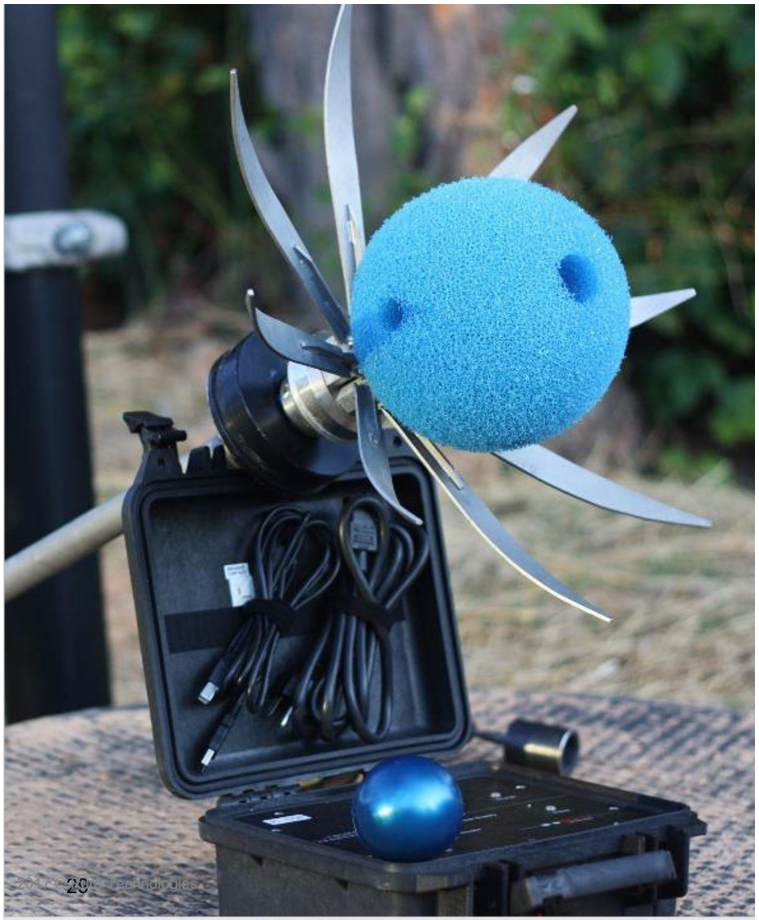


Our goal is to reduce your capital expenditures by focusing repair/rehab/replacement on bad pipe

PCCP Inspection Toolbox

- Transient pressure monitoring
- Leak and air pocket detection (Smart Ball)
- Structural pipe wall inspections - counting wire breaks (Pipe Diver)
  - Electromagnetics
  - Visual and Sounding
  - Forensic investigation and design review
  - Structural assessment
  - Remaining useful life
- Acoustic fiber optic (AFO) monitoring for wire breaks – (Option)

In-line Acoustic Leak & Gas Pocket Detection



- Free Swimming/ Non-Tethered Hydrophone
- Technology
- Locates leaks and gas pockets in transmission or force mains
- Launch and retrieve in live flow through
- 4” openings

Structural Pipe Inspection

External

Diameter: Any

Pipe segments excavated to springline

Manned system

Free-Swimming

Diameter: 16”+

Pipeline In Service

Free swimming

*SONAR

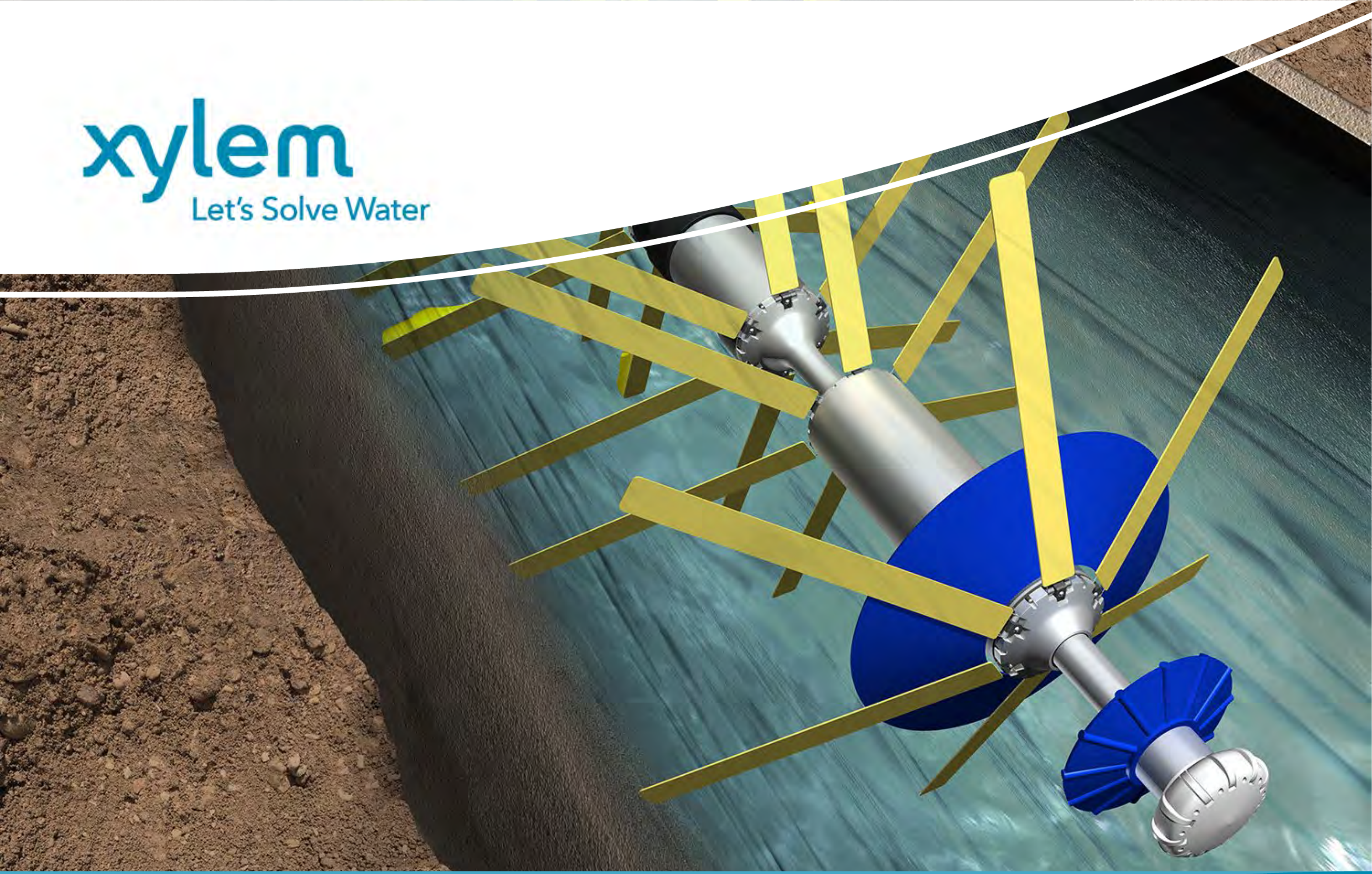
*CCTV recording

PCCP Pipe Inspection Proposal

- SmartBall – Identification and location of any leaks and/or air pockets in the pipeline as well as ARV installation recommendations.
- PipeDiver - Identification and location of the estimated number of broken prestressing wire wraps within each PCCP pipe section inspected.
- Xylem will also provide transient pressure monitoring and structural modeling (FEA curves) to determine the significance of any defects detected.
- Pure Technologies typically provides a presentation summarizing draft results to stakeholders to facilitate review of the draft report.

Summary

- Budgeted in 2019-2020 FY
- Scheduled to start fall 2019
- Preventitive and proactive maintenance with the goal to prevent a catastrophic failure
- Failures result in $$$ and loss of service
- Projects can be planned and more cost effective with control of service maintained
- Same program GLWA just completed first phase of inspection



Condition Assessment Report

Novi Road PCCP Water Transmission Main

City of Novi

August 2024

20 Truman Drive South | Edison, NJ, USA 08817 | Tel: +1 (908) 526-6600 | xylem.com

Quality Assurance and Quality Control Statements

This report has been prepared and reviewed in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies U.S. Inc., a Xylem brand:

August 5,2024

Philip Hwang, P.E. — Date
Project Manager

Editorial Review Statement

This report has been prepared and reviewed for editorial content in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies, a Xylem brand:

July 24, 2024

Marian Nance — Date
Editorial Reviewer

Technical Review Statement

This report has been prepared and reviewed for technical correctness in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies, a Xylem brand:

M. Sharma

August 2, 2024

Mohina Sharma — Date
Technical Reviewer

Contractual Review Statement

This report has been reviewed for contractual completeness in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies, a Xylem brand:

August 8, 2024

Evan Biedenbach — Date
Contractual Reviewer

Report Author

Samantha Vermillion

July 23, 2024

Samantha Vermillion — Date

Confidentiality Clause

This report contains confidential commercial information regarding proprietary equipment, methods, and data analysis, which is the property of Pure Technologies U.S. Inc., a Xylem brand. It is for the sole use of the City of Novi (Novi) and its engineering consultants and is not to be distributed to third parties without the express written consent of Pure Technologies U.S. Inc., a Xylem brand.

Table of Contents

Appendices

Executive Summary

The City of Novi (Novi) contracted Pure Technologies, a Xylem brand (Pure Technologies), to conduct a condition assessment of the 36-, 30-, and 24-inch Novi Road PCCP Water Transmission Main located in Novi, Michigan. The Novi Road PCCP Water Transmission Main consists of prestressed concrete cylinder pipe (PCCP), specifically lined cylinder pipe (LCP).

On October 29, 2019, and August 23, 2023, parts of the pipeline were inspected with the SmartBall platform. A summary of inspection results is presented in Table ES.1.

Table ES.1: Summary of SmartBall Inspection Results			
Pipeline	**Inspection Year**	**Total Length Inspected (feet)**	**Leaks Detected**
10 Mile Road 16-inch East	2019	2,269	1*
10 Mile Road 16-inch West	2019	5,235	2*
36-, 30- and 24-inch Novi Road PCCP Water Transmission Main	2023	11,398	1**

**Leaks detected appeared to be caused by valves that were not fully shut for the inspection. Valves have been repaired.*

*** Feature-Related Leak: Leak is from a hydrant at Station 100+50 which was used to dewater extraction.*

On February 15, 2020, an electromagnetic inspection was conducted using Pure Technologies' proprietary PipeDiver® platform to locate and identify pipes that have broken prestressing wire wraps. Due to complications with valve manipulation and tool passages, the full scope was not obtained during the 2020 inspection. Pure Technologies conducted a second non-destructive evaluation of the PCCP in the Novi Road PCCP Water Transmission Main on April 18, 2024, to complete most of the remaining inspection scope, with the exception of approximately 1,483 feet between the 2020 extraction location and the 2024 insertion location.

Electromagnetic analysis of the data obtained during the 2020 inspection determined that a total of eight (8) pipes displayed electromagnetic anomalies consistent with prestressing wire damage. Of those eight (8) distressed pipes, four (4) pipes (Pure Reference Number 10324, 10327, 10356, and 10367) were repaired with carbon fiber reinforced polymer (CFRP) in March 2024. Analysis of the data obtained during the 2024 inspection determined that zero (0) pipes displayed electromagnetic anomalies consistent with prestressing wire damage. A summary of inspection results is presented in Table ES.2. A complete discussion of the electromagnetic results is presented in Section 5.

Table ES.2: Summary of PipeDiver Inspection Results					
Pipeline	**Inspection Year**	**Diameter (inches)**	**Total Distance Inspected (feet)**	**Number of Inspected Pipes**	**Pipes with Broken Wire Wraps**
Novi Road PCCP Water Transmission Main	2020	30	25	2[1]	0
		36	9,568	591[1]	8
	2024	36	2,487	155	0
		30	5,448	292	0
		24	6,841	139[2]	0
Total			**24,369**	**1,179**	**8**

[1]***Number of Inspected Pipes*** *does not include seven (7) 30-inch valves, the 36-inch x 30-inch reducers, or the 30-inch piping associated with the valves.*

[2]***Number of Inspected Pipes*** *include an approximately 2,950 feet DIP represented as one (1) long section.*

In addition to the SmartBall and PipeDiver inspections, a transient pressure monitor (TPM) was installed at the meter vault location, NV-04. Pressure data was collected for a total of 43 days, from March 5, 2020, to April 17, 2020, in order to identify the hydraulic stresses acting on the pipeline. Maximum, minimum, and average pressures were recorded by the pressure logger at 4-minute intervals. The maximum pressure recorded during the monitoring period was 120.6 psi. The minimum pressure recorded, which occurred during a transient event was 62.3 psi, and the average pressure recorded was 93.3 psi. The TPM results are detailed in Section 4.

Following the conclusion of the inspection, Pure Technologies performed structural analysis to determine if the PCCP main satisfies the historical and current PCCP American Water Works Association (AWWA) C301 and C304 design. The evaluation considered the manufacturer's provided specifications under various earth cover depths found along the Novi Road PCCP Water Transmission Main.

Three-dimensional nonlinear Finite Element Analysis (FEA) was performed as part of structural analysis. The FEA develops a risk curve (or pipe performance curve) that plots theoretical failure limits on a chart of PCCP wire breaks versus pipe internal operating pressure. The pipe performance curve allows for various operating pressures to be applied at specific cover depths for a particular pipe class to determine if operating conditions (combined with the number of broken wire wraps) will likely result in pipe failure. A total of four (4) performance curves were developed for the 36-inch, 30-inch and 24-inch pipes across various ground covers to evaluate the structural consequence of broken prestressing wire wraps for each pipe design. The maximum pressure recorded on the TPM was applied to each performance curve at a specific depth of cover to determine if distressed pipes of given class were above the yield limit.

Additionally, a predictive modelling analysis was conducted to forecast future degradation of the Novi Road PCCP Water Transmission Main and assist with long-term capital planning. The model incorporates the current condition of the transmission main as determined through the inspection, and projects future degradation to predict the number of pipes that may need repair or replacement over the next 30 years.

Based on the findings of SmartBall and PipeDiver inspections, transient pressure monitoring, AWWA C301 and C304 analyses, FEA and predictive deterioration modelling, Pure Technologies determined the following:

Conclusions

- Electromagnetic inspection of the Novi Road PCCP Water Transmission Main identified eight (8) PCCP pipes were identified with broken prestressing wires, ranging from 5 to 30 as well as across the entire length of the pipe.
    - 2020 Inspection determined that a total of eight (8) pipes displayed electromagnetic anomalies consistent with prestressing wire damage. Of those eight (8) distressed pipes, 4 pipes (Pure Reference Number 10324, 10327, 10356, and 10367) were repaired with carbon fiber reinforced polymer (CFRP) in March 2024.
    - 2024 Inspection determined that zero (0) pipes in the Novi Road PCCP Water Transmission Main displayed electromagnetic anomalies consistent with prestressing wire damage.
- A total of four (4) feature-related leaks were detected during the 2019 and 2023 SmartBall inspections. The three (3) leaks identified in 2019 were caused by valves that were not fully shut during the inspection and were repaired. In 2023, a medium size leak detected was at Station 100+50, a fire hydrant used to dewater the extraction site.
- The AWWA C301design analysis evaluation:
    - 36-, 30- and 24-inch LCP pipes across various ground covers satisfy the criteria in the AWWA C301 Design Standard in place at the time the pipes were manufactured using the design operating pressure of 175 psi and a design operating plus surge pressure of 245 psi.
- The AWWA C304 design analysis evaluation:
    - 36-, 30- and 24-inch LCP pipes across various ground covers indicated that all Elastic Limit criteria and all Strength Limit criteria were satisfied.
    - 36-inch LCP Class A design with 8-feet depth of cover, 30-inch LCP Class 175-12 with 6-feet depth of cover and 24-inch LCP Class 175-14 with 8-feet depth of cover indicated that two (2) of the Serviceability Limit State criteria were not satisfied:
        - The criteria for core decompression and the criteria for coating cracking were above the allowable limits.
    - The AWWA C304 analysis for the 30-inch LCP Class # 184 with 8-feet depth of cover indicated that one (1) of the Serviceability Limit State criteria, Core Decompression was not satisfied.

- The Pipe Performance Curves were developed for 36-, 30- and 24-inch LCP pipes across various ground covers and the limits were determined using the maximum observed pressure of 121 psi. No distress was identified during 2024, therefore FEA evaluation for pipe 36-inch Class A LCP inspected in 2020 concluded:
  - One (1) pipe exceeded the yield limit at the maximum observed operating pressure.
  - Zero (0) pipes exceeded the strength limit at the maximum observed operating pressure.
  - One (1) pipe could not be correlated because the number of wire breaks could not be determined.
- The Predictive Modelling Analysis determined that in the year 2055, a cumulative number of 15 pipes are expected to exceed the intervention limit for the Novi Road PCCP Water Transmission Main. Note that this projection does not take into account failure through other modes, such as leaks due to corrosion in the steel joint rings.

Recommendations

The Novi Road Water Transmission Main inspection exhibits approximately 0.7 percent distress rate, which is well below the average of four (4) percent observed on prior projects performed by Pure Technologies for all clients. Based on the electromagnetic and acoustic inspection results, transient pressure monitoring, structural design analysis, and predictive analysis Pure Technologies would like to propose the City of Novi take the following actions for ongoing management of the Novi Road PCCP Water Transmission Main:

- Based on the condition of the prestressing wire wraps, the primary component of prestressed concrete cylinder pipe providing concrete compression, and following the March 2024 CFRP repairs, no remedial action is required at this time.
- Continue to operate the Novi Road PCCP Water Transmission Main following industry best practices, focusing specifically on maintaining a stable, consistent pumping process and operating pressure, stable above ground conditions and external loading on the pipe, and routine maintenance of features such as air valves and inline valves.
- Reinspect the Novi Road Water Transmission acoustically and electromagnetically in seven (7) to ten (10) years, or sooner if operating conditions change significantly, proactively managing the future serviceability of the watermain.

1. Project Background

The Novi Road Water Transmission Main is owned and operated by the City of Novi. It extends from a meter vault, NV-04 at the north end, near 14 Mile Road and Novi Road and extends southward along Novi Road and Old Novi Road to 10 Mile Road. The main consists mostly of lined cylinder pipe (LCP) a type of prestressed concrete cylinder pipe (PCCP). The pipes were manufactured by Interpace Corporation and Price Brothers Company in 1976 and 1977. The Novi Road Main is 36-inch LCP from 14 Mile Road to 12 Mile Road, with short sections of 30-inch pipe near each butterfly valve. The main is 30-inch LCP from 12 Mile Road to Grand River Avenue. It reduces to 24-inch LCP at Grand River Avenue. The main changes material from 24-inch LCP to 24-inch ductile iron pipe (DIP) at Main Street, due to construction of a bridge over the railroad. The DIP section continues southward until approximately 1,400 feet north of 10 Mile Road, where the material changes from DIP back to 24-inch LCP. The transmission main splits into two (2) 16-inch pipes at 10 Mile Road, one heading east, and the other heading west.

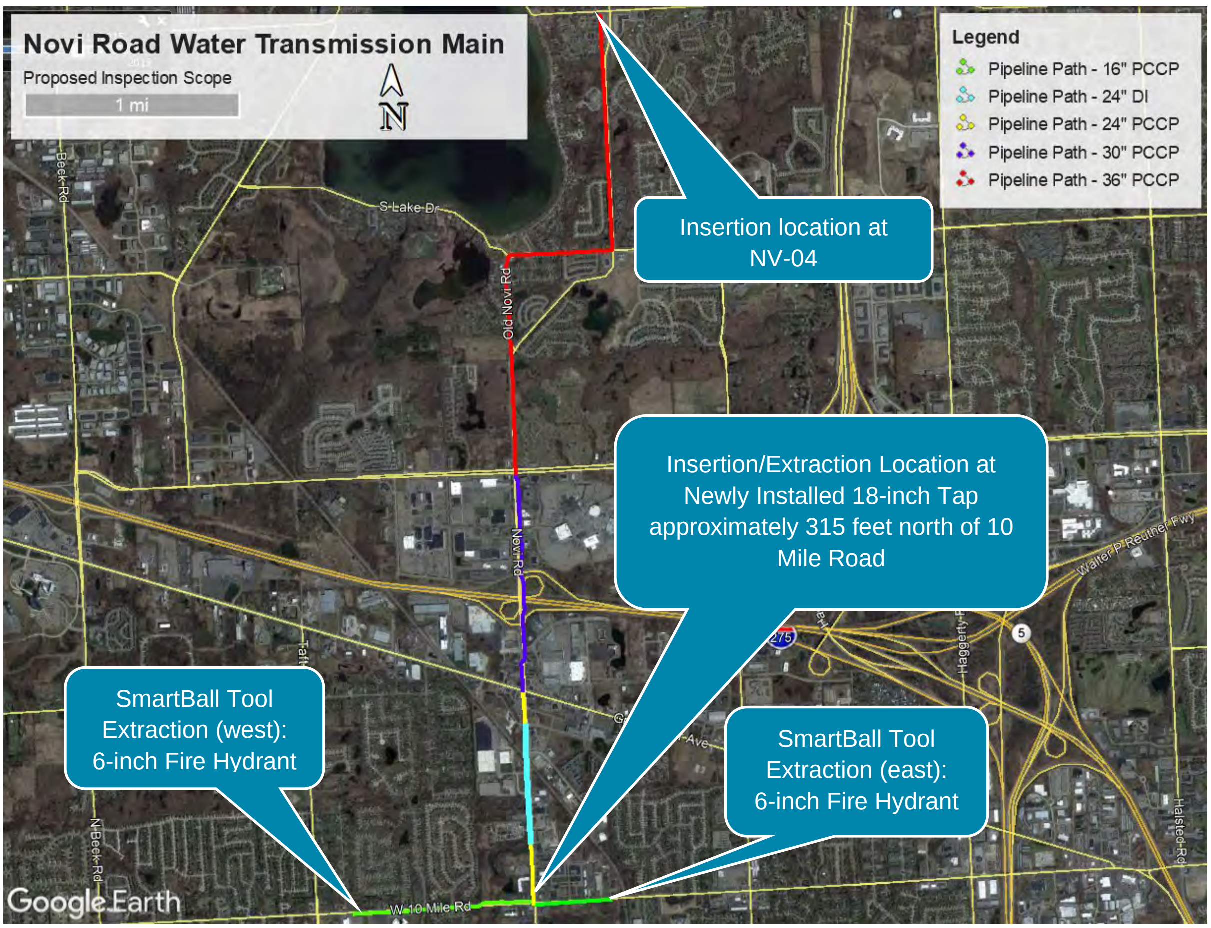


Figure 1.1: 2020 proposed inspected scope. Note: the green section on 10 Mile Road (16-inch PCCP) was planned to be inspected with the SmartBall tool only.

In 2020, Pure Technologies and Novi originally attempted to inspect the transmission main between 14-mile Road and 10-mile Road using the PipeDiver. However, during the inspection the PipeDiver tool became stuck on a broken inline 30-inch butterfly valve in the transmission main. This initial PipeDiver inspection ended with an unplanned recovery of the inspection tool at the butterfly valve, resulting in loss of scope, and cancellation of the remaining portion of contractual scope. The 2020 inspection comprised a cumulative distance of approximately 9,593 feet of 30-inch and 36-inch LCP.

An emergency SmartBall inspection was performed in August 2023 to identify and locate a leak that was observed at a welded joint of an encasement pipe under Interstate 96 during construction activities. Note that this leak was observed for a few days and then the leak appeared to stop as it was no longer observed at the joint. Figure 1.2 highlights the scope of the 2023 inspection.

The 2024 PipeDiver inspection scope began at a newly installed 18-inch Tapping Saddle and Valve at Station 31+97, near 12 ½ Mile Road, approximately 1,483-feet downstream of the location the PipeDiver tool was unable to traverse in 2020. The inspection comprised a cumulative distance of approximately 14,776 feet (2.80 miles) of 36-inch, 30-inch, and 24-inch LCP, approximately 2,950 feet (0.56 miles) of which was 24-inch DIP. The electromagnetic data collected for the 24-inch DIP was not analyzable. A map of the inspected sections of the Novi Road PCCP Water Transmission Main is shown in Figure 1.3. This map shows the approximate geographical location of the pipeline.

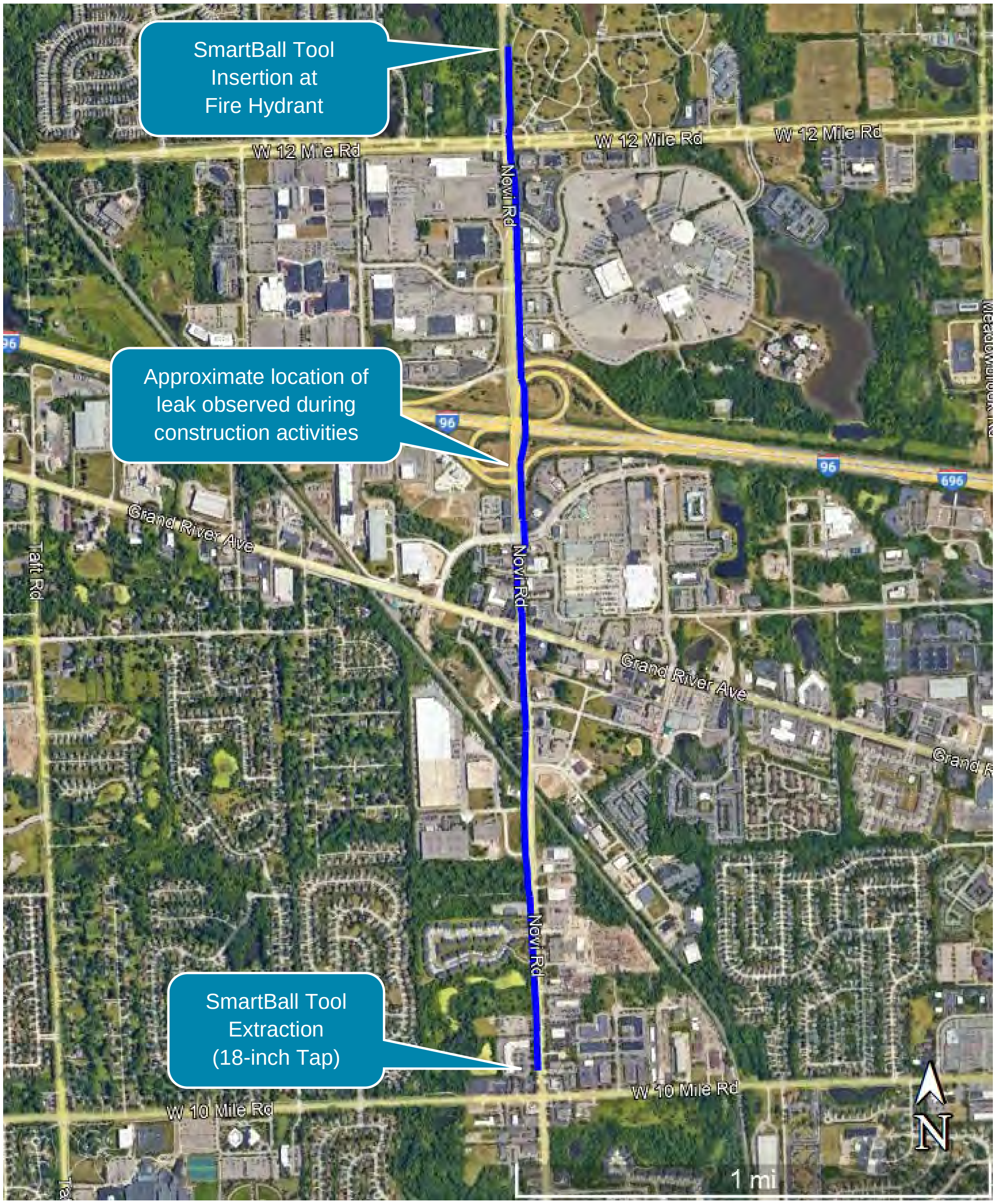


Figure 1.2: Aerial View of the 36-, 30-, and 24-inch Novi Road PCCP Water Transmission Main 2023 SmartBall Inspection.

Figure 1.3: 2020 and 2024 Inspection Limits.

Electromagnetic analysis of the data obtained during the 2020 inspection determined that a total of eight (8) pipes displayed electromagnetic anomalies consistent with prestressing wire damage. Of those eight (8) distressed pipes, four (4) pipes (Pure Reference Number 10324, 10327, 10356, and 10367) with broken wire wraps ranging from 10 to 30 as well as across entire length were repaired with carbon fiber reinforced polymer (CFRP) in March 2024. The locations of four (4) CFRP repaired pipes along the transmission are shown in Figures 1.4 and 1.5.

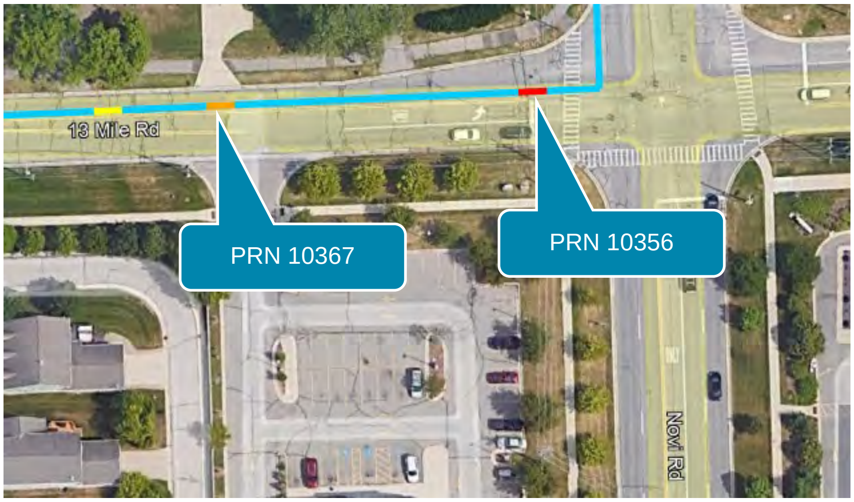


Figure 1.4: CFRP repair pipes – PRN 10356 and PRN 10367.

Figure 1.5: CFRP repair pipes – PRN 10324 and PRN 10327.

1.1. Condition Assessment Scope

The purpose of the condition assessment of the Novi Road Transmission Main is to provide an effective pipeline management strategy of the pipeline for the City of Novi. The scope of the assessment included the following investigative techniques:

- SmartBall acoustic leak and gas pocket detection inspection
- PipeDiver electromagnetic inspection
- Transient Pressure Monitoring
- American Water Works Association (AWWA) C301, and C304 Structural Design Checks
- Three-dimensional, nonlinear finite element analysis (FEA) for LCP PCCP
- Probability of Exceedance statistical analysis to determine the likelihood of pipes exceeding their determined Yield Limits.

1.2. Document Review

On Thursday, March 21, 2024, Pure Technologies and Novi performed a site visit to discuss the scope of work for the 2024 inspection of the PCCP Transmission Main. All parties completed introductions and a site safety meeting prior to performing a walkthrough of the pipeline to review points of interests and inspection risks. Information collected during the site visit and a review of the drawings reviewed during project planning and planning document development are compiled below.

Interpace Corporation. "CO-76-23 Pipe Specifications and Pipe Laying Schedules". Sheet 1-14, of 14. September 1976.

Oakland County, Michigan. City of Novi. J.K.M, M.G.K, J.P.C, R.D.H, D.O.M; Johnson & Anderson Inc. Consulting Engineers. *"City of Novi Water Transmission System, 14 Mile Road-to-12 Mile Road, 36" Water Main"*. Job No. 4455-01. Sheet No. 1-21. June 1976.

Oakland County, Michigan. City of Novi. J.K.M, W.V.W; Johnson & Anderson Inc. Consulting Engineers. *"Novi & Ten Mile Road Watermain Extension"*. Job No. 5653-00. Sheet No. 1-24. June 1976.

Oakland County, Michigan. City of Novi. J.K, C.N, M. Tonucci, M. DeDecker, S. Clark; G. Platz; Spalding DeDecker Associates Inc.; OHM Engineering Advisors. *"North of Ten Mile to Main Street"*. MDOT Job No. 75423A. Sheet No. 35, 38, 43, 46, 47, 51, 55, 56, 60, 63, 67, 70, 74, 78.

Oakland County, Michigan. City of Novi. J.K, C.N, M. Tonucci, M. DeDecker, S. Clark; G. Platz; Spalding DeDecker Associates Inc.; OHM Engineering Advisors. *"Novi Road 10 Mile to Grand River"*. MDOT Job No. NV12-002. Drawing No. NV12002AB. Sheet No. 1-2 of 2.

Thompson Pipe Group / Interpace Corporation. "SB-77-1 Pipe Specifications". Sheet 1-20. January 1977.

1.3. Overview of Prestressed Concrete Cylinder Pipe

The City of Novi made the pipe specifications and pipe laying schedules available to Pure Technologies in June 2020. All specifications and laying schedules indicate the transmission main on Novi Road is lined cylinder pipe (LCP), a type of PCCP. The results of the electromagnetic inspection as well as the structural analysis are based on the available data.

LCP is a complex, composite structure consisting of an inner concrete core, a steel cylinder lined with high strength steel wires, and a mortar coating. The concrete core and prestressing wire are the main structural components, while the steel cylinder acts primarily as a water barrier. The prestressing wire produces a uniform compressive force on the concrete core that holds the concrete in compression when the pipe is subjected to internal water pressure and external loading. A mortar coating surrounds the prestressing wire, embedding the wraps in an alkaline environment to protect them from external corrosive influences and physical damage. Figure 1.6 shows a cross-sectional view of LCP pipe.

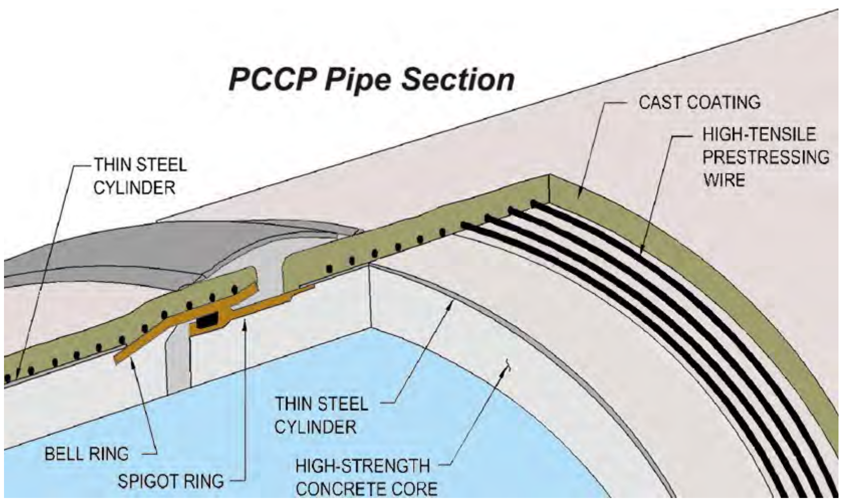


Figure 1.6: Cross-sectional view of LCP, a type of PCCP pipe.

PCCP design and manufacturing standards were gradually developed beginning in 1943 and the first tentative consensus standard for PCCP was approved by the AWWA in 1949. The AWWA C301 *Standard Specifications for Reinforced Concrete Water Pipe - Steel Cylinder Type, Prestressed* (AWWA C301-52) was revised multiple times, with the latest revision being released in 2014.

The early structural design requirements for the manufacturing of PCCP tended to be conservative, with high factors of safety. As experience with using this composite pipe grew, understanding of the behavior of PCCP increased, and advances in material sciences were achieved, the structural design and manufacturing processes for PCCP were changed to facilitate what appeared to be a more efficient design and cost-effective manufacturing process. Due to the competitive cost of PCCP in comparison to other pipe materials, its popularity grew significantly with water and wastewater utilities in the United States for their large diameter pressure pipelines in the 1960s and 1970s.

As the standards changed and the prestressing wire strength increased, classifications of prestressing wire were developed based on their tensile strength (Class I, Class II, and Class III). These practices culminated in the 1970s, when more liberal design and manufacturing processes were introduced. Pipes using an even stronger Class IV wire were manufactured. Class IV wire was produced by using a loophole in the ASTM and AWWA standards, which did not define a maximum tensile strength. In fact, Class IV prestressing wire was never included in the ASTM standards and was sometimes denoted in design specifications as Class III wire. Higher strength prestressing wire was drawn at very high temperatures to increase the ultimate tensile strength of the wire and thereby reduce the amount of steel required to achieve the desired compression in the concrete core. All classes of prestressing wire are susceptible to external corrosion, hydrogen embrittlement, and other failure modes; however, the high temperatures used to manufacture the higher strength prestressing wire made it particularly sensitive to hydrogen embrittlement and dynamic strain aging effects. Pipe from this era started experiencing a high rate of premature failures, primarily related to the new standards and manufacturing processes.

Beginning in the mid-1980s, PCCP design and manufacturing standards began to improve in response to the large number of failures that occurred in the late 1970s and early 1980s. The major revisions in the standards, design, and manufacturing of the PCCP consisted of changes in the maximum diameter of the PCCP, the quality (strength) of the concrete, the thickness of the steel cylinder, the prestressing wire specifications (e.g., wire diameter, wrapping stress, spacing), and the thickness of the mortar coating.

A more detailed overview of PCCP is included in Appendix B of this report.

2. SmartBall Inspection

2.1. SmartBall Acoustic Inspection

2.1.1. Planned SmartBall Acoustic Inspection Scope

The proposed scope for the SmartBall acoustic inspection of the transmission main started at a meter vault (NV-04), near 14 Mile Road, which is owned and operated by the Great Lakes Water Authority (GLWA). The proposed inspection scope continued southward along Novi Road and Old Novi Road to 10 Mile Road and included about 0.9 miles west on 10 Mile Road and 0.4 miles east on 10 Mile Road. There were three (3) planned insertion and extractions for the SmartBall acoustic inspections.

1. Insert at NV-04 and inspect south, extracting at a new tap approximately 315 feet north of 10 Mile Road on Novi Road. This would cover the 36-inch, 30-inch, and most of the 24-inch LCP/DIP.
2. Insert at the new tap approximately 315 feet north of 10 Mile Road on Novi Road and extract at a hydrant approximately 0.4 miles east of Novi Road on 10 Mile Road.
3. Insert at the new tap approximately 315 feet north of 10 Mile Road on Novi Road and extract at a hydrant approximately 0.9 miles west of Novi Road on 10 Mile Road.

2.1.2. Completed SmartBall Acoustic Inspection Scope

The 2020 inspection sections of the transmission main inspected with the SmartBall tool included items 2 and 3 from the planned scope above. The SmartBall was installed at the new tap approximately 315 feet north of 10 Mile Road on Novi Road and extracted at a hydrant approximately 0.4 miles east of Novi Road on 10 Mile Road. A SmartBall tool was then inserted a second time into the new tap and extracted at a hydrant approximately 0.9 miles west of Novi Road on 10 Mile Road.

In 2023, the SmartBall tool was inserted by pumping the SmartBall tool into the transmission main through a hydrant located at Station 47+00. The SmartBall tool was not inserted at NV-04 due to difficulties obtaining full scope of the PipeDiver electromagnetic platform. The internal components of the hydrant were removed in order to allow the SmartBall tool to pass through. Figure 2.3 illustrates the insertion set used for the inspection. The tool extraction was performed by using a SmartBall net at an 18-inch tap installed in 2019. Figure 2.4 shows the extraction net location and the SmartBall captured in the net.

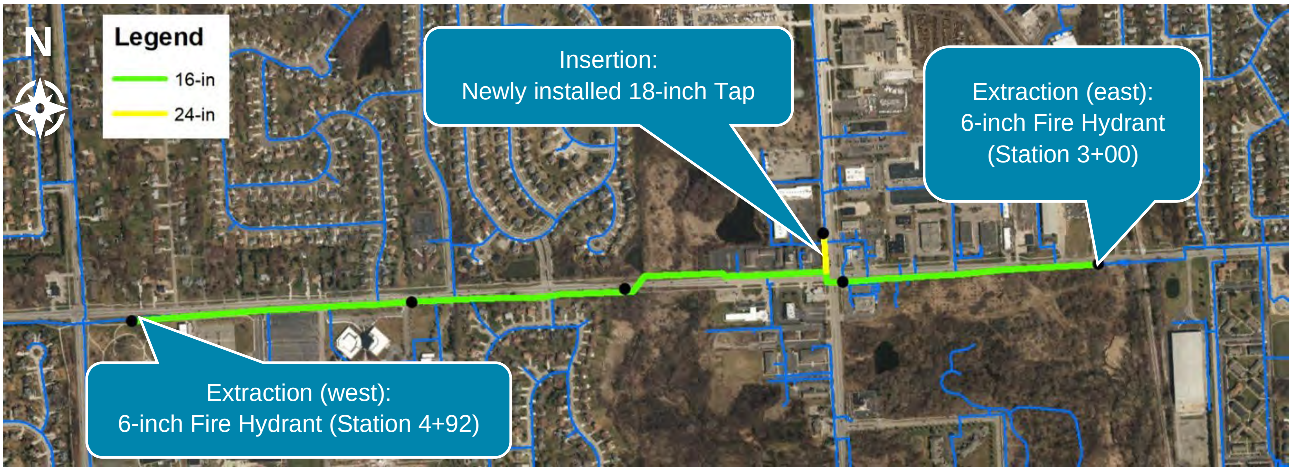


Figure 2.1: 2020 SmartBall tool completed inspected scope.

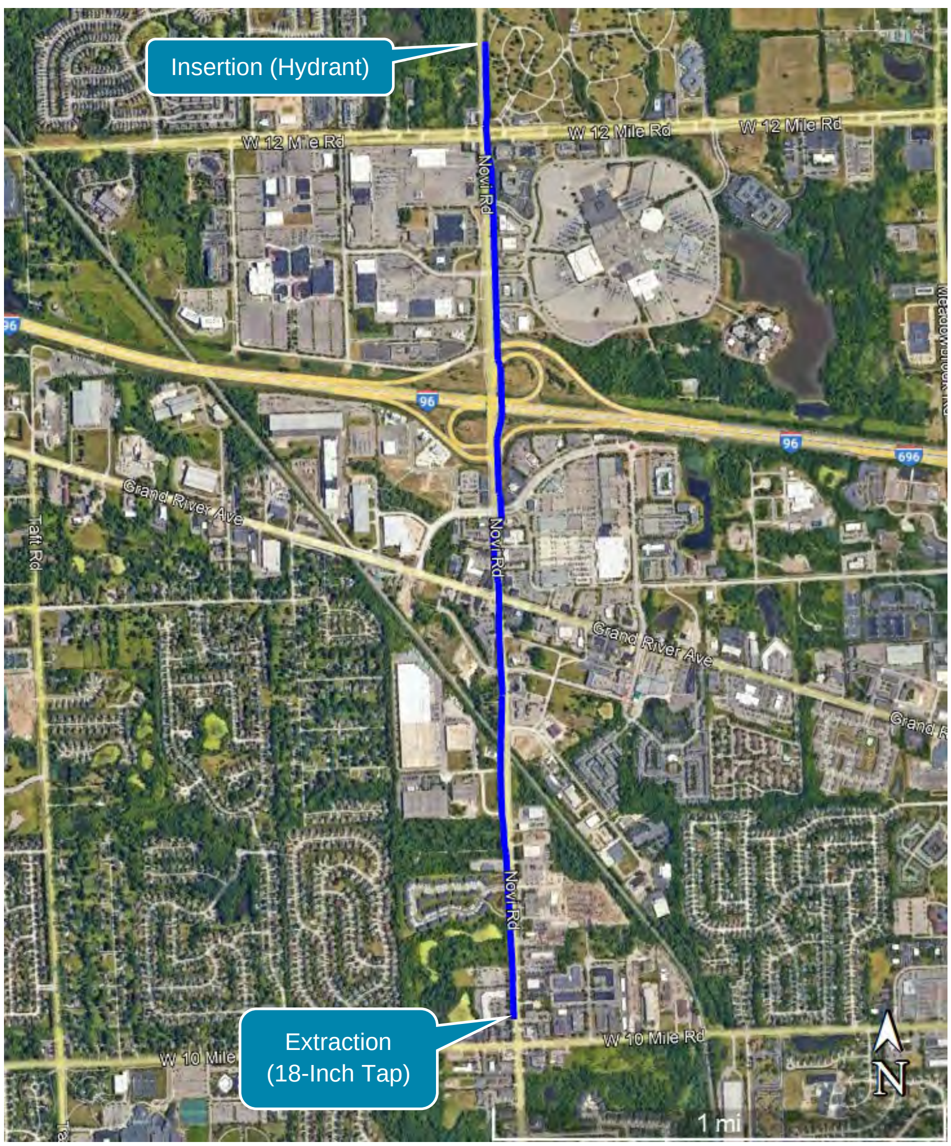


Figure 2.2: Aerial View of the 36-, 30-, and 24-inch Novi Road PCCP Water Transmission Main

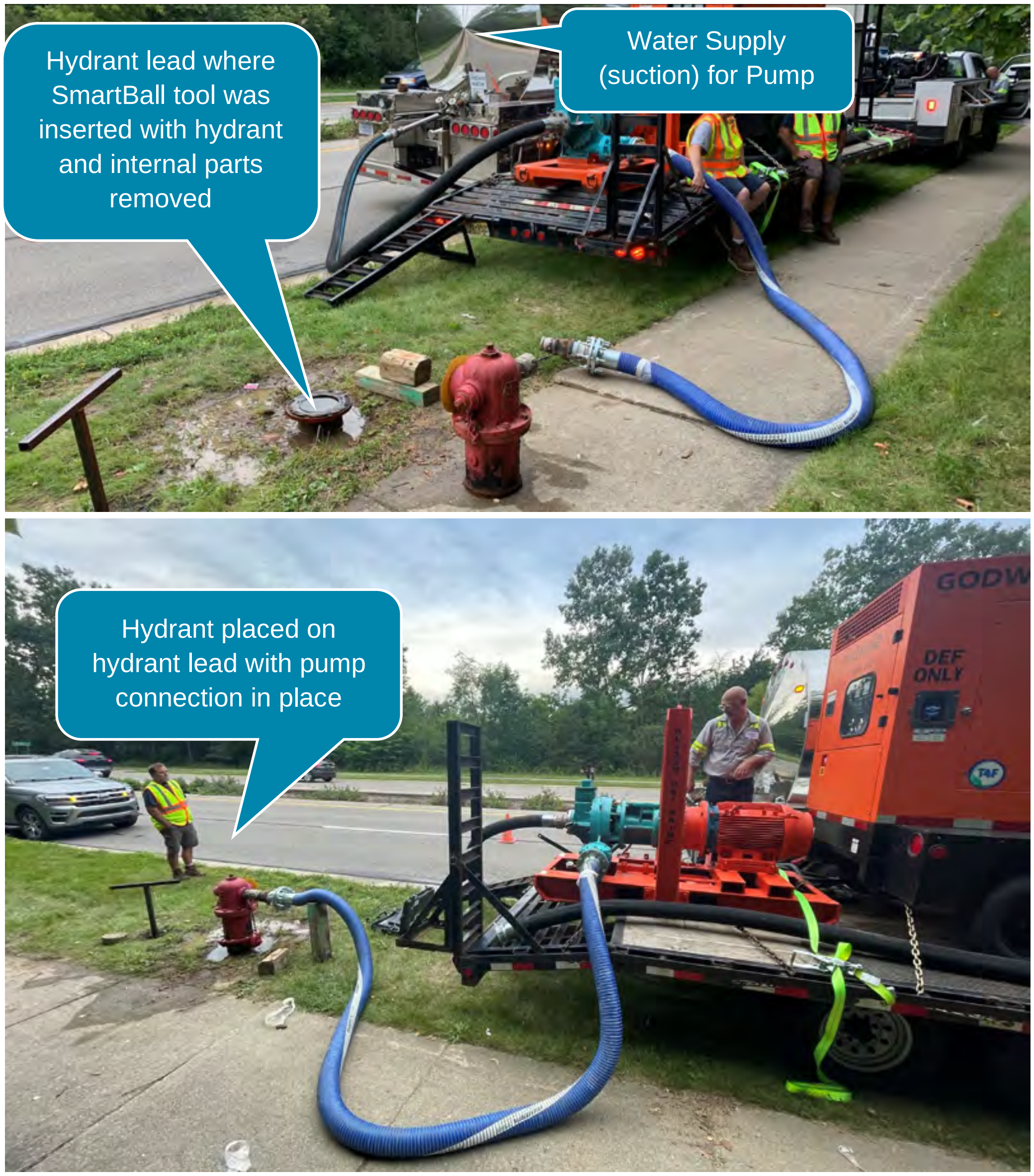


Figure 2.3: View of SmartBall Insertion Location, Pump used to push SmartBall Tool into the Main

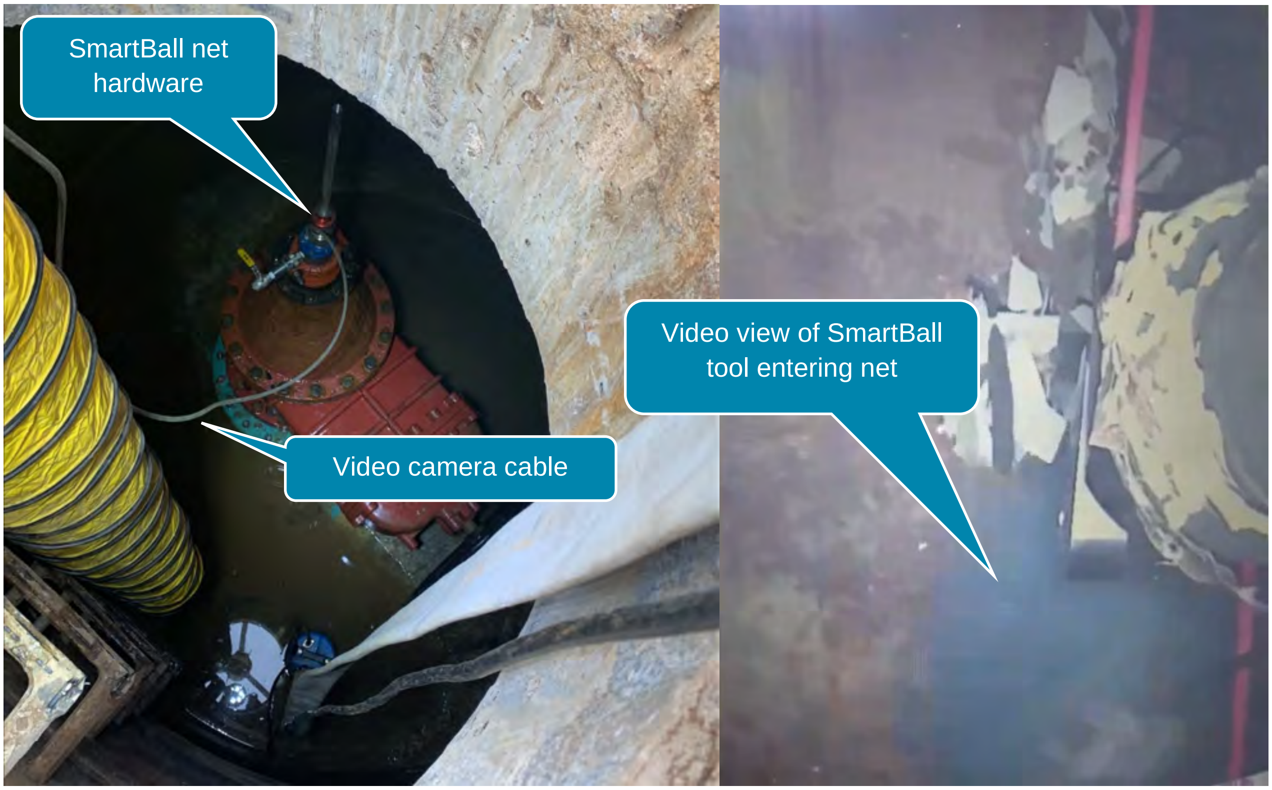


Figure 2.4: Extraction Location, Net installation (left), SmartBall Tool entering Net (right)

2.2. SmartBall Methodology

A SmartBall leak and gas pocket detection survey uses acoustic-based technology that detects anomalous acoustic activity associated with leaks or pockets of trapped gas in pressurized pipelines. The SmartBall tool comprises an aluminum alloy core that contains the power source, electronic components, and instrumentation. A protective outer foam shell encapsulates the aluminum core. This allows the device to be propelled through the pipeline as the flowing water comes into contact with a larger surface area. The outer foam shell also helps reduce some low frequency ambient noise that is typically present in a pipeline. The SmartBall tool is deployed into the flow of a pipeline, traverses the main, and is then captured at a point downstream.

Proprietary tracking devices, which detect the ultrasonic pulses emitted from the SmartBall tool, are attached along the pipeline, at Tracking Locations (TLs), to track the position of the device as it traverses the main. The tracking devices measure the time it takes the pulse to travel from the ball to the receiver and uses this data to calculate an approximate location of the SmartBall tool. This allows Pure Technologies' data analysts to correlate acoustic anomalies with the location of the SmartBall tool during the inspection. Pure Technologies has calibration data that allows analysts to determine which anomalies represent leaks or gas pockets and which anomalies are due to outside factors, such as ambient noise.

2.3. SmartBall Results

Acoustic data was collected on October 29, 2019 for the 10 Mile Road Transmission Main using the SmartBall leak and gas pocket detection technology. A summary of the inspection is provided in Table 2.1.

Table 2.1: 2019 SmartBall Inspection Details and Results		
Date Inspected	10/29/2019	
Segment Inspected	East	West
Pipe Diameter and Material	16-inch LCP-PCCP	
Total Length Inspected (feet)	2,269	5,235
Acoustic Anomalies Characteristic of Leaks[1]	1 (Medium)	2 (Large)
Acoustic Anomalies Characteristic of Air Pockets	0	0
Duration of Inspection	13 min	1 hour, 10 min
Average SmartBall Tool Velocity	2.8 ft/s	1.2 ft/s

[1]The reported leaks have since been identified as outlets that had valves that were not 100 percent closed.

The SmartBall inspection covered a total length of 7,504 feet (1.4 miles) of 16-inch Prestressed Concrete Cylinder Pipe (PCCP). Pure Technologies detected a total of three (3) acoustic events characteristic of leaks and zero (0) acoustic events characteristic of pockets of trapped air. The leaks detected in October of 2019 have since been identified as feature-related leaks. Table 2.2 provides a detailed summary of each leak detected by the SmartBall technology. The SmartBall Technology Report, further detailing the inspection methodology and results, for both the East and West inspection segments is contained in Appendix C.

Table 2.2: Critical Findings of 2019 SmartBall Inspection			
Size of Leak	**Distance from Nearest Tracking Location**	**Distance from Insertion**	**Suspected Source of Leak**
East			
Medium	518.4 feet after of 16-inch GV (Station 21+10)	978.4 feet	Hydrant V & B (Station 15+50)
West			
Large	657.8 feet after new 18-inch access manhole (ins) (Station 128+25.39)	657.8 feet	Side outlet for service
Large	161.1 feet before of 16-inch GV (Station 51+75)	3,096.9 feet	Side outlet for service

Acoustic data collected on August 23, 2023, for the Novi Road PCCP Water Transmission Main using the SmartBall leak, and gas pocket detection technology identified one (1) acoustic event characteristic of leaks and zero (0) acoustic events characteristic of pockets of trapped air. A summary of the inspection details and results is provided in Table 2.3. The SmartBall Technology Report, further detailing the inspection results is included in Appendix C.

Table 2.3: 2023 SmartBall Inspection Details and Results	
Pipeline Name:	Novi Road PCCP Water Transmission Main
Pipe Material:	PCCP
Diameter of Pipe:	36, 30, 24 inches
Product:	Water
Inspection Start Location:	Hydrant (STA. 47+00) (Insertion/TL #1)
Inspection End Location:	18-inch tapping saddle and valve (STA. 109+84) (Extraction/TL #8)
Total Length Inspected:	11,398 feet
Duration of the Inspection:	1 hour, 35 minutes
Average SmartBall Velocity:	2.0 feet/second
Total Number of Leaks:	1
Joint Leaks	0
Barrel Leaks	0
Undetermined if Joint or Barrel	0
Feature-Related Leaks	1
Total Number of Static Air Pocket Events:	0

Table 2.4: Critical Findings of 2023 SmartBall Inspection			
Size of Leak	**Distance from Nearest Tracking Location**	**Distance from Insertion**	**Suspected Source of Leak**
Medium	482 feet downstream of 20" Gate Valve and Well (TL #7)	10,771	Leak is from a hydrant at Station 100+50 which was used to dewater extraction.

3. PipeDiver Inspections

3.1. PipeDiver Electromagnetic Inspection Scope

3.1.1. 2020 Planned PipeDiver Electromagnetic Inspection Scope

The 2020 planned insertion location for the PipeDiver tool was the meter vault, NV-04. The planned extraction location for the PipeDiver tool was the newly installed 18-inch tap approximately 315 feet north of the intersection of 10 Mile Road and Novi Road. The planned scope covered all of the 36-inch and 30-inch LCP main and a majority of the 24-inch LCP pipe. The data gathered for the 24-inch DIP would not be analyzable.

3.1.2. 2020 Completed PipeDiver Electromagnetic Inspection Scope

Prior to the 2020 inspection, the inline butterfly valves were exercised to approximately 20 percent closed by Wachs Water Services (Wachs) in order to verify operation and promote a successful inspection. During a test shutdown, it was discovered that isolation of the insertion location, meter vault NV-04, would not be possible using just the valves next to the vault due to the 30-inch inline butterfly valve (Station 6+14), located just downstream of the meter vault, not closing fully. The extended shutdown area included an elementary school, so the shutdown could not take place while school was in session. Also, while exercising the valve that would not close, the valve was broken, limiting its ability to be exercised, which would be required should the PipeDiver tool become stuck on it. Therefore, the plan for inserting the PipeDiver tool included inserting it at NV-04 while the old meter was removed and pushing the tool past the broken butterfly valve. This required that the PipeDiver tool be utilized before the SmartBall tool for this section of the main.

The 2020 inspection took place during a mid-winter break of the elementary school, so that isolation of the insertion locations did not affect normal school operations. During the inspection, the PipeDiver tool was stopped on all but one (1) of the butterfly valves it encountered. Each valve was exercised the help the tool maneuver around the valve. When the tool reached the valve near the intersection of Austin Drive and Old Novi Road, the valve exercising was unsuccessful. It appeared the gears on the valve actuator were worn and turning the key did not move the valve. Flows were adjusted to try and free the tool, but it remained stopped at the valve. The PipeDiver tool was removed from the pipe on Friday April 17, 2020. In total, the 30-inch and 36-inch LCP-PCCP PipeDiver inspection spanned 9,593 feet (1.8 miles) from the 30-inch butterfly valve (Station 6+14) located just downstream of the meter vault, NV-04, to the 30-inch butterfly valve (Station 17+96) near the intersection of Austin Drive and Old Novi Road. An overview of the 2020 PipeDiver inspection is shown in Figure 3.1.

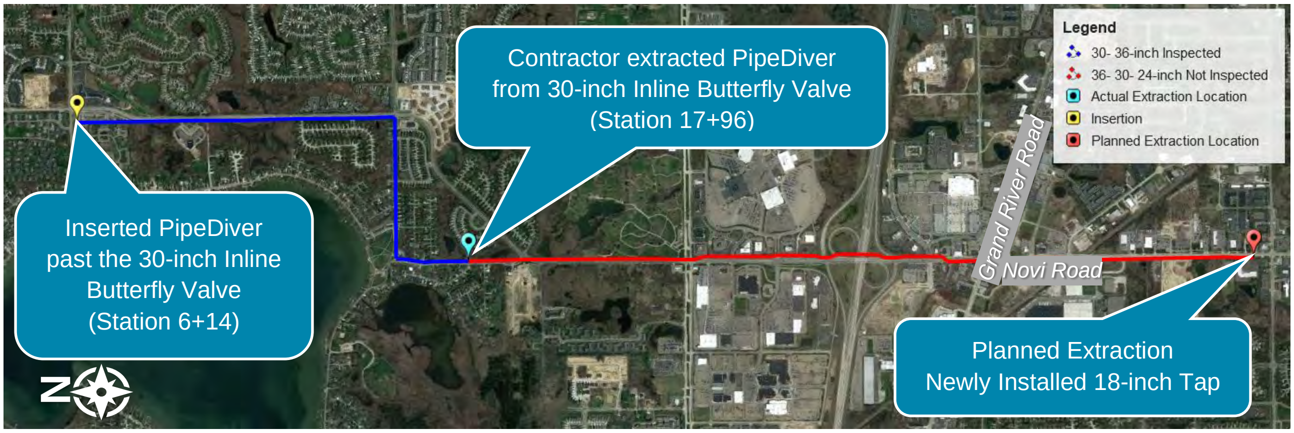


Figure 3.1: Planned PipeDiver electromagnetic inspection scope. Note the red line indicates the part of the planned scope that was not inspected.

3.1.3. 2024 PipeDiver Electromagnetic Inspection Scope

The 2024 planned insertion location for the PipeDiver tool was at a newly installed 18-inch Tapping Saddle and Valve at Station 31+97, near 12 ½ Mile Road, approximately 1,483-feet downstream of the location the PipeDiver tool was unable to traverse in 2020. The planned extraction location for the PipeDiver tool was the initial extraction location from the 2020 inspection, an 18-inch tap approximately 315 feet north of the intersection of 10 Mile Road and Novi Road. The 2024 planned scope covered the majority of the remaining 36-inch, 30-inch, and 24-inch LCP and 24-inch DIP from the original 2020 scope, with the exception of the 1,483 between the 2020 extraction and the 2024 insertion locations. An overview of the extents of the 2020 and 2024 PipeDiver inspections is shown in Figure 1.2.

3.2. PipeDiver Methodology

The electromagnetic inspection of the Novi Road Transmission Main was performed using Pure Technologies' PipeDiver electromagnetic inspection technology. Electromagnetic inspection is a non-destructive method of evaluating the current condition of the prestressing wire wraps. Electromagnetic inspections ascertain a magnetic signature for each pipe to identify anomalies that are produced by zones of broken wire wraps. Various characteristics associated with an anomaly (length, magnitude, phase shift, etc.) are evaluated to quantify the number of broken wire wraps.

A common analogy used to describe the physics of an electromagnetic inspection is to view the prestressing wire as a coiled inductor. If the prestressing wire, acting as an antenna, is intact, the receiver coil detects a signal with certain characteristics. When the end of a pipe is reached, the polarity of the detected field reverses because the coiled inductor ends. However, if the inductor is broken (i.e., the prestressing wire is broken), the signal is altered, and a pole reversal occurs part way through the pipe. These unexpected reversals delay the arrival of the signal at the receiver and can be quantified to estimate the number of broken wire wraps.

The data collected during an electromagnetic inspection is reviewed to identify anomalies consistent with broken prestressing wire wraps. The anomalies are then evaluated to estimate the number of broken prestressing wire wraps on each pipe.

3.3. PipeDiver Results

The industry average for distress present in PCCP as observed by Pure Technologies is approximately 4 percent. Figure 3.2 provides an overview of the prestressing wire wrap findings. The figure indicates that the overall distress rate for the pipes inspected in the Novi Road Water Transmission Main is 0.7 percent, which is lower than the industry average.

An inspection summary of Novi Road PCCP Transmission Main PipeDiver electromagnetic inspections from 2020 and 2024 is shown in Table 3.1. A summary of the total number of pipes between both inspections that had electromagnetic signatures consistent with broken prestressing wire wraps, as well as thicker cylinder pipes and replacement pipes is presented in Table 3.2.

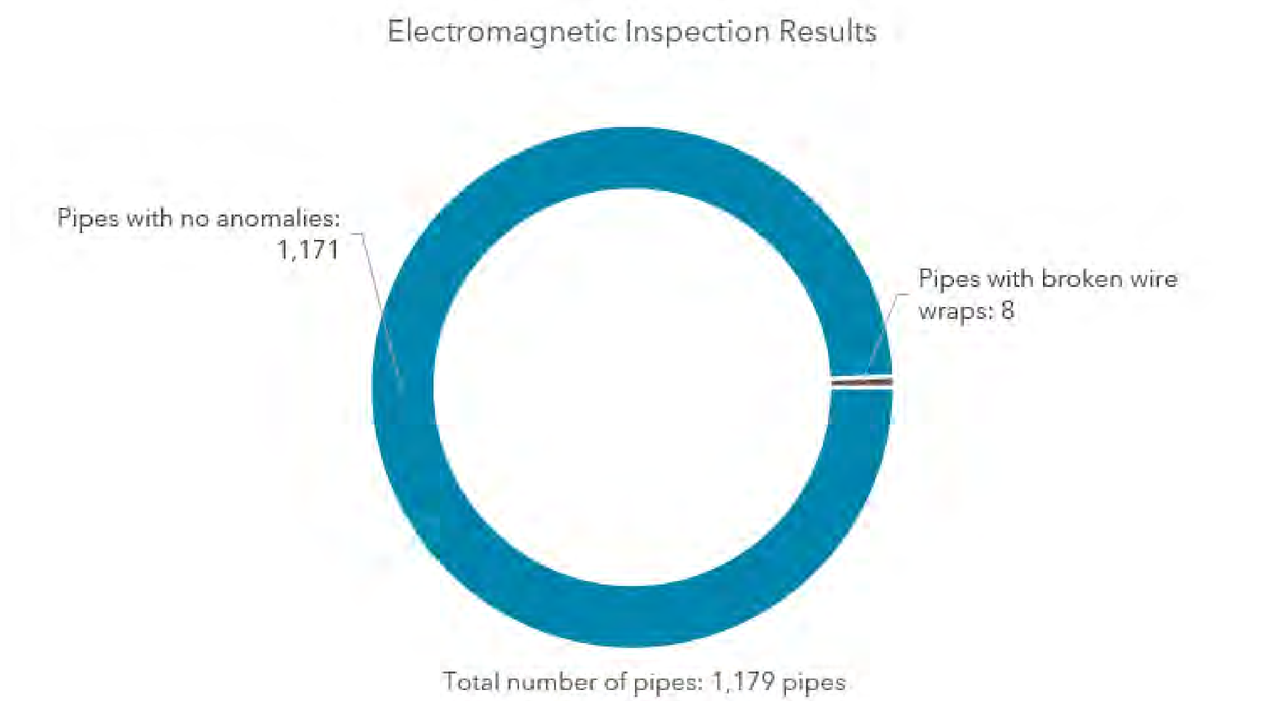


Figure 3.2: Prestressing wire wrap findings for the Novi Road PCCP Water Transmission Main.

<table>
<tr><th colspan="6">Table 3.1: Inspection Summary</th></tr>
<tr><th>Pipeline</th><th>Inspection Date</th><th>Diameter (inches)</th><th>Start Station</th><th>End Station</th><th>Distance</th></tr>
<tr><td rowspan="8">Novi Road PCCP Water Transmission Main</td><td rowspan="4">February 15, 2020</td><td>30</td><td>~6+20</td><td>6+44</td><td>25 feet</td></tr>
<tr><td rowspan="3">36</td><td>6+44</td><td>63+51</td><td>5,716 feet</td></tr>
<tr><td>31+00</td><td>4+91</td><td>2,557 feet</td></tr>
<tr><td>4+91</td><td>17+85</td><td>1,295 feet</td></tr>
<tr><td rowspan="4">April 18, 2024</td><td rowspan="2">36</td><td>32+97</td><td>52+72</td><td>1,966 feet</td></tr>
<tr><td>0+00</td><td>5+20</td><td>521 feet</td></tr>
<tr><td>30</td><td>5+20</td><td>58+92</td><td>5,448 feet</td></tr>
<tr><td>24</td><td>58+92</td><td>107+37</td><td>6,841 feet</td></tr>
<tr><td colspan="5">Total Distance</td><td>24,369 feet</td></tr>
</table>

Table 3.2: Summary of Inspected Pipes

Pipeline	Diameter (inches)	Number of Inspected Pipes	Pipes with Broken Wire Wraps	Thicker Cylinder Pipes	Replacement Pipes
Novi Road PCCP Water Transmission Main	36	746	8	1	0
	30	294	0	1	0
	24	139[1]	0	0	1
Total		**1,179**	**8**	**2**	**1**

Thicker Cylinder Pipes *include pipes with a cylinder thickness of 10-gauge.*

[1]***Number of Inspected Pipes*** *include an approximately 2,950 feet DIP represented as one (1) long pipe segment.*

A summary of pipes with broken wire wraps in Table 3.3, displays the number of pipes identified with broken wire wraps across the entire pipe length, pipes identified with broken wire wraps across a positional range, and pipes identified with 15, 10, and five (5) broken wire wraps, respectively. The number of broken wire wraps cannot be quantified for pipes with damage across the entire length of the pipe. The break location for one (1) pipe is reported as a range which indicates the presence of overlapping distressed regions.

Table 3.3: Summary of Pipes with Broken Wire Wraps						
Pipeline	**Diameter (inches)**	**5**	**10**	**15**	**30**	**Across Entire Pipe Length**
Novi Road PCCP Water Transmission Main	36	4	1	1	1[1]	1
	30	0	0	0	0	0
	24	0	0	0	0	0
Total		**4**	**1**	**1**	**1**	**1**

[1]Indicates this pipe contains a Break Positional Range that may indicate the presence of intermittent broken wire wraps across a positional span.

Of the 1,179 pipes inspected in the Novi Road PCCP Water Transmission Main during 2020 and 2024 inspections, eight (8) pipes had electromagnetic anomalies consistent with broken prestressing wire wraps. Analysis of the data obtained during the 2024 inspection determined that zero (0) pipes with broken wire wraps were present. The identified distressed pipes during the 2020 inspection are presented in Table 3.4, Table 3.5 and Table 3.6 and are ranked by the total number of broken wire wraps (where applicable).

- The Pure Reference Number is the unique pipe number assigned by Pure Technologies for reference only and does not correlate with existing pipeline information.
- The stationing shown in the table is the upstream station for the pipe.
- The Break Position of the region with broken wire wraps is measured from the upstream station of the distressed pipe to the center of the distress region and was rounded to the nearest 0.5 feet.
- The Number of Broken Wire Wraps by Region have each been rounded to the nearest five (5) broken wire wraps. Regions with fewer than five (5) broken wire wraps are reported as having five (5) broken wire wraps, which implies that regions shown as containing five (5) broken wire wraps may be overestimated.

Out of the eight (8) identified distressed pipes, one (1) pipe was identified with broken wire wraps across the entire length of the pipe, this means that a uniform signal shift was seen across the entire length of the pipe. The broken wire wraps for these pipes have not been quantified due to the complexity in the analysis and presence of overlapping distressed regions where each broken wire wrap region is not distinct. One (1) separate pipe was identified with a positional range as its break region in addition to a single distance from the upstream station joint.

Pipes that have been reported with a positional range as its break region would either have:

1. Broken wire wraps caused by corrosion across the entire length (widespread corrosion), or
2. Sporadic (i.e., a small number of) and non-contiguous broken wire wraps caused by hydrogen embrittlement.

The number of broken wire wraps reported on these pipes can be expected to span across the indicated break position range and, at the same time, does not necessarily mean that all of the wire wraps in that region are broken (i.e., broken wire wraps may exist intermittently with intact wire wraps). Due to the complexity in the analysis of these distress regions, there is more uncertainty in the number of broken wire wraps. The reported number of broken wire wraps represents the best estimates based on the available calibration curves.

Table 3.4: Pipes with Broken Wire Wraps Across the Entire Pipe Length in the Novi Road PCCP Transmission Main

Pure Reference Number	Upstream Station	Pipe Length (feet)	Pipe Class	Break Positional Range[1] (feet)
10327[2]	58+61	16	B	0.0-16.0

[1]***Break Positional Range*** *is measured from the upstream station (feet). It may indicate the presence of intermittent broken wire wraps across a positional span.*
[2]*Pipe repaired with CFRP in March 2024.*

Table 3.5: Pipes with Broken Wire Wraps Across a Positional Range in the Novi Road PCCP Transmission Main

Pure Reference Number	Upstream Station	Pipe Length (feet)	Pipe Class	Break Position[1] (feet)	*Number of Broken Wire Wraps by Region*	Total Number of Broken Wire Wraps
10356[3]	30+73	16	A	4.5[2];10.0-16.0	5;25	30

[1]***Break Positional Range*** *is measured from the upstream station (feet). It may indicate the presence of intermittent broken wire wraps across a positional span.*
[2]*The break region identified at 4.5 feet from the upstream joint is reported with less certainty due to its proximity to the valve located at Station 30+94.*
[3]*Pipe repaired with CFRP in March 2024.*

Table 3.6: Pipes with Broken Wire Wraps in the Novi Road PCCP Transmission Main

Rank	Pure Reference Number	Upstream Station	Pipe Length (feet)	Pipe Class	Break Position[1] (feet)	Number of Broken Wire Wraps by Region	Total Number of Broken Wire Wraps
1	10367[2]	28+96	16	A	3.0;13.0	10;5	15
2	10324[2]	58+13	16	B	6.5	10	10
3	10015	8+20	16	C	2.0	5	5
4	10201	38+19	16	A	2.5	5	5
5	10371	28+32	16	A	10.0	5	5
6	10376	27+52	16	A	13.0	5	5

[1]***Break Position*** *of the break region is measured from the upstream station (feet).*
[2]*Pipe repaired with CFRP in March 2024.*

3.3.1. Thicker Cylinder Pipes

A total of two (2) pipes in the Novi Road PCCP Water Transmission Main had thicker, 10-gauge (0.1406-inch) steel cylinders.

To date, the electromagnetic technology has concentrated on detecting broken wire wraps in pipes with 14-gauge and 16-gauge steel cylinder as these are the predominant cylinder thicknesses used for PCCP. As the cylinder thickness increases from 14-gauge, the data signal from the tool begins to react like it would in a steel pipeline. At that point, it becomes increasingly difficult to separate signal differences that are due to broken wire wraps from those due to the thicker cylinder.

Pure Technologies has conducted several calibration tests on pipes with cylinders thicker than 14-gauge (0.0781-inch) and have determined that the electromagnetic technology is applicable for pipes with thicker cylinders. Specifically, it was determined that under optimum tool settings, distress could be detected in pipes with a 7-gauge cylinder when a minimum of 15 consecutive wire wraps were broken. Similar tests have been conducted on pipes with other thicker cylinders and even though 15 consecutive broken wire wraps are detectable in a pipe with a 7-gauge cylinder, there is significantly reduced sensitivity to broken wire wraps in pipes with cylinders thicker than 14-gauge.

During the inspection, Pure Technologies collected data for all pipes in this portion of the Novi Road PCCP Water Transmission Main. For the thicker cylinder pipes, no distress was identified. Although the thicker cylinder pipes were analyzed using normal analysis procedures, there is a greater level of uncertainty in the results for these pipes due to the limitations stated above. Broken wire wraps can be detected on thicker cylinder pipes, although the quantification may be less accurate.

3.3.2. Replacement Pipes

Approximately 166 pipes have been removed between Main Street and W 10 Mile Road and an approximately 2,950 feet of ductile iron pipe was installed as part of a realignment in the Novi Road PCCP Water Transmission Main. The detail of the replacement pipe section is listed in Table 3.7. The replacement pipe section was not analyzed.

Table 3.7: Replacement Pipe Section in the Novi Road PCCP Water Transmission Main

Pure Reference Number	Piece Number	Low Station	Pipe Length (feet)	Replacement Type
10518	N/A	N/A	~2,950	Ductile Iron Realignment Pipe Section

3.3.3. Comparison and Correlation to Pipeline Drawings

City of Novi provided Pure Technologies with the plan and profile drawings and pipe laying schedules for the inspected portions of the Novi Road PCCP Water Transmission Main. The stationing used in this report was obtained from the pipe laying schedules.

An important part of the data analysis process is correlating the electromagnetic data to the physical pipe in which it was collected. Features that can be identified in the electromagnetic data, such as inline valves, bends or outlets, are used as correlation points. A few differences were noted between the provided pipe laying schedules and the collected data for the Novi Road PCCP Water Transmission Main. These differences included either a pipe or pipe feature observed in the data that was not listed in the pipe laying schedules or vice versa.

Once the electromagnetic data has been correlated to the pipeline, a Pipe List is generated for reference. The Pipe List is a record of all the inspected pipes and can be used as a reference when trying to locate any specific pipes. Most pipe joints are visible in the electromagnetic data which makes producing a pipe list possible, however, some joints may be masked by bends, nearby joints, or casings and encasements. The distances provided in the Pipe List table are based on the information provided. The best way to locate a specific pipe is to measure the distance from the nearest known locatable feature on both sides of the target pipe. Pure Technologies has extensive experience in locating and verifying pipes and are available to assist with any excavations or investigation. Please contact Pure Technologies for assistance. The Pipe List is attached to this report (Appendix E) as a spreadsheet and includes information that can be used to locate specific pipes.

Several pipes in the collected data were affected by tool movement when passing elbows and reducers or by the presence of electromagnetic noise. As a result, large signal variations are observed in the electromagnetic data, affecting the overall data quality. The affected pipes are listed in the Pipe List and the results for these pipes are reported with less certainty.

3.3.4. Calibration

Effective analysis of electromagnetic data requires knowledge of how the electromagnetic signal behaves when no broken wire wraps are present (i.e., the baseline condition) and being able to compare that baseline condition to the data signal received when there are broken wire wraps on the pipe.

As the data signal is sensitive to the properties of a particular pipe (i.e., wire diameter and spacing, cylinder thickness, etc.), pipes with the same diameter, but with different design specifications, exhibit different signal properties, or “baselines”. Additionally, these pipes will display data signals that respond differently when broken wire wraps are present.

To understand how the data signal responds in varying conditions, Pure Technologies performs calibration scans on pipes similar to the inspected pipe. The calibration process involves scanning a pipe or set of pipes with properties (i.e., diameter, wire class, wire gauge, etc.) that are as close as possible to the properties of the in-situ pipe. These representative pipes are initially scanned to establish the baseline signal. Pure Technologies uses this information to assess signal variation due to the pipe properties alone.

Once the baseline signal has been established, additional scans are performed on the pipe while varying the number and layout of broken wire wraps to determine:

- The resolution of the system when the number of broken wire wraps changes, and
- The optimal system settings that should be used for that particular pipe.

A calibration curve is created from this information and incorporated into Pure Technologies' analysis software. At this point, an experienced data analyst can measure a distress signal and compare it to the calibration curve to quantify the number of broken wire wraps represented by that signal. The distressed regions of each inspected pipe are then identified, measured, and compared against the calibration curves to quantify the number of broken wire wraps in each distressed region.

As the calibration process was not performed on any of the pipes from the Water Transmission Main, the calibration curve was calculated using mathematical modeling based on the pipe design properties (i.e., cylinder thickness, wire spacing, wire diameter, etc.) and Pure Technologies' in-depth knowledge of calibration scans from other projects.

Table 3.8: Comparison of Calibration and Inspected PIpes

Pipes	Pipe Diameter (inches)	Pipe Type	Wire Size (inches)	Wire Spacing (inches)
Calibration	36	LCP	0.192	0.8
Novi Road Transmission Main			Unknown	Unknown

Variations in pipe properties do not affect the ability of the electromagnetic inspection equipment to locate broken wire wraps, but the variations will affect the accuracy of the quantification of distress. If calibration tests are done on any pipes from the 36-inch Novi Road PCCP Transmission Main at a future date, the resulting calibration curve can be applied to the data signal from this inspection to refine the calculated number of broken wire wraps for the distressed pipes.

4. Transient Pressure and Hydraulic Analysis

4.1. Pressure Monitoring Methodology

A hydraulic evaluation is conducted in order to understand the operational and surge pressures within a pipeline. When the degradation of the pipe wall is combined with surge pressures, the likelihood of pipe failure can be significantly increased. Evaluation of pump station operation, such as pump start-up mode, typical and peak flows, operating and surge pressures, and surge protection, can provide important information on the stresses imparted on the pipeline.

Hydraulic pressure transients occur in pipelines when the steady-state conditions of the system change due to pressure and/or flow disturbances (e.g., the rapid closure of a valve, pump start-up/shutdown, gas pockets). The magnitude of a transient is related to several factors including the flow rate within the pipeline, the time (how fast) in which the change in steady-state condition occurs, and pipe hoop rigidity. During a transient event, the kinetic energy of the flow momentum is converted into potential energy, a rise in pressure, and strain energy in the pipe walls with the propagation of pressure waves. The resultant pressure transient is superimposed on the existing, steady-state pressure within the pipeline. Air pockets combined with pressure transients can also have a significant impact on the structural integrity of the pipeline as vacuum conditions may be created. The rapid collapse of these air pocket vacuum regions may cause cavitation as the transient passes, resulting in mechanical wear on the pipe wall and thereby increasing the risk of failure if the structural capacity has been compromised.

Conventional pressure monitors collect data in intervals of seconds or minutes while transients may occur in fractions of seconds and may be missed by traditional equipment. The LPR-31i pressure monitor, utilized on this project, continuously samples pressure at a high rate and records data every few minutes under normal operating conditions; however, when a transient pressure event is detected in the pipeline, the device records at the high sample rate 20 Hz to provide an accurate recording of the pressure transient event.

4.2. Analysis Background

To translate the recorded pressures from the installation location along the inspected length of the transmission main, basic assumptions about the transmission of the transient pressures were made:

1. Observed transient pressures are superimposed on the steady-state pressure at each point along the pipeline.
2. The observed transient amplitude (above the background steady-state pressure) is consistent along the length of the pipeline.
3. Dynamic losses along the length of the pipeline are neglected; the static elevation pressure differences are assumed to govern and are used in the translation of the recorded pressures.

Hydraulic surge modeling may be performed to refine these assumptions, or additional transient pressure monitoring locations may be selected based on these initial findings if there are areas of particular concern.

Occasionally, pump operation causes negative pressure events. As these pressure events travel downstream, vacuum conditions may occur which can lead to premature failures. Additional monitoring at high points along the line would refine the approximations. Pump operating data should be evaluated to determine if a cause can be determined, and active measures such as valve timing, pump throttling, or ARV maintenance should be investigated to alleviate these events.

4.3. Results

A summary of the TPM hydraulic evaluation is shown in Table 4.1.

Table 4.1: Summary of Novi Road TPM Results

Site	Downstream of NV-04 (approximate Station 6+14)
Dates Collected	3/5/20 - 4/17/20
TPM Mount Location	Existing 1-inch Corporation Stop approximately 10-feet downstream of the flow meter
Maximum Pressure Recorded	120.6 psi
Minimum Pressure Recorded*	62.3 psi
Average Pressure Recorded	93.3 psi
Approximate Elevation of TPM	944 feet above mean sea level

**Minimum pressure recorded was detected during a transient event.*

Figure 4.1: TPM mounted downstream of NV-04.

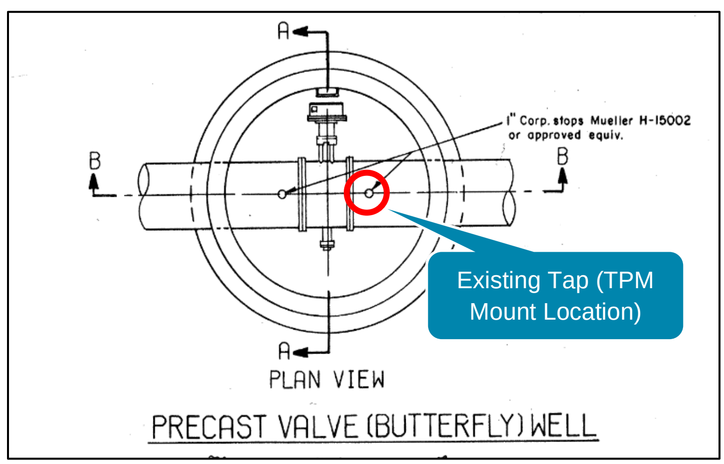


Figure 4.2: Plan view of valve (Station 6+14).

Maximum, minimum, and average pressures were recorded by the pressure logger at four-minute intervals. The maximum pressure recorded during the monitoring period was 120.6 pounds per square inch (psi), the average pressure was 93.3 psi, and the minimum pressure recorded was 62.3 psi. A chart of the pressures recorded over the full monitoring period is included in Figure 4.3. Maximum pressures in a given four-minute recording interval are plotted along red lines, minimum pressures are plotted along blue lines, and average pressures are plotted along green line.

The standard deviation of the recorded pressure data is 2.5 psi. Of all the pressure samples recorded, 68.2 percent are between 90.9 psi and 95.8 psi, and 95.4 percent are between 88.4 psi and 98.3 psi.

The transient pressure logger was installed on the water main, where the crown elevation of the pipe is approximately 944.0 feet above mean sea level (MSL). The low point of the water main is approximately 926.0 feet above MSL. Therefore, the maximum observed pressure throughout the pipeline, using previously listed assumptions, is approximately 128.4 psi at the low point.

The minimum recorded pressure downstream of meter vault NV-04 monitoring location of 62.3 psi occurred on April 9, 2020. The transient event was observed at this time appears to be associated with a pump being shut off. It is recommended that supervisory control and data acquisition (SCADA) be reviewed to confirm this. The high point of the water main is 954.0 feet above MSL. Therefore, the minimum observed pressure throughout the pipeline, using previously listed assumptions, is approximately 57.9 psi. Further monitoring at different locations would refine this approximation.

Two (2) high sample-rate transient pressure events were recording during the monitoring period which appear to coincide with pump shutoff operations. A sample week of transient pressure data is shown in Figure 4.4 and a sample day is shown in Figure 4.5. Figure 4.6 shows the apparent pump shutoff that triggered a high sample-rate recording. This coincides with the minimum pressure recorded over the monitoring period. Figure 4.7 shows the day that the maximum pressure over the monitoring period was recorded.

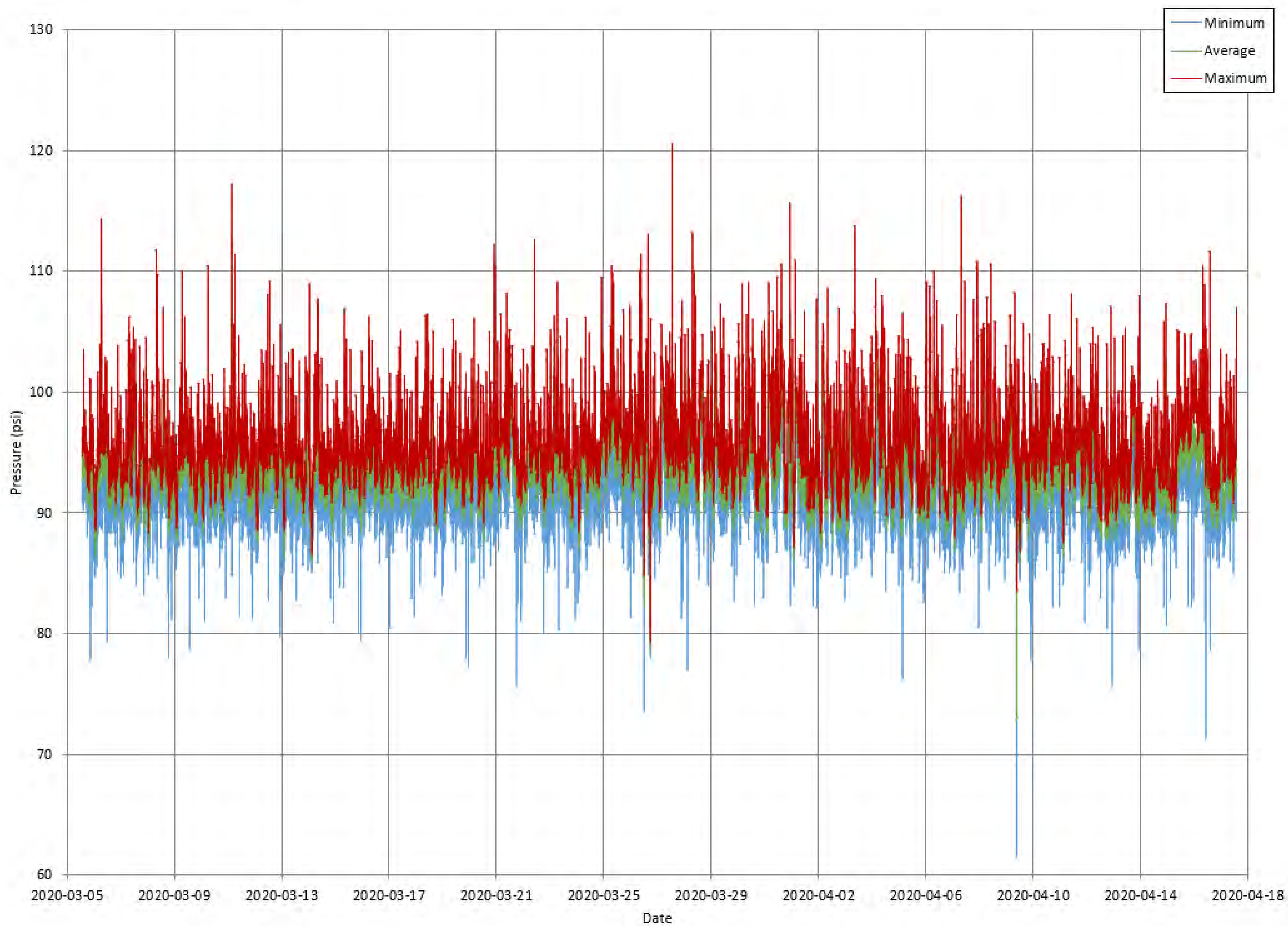


Figure 4.3: Novi Road Transmission Main (near NV-04) TPM Data - Full Monitoring Period.

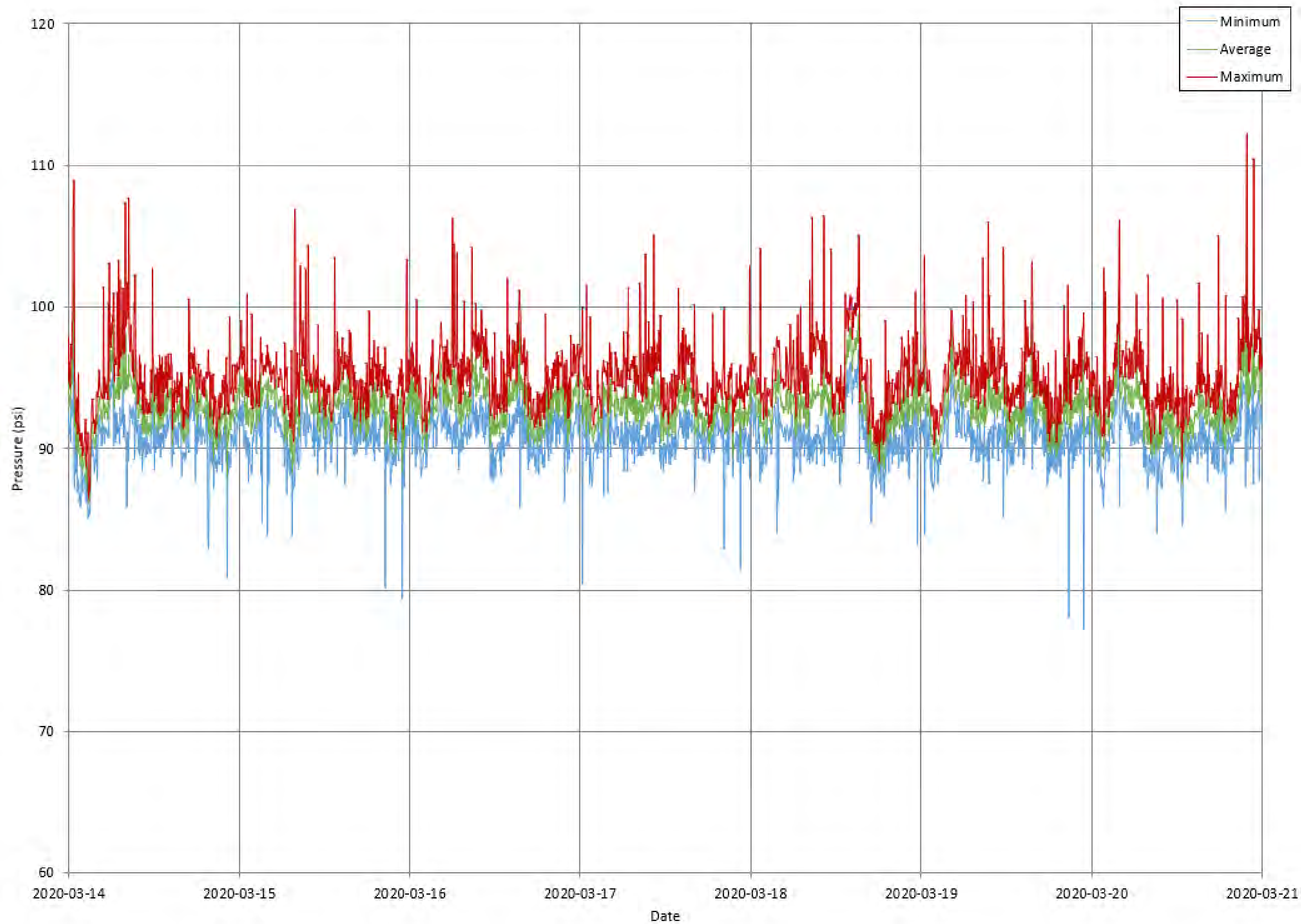


Figure 4.4: Novi Road Transmission Main (near NV-04) TPM Data - Sample Data (3/14/20 to 03/21/20).

Figure 4.5: Novi Road Transmission Main (near NV-04) TPM Data - Sample Data (3/18/20).

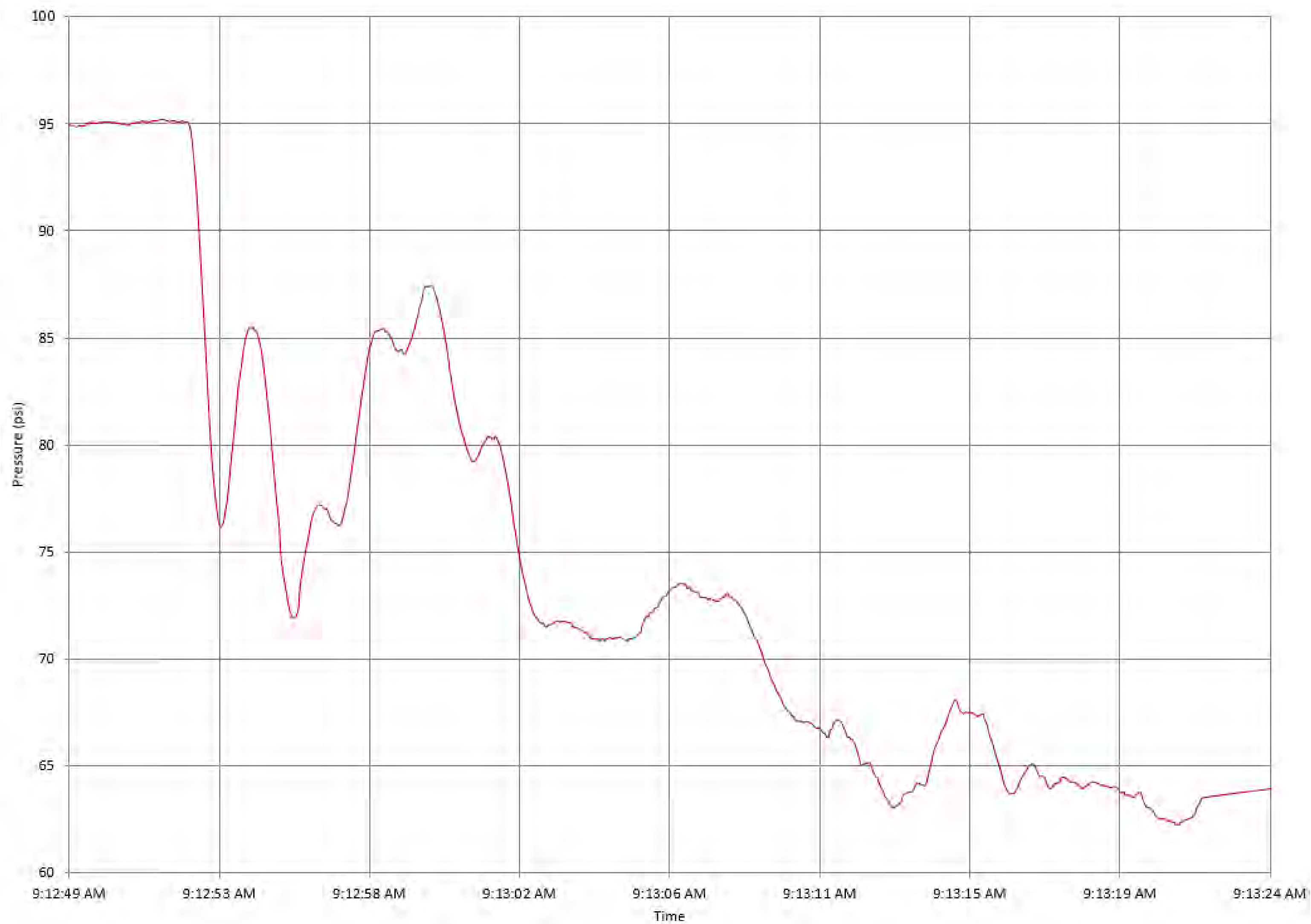


Figure 4.6: Novi Road Transmission Main (near NV-04) TPM Data - Minimum Pressure Recording: Apparent Pump Shutoff (4/9/20).

Figure 4.7: Novi Road Transmission Main (near NV-04) TPM Data - Maximum Pressure Recording (3/27/20).

5. Structural Analysis

The structural analysis is performed to determine if the PCCP main satisfies the historical and current PCCP design standards (AWWA C301 and AWWA C304). The structural analysis also develops a risk curve that plots theoretical failure limits on a chart of PCCP wire breaks versus pipe internal operating pressure, which is also called a pipe performance curve. These analyses are detailed in the following sections.

Pure Technologies obtained pipe manufacturer design specifications for the electromagnetically inspected contract section of the Novi Road PCCP Transmission Main. Manufacturer's specifications are important because they normally provide the actual pipe material parameters used in the installed pipe. These material parameters are required for the structural analysis of the installed pipe. The pipe manufacturer's specifications will be used to perform structural analyses on one (1), of the three (3) pipe classes (Class A), including design checks and the development of pipe performance curves. The Class A pipe specification contained the highest number of distressed pipes along with the highest quantifiable level of distress observed on any pipe throughout this inspection. Table 5.1 describes the various pressures used in the structural analysis and what part of the analysis they pertain to.

Table 5.1: Internal Pressures

Pressure	Value (PSI)	Analysis
Design Operating	175	C301/C304
Design Surge	70	
Design Operating + Design Surge	245	C301/C304
Maximum Observed (from TPM)	120.6	Applied to pipe performance curve*

**The maximum observed pressure is not used to develop the pipe performance curve, but rather it is applied to the pipe performance curve to determine the structural limits of a pipe based on the number of broken wire wraps.*

5.1. Design Specifications and Assumptions for Modeling

5.1.1. Pipe Properties

Table 5.2 lists the observed material properties used by Pure Technologies for the structural analysis and FEA modeling of the 36-inch Novi Road PCCP Transmission Main.

The following parameters were obtained from the Class A pipe specifications; diameter of pipe, core thickness, outside diameter of cylinder, cylinder thickness, diameter of wire, specified coating thickness, area of steel wire, ultimate strength of wire, earth cover, and gross wrapping stress of wire.

Table 5.2: Design Specifications – 36-Inch Class A					
Pipe Parameters	Units	Value			
		36-inch Class A	30-inch Class #184	30-inch Class 175-12	24-inch Class 175-14
Pipe Type		LCP	LCP	LCP	LCP
Nominal Diameter of Pipe	inches	36	30	30	24
Design Operating Pressure	psi	175	175	175	175
Operating plus Surge Pressure	psi	245	245	245	245
Design Earth Cover	feet	8	8	6	8
Thickness of the Steel Cylinder	inches	0.0598	0.0598	0.0598	0.0598
Thickness of the Concrete Core	inches	2.25	1.875	1.875	1.5
Nominal Mortar Coating Thickness	inches	1	1	1	1
Prestressing Wire Diameter	inches	0.162	0.1943	0.1664	0.1664
Prestressing Wire Class		IV	III	IV	IV
Prestressing Wire Area	inch^2/foot	0.334	0.35	0.285	0.237

5.1.2. External Loading

The earth loading assumed a soil unit weight of 120 pounds per cubic foot and a Kμ' value of 0.165, which is representative of sand and gravel. Kμ' is the ratio of the active lateral unit pressure to the vertical unit pressure times the coefficient of friction between the fill material and the sides of the trench.

An Olander bedding angle of 45 degrees was used for the analysis. The bedding factor used to analyze the pipe design during the AWWA C301 analysis was 1.50, representing Class C bedding (pipes with lightly compacted backfill and compacted granular material or densely compacted backfill foundation).

A depth of cover of 8 feet for the structural evaluation performed on the 36-inch Novi Road Transmission Main was based on the earth cover observed on the as-built drawings at the distressed pipe locations. Typically, the depth of cover can be used to obtain reasonably consistent structural limits for depths +/- 2 feet; but for pipes that fall outside this range, it is recommended that additional structural analysis be performed, though typically the resultant wire break count difference is minimal when the depth of cover is not significantly different.

5.1.3. Internal Pressure

An important input for the structural evaluation is the internal pressures of the pipeline, including operating pressure and transient (also called surge) pressures. Pure Technologies performed a transient pressure evaluation to determine the working/operating pressures and transient pressure for the Novi Road Transmission Main, as discussed in Section 4.3. The transient pressure evaluation determined that the maximum, average, and minimum observed pressures were 120.6 psi, 93.3 psi, and 62.3 psi, respectively. Transient pressure monitoring (TPM) was performed on the Novi Road Transmission Main at the meter vault, NV-04, for a period of approximately 43 days. Transient pressure events were detected during the monitoring period which typically coincide with pump operation on and off, as well as valve manipulation.

When TPM data is not available, transient pressure events are normally accounted for in the evaluation using the minimum surge allowance specified by AWWA C301-72, which is either 40 percent of the operating pressure or 40 psi, whichever is greater. In the case of Class A for this contract, a surge of 70 psi was used for the design. Note that this matches 40 percent of the design operating pressure. This surge is also included in the current AWWA C304-07 design standard. We used the design operating pressure of 175 and the design surge of 70 for the C301 and C304 design checks. The highest pressure recorded by the TPM was applied to the pipe performance curve to the determine the structural limits based on the number of broken prestressing wire wraps for the Class A pipes.

5.2. AWWA C301 Analysis

Pure Technologies evaluated the pipe designs utilizing Appendix A, “Cubic Parabola Design Method” of the 1972 AWWA C301 *Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, For Water and Other Liquids*. The AWWA C301 Appendix A design method used a semi-empirical approach for evaluating the strength of a PCCP based on the three-edge bearing test load that causes incipient cracking and the maximum internal design pressure that relieves the residual compression in the concrete core. Analyzing the pipe design using AWWA C301-72 allowed Pure Technologies to evaluate the structural adequacy of the design based on the historical standard.

The AWWA C301 analysis was performed for the Novi Road Transmission Main as specified in Table 5.1. The AWWA C301 curves for the Novi Road Transmission Main LCP at a specific depth of six (6) or eight (8) feet earth cover per design are shown in Figures 5.1-5.4. The design operating pressure of 175 psi and the design surge pressure of 70 psi were used in the analysis. The specific depth of cover for Figure 5.1 was based on the depth of cover present for pipes with prestressing wire breaks as indicated in the as-built drawings and designs.

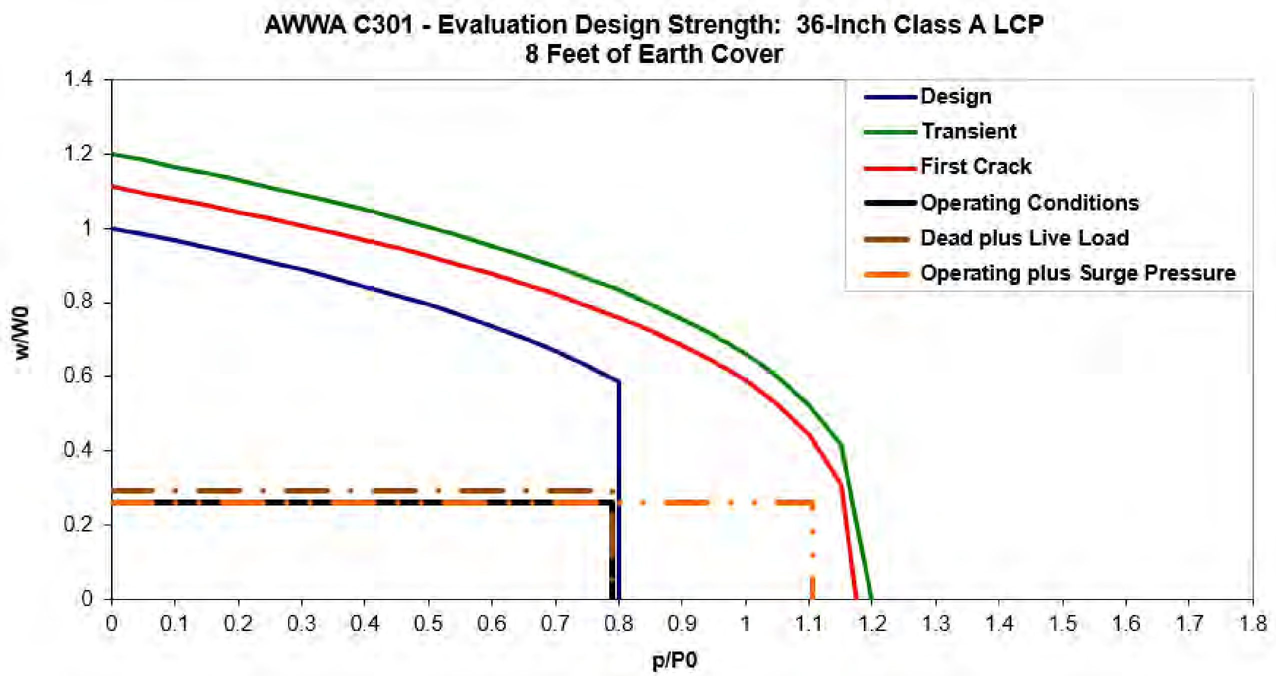


Figure 5.1: AWWA C301-Curve for the 36-inch Class A LCP pipe with 8 feet of Earth Cover.

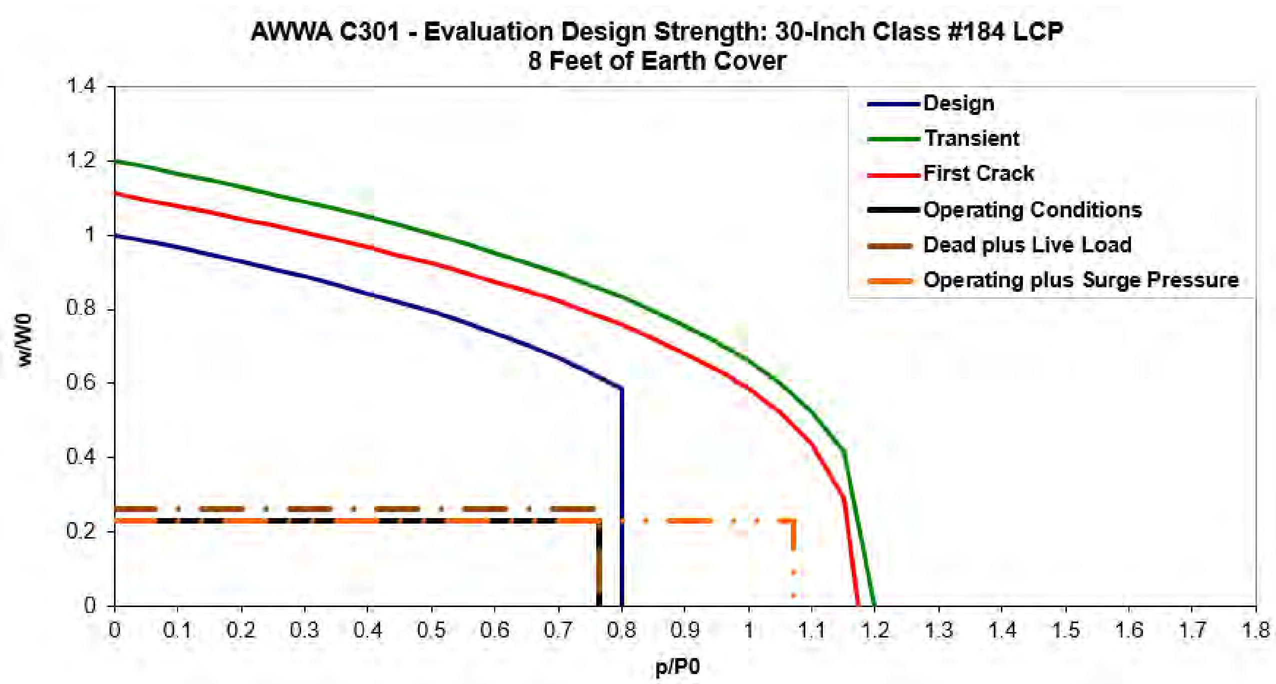


Figure 5.2: AWWA C301-Curve for the30-inch Class #184 LCP pipe with 8 feet of Earth Cover.

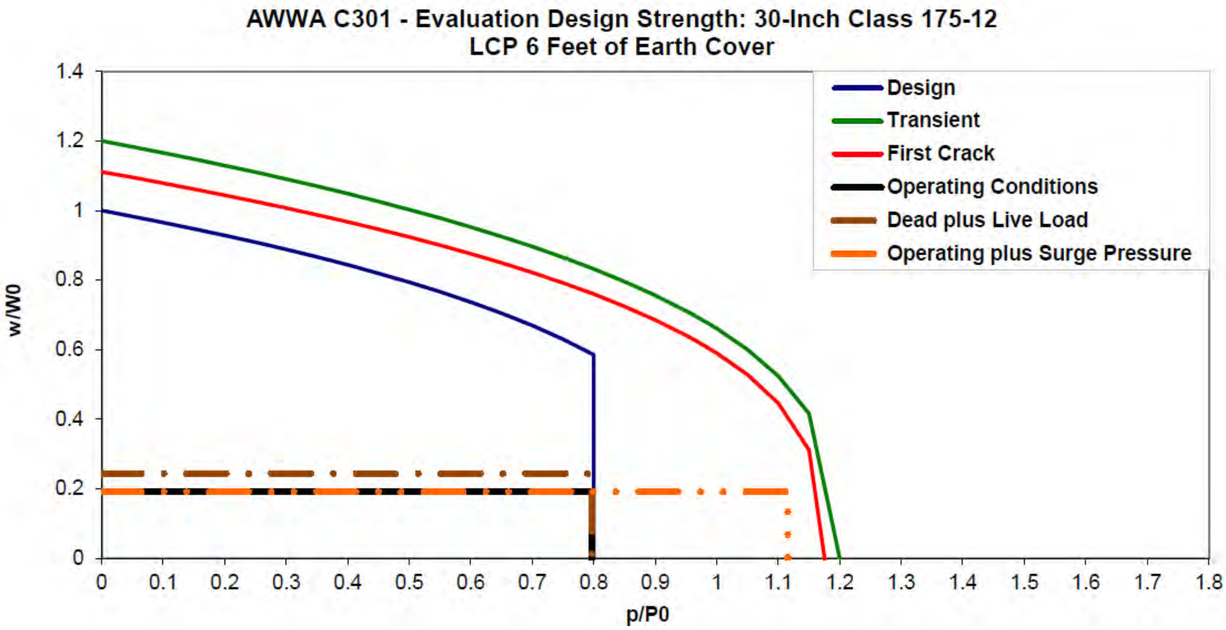


Figure 5.3: AWWA C301-Curve for the 30-inch Class 175-12 LCP pipe with 6 feet of Earth Cover.

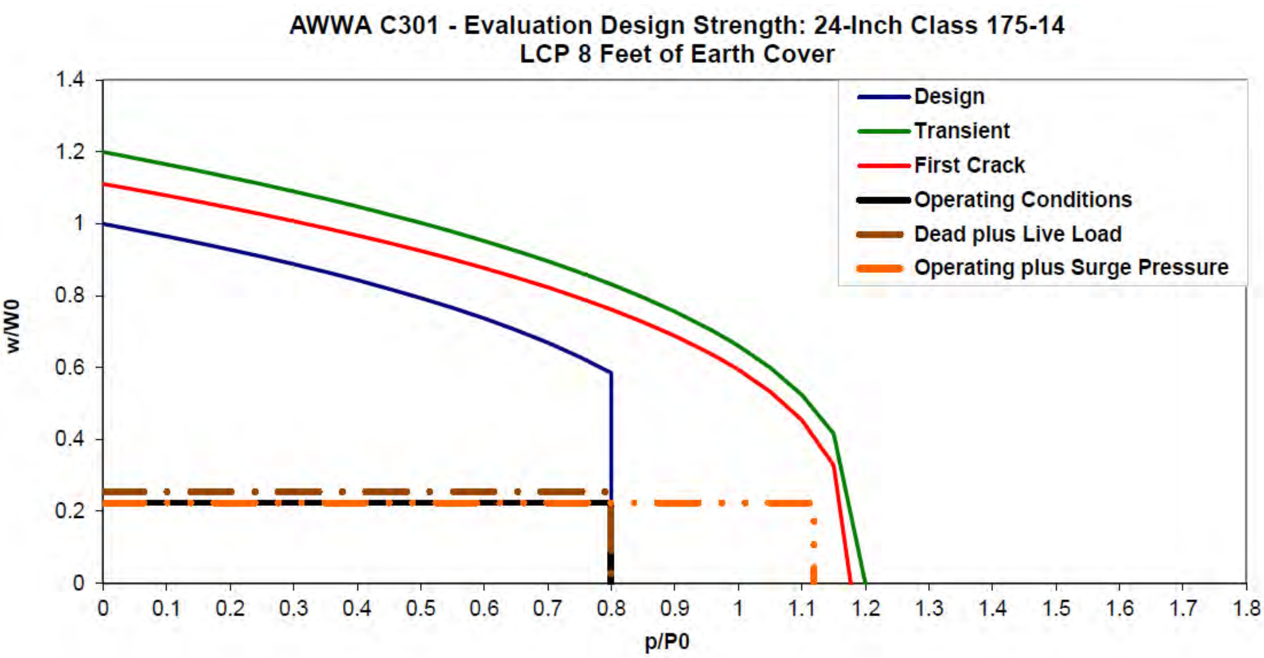


Figure 5.4: AWWA C301-Curve for the 24-inch Class 175-14 LCP pipe with 8 feet of Earth Cover.

The AWWA C301 Appendix A design method evaluates a particular pipe design using the actual internal pressure and external loading conditions for the pipeline and then compares the calculated values with the Design and Transient Limit curves (blue and green curves, respectively). The y-axis represents the external loading conditions on the pipe. W is the external load considered while W0 is equivalent to 90 percent of the three-edge-bearing load that produces incipient cracking in the concrete core when no internal pressure is applied. The x-axis represents the internal pressure conditions in the pipeline. P is the internal pressure being considered while P0 is the zero- compression pressure, which is the threshold between tension and compression in the concrete when the total stress is equal to 0 psi. P0 is independent of any external loading.

The black "Operating Conditions" curve is calculated using the dead load on the pipe as W and the internal operating pressure as P. This curve must remain inside of the blue "Design" curve to satisfy the AWWA C301-Appendix A Design Standard. The brown "Dead plus Live Load" curve considers the dead and live loads on the pipe as W, while P is taken as the internal operating pressure. The orange "Operating Pressure plus Surge Pressure" curve considers the operating plus a surge allowance as P and uses the dead load on the pipe as W. The AWWA C301-Appendix A Design Standard is satisfied when both the brown and orange curves remain inside of the green "Transient Limit" curve.

The red "First Crack" curve is an empirical equation that represents the point when cracking is first expected in a pipe. Based on laboratory testing, the first crack is considered to be 0.001 inches wide and 12 inches long. Because transient loads are not constant, these first cracks would be expected to close once the increased loading is removed. If the brown or orange curves exceed the red curve, cracking could occur in the concrete core; however, the AWWA C301 Appendix A Design Standard would still be satisfied as long as the curves remain below the green "Transient Limit" curve.

Using the aforementioned design information, the AWWA C301 analysis for each of the 36-inch Class A, 30-inch Class #184, 30-inch Class 175-12, and 24-inch Class 175-14 Novi Road Transmission Main pipes at a design plus surge pressure of 245 psi and 6 or 8 feet of earth cover per design were satisfied. The AWWA C301 analyses for the pipes performed in the structural analysis were all satisfied at the operating pressure plus a surge pressure of 245 psi. See Appendix F for C301 results.

5.3. AWWA C304 Analysis

In 1992, the AWWA Committee created a new standard for the design of PCCP called AWWA C304 Design of Prestressed Concrete Cylinder Pipe. AWWA C304 is a more rigorous design method than AWWA C301-58, which was not used by the industry at the time that the PCCP in the Novi Road Water Transmission Main were manufactured. This report uses the AWWA C304 3rd edition, which was approved in 2007. The AWWA C304 design standard evaluates stress and strain in undamaged PCCP under several loading combinations and is especially sensitive to the effect of external loading. Pure Technologies analyzed the pipe design using AWWA C304 to evaluate their adequacy in relation to the current PCCP design standard.

AWWA C304 adopted three (3) Limits with criteria that consider multiple load combinations of external loads, pipe and fluid weights, and internal pressures. The three (3) Limits are the Serviceability Limit, the Elastic Limit, and the Strength Limit. The Serviceability Limit is defined by stress and strain criteria that preclude the appearance of both micro cracks and visible cracks in the concrete core and the mortar coating under different loading conditions. The Serviceability Limit is also controlled by criteria related to the radial tensile stress, the core compressive stress, and the pressure in the pipe. The Elastic Limit is determined by the elastic response of the pipe under operational and operational plus surge pressures. The Elastic Limit controls the amount of stress applied to the prestressing wire and the steel cylinder. The Strength Limit provides a factor of safety for operational and abnormal conditions to protect the pipe against yielding of the prestressing wire or crushing of the concrete core.

Based on the results of the AWWA C304 analyses, all of the criteria for the Elastic Limit and Strength Limit were satisfied. Two (2) Serviceability Limit criteria were above the allowable limits for the 36-inch Class A, 30-inch Class 175-12, and 24-inch Class 175-14 designs- the Core Decompression and the Coating Cracking criteria. One (1) Serviceability Limit criteria was above the allowable limits for the 30-inch Class #184 design - the Core Decompression criteria. See Appendix F for C304 results.

5.3.1. AWWA C301 and C304 Results

Table 5.3 shows the results from the AWWA C301 and C304 analyses performed on the Novi Road PCCP Water Transmission Main.

Table 5.3: AWWA C301 and C304 Results

Pipe Class	Earth Cover (feet)	Evaluation Pressure (psi)	C301	C304
36-inch Class A	8	245	Pass	Fail
30-inch Class #184	8	245	Pass	Fail
30-inch Class 175-12	6	245	Pass	Fail
24-inch Class 175-14	8	245	Pass	Fail

The evaluated pipe design for the Novi Road PCCP Water Transmission Main passed the contemporary AWWA C301 standard. However, the pipe designs did not pass the AWWA C304 standard. As AWWA C304 standards are more rigorous than its predecessor C301, it is not expected for pipes manufactured prior to the publication of the AWWA 304 standard to pass all criterion. Based on the results of the AWWA C304 analysis, 36-, 30- and 24-inch LCP pipes across various ground covers indicated that all Elastic Limit criteria and all Strength Limit criteria were satisfied. Two (2) Serviceability Limit criteria were above the allowable limits, the Core Decompression and the Coating Cracking criteria for 36-inch LCP Class A design with 8-feet depth of cover, 30-inch LCP Class 175-12 with 6-feet depth of cover and 24-inch LCP Class 175-14A. AWWA C304 analysis of the 30-inch LCP Class # 184 with 8-feet depth of cover indicated that one (1) of the Serviceability Limit State criteria, Core Decompression was not satisfied.

5.4. Finite Element Analysis

Finite Element Analysis (FEA) is an accurate method for modeling complex geometry under different loading conditions. Recent developments in finite element modeling and increased computational speed allow for the analysis of complex nonlinear problems, which is required to provide accurate models of PCCP with broken prestressing wire wraps.

The FEA model has been developed by Pure Technologies to determine the structural consequence of broken prestressing wire wraps by utilizing pipe design specifications, design parameters, and the current condition of the prestressing wire wraps, as determined during the electromagnetic inspection. During the analysis, the model of a pipe design is subjected to internal pressure, pipe and fluid weights, and external loads while varying the number of broken wire wraps. Commercial finite element analysis software (Abaqus®) was used to investigate the response of a PCCP under these different loading conditions.

The FEA model predicts the performance of a PCCP utilizing the tensile strengths of the prestressing wire, the steel cylinder, and the concrete core, as well as a plasticity algorithm that simulates concrete crushing in compression regions. A performance curve, displaying the effects of broken wire wraps, is formulated and used to determine the number of broken wraps required for the design to exceed theoretical Limits. It should be noted that in performing the structural analysis, the values used in the models were taken directly from the provided specifications and the AWWA C301 design standard.

A typical LCP is modeled using a composite element with four (4) layers to represent the concrete core, the steel cylinder, the prestressing wire, and the mortar coating. Care is needed when modeling the prestressing wire wraps and the joint rings to ensure that a realistic behavior of the PCCP is achieved. Once the pipe is modeled correctly, all other loads (pipe weight, fluid weight, earth load, live loads, and internal pressure) are applied. Figure 5.5 shows the 3D mesh and composite model used in the analysis of an LCP (note that the prestressing wire layer is not visible in the 3D mesh).

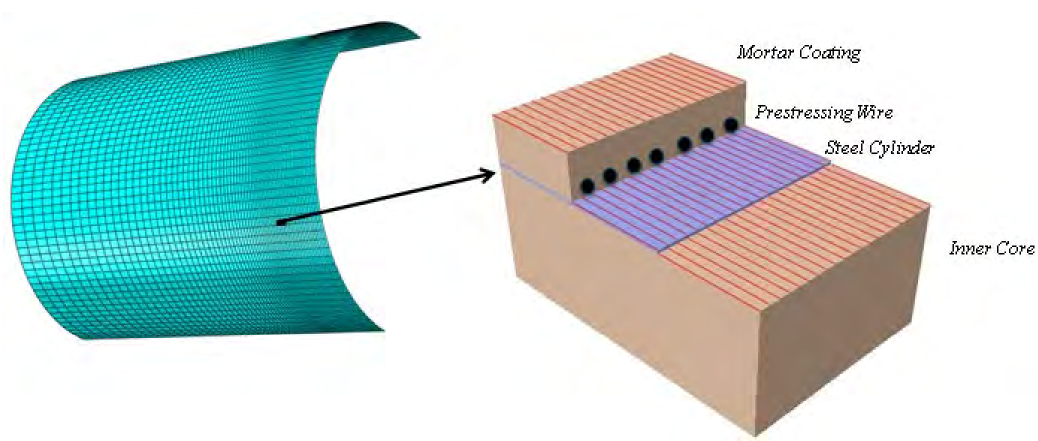


Figure 5.5: 3D FEA Representation of an LCP.

In the following example, FEA was performed for a pipe design. Figure 5.6 shows the stresses developed in the concrete core, mortar coating, prestressing wire, and steel cylinder during the analysis of a pipe with 35 broken wire wraps. In the figures, the zone of broken wire wraps is located at the far-right edge of each image. Stress is measured in the 1-1 direction of the local coordinate system (S11), which is comparable to the hoop stress developed circumferentially around the pipe in the global coordinate system (σH). In the figures below, color gradients indicate the calculated range of stress for each element in the FEA model. Positive values for stress, shown as red and orange areas for the concrete core [Figure 5.6 (a)] represent tension, while negative values, shown as yellow, green, and blue areas for the concrete core, indicate compression. In the models, stress is measured in pounds per square inch (psi).

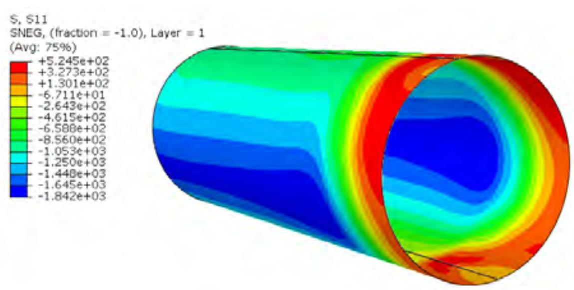


Figure 5.6 (a): Stresses in the Concrete Core

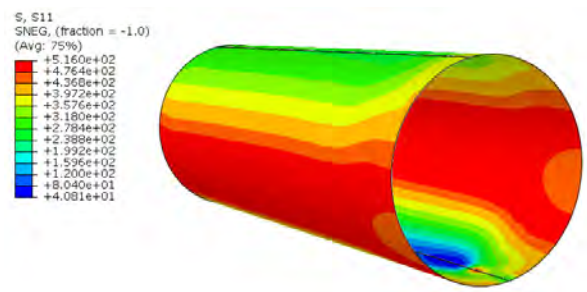


Figure 5.6 (b): Stresses in the Mortar Coating

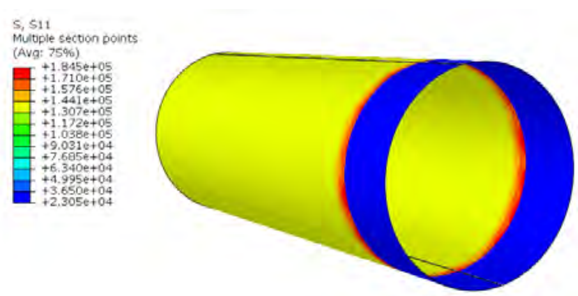


Figure 5.6 (c): Stresses in the Prestressing Wire

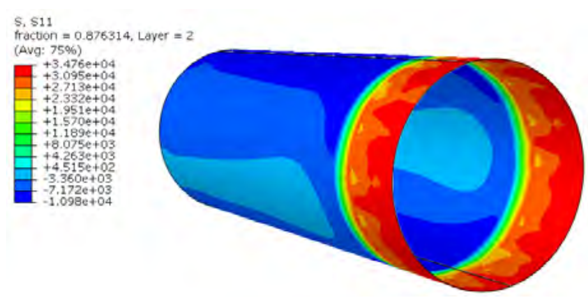


Figure 5.6 (d): Stresses in the Steel Cylinder

Cracking in PCCP is due to excessive tension in the concrete core and the mortar coating. Figure 5.7 shows the damage due to tension in the concrete core and mortar coating of a pipe with 35 broken wire wraps. In this figure, the color gradients indicate the probability of visible cracking for each element in the FEA model. Dark blue areas indicate sections of the model where there is a very low probability of visible cracking. By contrast, bright red areas indicate sections of the model where there is over a 90 percent probability of visible cracking.

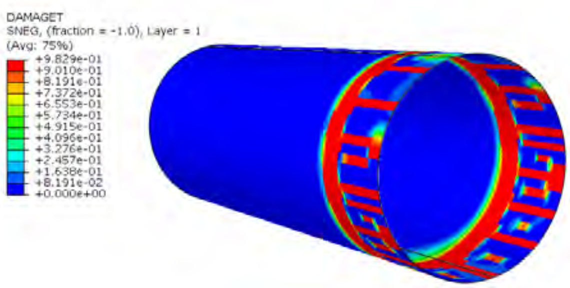


Figure 5.7 (a): Damage in the Concrete Core

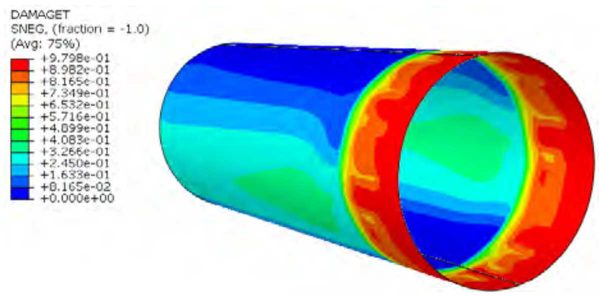


Figure 5.7 (b): Damage in Mortar Coating

5.4.1. Performance Curve

The number of broken prestressing wire wraps that a particular pipe design will tolerate under operational and surge conditions can be determined using an FEA performance curve. Pure Technologies uses four (4) Limits, Micro Cracking, Visible Cracking, Yield, and Strength, to classify the condition of a distressed PCCP. Note that although they have similar descriptions and values, these Limits are different than the Limits and Limiting Criteria described in the AWWA C304 analysis.

Table 5.4 defines the Limits used by Pure Technologies to describe the predicted condition of a PCCP with a known quantity of broken wire wraps. The actual number of broken wire wraps required to reach these Limits varies according to the pipe design and earth cover.

Table 5.4: Predicted Condition of a Pipe with Broken Wire Wraps

Limit	Description
Micro Cracking	Micro cracking of the mortar coating or concrete core (defined by the strain associated with a crack that is greater than or equal to 0.001 inches wide)
Visible Cracking	Visible cracking of the mortar coating or concrete core (defined by the strain associated with a crack that is greater than or equal to 0.002 inches wide)
Yield	Prestressing wire or steel cylinder reach their yield strength
Strength	Prestressing wire or steel cylinder reach their ultimate tensile strength

A pipe reaches the Micro Cracking Limit when strain in the mortar coating or concrete core exceeds the AWWA C304 tensile strain limit for micro cracking. Micro cracking in the mortar coating or concrete core is described as cracks greater than 0.001 inches wide and 12 inches in length and can be considered the preliminary level of damage in a PCCP. The Visible Cracking Limit is reached when the mortar coating or concrete core experiences cracks greater than 0.002 inches wide and 12 inches in length.

The values used to represent the performance of the steel components in the field are based on the yield and ultimate strengths provided on the pipe design specifications sheet or the standard values in the relevant design standard, if the pipe design is not available. The yield strength for the prestressing wire is typically 85 percent of its ultimate strength, while the yield strength of the steel cylinder is either denoted on the pipe design specification sheet or taken from the design standard in place at the time of production. The Yield Limit is reached when either the steel cylinder or the prestressing wire exceeds its yield strength. The ultimate strength of the prestressing wire is dictated by the gage and class of the wire, while the ultimate strength of the steel cylinder is determined by the grade of the steel. The Strength Limit is exceeded when one (1) of the PCCP components reaches its ultimate strength, which, theoretically, will cause the failure of the pipe.

By evaluating the predicted structural condition of a pipe using FEA and analyzing all critical variables, a risk assessment for distressed pipes can be performed to determine if and when a particular pipe should be rehabilitated. An FEA performance curve evaluates the impact of a growing number of broken prestressing wire wraps on the performance of a pipe and the corresponding likelihood of failure as a result of this damage. Failure risk is expressed in terms of the Limits, given in Table 5.4, as it relates to the capacity of a pipe with broken prestressing wire wraps.

As per the designs an FEA curve was created for each of the 36-inch Class A, 30-inch Class #184, and 24-inch Class 175-14 pipes at 8 feet of earth cover. An FEA curve was created for the 30-inch Class 175-12 pipes at 6 feet of earth cover. Based on the analyses, plots were generated that show the Limits in terms of the number of broken wire wraps and the applied internal pressure. Figures 5.8-5.11 show the performance curves generated for the design at the maximum observed pressure. Yield and Strength limits are when the prestressing wires or steel cylinder reach their yield strength or ultimate tensile strength, respectively. A more detailed description of the FEA methodology and limitations is provided in Appendix G.

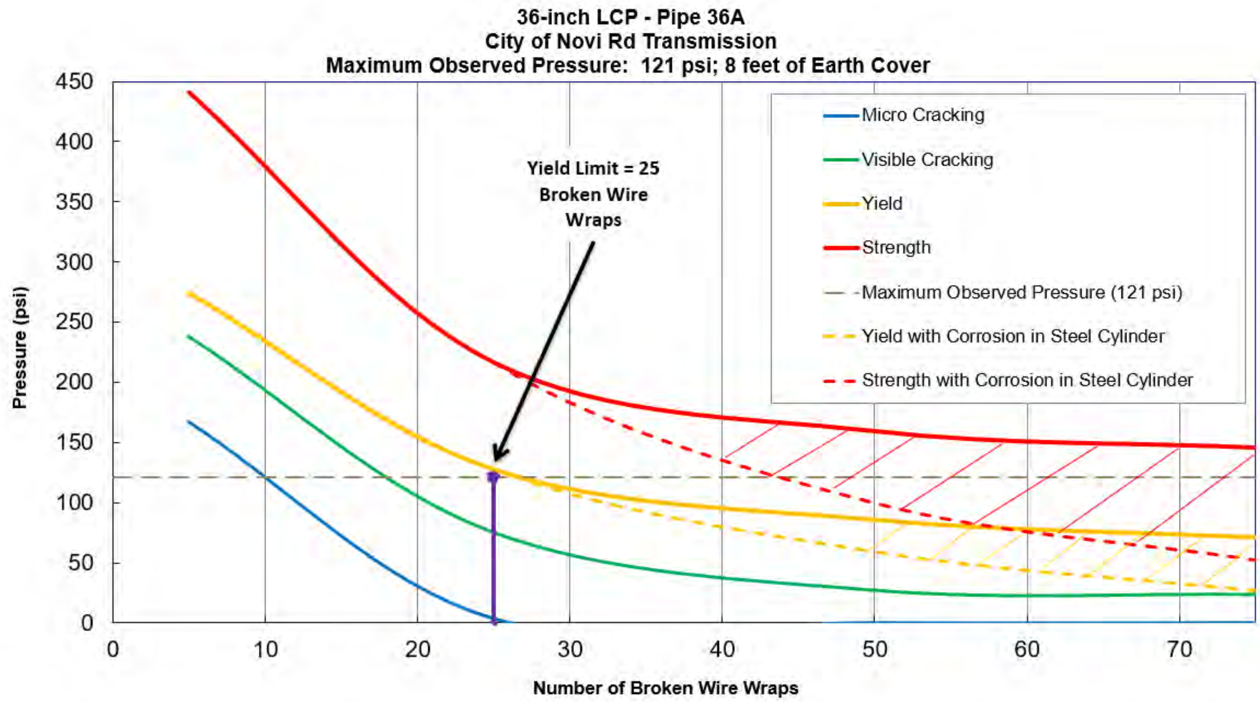


Figure 5.8: Performance curve for the 36-inch Class A LCP pipe at maximum observed pressure.

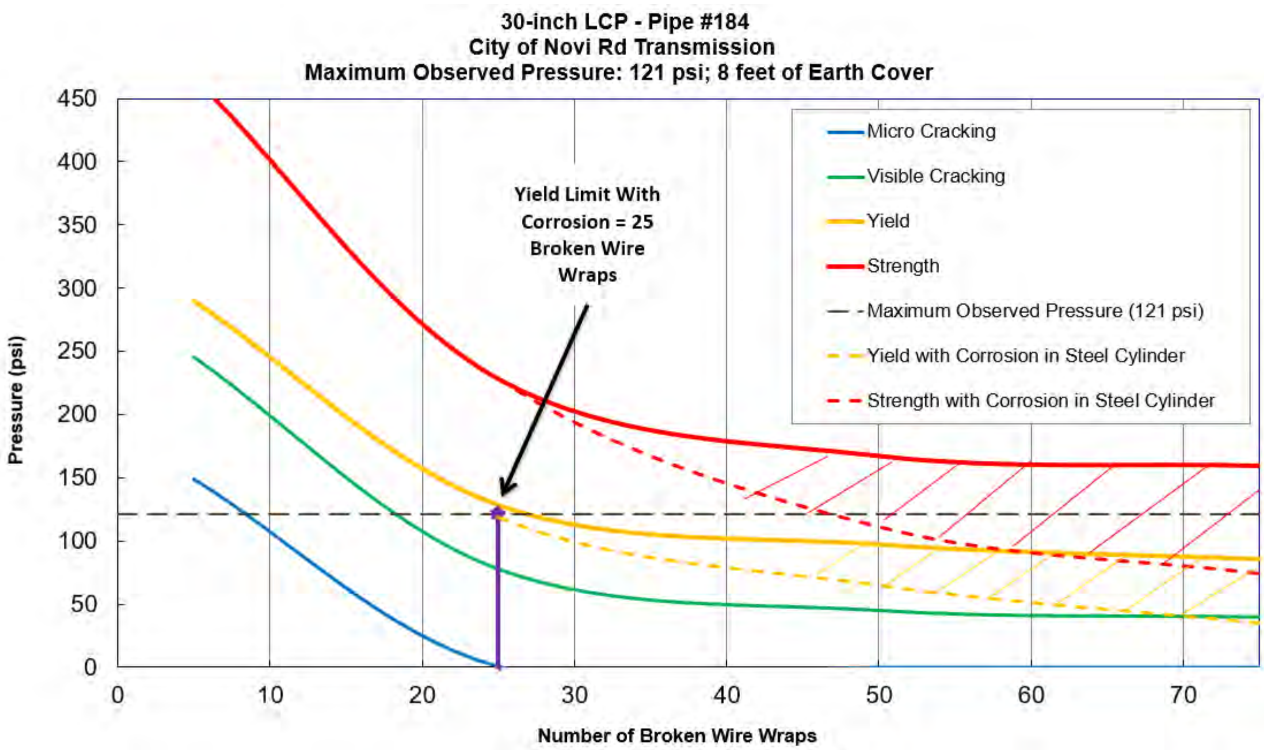


Figure 5.9: Performance curve for the 30-inch Class #184 LCP pipe at maximum observed pressure.

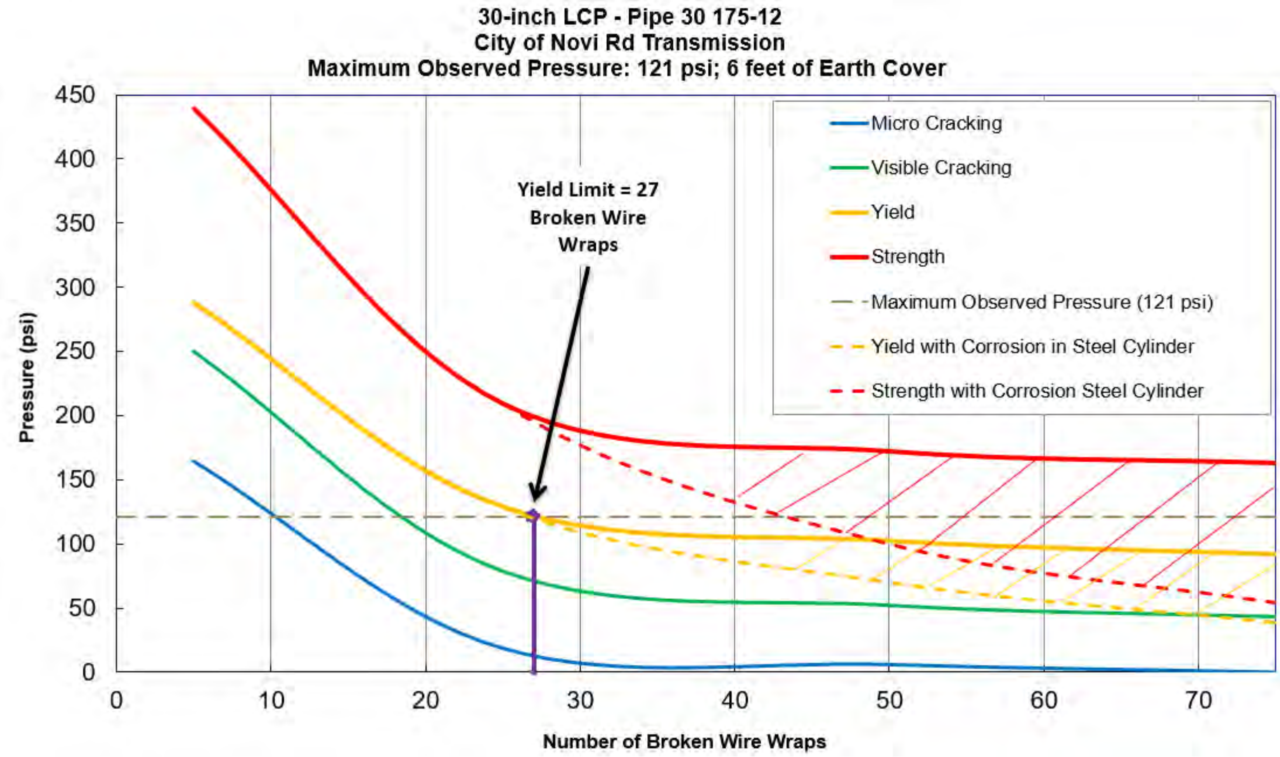


Figure 5.10: Performance curve for the 30-inch Class 175-12 LCP pipe at maximum observed pressure.

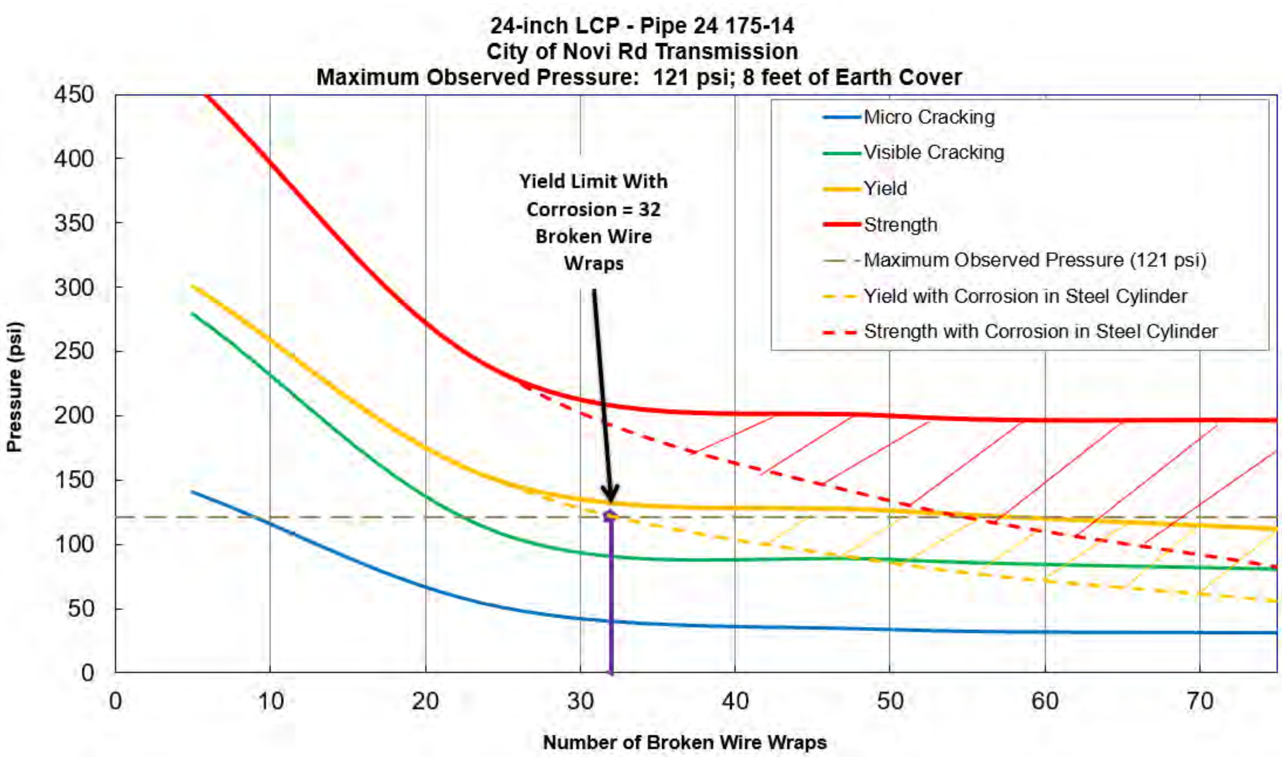


Figure 5.11: Performance curve for the 24-inch Class 175-14 LCP pipe at maximum observed pressure.

Pure Technologies typically recommends mitigating the risk associated with operating a particular pipe when the model predicts that the pipe meets or exceeds the Yield Limit. In reality, the Limit that a pipe exceeds is only one factor to consider when deciding whether to rehabilitate a pipe. Other variables that are critical for the City of Novi (e.g., redundancy, consequence of failure, and criticality) should be evaluated when determining the risk tolerance associated with a distressed pipe. When the wire breaks in lined cylinder pipes approach 25 – 30 wire breaks, Pure Technologies assumes the steel cylinder is corroding (dashed line extensions of the yield and strength curves), this is due to the makeup of lined cylinder pipes, as the prestressing wires line the steel cylinder. The assumed spread of corrosion effectively reduces the pressure and wire break counts for a particular pipe to exceed the yield and strength curves. Once the number of broken wire wraps on a pipe reaches the Yield Limit, a pipe may experience a higher rate of wire breaks until it reaches the Strength Limit. Due to the conservative nature of the FEA, reaching the Strength Limit does not necessarily indicate an immediate failure.

Table 5.6 provides the number of broken prestressing wire wraps required to exceed each limit at the evaluation pressures.

Table 5.6: Number of Broken Wire Wraps Required to Exceed Each Limit

Pipe Design	Maximum Observed Pressure (psi)	Earth Cover (feet)	Micro Cracking	Visible Cracking	Yield	Strength
36-inch Class A	121	8	10	18	25	43
30-inch Class #184	121	8	8	18	25	47
30-inch Class 175-12	121	6	10	18	27	43
24-inch Class 175-14	121	8	9	22	32	54

5.5. Correlation of Pipe Wire Breaks and Pipe Performance Curves

Table 5.7 summarizes a correlation of the pipe performance curve and the wire break data using the maximum observed pressure during a 43-day period utilizing the transient pressure monitor (TPM) at the meter vault, NV-04. If a year-round pressure monitoring period shows higher pressure data, these values can be adjusted to match the new maximum observed pressure reading. The pressure data was adjusted based on the elevation of each specific pipe using the elevation data found in the as-built drawings.

Table 5.7: Pipe Wire Breaks and FEA Pipe Performance Curve Correlations – CO-76-23 – 36-inch Pipe at 8-ft of Cover

Pure Reference Number	U/S Station	Total Number of Broken Wire Wraps	Maximum Observed Pressure (TPM) Adjusted for Elevation (psi)	Exceeds Yield Limit at Maximum Observed Pressure Adjusted for Elevation	Exceeds Strength Limit at Maximum Observed Pressure Adjusted for Elevation
10015[1]	8+20	5	121	N/A	N/A
10201	38+19	5	128	No	No
10324[1,2]	58+13	10	120	N/A	N/A
10327[1,2]	58+61	D	120	N/A	N/A
10356[2]	30+73	30	117	Yes	No
10367[2]	28+96	15	117	No	No
10371	28+32	5	118	No	No
10376	27+52	5	118	No	No

[1]Identified pipe classes vary from FEA curve (Class A), additional curves would need to be performed to apply translated pressures.
[2]Pipe repaired with CFRP in March 2024.

Pure Technologies typically recommends repair or replacement once a pipe has reached the yield limit of the performance curve. One (1) pipe evaluated exceeded the yield limit at the maximum observed pressure and zero (0) pipes exceeded the strength limit at the maximum observed pressure.

****Special Note**: The pipe with distress reported across the entire length of the pipe ("D" pipe) may not have all of the prestressing wires broken, but because the electromagnetic signal did not recover, the actual number of broken prestressing wires cannot be accurately reported. The "D" pipe is not class A, so the pipe performance curve developed is not applicable. Having a pipe performance curve for this pipe would not be all that beneficial, as the number of broken prestressing wires is unknown. It would be of great benefit to perform a destructive forensic test on this pipe to determine what the extent of the prestressing wire breaks. The forensic test would include using a verification tool (v-tool) to verify the correct pipe was exposed, a significant portion of an adjacent pipe would need to be exposed to verify the signal recovers. The v-tool cannot quantify the number of broken prestressing wires so continuity testing would be performed in order to identify precisely which prestressing wires are broken. This will provide an example of what a "D" pipe exhibits in the field. This information would be helpful in how to assess any "D" pipes that may be detected in future inspections.

Additionally, of those eight (8) distressed pipes, four (4) pipes (Pure Reference Number 10324, 10327, 10356, and 10367) with broken wire wraps ranging from 10 to 30 as well as across entire length were repaired with carbon fiber reinforced polymer (CFRP) in March 2024.

6. CCTV Results

The PipeDiver platform is equipped with three (3) rear-facing cameras which allows for visual documentation and recording of the internal condition of the pipeline under optimal conditions. A review of the collected video footage was performed to identify visible deterioration and any other notable findings. The goal of a visual inspection is to identify defects that signify potential structural failure or abnormal wear beyond what is expected for the in-service life of the pipe. The defects could be a result of improper design, installation, operations, or external factors (e.g., unforeseen loading, changing ambient conditions such as groundwater pH, or damage due to peripheral construction activities). Note that PipeDiver video quality is highly dependent on water clarity, tool speed and movement, as well the color of the pipe wall. There were sections of the Novi Road Transmission Main where visual observations were limited due to water quality as well as tool speed.

6.1. Possible Notable Observations in PCCP

The following sections describe possible deterioration that may be identified in the video review along with context regarding evaluating their significance. Any observations in the video collected during the inspection of the Novi Road Transmission Main are detailed in Section 6.2.

6.1.1. Spalling

Spalling is defined as a localized delamination or deterioration of concrete along the wall of the pipe or at the edges of cracks. Spalling is a common mechanism of pipe degradation and occurs as shear stresses near the surface begin to separate thin sheets of mortar from the pipe wall. Spalling can be caused by freezing and thawing, unloading, thermal expansion and contraction, or salt deposition.

Minor or isolated spalls are not a problem and can be repaired to prevent corrosion of the steel. In precast concrete pipe, spalls often occur along the edges of cracks due to overloading or poor support rather than simple tension cracking. Spalling can also occur at the pipe invert due to a combination of high flow velocities and suspended solids.

6.1.2. Longitudinal Cracks

Hairline longitudinal cracks in the crown or invert indicate that the steel in the pipe has accepted part of the load. Other signs of distress, such as differential movement, efflorescence, spalling, or rust stains may occur. Cracking may also be caused by the improper use of construction equipment to push on the pipe to obtain proper grade. Displacement across the crack is shown by a differential movement or unevenness of the crack and is indicative of a high shear condition. While flexural cracks appear at the invert and crown locations of the pipe, cracks resulting from shear or spalling are more likely found in the springline area of the pipe. The video observations from the PipeDiver platform include calling out longitudinal cracks that span the majority of the pipe length.

6.1.3. Circumferential Cracks

Poor bedding may cause circumferential cracks. Cracks may occur across the bottom of the pipe (broken belly) when the pipe is only supported at the ends of each section. This is generally the result of poor installation practices such as not providing indentations (bell holes) in hard foundation material for the end of the bell and spigot-type pipe or not providing a sufficient depth of suitable bedding material. Cracks may occur across the top of pipe (broken back) when settlement occurs and rocks or other areas of hard foundation material near the midpoint of a pipe section are not adequately covered with suitable bedding material.

6.1.4. Joint Defects

Joint defects may range from minor problems to problems that are serious in nature. Typical joint defects include leakage (exfiltration and infiltration), cracks, and joint separation. Exfiltration occurs when leaking joints allow water flowing through the pipe to leak into the supporting material. The most significant joint defect could be that the joint has completely separated at the ring itself and resulted in lateral displacement of adjoining pipe sticks. This issue would result in significant fluid loss, unexpected pressure fluctuations and exposure of the joint to increased wear.

6.1.5. Other Observations

Other observations include:

- Debris at invert – significantly sized foreign objects
- Leaking features – spray or continuous dripping (i.e. flowing leak)
- Unique – clear change in pipe ovality, numerous cracks emanating from a point

6.2. Novi Road Transmission Main Video Observations

The video footage obtained by the PipeDiver tool was reviewed to identify any visual anomalies. The footage surrounding the location of the acoustic event identified in the 2023 SmartBall inspection in Section 2 was examined. Figures below illustrate interesting findings observed during the video review.

The PipeDiver video captured a visual of the 6-inch outlet, near the location of the leak at the hydrant at Station 100+50, in Pure Reference Number 11546. Figure 6.1 illustrates the visual captured from the video footage.

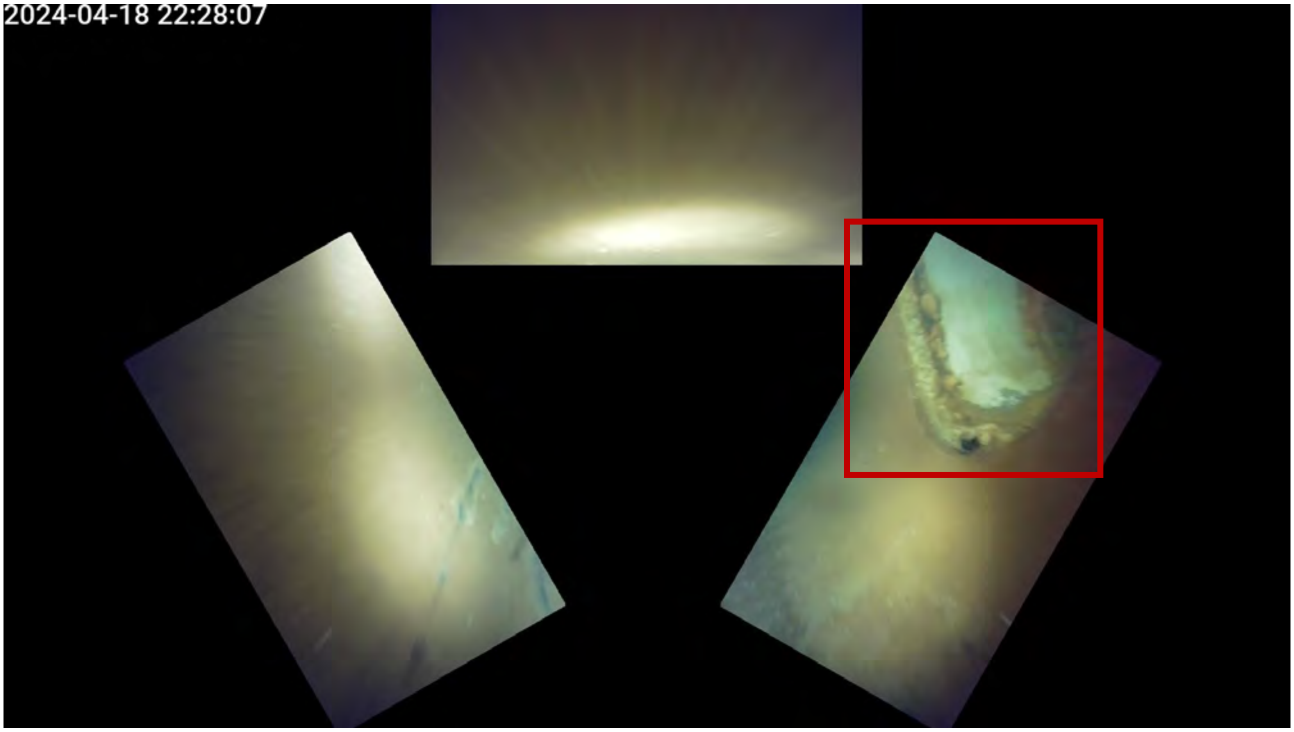


Figure 6.1: Hydrant outlet in Pure Reference Number 11546

In addition to the leak location, several other observations were reviewed. Discoloration was noted in PRN 11173, as shown in Figure 6.2. Material buildup was observed in PRN 11169, 11289, and 11577, examples of which are shown in Figure 6.3. A possible protrusion into the pipe was observed in PRN 11194, illustrated in Figure 6.4. A visual anomaly was observed in Pure Reference Number 11506, seen in Figure 6.5. Details of video review are included in Appendix H.

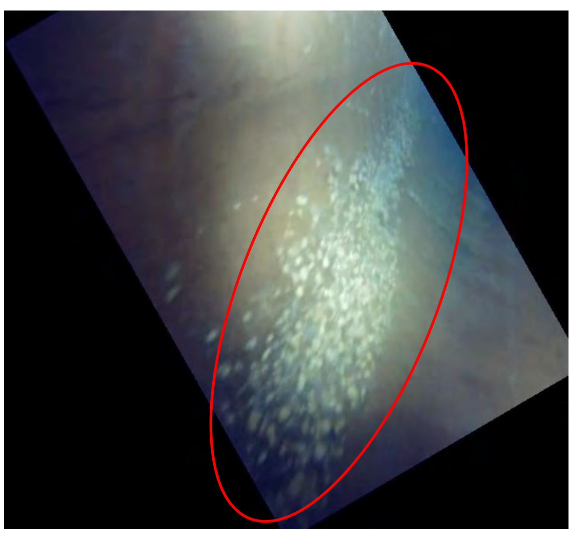


Figure 6.2: Discoloration seen on Pure Reference Number 11173

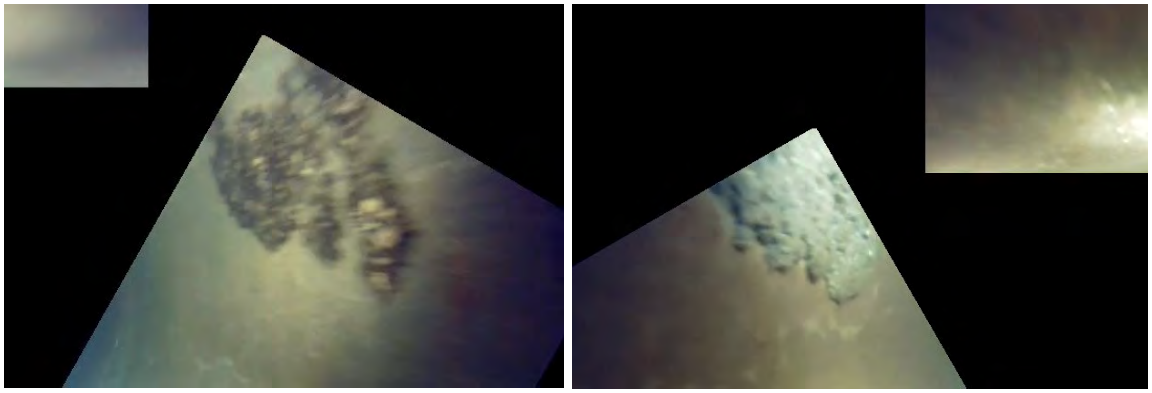


Figure 6.3: Material buildup seen on Pure Reference Number 11552 (left) and 11577 (right)

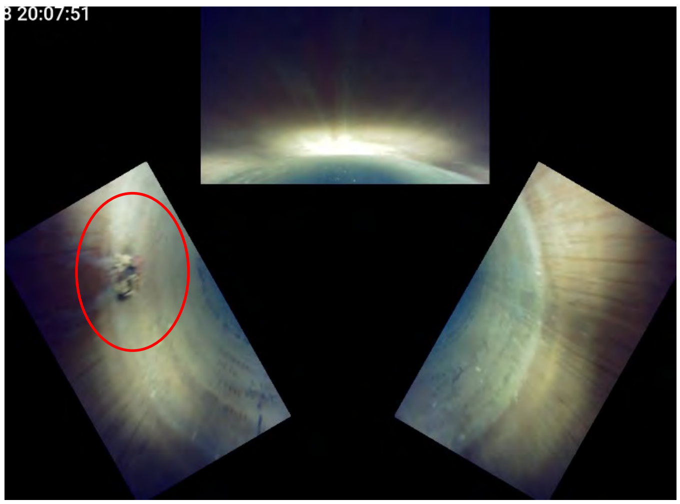


Figure 6.4: Possible protrusion into the pipe in Pure Reference Number 11194

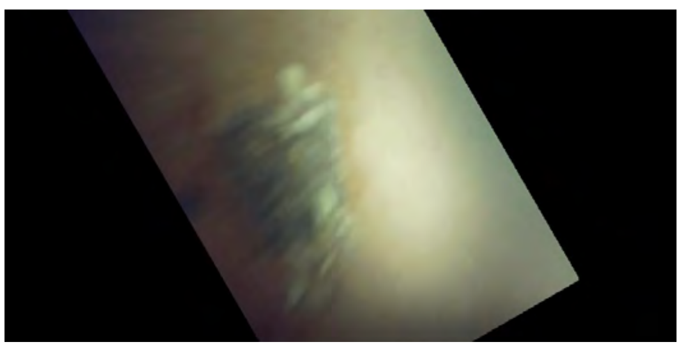


Figure 6.5: Potential mortar spalling observed in PRN 11506

7. Probability of Exceedance Predictive Analysis

7.1. Introduction

Pure Technologies developed a predictive model, which focuses on the Novi Road PCCP Water Transmission Main that is composed of lined prestressed concrete cylinder pipe (PCCP-LCP). A predictive model provides insight into future degradation rates and can be helpful in planning capital budgets until 2055. The goal is to provide the City of Novi with pipe degradation information that can then be used as a tool to identify a long-term management strategy, such as the frequency of re-inspections or repairs.

Predicting the future condition of PCCPs is complicated given the numerous causal factors of deterioration. Deterioration of prestressed concrete is primarily indicated by broken prestressing steel wire wraps; that is, the more broken wire wraps there are, the more distressed the pipe is. Pure Technologies deployed electromagnetic technology to conduct a non-destructive inspection of the transmission main to identify the number of broken wire wraps in each pipe section. Additionally, Pure Technologies developed custom finite element analysis (FEA) model of the main, and generated a performance curve, to estimate the structural limits based on the operating pressure and distress (i.e., broken wire wraps) levels.

This analysis focuses on estimating degradation rates and probabilities of exceeding (PoE) the specified intervention limits for the Novi Road PCCP Water Transmission Main. A total of 8 pipes had electromagnetic anomalies consistent with prestressing wire damage, ranging between five (5) to 30 broken wire wraps pipe as well as a pipe identified with prestressing wire damage across the entire pipe length, denoted as distress across (D). Four (4) of these eight (8) distressed pipes were repaired in March 2024. Therefore, the predictive analysis was performed on the remaining non-repaired PCCPs from 2020 and 2024 inspections.

The structural yield limit at design operating plus surge pressure has been selected as the intervention limit. Such intervention limit has been chosen as the critical limit, meaning a pipe with equal or more contiguous broken wire wraps than the specified intervention limit, is classified as requiring intervention. Table 7.1 summarizes the intervention limits used in the current analysis.

Table 7.1: Novi Road PCCP Water Transmission Main – Structural Analysis and Intervention Limits

Pipe Class	Diameter (inches)	Evaluated Earth Cover (feet)	Number of Pipes with Broken Wire Wraps	Intervention Limit (Yield Limit at Maximum Operating Pressure)
A	36	8	8[1]	25
#184	30	8	0	25
175-12	30	6	0	27
175-14	24	8	0	32

[1]Identified pipe classes vary from FEA curve (Class A), count includes two (2) pipes from Class B and one (1) pipe from Class C.

7.2. Degradation Model Methodology

There are many factors that contribute to the deterioration of PCCPs, such as operating conditions, environmental factors, installation, and third-party damage, which makes predicting a degradation rate for these pipes complicated. Given the numerous factors contributing to the active degradation of prestressed concrete pipes, degradation itself is considered as a 'random variable' in the analysis and uses current and past condition data to examine degradation trends to select the best fit.

Assumptions and factors affecting the analysis include:

- It is assumed that the number of broken wire wraps is zero (0) at the pipe installation year.
- The electromagnetic inspection usually shows varying levels of distress. Therefore, it has been conservatively assumed that the pipes will continue to actively deteriorate in the succeeding years using the state of distress captured during the inspection.
- Broken wire wraps were assumed to be contiguous, which is a conservative approach as wire wrap breaks are quite often non-contiguous (spread across the length of the pipe).
- The structural yield limit at maximum pressure was considered as the intervention limit and was obtained from structural curves derived based on pipe classes.

Figure 7.1 provides a diagram illustrating the methodology that was utilized in this analysis. Briefly, the data is organized such that deterioration rates can be calculated by using available electromagnetic inspection data from the Novi Road PCCP Water Transmission Main, supplemented with Pure Technologies' database (i.e., data augmentation). Then, deterioration cases are developed from the inspection data by categorizing the data into different "bins" based on number of broken wire wraps (i.e., 0 BWW, 5 BWW, 10 BWW, etc.). The 'degradation rates' per case were calculated as the number of wire wrap breaks per year (BWW/year). Each case has multiple data points, which represent pipes deteriorating at different rates, and the distribution of the degradation rates per case were calculated. Finally, pipe degradation rates are simulated using Monte Carlo simulations that rely on repeated random sampling to obtain numerical results by fitting exponential distributions to the degradation rates for each deterioration case. The generated probability distributions were used in the Monte Carlo simulation for projecting pipe degradation rates. Each step of the methodology is explained in detail in sections below.

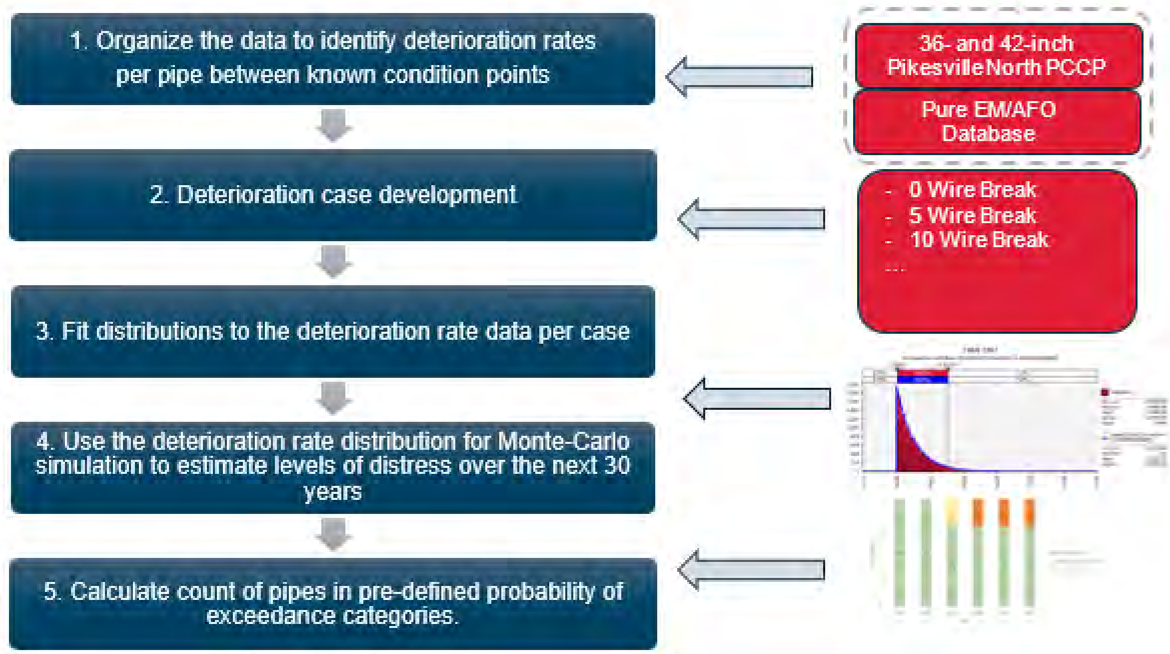


Figure 7.1: Methodology of PoE Calculation

7.2.1. Data Set Selection

The February 2020 and April 2024 electromagnetic inspections of the Novi Road PCCP Water Transmission Main have been the only such inspections to date. For cases like this, where typically the dataset available is scarce and there is no acoustic fiber optic (AFO) monitoring data available, Pure Technologies uses its entire database of previous electromagnetic and AFO inspection results to augment the data. In the absence of additional electromagnetic inspection/AFO data for the Novi Road PCCP Water Transmission Main, data augmentation is necessary to ensure supplemental degradation rate values for all zero and non-zero broken wire wrap deterioration cases to be able to perform the current analysis. This process involves selecting results from pipes that share similar characteristics with the subject pipeline. Pure Technologies has mined its EM/AFO database and only used degradation rates from the pipes that shared similar installation year, sizes and materials as the Novi Road PCCP Water Transmission Main. To account for changes in standards and any possible effects they might have had on the frequency of distressed pipes, the data are analyzed in different groups of installation years that shared similar characteristics (AWWRF Study, 2008).

7.2.2. Deterioration Case Development

To provide a more detailed analysis of the PCCP degradation rates, 'degradation cases' were developed and examined independently using the available inspection data by categorizing it into different "bins" (or degradation cases) based on number of broken wire wraps a PCCP had at its most recent electromagnetic inspection. The degradation cases have been defined in multiples of five (5), (e.g., 0 broken wire wraps, 5 broken wire wraps, 10 broken wire wraps), and they align with the most recent known state of the pipeline according to results from inspections and the conditions we expect to see until 2055.

7.2.3. Degradation Rate Development

With the development of the independent deterioration cases, the 'degradation rates' per case were calculated. Degradation rate is expressed as broken wire wraps per year (BWW/year). Each case has multiple data points, which represent pipes deteriorating at different rates, and the distribution of the degradation rates per case were calculated.

For each degradation rate case, the distribution of the calculated degradation rates was generated. Several probability distribution fits were modelled for the degradation rate distribution for each pipeline for each initial broken wire wrap degradation case, and the best fit was chosen for further analysis. In all cases, the best fit distribution was an exponential distribution.

As an example, the distribution of degradation rates for the 10-broken wire wrap bin is shown in Figure 7.2. The x-axis represents each of the calculated degradation rate values and the y-axis shows the frequency of occurrence for each of the possible degradation rate values. The fitted distribution (red line) shows that there is a 96 percent probability (red bar) that the degradation rate is between zero (0) and 3.33 BWW/year. Note that Figure 7.2 is shown as an example and does not reflect the distribution of the degradation rates of the Novi Road PCCP Water Transmission Main.

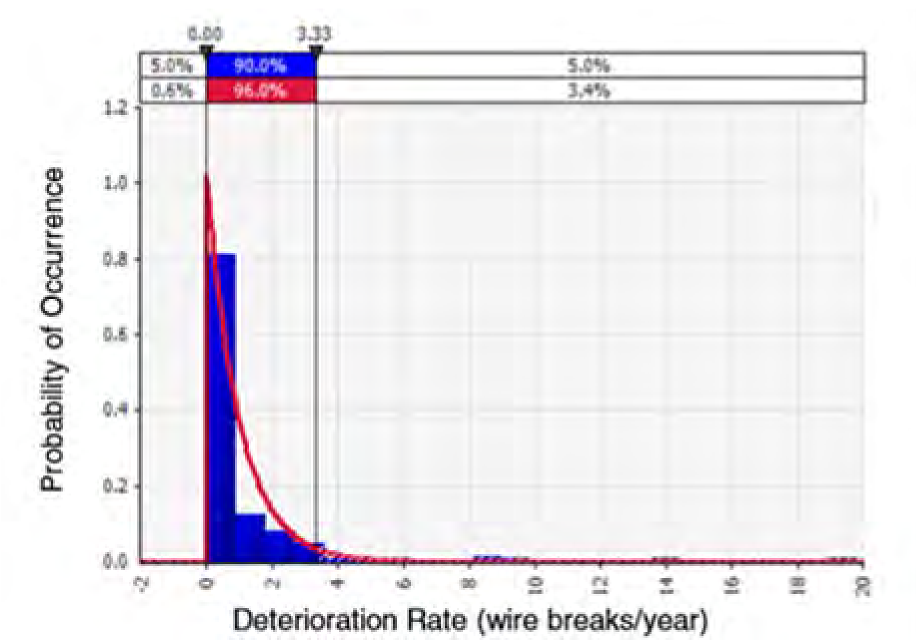


Figure 7.2: Example Distribution of Degradation Rate of the 10 Broken Wire Wraps

7.2.4. Deterioration Projection

Pipe degradation rates are simulated using Monte Carlo simulations that rely on repeated random sampling to obtain numerical results. As described in the previous section, to calculate the degradation cases, exponential distributions were derived from the degradation rates for each scenario based on the number of wire wrap breaks. The generated probability distributions were used in the Monte Carlo Simulation for projecting pipe degradation rates.

The Monte Carlo algorithm estimates future wire wrap breaks by drawing a random degradation rate from the distributions and then computes the number of wire wrap breaks expected over a given time frame using the selected degradation rate. The distribution determines how likely it is that the degradation rates will be selected. The analysis was performed 10,000 times per simulation to determine the expected range of broken wire wraps that may occur in a given time frame. In this manner, the expected distribution of wire wrap breaks each year were projected.

Figure 7.3 shows an example of a typical projected wire wrap break distribution. The baseline condition (degradation case) of this PCCP was 20 broken wire wraps, with an intervention limit of 88 broken wire wraps. The probability distribution of this example pipe 3 years after the initial inspection is presented. The bar at the top of the graph shows that the probability that the number of wire wrap breaks are below 88 broken wire wraps at Year 3 is 92.8 percent. The x-axis shows the possible number of broken wire wraps that may occur, and the y-axis shows the probabilities of reaching this number of broken wire wraps. Figure 7.3 is shown as example, and it is not the broken wire wrap probability distribution of the Novi Road PCCP Water Transmission Main.

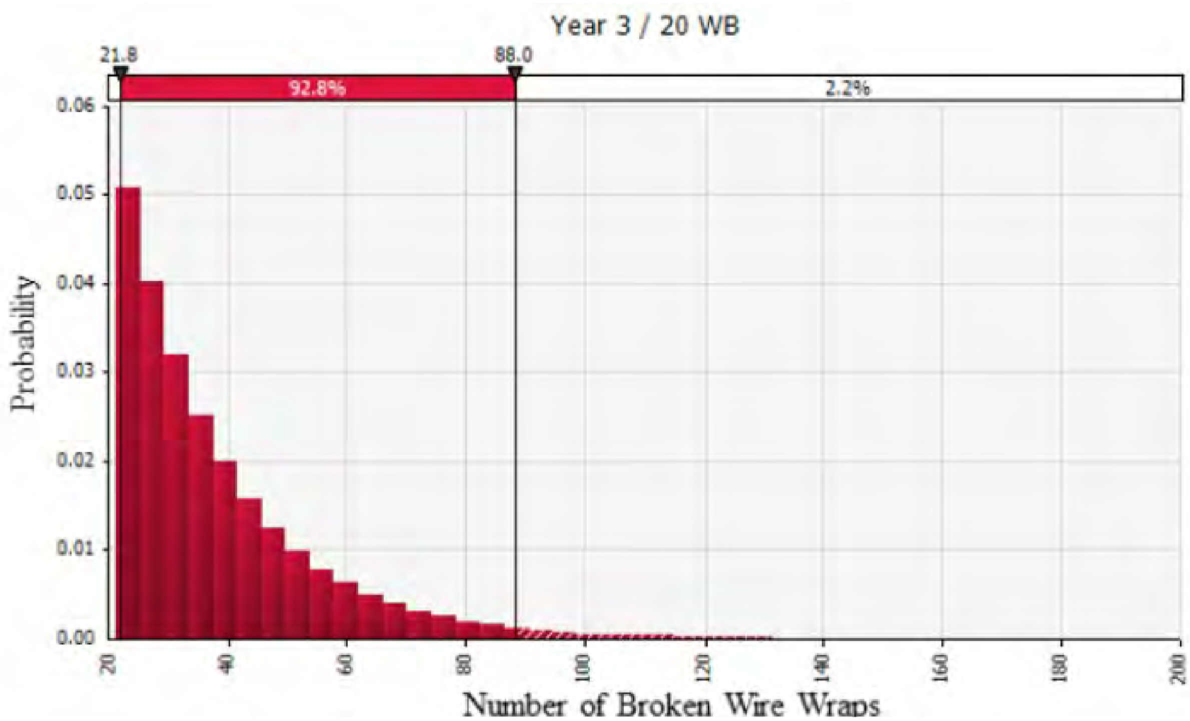


Figure 7.3 Example Broken Wire Wrap Probability Distribution in Year 3 from the Last Inspection for a Pipe with 20 Broken Wire Wraps

The predictive model calculates the broken wire wrap probability distribution for each degradation case bin (i.e., 0 BWW, 5 BWW, etc.) each year over the next 30 years. Using the resulting distribution of expected number of broken wire wraps per year, the probability of exceeding the specified intervention limit was identified for each PCCP in the Novi Road PCCP Water Transmission Main.

7.3. Degradation Model Results

7.3.1. Probability of Exceedance Results

The developed degradation projection gives insight into the pipeline's current and future condition. The degradation rates were used to estimate the future number of broken wire wraps and expressed as a probability that the pipe will reach the specified intervention limit.

Three (3) different probability categories have been defined:

- Low PoE = Low probability of reaching or exceeding yield limit (less than 1 percent).
- Medium PoE = Medium probability of reaching or exceeding yield limit (1 percent to 10 percent).
- High PoE = High probability of reaching or exceeding yield limit (greater than 10 percent).

Figure 7.4 shows the distribution of pipes within each probability category (probability of reaching or exceeding the intervention limit) for every five (5) years, until 2055, for Novi Road PCCP Water Transmission Main.

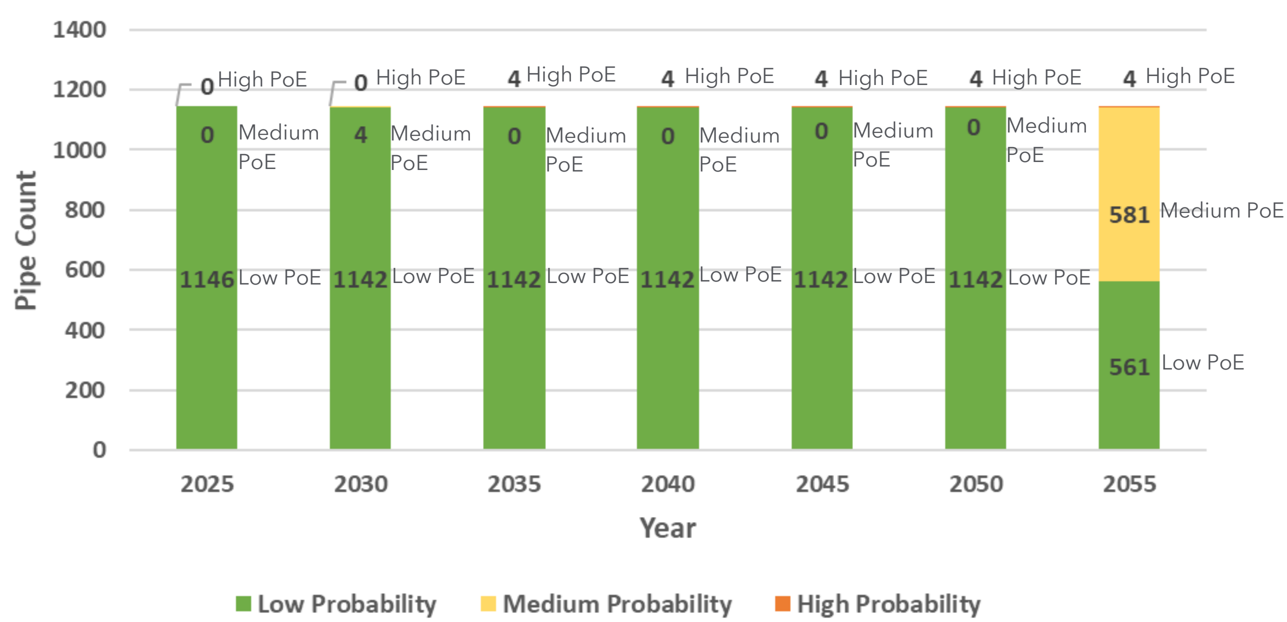


Figure 7.4. Expected Number of Pipes to Exceed Intervention Limit by Probability Categories.

A total of 4 pipes are expected to exceed their specified intervention limits with high PoE (greater than 10 percent), 581 pipes are expected to have a medium PoE (1 percent to 10 percent), and the remaining 561 pipes are expected to exceed their intervention limits with a low PoE until the year 2055.

Other than probability of exceeding the intervention, the number of broken wire wraps per pipe in any given year is a beneficial metric for understanding the pipe's condition. Presenting the predicted number of broken wire wraps allows for an understanding of the level of potential broken wire wrap damage over the years, independent of the yield limit. This helps visualize the projected deterioration of the pipes.

Figure 7.5 and Figure 7.6 below present the distribution of the projected number of broken wire wraps from 2025 to 2055 for a sample pipe with zero (0) BWWs, based on the 2020 and 2024 condition assessment data, respectively. for the Novi Road PCCP Water Transmission Main with zero (0) broken wire wraps based on the 2020 and 2024 electromagnetic inspections, using 10,000 Monte Carlo iterations of the degradation model for each year. The yellow bar shows the median number of predicted broken wire wraps. The thick blue bar shows the 25 percent and 75 percent confidence intervals of the results, while the thin blue line shows the 5 percent and 95 percent confidence intervals.

Based on the projected number of broken wire wraps, it is projected with 95 percent confidence that by 2055, the number of broken wire wraps of a pipe with zero (0) broken wire wraps in 2020 will be between 0 and 13 broken wire wraps. It should be noted that as the prediction extends further into the future, the uncertainty associated with the predictions increases. In the future, as more inspection data is collected, it is anticipated that the uncertainty associated with this analysis will reduce.

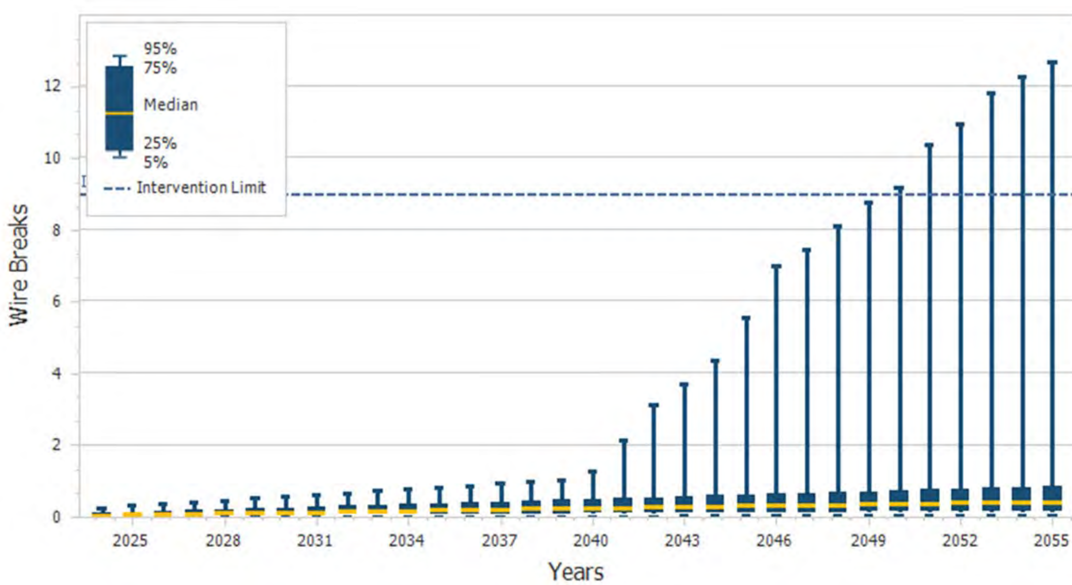


Figure 7.5: Predicted BWWs for a Pipe with Zero (0) BWWs Using 2020 Condition Assessment Data, until 2055.

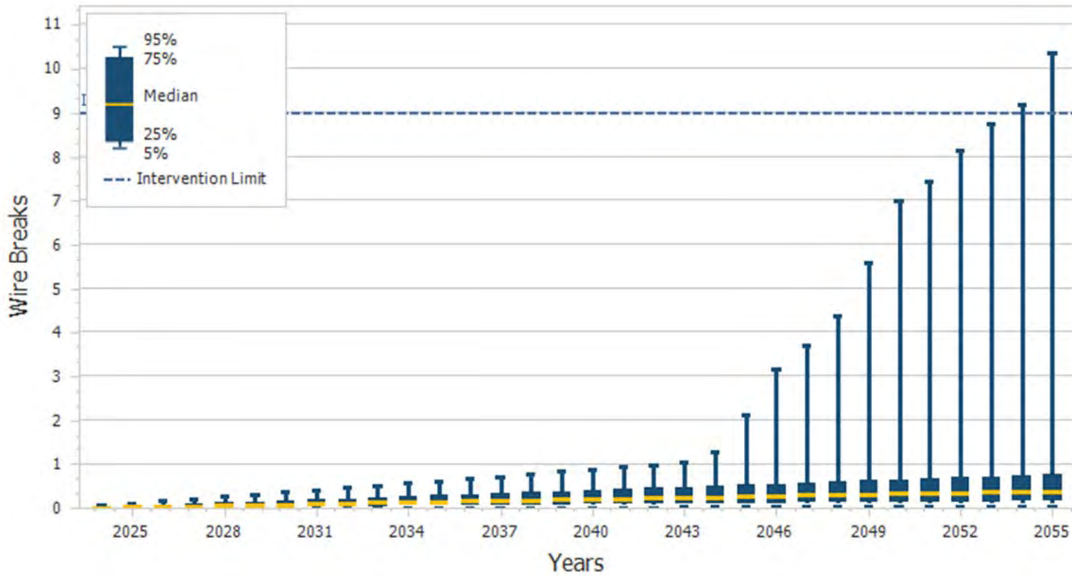


Figure 7.6: Predicted BWWs for a Pipe with Zero (0) BWWs Using 2024 Condition Assessment Data, until 2055.

7.3.2. Cumulative Number of Pipes to Exceed Intervention Limit

The probability of exceedance for all the individual pipes in the Novi Road PCCP Water Transmission Main can be amalgamated to provide a prediction of the total number of pipes expected to reach or exceed their intervention limit over the prediction timeline.

To calculate the cumulative number of pipes expected to reach the intervention limit in a given year, the following example is provided. Considering 100 pipes in 2024, the predicted probabilities of exceeding the intervention limit of 40 wire breaks in 2041 are 5 percent. Accordingly, the expected number of pipes to exceed this intervention limit in 2041 is calculated by multiplying the number of pipes (in this example, 100 pipes) with the probability of exceeding the specified intervention limit in 2041, i.e., 5 percent. In this example, the expected number of pipes to exceed the limit in 2041 is five (5) pipes.

Figure 7.7 presents the summary of the cumulative number of pipes expected to exceed the intervention limit from 2025 to 2055, in 5-year increments for the Novi Road PCCP Water Transmission Main.

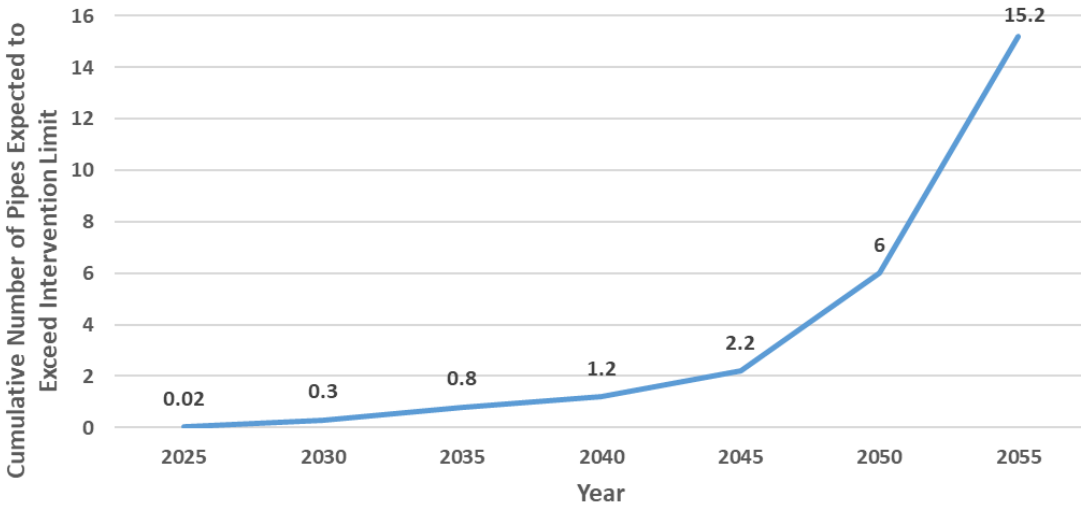


Figure 7.7. Cumulative Number of Pipes Expected to Exceed the Intervention Limit.

The predictive modelling analysis estimates that 15 pipes will reach their Yield Limit at the current maximum operating pressure by the year 2055. The results of the modelling are probabilistic and can be used for long-term capital planning rather than short-term repair decisions.

7.4. Predictive Analysis Summary

Analysis of past and current condition data of the pipes in the Novi Road PCCP Water Transmission Main allows for the development of valuable insights that can be used to aid in the decision-making process when developing a pipe repair or replacement program. This is achieved by incorporating condition assessment data into a predictive model to forecast how many pipes may reach an intervention limit over the next 30 years. Pipe segments of varying distress levels can be separated and analyzed independently to determine case-specific degradation rates. Degradation rates per case were aggregated as a distribution rather than a single value or average, and degradation rate distributions were used in Monte Carlo simulations to determine the probability of a pipe exceeding a defined intervention limit.

It should be noted that, while the model predicts the rate at which prestressing wires will break over time, it does not consider where along the length of a pipe segment the wire breaks may propagate and assumes the worst case, that the wire breaks are contiguous. Further, the intervention limit is set at a threshold representing a structural limit state that does not represent imminent or catastrophic failure which is also a conservative assumption in the model. As such, expected exceedances do not represent catastrophic pipe failure, rather, they represent a state at which intervention would be warranted to avoid pipe failure. That said, as with any predictive model, the output of the analysis performed herein should not be treated as absolute. Additional future inspection data of the Novi Road PCCP Water Transmission Main will help in reducing the uncertainty associated with this analysis by updating the degradation model. Table 7.2 below summarizes the results of the predictive modelling of the Novi Road PCCP Water Transmission Main.

Table 7.2. Summary of Predictive Results

Year	Predicted Cumulative Pipe Failure	Predicted Pipe Count with Low PoE (<=1%)	Predicted Pipe Count with Medium PoE (1% to 10%)	Predicted Pipe Count with High PoE (>10%)
2025	0	1146	0	0
2030	0.3	1142	4	0
2035	0.8	1142	0	4
2040	1.2	1142	0	4
2045	2.2	1142	0	4
2050	6	1142	0	4
2055	15.2	561	581	4

Based on the current analysis, it is recommended that the Novi Road PCCP Water Transmission Main to be re-inspected within seven (7) to ten (10) years from the date of the last inspection. Following the re-evaluation, the current analysis should be performed again to re-establish the failure prediction results based on the new and updated inspection dataset.

8. Conclusions and Recommendations

Conclusions

Based on the findings of SmartBall and PipeDiver inspections, transient pressure monitoring, AWWA C304 analyses, FEA and predictive, Pure Technologies determined the following:

- Electromagnetic inspection of the Novi Road PCCP Water Transmission Main identified eight (8) PCCP pipes were identified with broken prestressing wires, ranging from 5 to 30 as well as across the entire length of the pipe.
    - 2020 Inspection determined that a total of eight (8) pipes displayed electromagnetic anomalies consistent with prestressing wire damage. Of those eight (8) distressed pipes, 4 pipes (Pure Reference Number 10324, 10327, 10356, and 10367) were repaired with carbon fiber reinforced polymer (CFRP) in March 2024.
    - 2024 Inspection determined that zero (0) pipes in the Novi Road PCCP Water Transmission Main displayed electromagnetic anomalies consistent with prestressing wire damage.
- A total of four (4) feature-related leaks were detected during the 2019 and 2023 SmartBall inspection. The three (3) leaks identified in 2019 were caused by valves that were not fully shut during the inspection and were repaired. In 2023, a medium size leak detected was at Station 100+50, a fire hydrant used to dewater extraction.
- The AWWA C301design analysis evaluation:
    - 36-, 30- and 24-inch LCP pipes across various ground covers satisfy the criteria in the AWWA C301 Design Standard in place at the time the pipes were manufactured using the design operating pressure of 175 psi and a design operating plus surge pressure of 245 psi.
- The AWWA C304 design analysis evaluation:
    - 36-, 30- and 24-inch LCP pipes across various ground covers indicated that all Elastic Limit criteria and all Strength Limit criteria were satisfied.
    - 36-inch LCP Class A design with 8-feet depth of cover, 30-inch LCP Class N/A with 6-feet depth of cover and 24-inch LCP Class # N/A indicated that two (2) of the Serviceability Limit State criteria were not satisfied:
        - The criteria for core decompression and the criteria for coating cracking were above the allowable limits.
    - The AWWA C304 analysis for the 30-inch LCP Class # 184 with 8-feet depth of cover indicated that one (1) of the Serviceability Limit State criteria, Core Decompression was not satisfied.

- The Pipe Performance Curves were developed for 36-, 30- and 24-inch LCP pipes across various ground covers using the maximum observed pressure of 121 psi was. No distress was identified during 2024, therefore FEA evaluation for pipe 36-inch Class A LCP inspected in 2020 concluded:
    - One (1) pipe exceeded the yield limit at the maximum observed operating pressure.
    - Zero (0) pipes exceeded the strength limit at the maximum observed operating pressure.
    - One (1) pipe could not be correlated because the number of wire breaks could not be determined.
- The Predictive Modelling Analysis determine that in year 2055, a cumulative number of 15 pipes are expected to exceed the intervention limit for the Novi Road PCCP Water Transmission Main. Note that this projection does not take into account failure through other modes, such as leaks due to corrosion in the steel joint rings.

Recommendations

The Novi Road Water Transmission Main inspection exhibits approximately 0.7 percent distress rate, which is well below the average of four (4) percent observed on prior projects performed by Pure Technologies for all clients. Based on the electromagnetic and acoustic inspection results, transient pressure monitoring, structural design analysis, and predictive analysis Pure Technologies would like to propose the City of Novi take the following actions for ongoing management of the Novi Road PCCP Water Transmission Main:

- Based on the condition of the prestressing wire wraps, the primary component of prestressed concrete cylinder pipe providing concrete compression and following the March 2024 CFRP repairs, no remedial action is required at this time.
- Continue to operate the Novi Road PCCP Water Transmission Main following industry best practices, focusing specifically on maintaining a stable, consistent pumping process and operating pressure, stable above ground conditions and external loading on the pipe, and routine maintenance of features such as air valves and inline valves.
- Reinspect the Novi Road Water Transmission acoustically and electromagnetically in seven (7) to ten (10) years, or sooner if operating conditions change significantly, proactively managing the future serviceability of the watermain.

9. References

1. American Concrete Pipe Association (ACPA), 2007. Concrete Pipe Design Manual, Vienna: ACPA.
2. American Water Works Association (AWWA), 1984. AWWA C301 Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, For Water and Other Liquids, Denver, Colorado.
3. American Water Works Association (AWWA), 2014. AWWA C304 Standard for Design of Prestressed Concrete Cylinder Pipe, Denver, Colorado.
4. American Water Works Association Research Foundation (AWWARF), 2007. Failure of Prestressed Concrete Cylinder Pipe, Denver, Colorado.
5. Galleher J.J., Stift M.T., 1998. Internal Inspection and Database Development of PCCP, Pipelines in the Constructed Environment, ASCE, Reston, VA, pp. 721-730.
6. Interpace, Lock Joint Concrete Pressure Pipe, 1973. Engineering Manual. Cherry Hill.
7. Kennison, Hugh F., 1950. Design of Prestress Concrete Cylinder Pipe, Journal American Water Works Association, Vol. 42, No. 11, November, pp. 1049-1064
8. Knowles W.L.C., 1990. Failure of Prestressed Concrete Embedded Cylinder Pipe, Design and Installation, Kenneth Kienow ed., ASCE, NY, pp. 434-441.
9. Ojdrovic R.P., Zarghamee M.S., Hegar J.R., and Westman T., 2001. Condition Assessment of a PCCP Line Accessible from Outside Only, Pipelines 2001-Advances in Pipeline Engineering & Construction, Joseph Castronov ed., ASCE, Reston, VA (CD-ROM).
10. Parks R.R., Drager J.K. and Ojdrovic R.P., 2001. Condition Assessment and Rehabilitation of the Windy Gap Pipeline - An Owner's Perspective, Pipelines 2001-Advances in Pipeline Engineering & Construction, Joseph Castronov ed., ASCE, Reston, VA (CD-ROM).
11. Price R.E., 1990. The Investigation Cause and Prevention of PCCP Failures, Proceeding AWWA Annual Conference, pp. 663-681.
12. Price R.E., Lewis R.A., and Erlin B., 1998. Effects of Environment on the Durability of Prestressed Concrete Cylinder Pipe, Pipelines in the Constructed Environment, ASCE, Reston, VA, pp. 584-593.
13. Villalobos J.L., 1998. Effects of Prestressed Concrete Pipe in a High Chloride Environment after 19 Years of Service, Pipelines in the Constructed Environment, ASCE, Reston, VA, pp. 575-5.

APPENDIX A

Glossary & Abbreviations

ARV: Air Release Valve

AV: Air Valve

BO: Blowoff

BWP: Bar Wrapped Pipe

CIP: Cast Iron Pipe

DIP: Ductile Iron Pipe

ECP: Embedded Cylinder Pipe

EL: Elbow

EM: Electromagnetic

GV: Gate Valve

HDPE: High Density Polyethylene

LCP: Lined Cylinder Pipe

LS: Lift Station

MH: Manhole

NSS: Non-Shorting Strap

OL: Outlet

PCP: Prestressed Concrete Pipe

PCCP: Prestressed Concrete Cylinder Pipe

PVC: Polyvinyl Chloride

PS: Pumping Station

PW: Pumping Wells

RCP: Reinforced Concrete Pipe

RCCP: Reinforced Concrete Cylinder Pipe

SP: Short Pipe Length

SS: Shorting Strap

STD: Standard Pipe Length

TEE: Tee-Connection

TO: Turn Out

VS: Vent Structure

WYE Wye-Connection

Amplitude: A component of the data signal produced during pipeline inspection; amplitude is an indication of signal strength.

Anomalous Pipe: A pipe that produces a data signal that cannot be interpreted as distressed or distress-free due to some irregularity. This irregularity may be due to unexplained signal influence during the inspection process or due to the properties of the pipe itself.

Calibration: A controlled inspection of a pipe similar to the in situ pipe that is performed to determine the expected signal response. The data signal recorded while inspecting the in situ pipes is then compared to this signal to estimate the number of broken wire wraps. Calibration typically requires the destructive testing of a removed pipe.

Distressed Pipe: A pipe that exhibits electromagnetic anomalies consistent with broken wire wraps. The amount of distress can be estimated by comparing the distress signal with the signal obtained during the calibration process.

Distressed Region: A section of pipe that exhibits electromagnetic anomalies consistent with broken wire wraps. There may be one or more regions of distress in any distressed pipe.

Downstream: In the direction of water flow.

Feature: Fixtures in the pipeline that affect the inspection (e.g., Manholes, Air Valves, Tees, Elbows).

Feature Pipe: Pipes with features that may be used to locate distressed pipes. The feature pipes cannot be analyzed for distress at or near the feature due to the signal distortion caused by the presence of the feature.

Joint: An area of the pipeline where two pipe ends are fixed together. Typically, pipe ends are joined spigot to bell; however, special pipes are available that join two bell ends or two spigot ends.

Phase: A component of the data signal produced during pipeline inspection; phase is a representation of the signal's travel time.

Pipe: Single section of pipe, from bell end to spigot end.

Rank: Listing of pipes with respect to the total number of broken wire wraps in the pipe (descending order).

Rolling Motion: The measurement of the SmartBall tool's heading and end-over-end rolling motion using onboard accelerometer and gyroscope sensors.

Upstream: Against the direction of water flow.

APPENDIX B

History of PCCP

Overview of Prestressed Concrete Cylinder Pipe

B.1.1. PCCP History and Manufacturing

PCCP has been used for large diameter water transmission and distribution mains since 1942. PCCP is a complex, composite structure consisting of a concrete core, a thin steel cylinder, a high-strength steel prestressing wire, and a mortar coating. The concrete core and prestressing wire are the main structural components, while the steel cylinder acts primarily as a water barrier. The prestressing wire produces a uniform compressive force on the concrete core that holds the concrete in compression when the pipe is subjected to internal water pressure and external loading. A mortar coating surrounds the prestressing wire, embedding the wraps in an alkaline environment to protect them from external corrosive influences and physical damage.

Two types of PCCP are used in transmission mains: lined cylinder pipe (LCP) and embedded cylinder pipe (ECP). In LCP, the prestressing wire is wrapped directly against the steel cylinder, while in ECP, the steel cylinder is embedded in the concrete core, meaning that the prestressing wire is wrapped against the outer concrete core rather than the steel cylinder. The diameter ranges for LCP and ECP are 16 to 60 inches and 30 to 256 inches, respectively. Cross-sectional views of LCP and ECP, as described in the current AWWA C304-14 Standard, Design of Prestressed Concrete Cylinder Pipe, are shown in Figure D.1.

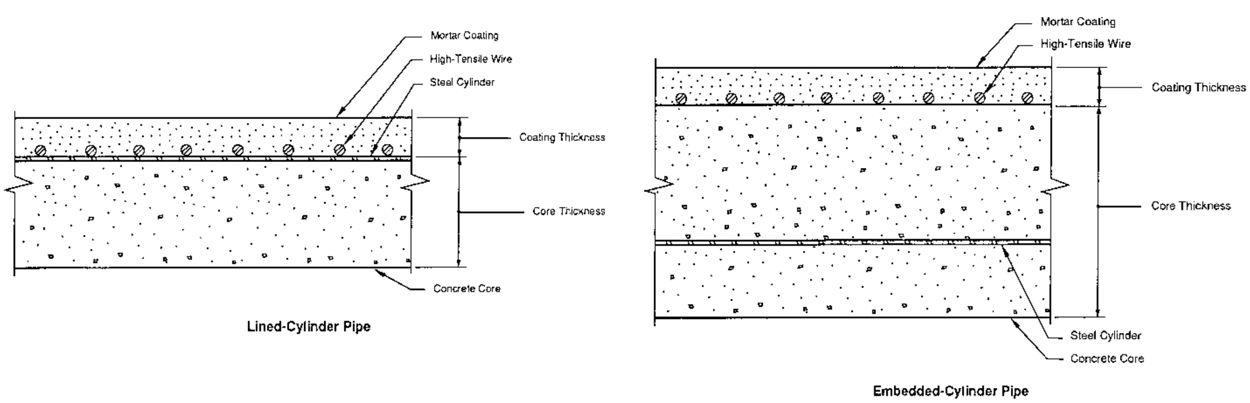


Figure B.1: Cross Sectional Views of PCCP

PCCP design and manufacturing standards have gradually developed since 1943, with the first tentative consensus standard for PCCP being approved by the AWWA in 1949. The AWWA C301 *Standard Specifications for Reinforced Concrete Water Pipe - Steel Cylinder Type, Prestressed* (AWWA C301-52) was revised multiple times, with the latest revision being released in 2014. In 1992, the AWWA created a new standard for PCCP design and manufacturing called AWWA C304 *Design of Prestressed Concrete Cylinder Pipe* (AWWA C304).

The initial structural design requirements for the manufacturing of PCCP tended to be conservative, with high factors of safety. As experience with using this composite pipe grew, understanding of the behavior of PCCP increased, and advances in material sciences were achieved, the structural design of PCCP was changed to reduce the cost of manufacturing. Increases in the applied tensile strength of the wire that occurred during manufacturing in the late 1960s and early 1970s reduced the amount of prestressing steel wire required and allowed for the use of smaller diameter wire. This resulted in what appeared to be a more efficient design and cost-effective manufacturing process.

Changes in PCCP design with respect to the prestressing wire were primarily based on updates to the American Society for Testing and Materials (ASTM) A227*, Standard Specifications for Hard-Drawn Steel Spring Wire,* and ASTM A648*, Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Pipe*. The updated standards significantly changed the composition of the steel prestressing wire in order to increase its tensile strength. Tensile strength is defined as the amount of stress the wires are able to withstand before either permanent deformation or failure occurs. Increasing the material strength by modifying the composition of the steel and the manufacturing process allowed for a reduction in the overall amount of steel needed to achieve the minimum tensile strength required for the pipe design. This created a cost reduction for the pipe manufacturer and provided a cost advantage for the pipe owner. Due to the competitive cost of PCCP in comparison to other pipe materials, its popularity grew significantly with water and wastewater utilities in the United States for their large diameter pressure pipelines in the 1960s and 1970s.

Updates to the ASTM standards and the adoption of the AWWA C301-64 Standard in 1964 led to significant changes in the design and manufacture of PCCP that decreased the minimum prestressing wire diameter, increased the allowable concrete core stress when the wire was wrapped, reduced the amount of Portland cement in the core, and decreased the minimum coating thickness. As the ASTM standards changed and wire strength increased, classifications of wire were developed based on their tensile strength (Class I, Class II, and Class III).

These practices culminated in the 1970s when pipes using an even stronger Class IV wire and other cost saving measures were manufactured. Class IV wire was produced by using a loophole in the ASTM and AWWA standards, which did not define a maximum tensile strength. Class IV prestressing wire was drawn at very high temperatures to increase the ultimate tensile strength and thereby reduce the amount of steel required. All classes of prestressing wire are susceptible to external corrosion, hydrogen embrittlement, and other failure modes; however, the high temperatures used to manufacture Class IV wire made it particularly sensitive to hydrogen embrittlement and dynamic strain aging effects. Pipe from this era using Class IV prestressing wire started experiencing a high rate of premature failures, primarily related to the new standards and manufacturing processes.

Updates to the AWWA C301 Standard beginning in the 1980s have significantly improved the design and manufacturing of PCCP, increasing the quality of pipe produced and installed. The major revisions in the standards, design, and manufacturing of the PCCP consisted of changes in the maximum diameter of the PCCP, the quality (strength) of the concrete, the thickness of the steel cylinder, the prestressing wire specifications (e.g., wire diameter, wrapping stress, spacing), and the thickness of the mortar coating.

Figures B.2 (a), B.2 (b), and B.2 (c) provide graphic representations of the minimum steel cylinder thickness, prestressing wire diameter, and mortar coating thickness required by the AWWA C301 and AWWA C304 Design Standards between 1949 and 2014.

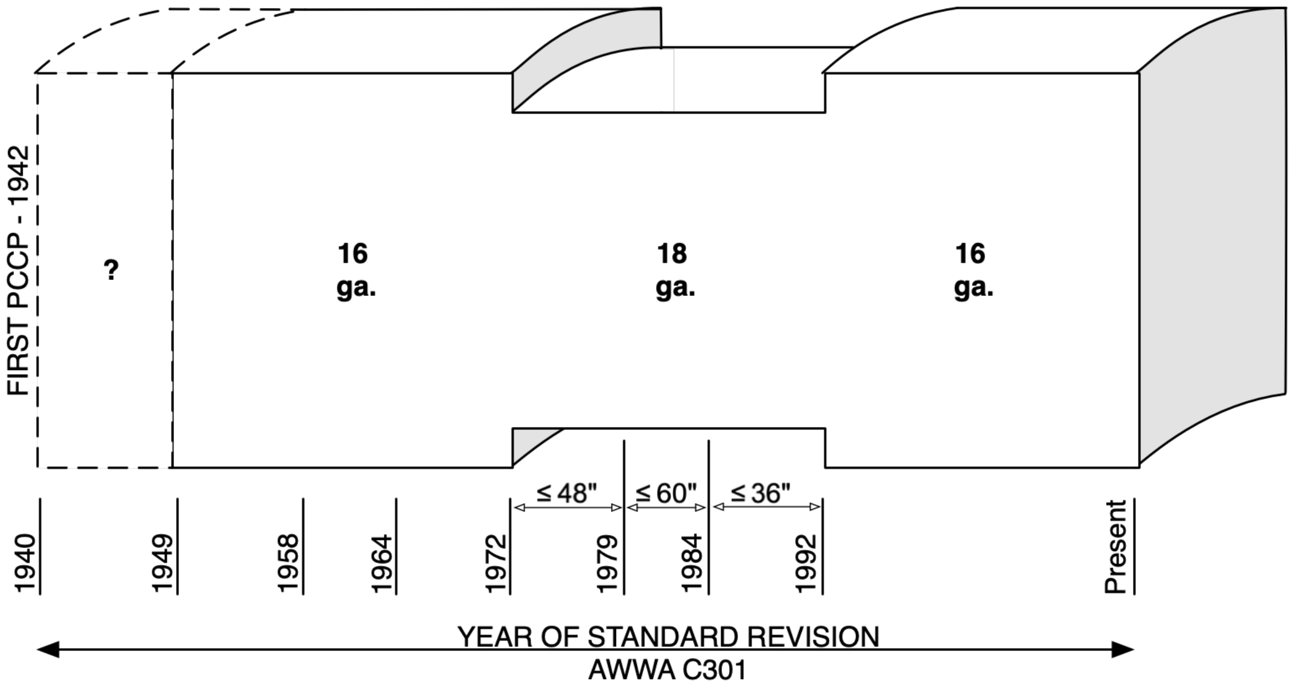


Figure B.2 (a): Minimum Required Steel Cylinder Thickness

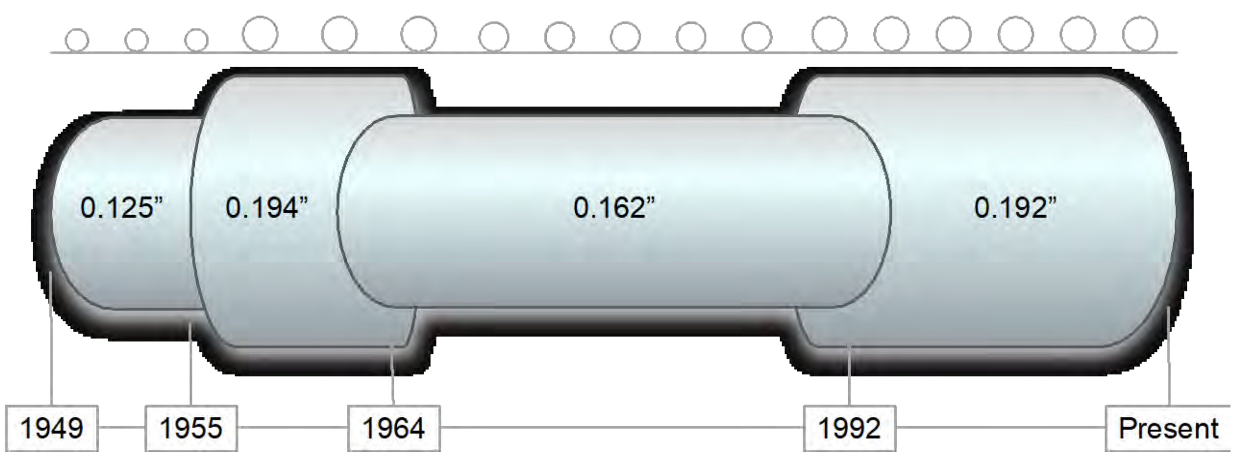


Figure B.2 (b): Minimum Required Size of Prestressing Wires

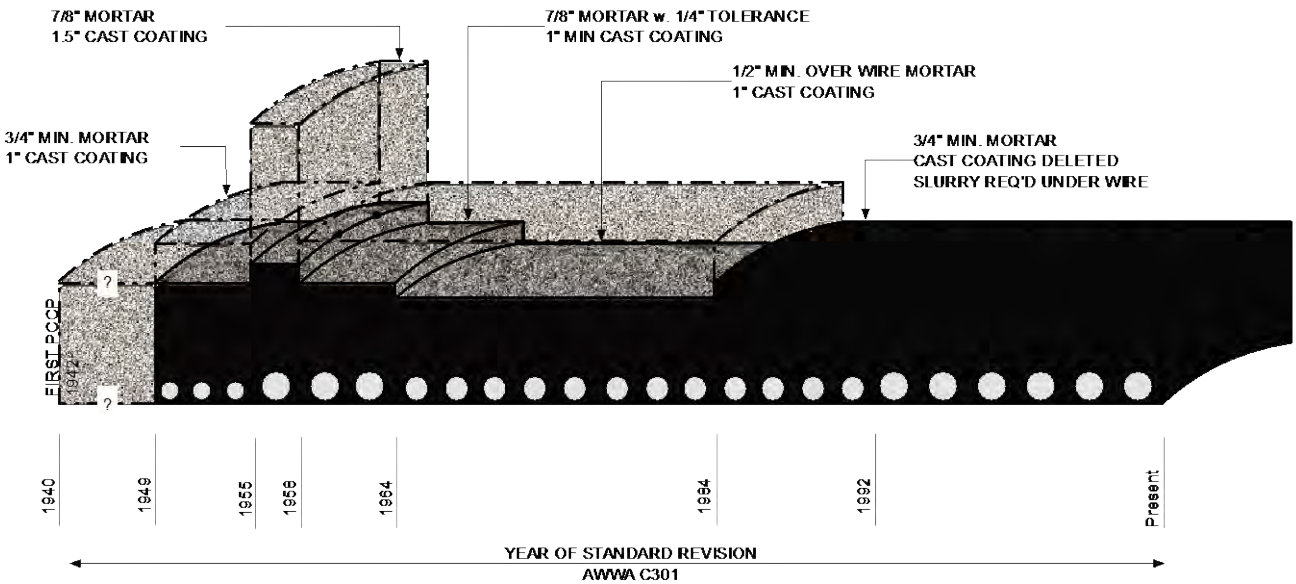


Figure B.2 (c): Minimum Required Mortar Coating Thickness

B.1.2 PCCP Failure Modes

Several causes for PCCP failure have been reported in the literature including: a high chloride environment, poor quality of mortar coating, poor quality of prestressing wire, a corrosive environment, inadequate thrust resistance, construction damage, cracks in the cylinder welds, and delamination of coating. Failure, as defined in the AWWA Research Foundation 'Failure of Prestressed Concrete Cylinder Pipe' Report, is the loss of use of a pipe section or reduction in confidence in that pipe section to remain in service, after discovery of a pipe section deficiency.

Most PCCP failures result from a breakdown of the mortar coating leading to corrosion or hydrogen embrittlement of the prestressing wire wraps. This causes incremental wire break damage that grows with time until the pipe eventually ruptures. As each wire wrap breaks, the individual pipe's strength is incrementally reduced. A summary of PCCP failures, as reported in the AWWA Research Foundation report, include:

- Ruptures or breaks in the prestressing wire wraps
- Leaking at the joints
- Cracks in the concrete core
- Low quality concrete core (poor concrete strength)
- Hydrogen sulfide (H_2S – wastewater applications)
- Dents in the PCCP due to fabrication and construction defects
- Overwrapping of the prestressing wire, resulting in the wire wraps being spaced too closely
- Inadequate total prestressing in the pipe
- Loss of prestress during production
- Missing joint coating

- Cracking in the cylinder welds (poor fit up)
- Low quality prestressing wire
- Overloading due to excessive dead load and live load during service life
- Excessive surge pressures
- Inadequate total prestressing following a wire splice
- Low quality of mortar (low density, low thickness, low cement content)
- High chlorides in the soil (corrosive or aggressive soil)
- Poor bedding
- Hydrogen embrittlement
- Construction damage (coating damaged and not repaired)
- Coating delamination
- Cracking in the joint welds
- Hydrotest pressure in excess of the design pressure
- Excessive external load (greater than the design load)
- Inadequate joint restraint (pipe moved, exposing the joint to the environment

B.1.3 PCCP Failure Rate by Pipe Vintage

A comparison study of pipe failures to their manufactured date indicates the consequence of "Class IV" wire showing a failure rate that is orders of magnitude higher than other vintages. The failure rate for pipes manufactured between 1979 and 1991 decreased dramatically as liberal design and manufacturing standards were identified and corrected beginning in the late 1970s and early 1980s. The summary of pipe failures by manufacturing date is shown in Figure B.3 and the rates of PCCP distress are shown in Figure B.4.

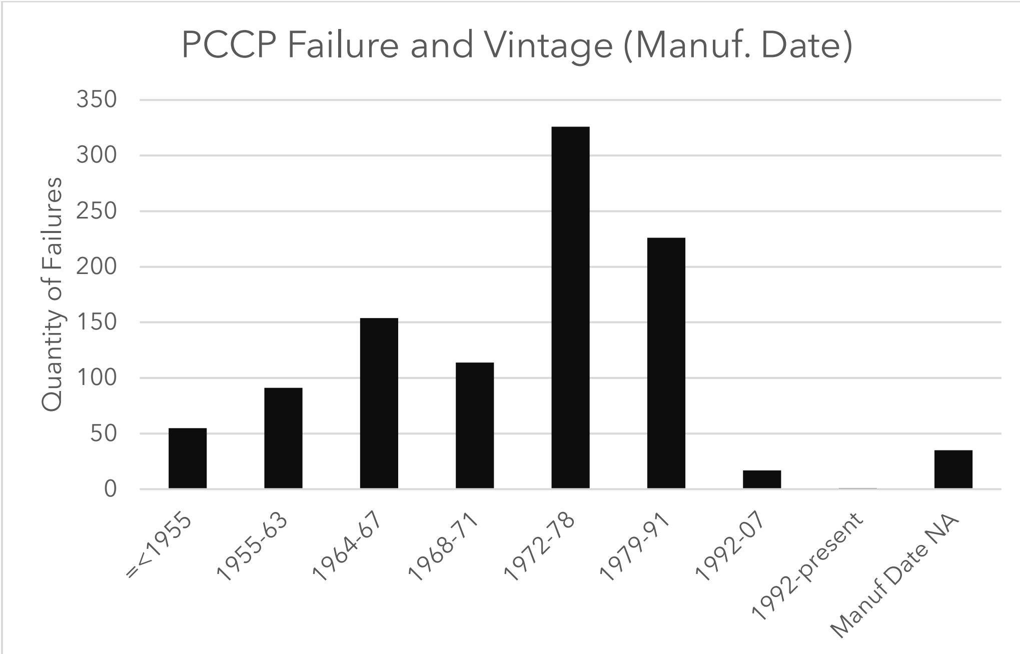


Figure B.3: Pipe Failures Recorded by Manufacturing Date

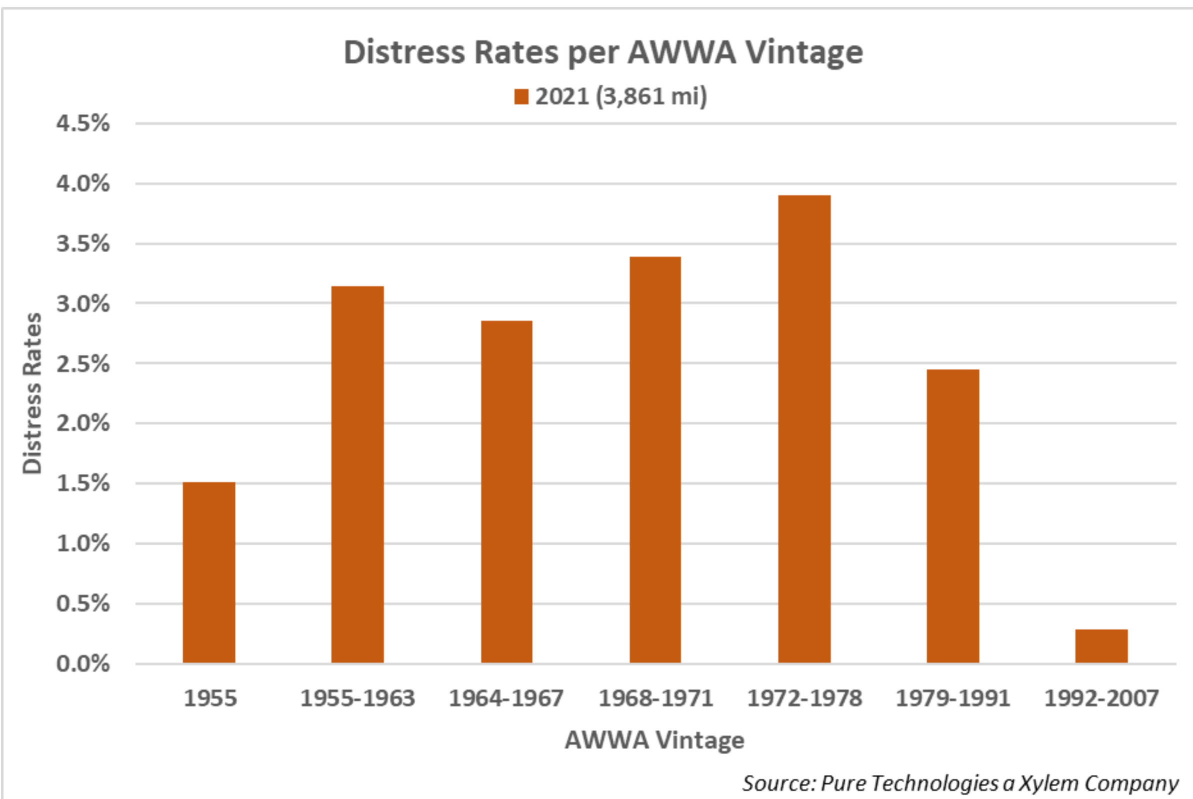


Figure B.4: Average PCCP Distress Rates per AWWA Vintage based on 3,861 miles of Electromagnetic Inspection

APPENDIX C

SmartBall® Inspection Reports

SmartBall® Inspection Report

10 Mile Road PCCP Water Main

DRAFT

Prepared for:

The City of Novi

By:

Pure Technologies U.S. Inc., a Xylem brand

December 2019

4820 Poplar Place Drive, Suite 200 | Louisville, KY 40213 | puretechltd.com

SmartBall® Inspection Report

10 Mile Road PCCP Water Main

DRAFT

Prepared for:

The City of Novi

Prepared by:

Pure Technologies U.S. Inc., a Xylem brand

December 2019

Quality Assurance and Quality Control Statement

By my signature I attest that this report has been prepared and reviewed in accordance with the Pure Technologies U.S. Inc., a Xylem brand. Quality Assurance and Quality Control procedures:

Heather A. Schuchard, Program Manager Date

Table of Contents

Appendices:

Executive Summary

The City of Novi (City) retained the services of Pure Technologies U.S. Inc., a Xylem brand (Pure Technologies) to inspect the 10 Mile Road Prestressed Concrete Cylinder Pipe (PCCP) Water Main located in Novi, Michigan. A SmartBall® leak and air pocket detection inspection of the 10 Mile Road Water main was conducted on October 29, 2019. The purpose of the SmartBall inspection was to identify and locate leaks and pockets of trapped air along the pipeline.

The inspection was split into two segments starting at the Novi Road and W. 10 Mile Road intersection: the first proceeding approximately 2,269 feet east and the second proceeding approximately 5,235 feet west. The completed SmartBall[1] inspection scopes are highlighted below in Table ES.1.

Table ES.1: Completed Inspection Scope		
Technology	**SmartBall**	**SmartBall**
Segment	East	West
Pipe Material	PCCP; LCP	PCCP; LCP
Starting Location	New 18-inch tap installed near 24259 Novi Rd. - approximately 250 feet north of the intersection of Novi Road and W. 10 Mile Road (estimated to be Station 108+84)	
Ending Location	Fire Hydrant near 42700 W. 10 Mile Rd. approximately 780 feet west of Myrtle Ct. (estimated to be Station 3+00)	Fire Hydrant near 45255 W. 10 Mile Rd. approximately 315 feet west of Glenda St. (estimated to be Station 4+92)
Diameter of Pipe (inch)	16	16
Total Inspected (feet)	2,269	5,235
Duration of the Inspection	13 min	1 hour, 10 min
Average Tool Velocity	2.8 ft/s	1.2 ft/s

Both SmartBall inspections covered a total length of 7,504 feet (1.42 miles) of 16-inch PCCP. Pure Technologies detected three (3) acoustic events characteristic of leaks and zero (0) acoustic events characteristic of pockets of trapped air. A summary of the SmartBall inspection results is shown in Table ES.2.

[1] Additional SmartBall and PipeDiver inspection footage was also planned for this week, however an inoperable 30-inch valve will require this inspection to be performed at a later date (and results will be documented under separate cover).

Table ES.2: Summary of SmartBall Inspection Results				
Pipeline	**Diameter (inches)**	**Total Length Inspected (feet)**	**Leaks Detected**	**Pockets of Trapped Air Detected**
10 Mile Road East Segment	16	2,269	1 (Medium)	0
10 Mile Road West Segment	16	5,235	2 (Large)	0
Total		**7,504**	**3**	**0**

1. Project Background and Location

The pipeline included in this SmartBall inspection is approximately 7,504 feet (1.42 miles) of 16-inch and 24-inch PCCP Water Main located along W. 10 Mile Road between Glenda St. and Myrtle Ct. Owned and operated by the City, this pipeline is composed of lined cylinder pipe (LCP), a form of PCCP. According to Record Drawing 5653-00 (Novi and Ten Mile Road Watermain Extension), the pipeline was installed in 1976 and is approaching 45 years of age. A large portion of the City's customers receive their potable water from this distribution main, including the Lower and Intermediate Water Pressure Districts in the south half of the City. Due to these project drivers, the City has identified this to be a critical pipe segment and a proactive condition assessment is needed to ensure consistent and reliable water service.

The inspection was split into two segments: the first spanning from a newly-installed 18-inch tap and 6-inch gate valve (Station 108+84) eastward to a fire hydrant (Station 3+00) and the second spanning from a newly-installed 18-inch tap and 6-inch gate valve (Station 108+84) westward to a fire hydrant (Station 4+92).

An overview of the water main inspection is shown in Figure 1.1.

Figure 1.1: Inspection Overview

2. Inspection Details

2.1 Planning Document and Drawing Review

The City provided Pure Technologies with drawings for review in order to complete the planning of this project. A list of all material provided is shown below.

- Thompson Pipe Group / Interpace Corporation. "SB-77-1 Pipe Specifications". Sheet 1-20. January 1977.
- Johnson & Anderson, Inc. Consulting Engineers. *"Novi 10 Mile Rd Water Main."* Job No. 5653-00. Sheets 1 – 24, of 24. December 1976.
- Spalding DeDecker Associates, Inc. Engineering Consultants. *"Novi Road, North of Ten Mile to Main Street, City of Novi"* Project No. 476-00-141. Sheets 1, 2, 35, 38, 43, 46, 47, 51, 55, 56, 60, 63, 67, 70, 74, 78. May 2012.

Once this background information was evaluated, team members from Pure Technologies performed a site visit on June 26, 2019. This site visit confirmed there were many discrepancies between the record drawings and the asset type/size actually found in the field. Thus, Wachs Water Services performed a Valve Assessment along the pipeline to confirm operability and specifications. With this information, a draft planning document was delivered the City on August 28, 2019, that described the upcoming SmartBall inspection and advance preparations.

2.2 Valve Configuration and Flow Testing

As described in the planning document, the pipeline was required to be isolated to avoid having the tool travel down an unintended path. All valves on offtakes and connections were closed and remained closed for the duration of the inspection. In addition, all inline valves remained fully open. Figures 2.1 and 2.2 illustrate the valve configuration requirements which were performed by City staff.

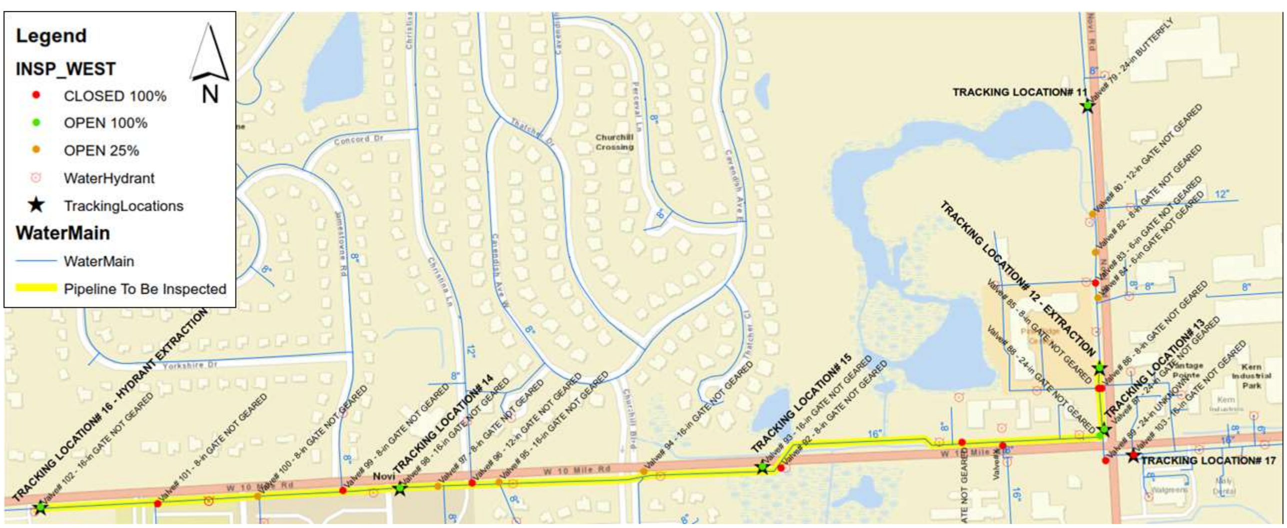


Figure 2.1: Valve Configuration for the West Inspection

Figure 2.2: Valve Configuration for the East Inspection

Since fire hydrants were used as the extraction location, the fire hydrant at Station 3+00 and Station 4+92 were opened for the east and west inspection, respectively. A hose was used to direct the water into a nearby storm manhole. Pure Technologies installed a flow meter at the insertion location and measured flow prior to launching the tool. The goal was to obtain constant water velocity of 2.5 feet per second (in the 24-in, this equates to 3,528 GPM or 1,568 gpm or 5.08 mgd). Due to the turbulence experienced during the east inspection, the SmartBall was launched when the flow meter recorded an average flow of approximately 2.0 fps. For the west inspection, the flows were reduced, and hydrant dialed back by 1 or 2 turns to decrease the velocity.

Figure 2.3: Fire Hydrant Configuration

2.3 SmartBall Tool Insertion

The SmartBall tool was inserted into the newly-installed 18-inch tap with 6-inch gate valve. This location is approximately 315 feet north of the intersection of Novi Road and W. 10 Mile Road (estimated to be Station 108+84). The tool was inserted using Pure Technologies' custom insertion claw, which is used to push the SmartBall tool into a live, pressurized pipeline without interruption to flow. This insertion location and method was utilized for both eastern and western inspections. Figure 2.4 below shows the SmartBall tool insertion located and insertion equipment installed.

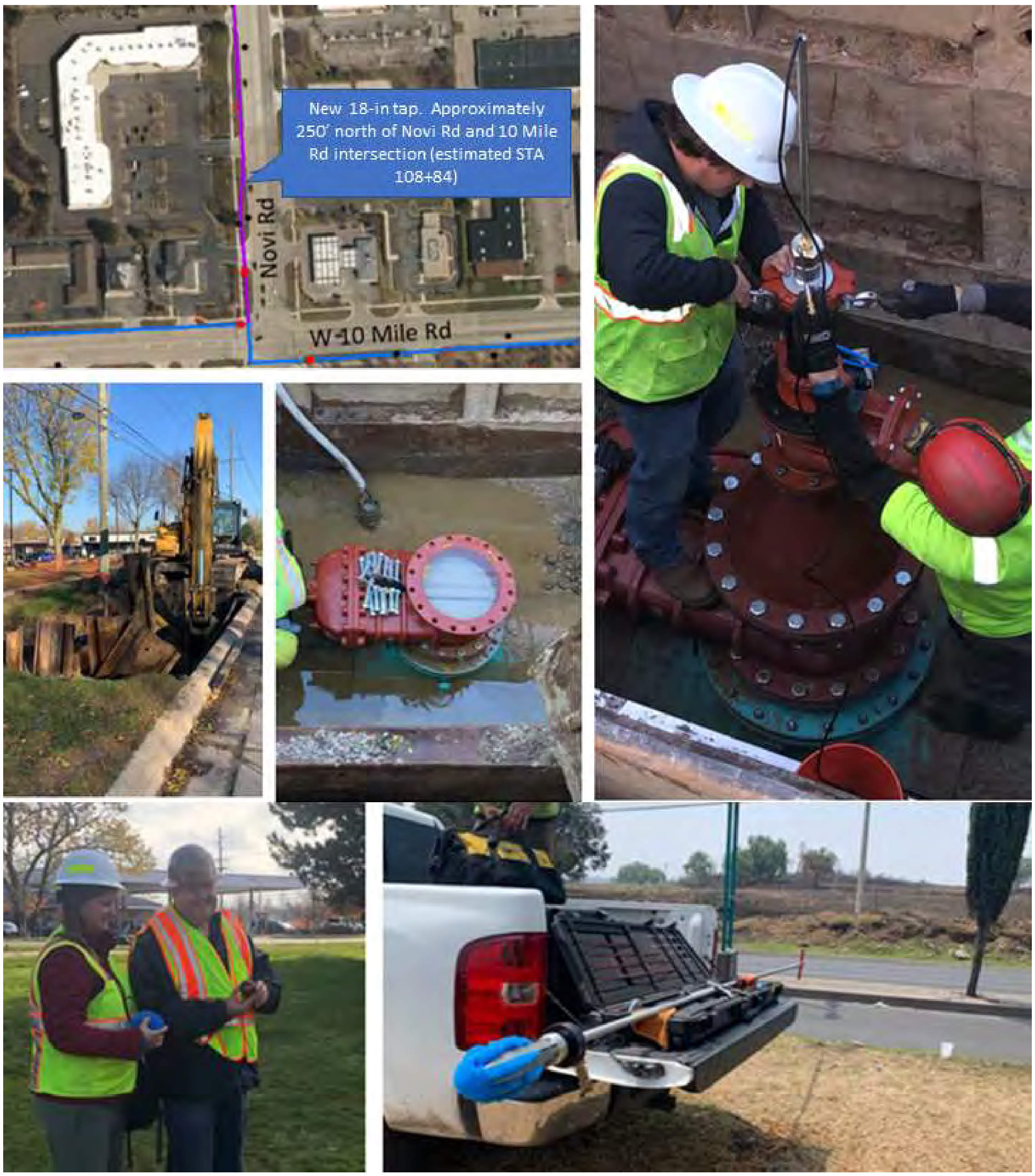


Figure 2.4: SmartBall Tool Insertion

2.4 Tool Tracking

A total of four (4) surface mounted acoustic sensors (SMS) were placed along the pipeline to track the progress of the SmartBall tool during the inspections. As shown in the figure below, two (2) tracking sensors were used for the east inspection and three (3) tracking sensors were used for the west inspection. These sensor locations are detailed in Table 2.1.

Figure 2.5: Tracking Location Map

Table 2.1: Summary of Tracking Locations				
Inspection	**SBR**	**Distance from Insertion (feet)**	**Location Description**	**Approximate GPS Coordinates**
East and West	SBR #13	0 ft	Insertion Location - new 18-inch access manhole located approximately 315 feet north of the intersection of Novi Rd. and W. 10 Mile Rd.	42.4674, -83.4748
East	SBR #17	460 ft	Inline 16-in GV located approximately 75 feet east of the intersection of Novi Rd. and W. 10 Mile Rd.	42.4665, -83.4744
West	SBR #14	1,747 ft	Inline 16-in GV located approximately 1,450 feet west of the intersection of Novi Rd. and W. 10 Mile Rd.	42.4665, -83.4801
West	SBR #15	3,258 ft	Inline 16-in GV located approximately 2,966 feet west of the intersection of Novi Rd. and W. 10 Mile Rd.	42.4663, -83.4856

*Note: Additional sensors where also installed on the Extraction Locations (fire hydrants). However, these tracking locations were deemed too noisy and were not successfully used for tracking.

During inspection, the SmartBall tool location is tracked at known points (shown above) along the alignment to correlate the inspection data with specific locations. The on-board accelerometer records the rotation of the SmartBall tool, and this data can be translated to a rate of rotation. A velocity profile for the device is then generated as it travels the entire length of the pipeline. This data and analysis are integral steps in identifying acoustic event locations. Additional information about the SmartBall technology can be found in Appendix D.

For the east inspection, Figure 2.6 below shows a plot of the distance the SmartBall tool traveled versus time of day. The slope of the plotted line indicates the instantaneous velocity of the SmartBall tool. This calculated velocity is shown versus time of day in Figure 2.7.

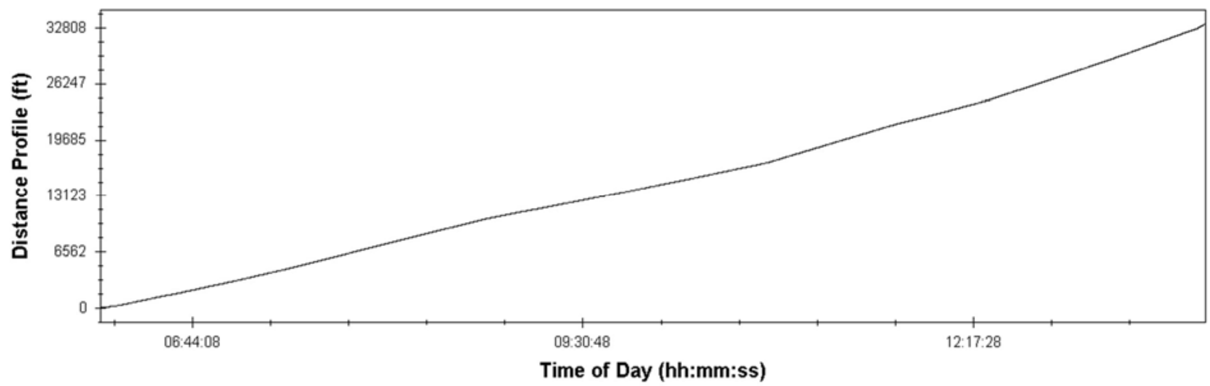


Figure 2.6: Distance the SmartBall Tool travelled versus Time of Day during the inspection (EAST)

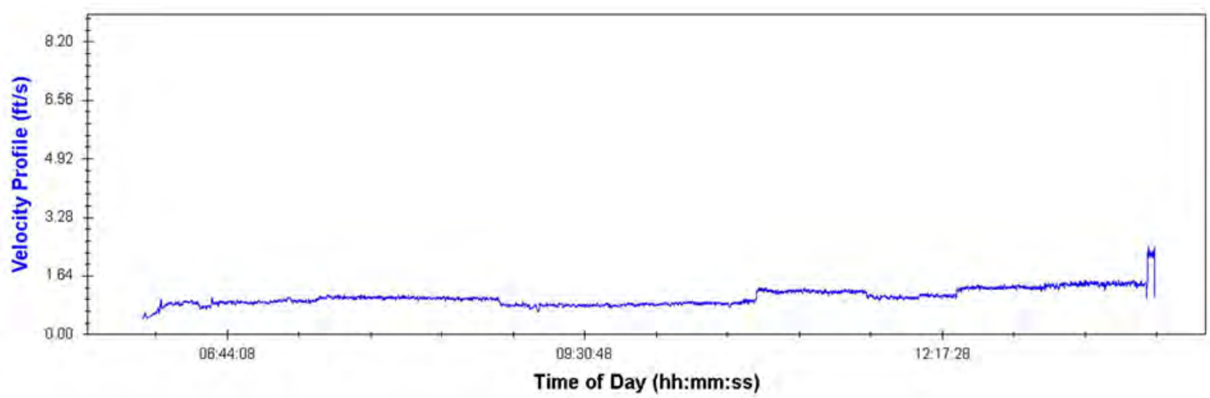


Figure 2.7: Velocity of the SmartBall Tool versus Time of Day during the inspection (EAST)

Figures below detail the results for the west inspection.

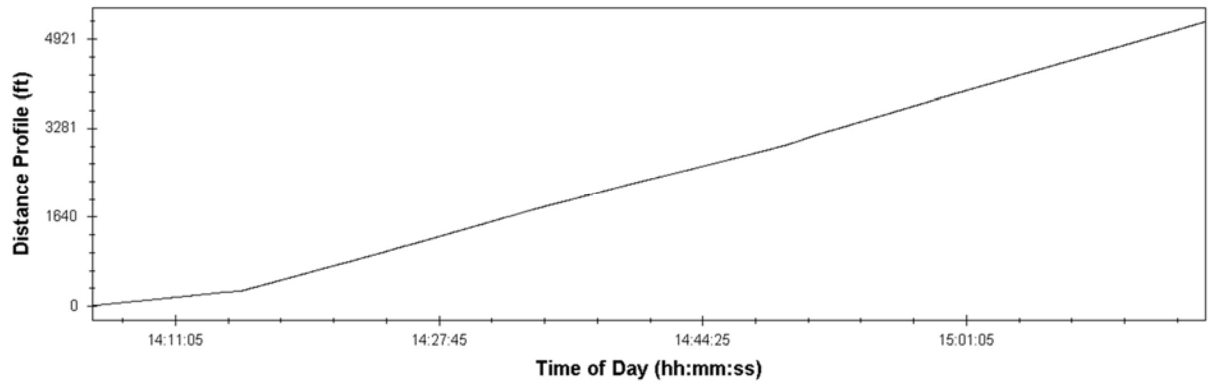


Figure 2.8: Distance the SmartBall Tool travelled versus Time of Day during the Inspection (WEST)

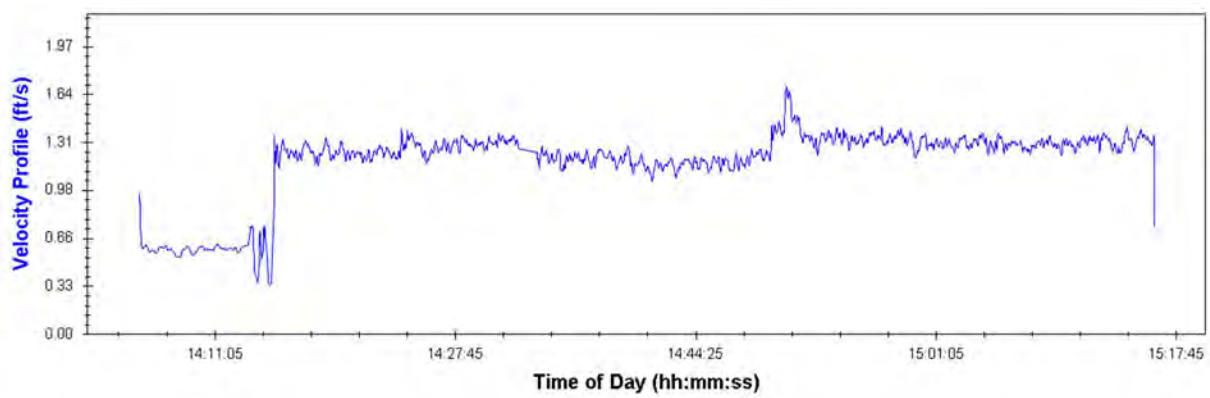


Figure 2.9: Velocity of the SmartBall tool versus Time of Day during the Inspection (WEST)

2.5 Tool Extraction

The SmartBall tools were extracted from the 16-inch PCCP water main by use of a 6-inch fire hydrant (Station 3+00 and Station 4+92 for the east and west portions, respectively). The SmartBall tool arrived within 13 minutes for the faster-flowing and shorter eastern inspection. Flow rates where slowed down a bit, and the SmartBall arrived at the extraction location within 1 hour and 10 minutes for the longer western inspection. Figures below show the SmartBall tool being removed from the pipeline.

Figure 2.10: SmartBall Tool Extraction

3. Inspection Results

Pure Technologies reports leaks as being small, medium of large:

- Small leaks are estimated to be in the range of 0-2 gallons per minute (GPS)
- Medium leaks are estimated to be in the range of 2-10 GPM
- Large leaks are estimated to be greater than 10 GPM

In addition, whenever possible, leaks are reported as one of four different types:

1. Joint Leak – a leak which, based on SmartBall data, locates on a pipe joint
2. Pipe Barrel Leak – a leak which, based on SmartBall data, locates on the barrel of a pipe section. This may be indicative of a reduction in the pipe integrity.
3. Suspected Feature Related Leak – An acoustic signature which has the properties of a leak but is near a known feature. This could indicate that either
   a. A real leak is present near the feature or
   b. The feature itself is emitting an acoustic signature resembling a leak (e.g. a partially closed valve)
4. Undetermined– SmartBall data cannot distinguish if the leak is at a joint, on the barrel or at a feature

In the case of a Suspected Feature Related Leak, Pure advises first investigating the area near the feature for a source of the acoustic signal. If the feature is found to be in working order and not generating an acoustic signature of its own, then the acoustic sound must be associated with a leak and should be investigated as such.

3.1 East Inspection Results

The acoustic data recorded by the SmartBall tool was analyzed and cross-referenced with the position data from each SBR to determine a location for each acoustic event. A summary of the leaks identified during the east SmartBall inspection is provided in Table 3.1.

Figure 3.1 shows the acoustic profile of the inspection with respect to the position of the tool within the pipeline, as detected by the SmartBall technology. The magnitude of leaks is estimated by correlating the value of the acoustic signal with historical calibration data.

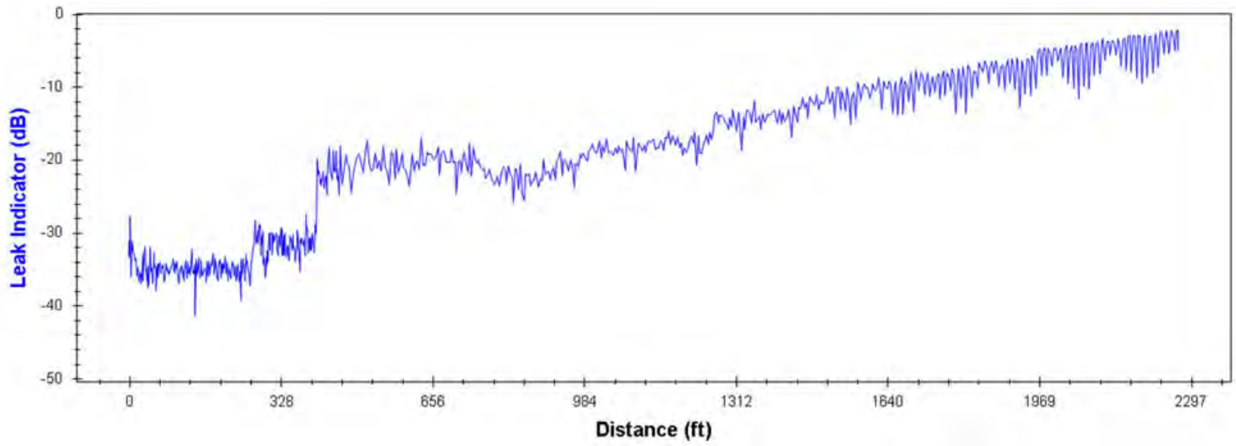


Figure 3.1: Acoustic summary of the SmartBall inspection versus Distance Traveled for the Inspection

It is important to note that this overview may contain anomalous spikes in the data. These spikes may have been caused by ambient noise around the pipeline from external sources such as pumps or nearby traffic. These sources of ambient noise are easily distinguishable from leaks or other points of interest upon analysis by trained personnel. Ambient noise generally occurs at a much lower frequency than the frequencies generated by a leak or pockets of trapped gas. The critical findings of the SmartBall inspection are summarized in Table 3.1.

Table 3.1: Summary of Leaks (East Inspection)		
Type of Leak	**Size of Leak**	**Distance from Nearest Feature**
Suspected Feature	Medium	518.4 ft after SBR 17

Additional details on the location of this potential leaks can be found in Appendix A.

Figure 3.2: General Layout of Novi East Inspection with leak locations mapped

3.2 West Inspection Results

The acoustic data recorded by the SmartBall tool was analyzed and cross-referenced with the position data from each SBR to determine a location for each acoustic event. A summary of the leaks identified during the SmartBall inspection is provided in Table 3.2.

Figure 3.3 shows the acoustic profile of the inspection with respect to the position of the tool within the pipeline, as detected by the SmartBall technology. The magnitude of leaks is estimated by correlating the value of the acoustic signal with historical calibration data.

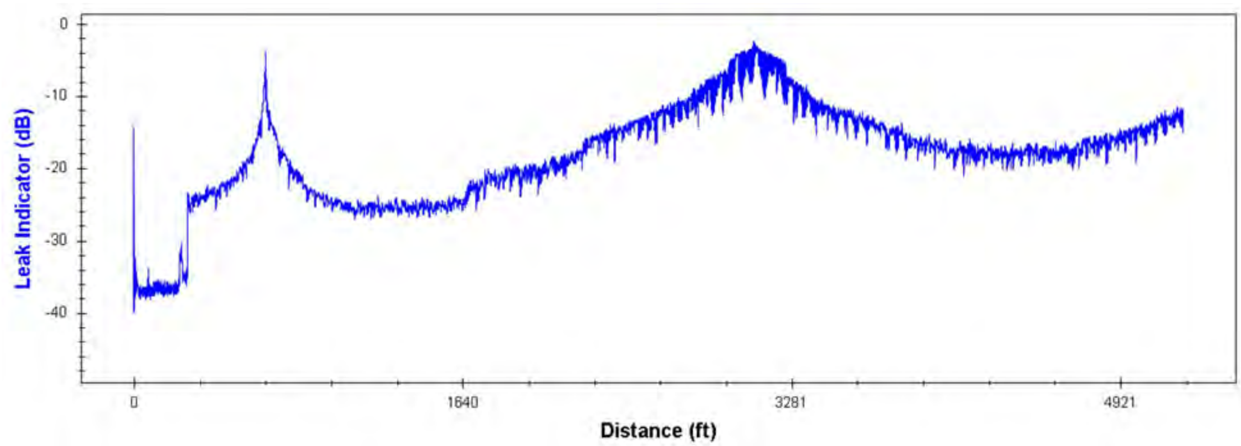


Figure 3.3: Acoustic summary of the West Inspection versus Distance Traveled

Table 3.2: Summary of Leaks (West Inspection)		
Type of Leak	**Size of Leak**	**Distance from Nearest Feature**
Undetermined if joint or barrel	Large	657.8 ft after Insertion
Suspected Feature	Large	161.1 ft before SBR 15

Additional details on the location of these potential leaks can be found in Appendix A.

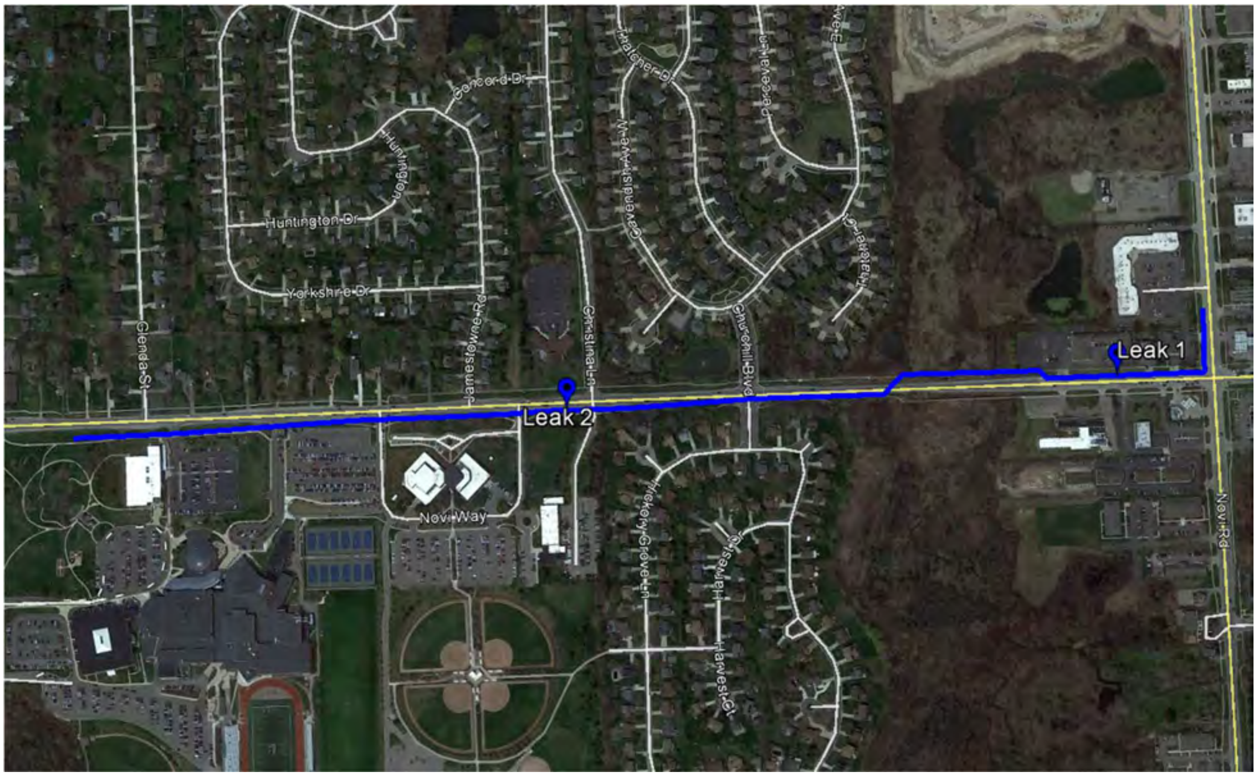


Figure 3.4: General Layout of West Inspection with leak locations mapped

4. Conclusions and Recommendations

Pure Technologies' evaluation of the 10 Mile Road PCCP Water Main concluded that:

- The SmartBall inspection covered a total length of 7,504 feet (1.42 miles) of 16-inch PCCP. Pure Technologies detected three (3) acoustic events characteristic of leaks and zero (0) acoustic events characteristic of pockets of trapped air.
- The location of two of these leaks is in close proximity to nearby features (i.e. service leads, fire hydrant leads, or another appurtenance). However, the acoustic signature and magnitude does show evidence of a medium / larger sized leak and should be further investigated immediately.
- Pure Technologies can provide additional support, such as: providing detailed Dig Sheets with measurements to assist in the leak locating and/or providing on-site assistance and staff to use hydrophone to listen/validate leak and mark pavement.

xylem
Let's Solve Water

SmartBall® Inspection Report

Novi Road PCCP Water Transmission Main

City of Novi, Michigan

Version 1.1 – October 2023

pure TECHNOLOGIES
a xylem brand

20 Truman Drive. S. | Edison, NJ 08817 | **xylem.com**

Quality Assurance and Quality Control Statements

This report has been prepared and reviewed in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies, a Xylem brand:

October 2, 2023

Philip Hwang Date
Project Manager

Editorial Review Statement

This report has been prepared and reviewed for editorial content in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies, a Xylem brand:

September 26, 2023

Linda Konopka Date
Editorial Reviewer

Technical Review Statement

This report has been prepared and reviewed for technical correctness in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies, a Xylem brand:

September 26, 2023

Dustin Park Date
Technical Reviewer

Confidentiality Clause

This report contains confidential commercial information regarding proprietary equipment, methods, and data analysis, which is the property of Pure Technologies, a Xylem brand. It is for the sole use of City of Novi, Michigan and its engineering consultants and is not to be distributed to third parties without the express written consent of Pure Technologies, a Xylem brand.

Table of Contents

Executive Summary

The City of Novi retained the services of Pure Technologies, a Xylem brand (Pure Technologies), to perform a SmartBall® inspection of the Novi Road PCCP Water Transmission Main (NRWTM) on August 23, 2023. The scope of the SmartBall inspection included leak detection and air pocket detection. The SmartBall inspection details and results are presented in Table ES.1.

Table ES.1: SmartBall Inspection Details and Results	
Pipeline Name:	Novi Road PCCP Water Transmission Main (NRWTM)
Pipe Material:	PCCP
Diameter of Pipe:	36, 30, 24 inches
Product:	Water
Inspection Start Location:	Hydrant (STA. 47+00) (Insertion/TL #1)
Inspection End Location:	18-inch tapping saddle and valve (STA. 109+84) (Extraction/TL #8)
Total Length Inspected:	11,398 feet
Duration of the Inspection:	1 hour, 35 minutes
Average SmartBall Velocity:	2.0 feet/second
Total Number of Leaks:	1
Joint Leaks	0
Barrel Leaks	0
Undetermined if Joint or Barrel	0
Feature-Related Leaks	1
Total Number of Static Air Pocket Events:	0

1. Project Background

The SmartBall inspection was performed to identify and locate a leak that was observed at a welded joint of an encasement pipe under Interstate 96 during construction activities. Note that this leak was observed for a few days and then the leak appeared to stop as it was no longer observed at the joint. The approximate pipeline location is shown in Figure 1.1. Flow proceeds from Insertion to Extraction.

Figure 1.1: Aerial View of the 36-, 30-, and 24-inch Novi Road PCCP Water Transmission Main

2. SmartBall Inspection Details

2.1. Insertion

The SmartBall Insertion was performed by pumping the SmartBall tool into the transmission main through a hydrant. The internal components of the hydrant were removed in order to allow the SmartBall tool to pass through.

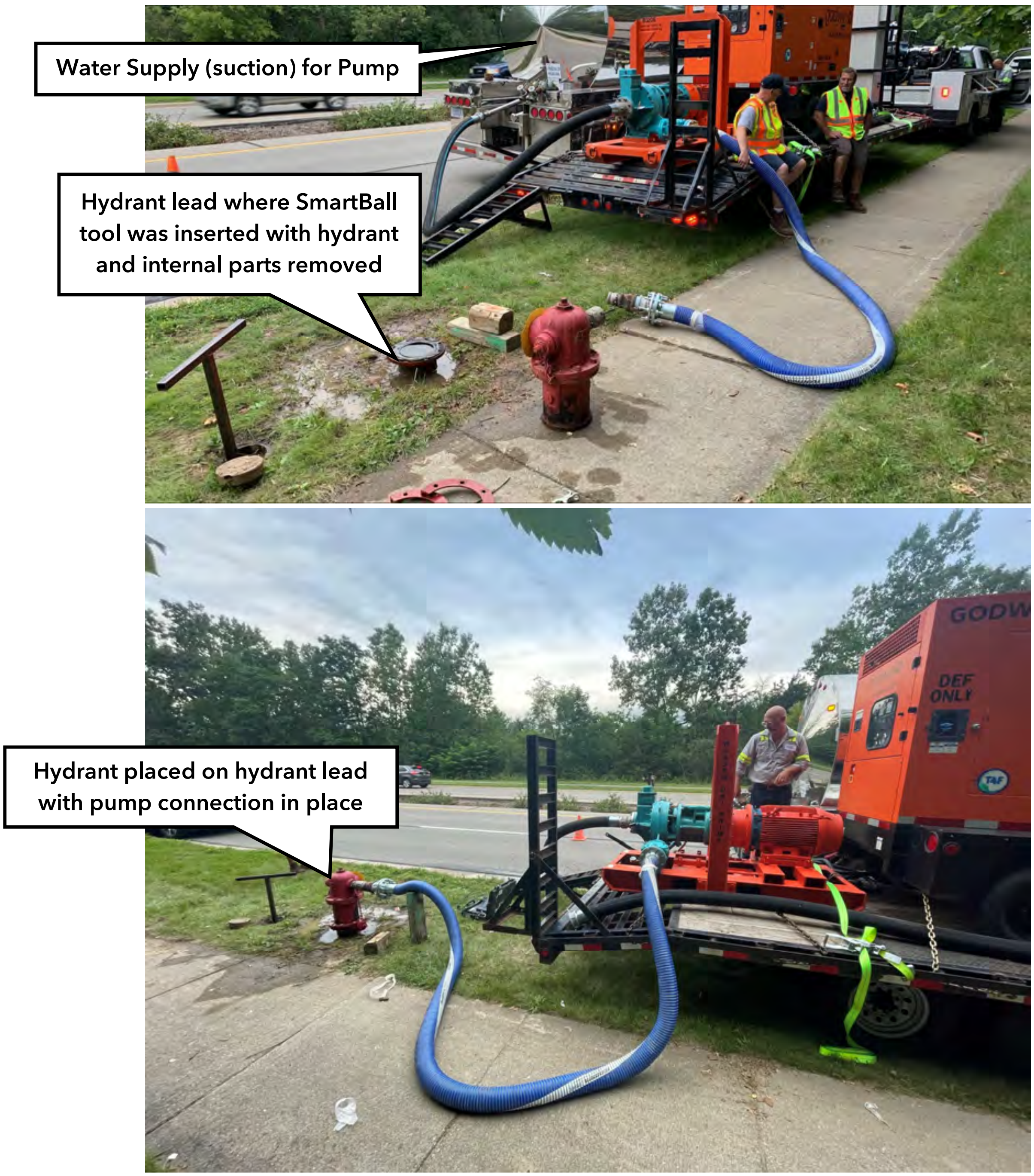


Figure 2.1: View of SmartBall Insertion Location, Pump used to push SmartBall Tool into the Main

2.2. Extraction

The SmartBall Extraction was performed by using a SmartBall net at an 18-inch tap. The tap was installed in 2019. The SmartBall net was installed during an isolation and shutdown of this section of the main the day before the inspection, on Tuesday August 22, 2023. Once the SmartBall arrived at the net, the main was isolated so the net and SmartBall could be recovered.

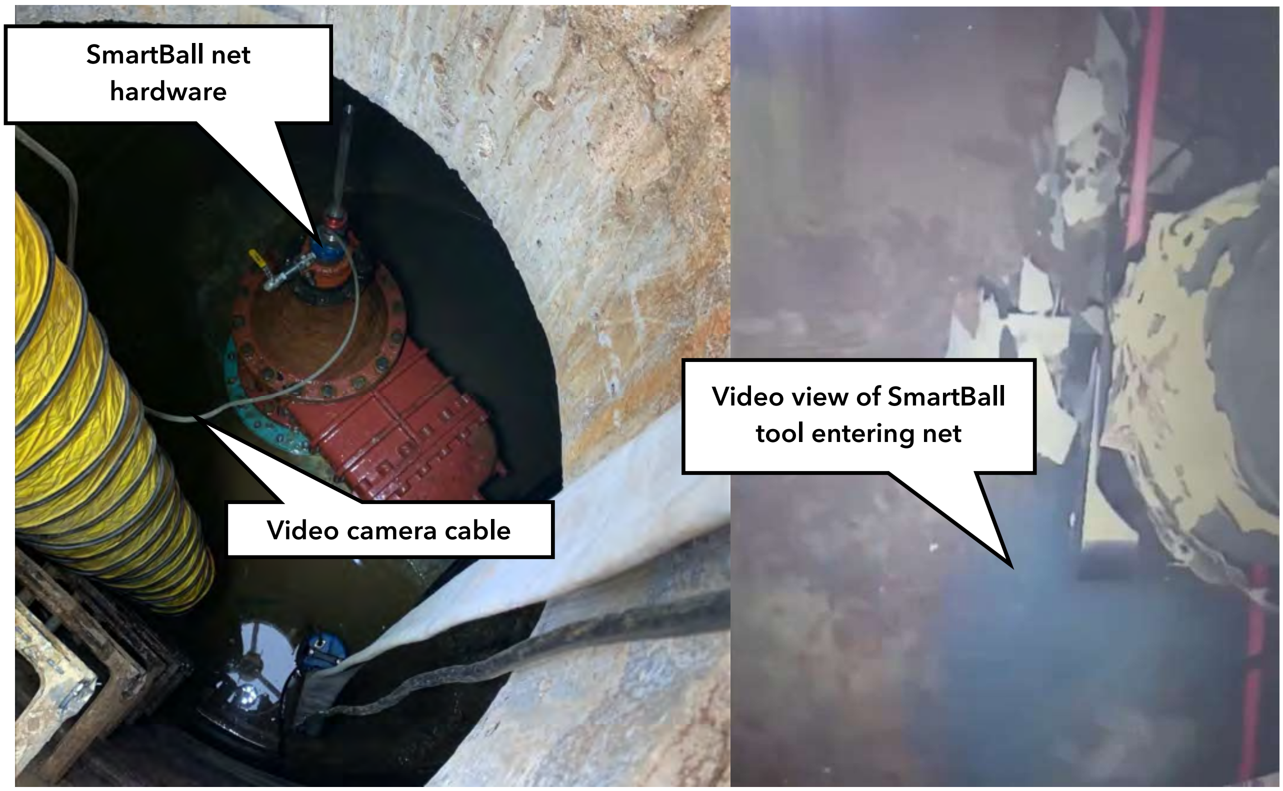


Figure 2.2: Extraction Location, Net installation (left), SmartBall Tool entering Net (right)

2.3. Tracking

The Pure Technologies' proprietary tracking devices were used to track the SmartBall inspection tool during the inspection. The tracking devices were connected to sensors attached to the pipeline at Tracking Locations listed in Table 2.1. The distance between and location of these Tracking Locations are based on GPS points collected by Pure Technologies, as well as drawings and/or GIS information provided by City of Novi. Figure 2.3 shows the location of the tracking locations. Note that Tracking Location 5 was not used as it was in the intersection of Grand River Avenue and Novi Road.

Table 2.1: SmartBall Receiver Tracking Locations

Tracking Location Number	Distance from Insertion (feet)	Passage Time [hh:mm:ss]	Location Description	GPS Coordinates
TL #1	0	9:41:03 AM	Hydrant (STA. 47+00) (Insertion/TL #1)	42.498455, -83.476184
TL #2	530	Tracking Not Acquired*	30" Valve and Well (STA. 52+18)*	42.497002, -83.476147
TL #3	3,382	10:14:18 AM	24" Valve and Well (STA. 28+12.50)	42.489196, -83.475664
TL #4	5,838	10:35:28 AM	Air Release Valve Vault (STA. 52+00)	42.482632, -83.475801
TL #6	8,457	10:54:30 AM	20" Valve and Well (STA. 18+30)	42.475475, -83.475486
TL #7	10,289	11:08:24 AM	20" Gate Valve and Well	42.470465, -83.475080
TL #8	11,398	11:16:43 AM	18" Tapping Saddle and Valve (STA. 109+84) (Extraction)	42.467425, -83.474909

**The tracking sensor at TL #2 was held in place using a PVC pipe as there was not enough room to install a sensor on the pipe wall. This sensor was not able to detect the SmartBall tool.*

Note: TL 5 was not used as it was in an intersection.

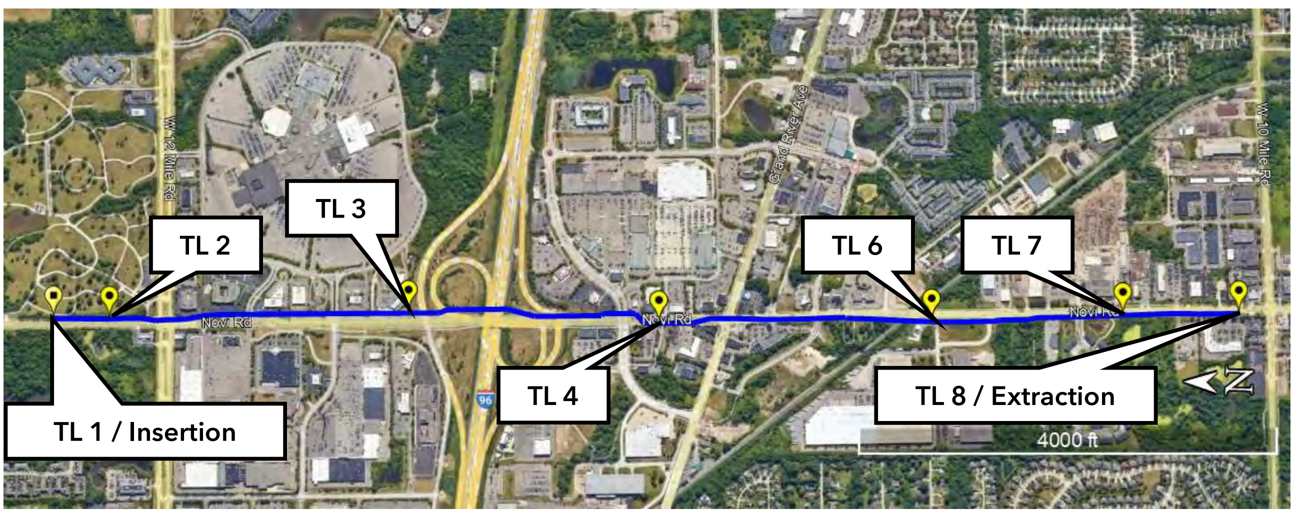


Figure 2.3: Aerial View of Tracking Locations

A plot was created showing the distance traveled by the SmartBall inspection tool versus time of day based on the tracking data collected and is shown in Figure 2.4. The slope of the black line indicates the instantaneous velocity of the SmartBall inspection tool.

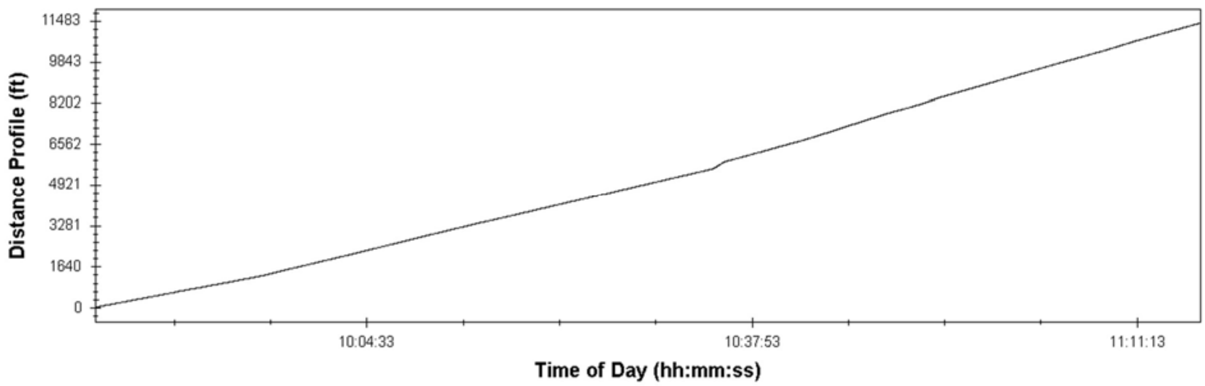


Figure 2.4: Distance Traveled by SmartBall Tool versus Time of Day during the Inspection

3. Summary of Acoustic Events

The SmartBall inspection detected one (1) acoustic event characteristic of leaks and zero (0) acoustic events characteristic of pockets of trapped air.

Table 3.1 provides a detailed summary of each leak detected by the SmartBall technology.

Table 3.1: Summary of Leaks

Leak Number	Type of Leak	Size of Leak	Acoustic Intensity	Time Since Insertion	Nearest Tracking Feature	Distance from Nearest Tracking Feature	Comments
Leak #1	Feature-Related Leak	Medium	-19.9 dB	01:30:41	20" Gate Valve and Well	482 feet downstream of 20" Gate Valve and Well (TL #7)	Leak is from a hydrant at Station 100+50 which was used to dewater extraction.

Distances provided are based on client supplied GIS data and inaccuracies in this information will impact the accuracy of the supplied location.

Type of Leak

- *Joint Leak is a leak located on a pipe joint.*
- *Pipe Barrel Leak is a leak located on the barrel of a pipe section.*
- *Suspected Feature-Related Leak is an acoustic signature exhibiting properties of a leak, located near a known feature on the pipeline. The pipeline feature should be investigated further to determine the source of the acoustic signature. If the feature is found to be in working order and not generating an acoustic signature of its own, then the acoustic signal should be considered a true leak and should be investigated as such.*
- *Undetermined if Joint or Barrel Leak – the leak cannot be classified as a joint leak, barrel leak, or suspected feature-related leak.*

Size of Leak and Acoustic Intensity

Xylem reports leaks in three (3) categories: small, medium, and large. Small leaks are estimated to be less than 2 gallons per minute (GPM). Medium leaks are estimated to be in the range of 2 - 10 GPM. Large leaks are estimated to be greater than 10 GPM.

An aerial view of the approximate location of the leak is shown Figure 3.1.

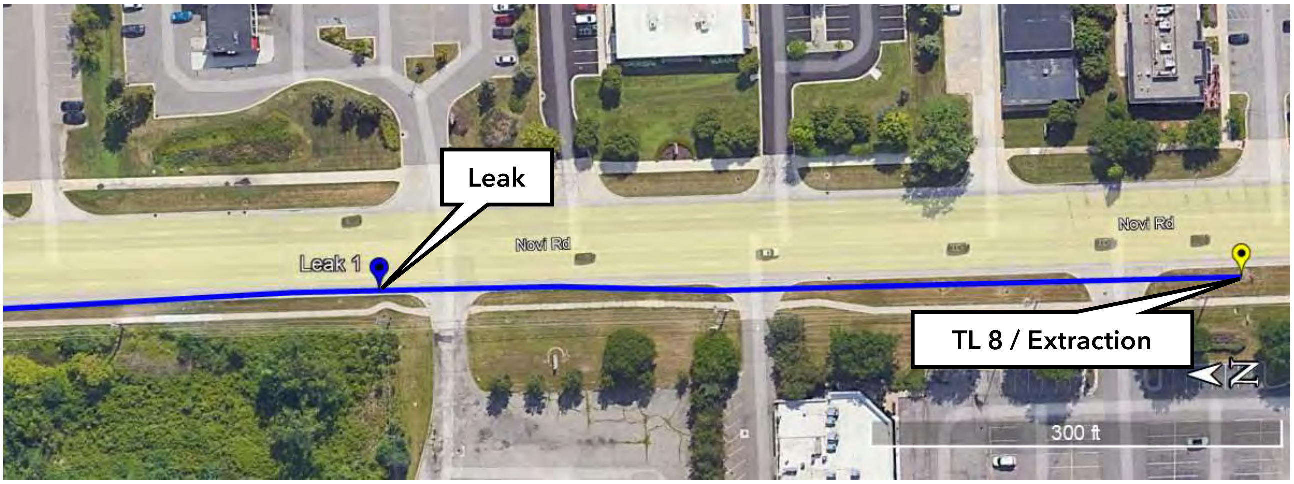


Figure 3.1: Aerial View of Novi Road PCCP Water Transmission Main with Location of Leak

The acoustic intensity of the leak event detected by the SmartBall technology is presented in Figure 3.2.

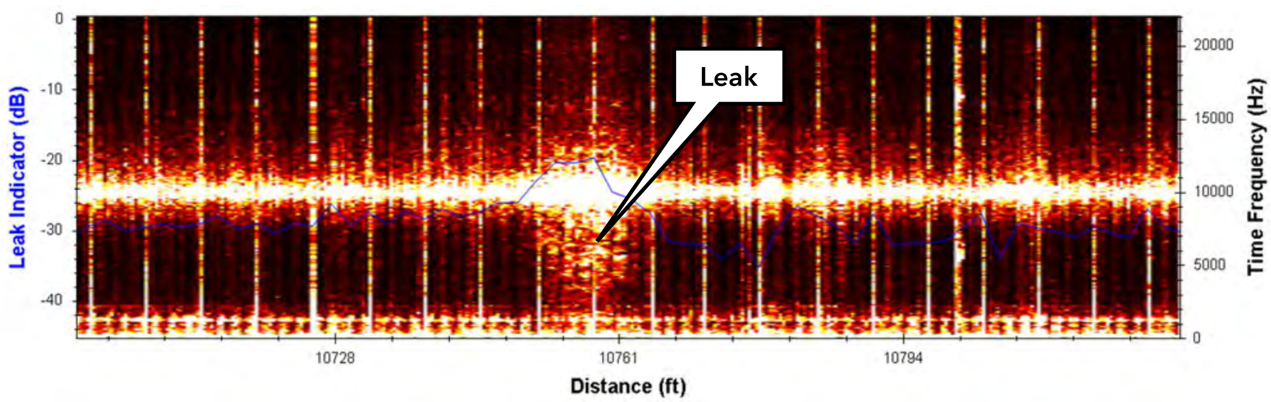


Figure 3.2: Acoustic Intensity of Leak #1

APPENDIX D

Electromagnetic Inspection Technology

D.1 Electromagnetic Inspection Technology

Assessing the condition of a prestressed concrete cylinder pipe (PCCP) transmission main is a challenging task that is best performed using a combination of non-destructive testing technology, internal visual inspection and sounding (in embedded cylinder pipe (ECP)), engineering science, and experiential judgment. The primary goal of an inspection is to provide an understanding of the condition of the structural component that provides the pipe's strength, the prestressing wire. An electromagnetic inspection provides a non-destructive method of evaluating the baseline condition of the prestressing wire. Electromagnetic inspections ascertain a magnetic signature for each pipe to identify anomalies that are produced by zones of broken wire wraps. Various characteristics associated with an electromagnetic anomaly are evaluated to provide an estimate of the number of broken wire wraps. This inspection method is able to quantify the amount of wire wrap damage and is the best method of determining the baseline condition of a pipeline.

D.1.1 Background and Theory of Electromagnetic Inspection

For years, it has been possible to exploit the concept of eddy currents to measure structural properties in metals. The application of a time-varying magnetic field to metal structures can create internal electric currents as free electrons which are driven by the field along discontinuities in the metal itself. Many applications of this phenomenon have been developed to detect damaged sections in steel and iron pipelines.

For PCCP, a different mechanism exists that can be used to determine the structural condition of the pipe. Eddy currents that are generated in a wire wrap can flow along the length of the wire wrap, generating a solenoidal field (see Figure D.1). If the current is interrupted by a break in the prestressing wire, the field will be affected.

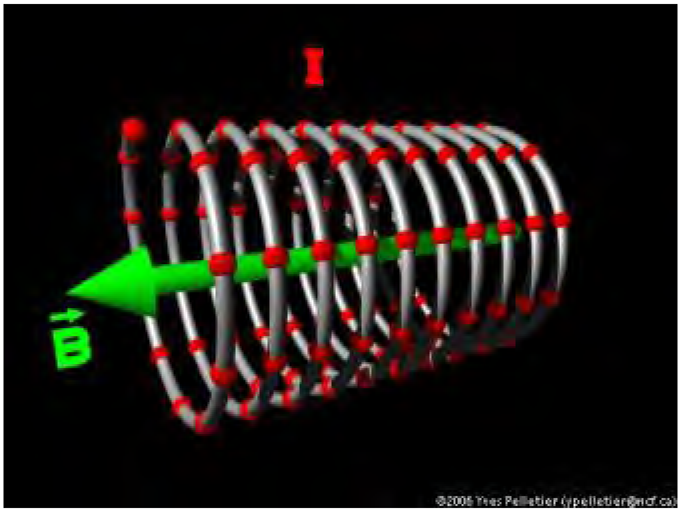


Figure D.1: Electric currents induced by time-varying magnetic field

The electromagnetic system used by Pure Technologies generates eddy currents in the wire wrap and detects where the field is altered by the presence of breaks in the prestressing wire.

To create an electric current in the prestressing wire, the Pure Technologies electromagnetic system generates a magnetic field inside a PCCP. A signal generator outputs a low frequency alternating electric current (typically less than 100 Hz) into a coil of wire (known as an exciter coil) positioned near the inner surface of the pipe. The magnetic field generated by this coil extends through the concrete core, steel cylinder, and finally into the prestressing wire wraps. As the coil travels along the length of the pipe, the field moves as well, creating a localized magnetic field that then generates eddy currents in the wire. As long as there are no breaks in the prestressing wire, the current will flow uniformly along the wire; however, where a broken wire wrap exists, a discontinuity in the current forms. As the magnetic field passes over the section of the broken wire, currents are generated that form opposing magnetic field lines.

Detectors are placed on the opposite side of the pipe from the exciter coil to record the variations in the magnetic field that are created when broken wire wraps interrupt the current flow. Analyzing and interpreting the response of the magnetic field allows for estimates of the number of broken wire wraps and the approximate location of the broken wire wraps along the length of the pipe.

D.1.2 Analysis Considerations

Electromagnetic inspections detect electromagnetic anomalies, or differences, in the expected induced field of a PCCP. Anomalies that are consistent with broken wire wraps are important; however, the induced field of interest is small and other sources of interference can mask or distort the size and shape of the electromagnetic signal. The accuracy of the broken wire wrap detection and quantification depends on a number of factors including, but not limited to:

- Accuracy and completeness of the information supplied by the client
- Type and configuration of pipe being inspected
- Availability of relevant calibration information
- Type, complexity, location, and number of distressed regions in a given pipe
- Inspection conditions observed in the pipe during the data collection period

Accuracy and completeness of the information supplied by the client. The inspection system is sensitive to all magnetic properties of a pipe, including cylinder thickness and composition, wire spacing and diameter, and the number of wire wraps. Pure Technologies uses the information provided by the client to perform the analysis. Drawings that indicate the exact location of pipe features and varying pressure classes are used to correlate the inspection data. Drawings that indicate how each class of pipe is constructed (cylinder thickness, wire diameter and spacing, shorting strap or non-shorting strap, etc.) are used to identify and quantify regions of distress. Discrepancies in the drawings and the data may affect the accuracy of the analysis.

Unknown or sealed appurtenances along the pipeline. Although most appurtenances exhibit a signal that is different and distinguishable from broken wire wraps, in some cases, the signals are similar, and an appurtenance could be misinterpreted as broken wire wraps if it is not listed on the drawings and not visible during the inspection.

Existence of ferromagnetic (steel) materials near the pipeline. When extra steel is in close proximity to the pipeline, it can cause a signal distortion that may mask broken wire wraps or could also cause anomalies that may be misinterpreted as broken wire wraps.

Previously repaired pipes. There are a variety of methods used to repair distressed PCCP. Some of these methods allow electromagnetic inspections to be conducted on the repaired pipe while others do not. Internal carbon fiber repairs do not appear to distort the electromagnetic signal and to date, successful repeat inspections have been performed on these repaired pipes and updated quantities of broken wire wraps have been provided for them. Conversely, external tendon repairs, internal or external steel bands, steel slip lining, and internal joint seals can all affect the electromagnetic signal. Consequently, analysis cannot be provided for these types of repaired pipes.

Changes in wire diameter and wire pitch. Broken wire wraps are estimated by measuring the physical length of an anomaly and entering it into a mathematical model known as a calibration curve. Calibration curves are based on either field testing of a similar pipe or mathematical modeling based on an extensive database of calibration test data and finite element analysis. In the case of mathematical modeling, the wire diameter and pitch information are critical factors in the calculations. If this information is not correct, the quantity of broken wire wraps will likely be incorrectly estimated.

Changing distance of the wire wrap and steel cylinder. If, during manufacturing of the pipe, there is variation in the distance of the prestressing wire and the steel cylinder, the resultant signal during an electromagnetic inspection may vary, possibly mimicking broken wire wraps. Typically, it is unknown if there are any pipes affected by this issue as only excavation and forensic analysis can reveal manufacturing defects.

Discontinuities or variations such as abnormal welding in liner construction. These discontinuities can mask actual damage or mimic damage where none exists. This situation could cause over or under estimation of the number of broken wire wraps.

Proximity to power lines. In some cases, power lines can cause distortion in the signal due to the stray magnetic fields. This can limit the effectiveness of the analysis if the distortion is too severe. This interference is rare but is noted for completeness of this document.

Motion. Turbulence, excessive debris/build up, and passing through bends or valves all produce distortion which can affect the detection and estimation of broken wire wraps or may mask actual damage in those areas. The inspection tool is designed to move as smoothly as possible to ensure optimum data quality; however, contact with the pipe wall is inevitable in some situations. Areas where noise are present and may reduce the confidence in defect detection are noted in the Pipe List.

D.1.3 Type and Configuration of Pipe Being Inspected

The sensitivity to broken wire wraps is affected by the type of pipe being inspected. The following information on detection limits is based on previous calibration testing performed by Pure Technologies.

Lined Cylinder Pipe (LCP)

In LCP, it is difficult to detect one (1) single broken wire wrap. Tests have shown subtle signal changes from one (1) single broken wire wrap in the middle of the pipe; however, typically five (5) or more consecutive broken wire wraps are required before it can be reliably measured. The limits of detection for end breaks have varied vary from 10 to 20 broken wire wraps, and the minimum separation required to distinguish between two regions with broken wire wraps can vary from 10 to 30 continuous unbroken wires.

Feature Pipes. The electromagnetic technology can detect distressed regions in some feature pipes; however, due to the impact of the feature on the electromagnetic signal, results are presented with less certainty for regions of the pipe near fittings, manholes, blowoff valves, or other features.

Short Pipes. The identification of broken wire wraps on pipes with a shorter length is challenging. As the effect of the changes in the data signal near the end of a pipe (bell or spigot) span is constant regardless of the pipe length (see Effects of Joints), its overall impact on the electromagnetic signal is greater as the length of a pipe decreases. For short pipes, the electromagnetic signal along the barrel of the pipe remains analyzable when it is unaffected by the joint effect; however, when most of the electromagnetic signal of a pipe is end effects, it becomes increasingly challenging to identify regions with broken wire wraps. In addition, short pipes typically make up a small portion of the pipe inventory inspected and there the number baselines (background signals) available for comparison is limited.

D.1.4 Details of Estimates of Broken Wire Wraps

Break Position. The signal of a region with broken wire wraps varies along the length of a given pipe. Broken wire wraps in the middle of a pipe are easier to detect and measure than broken wire wraps near the joint. The increased presence of metal at the joint causes a distinct signal response which may affect the detection and accuracy of low to moderate quantities of broken wire wraps within approximately 18 inches or 0.5 meters of the joint. Additionally, broken wire wraps are more difficult to detect and quantify at the bell end of the pipe than at the spigot end of the pipe, since a portion of the bell section will overlap the spigot end. The minimum number of broken wire wraps required for the signal to be detectable and quantifiable depends on the pipe type (embedded cylinder pipe (ECP), lined cylinder pipe (LCP), or non-cylinder pipe (NCP)), joint configuration, proximity of the center of the break region to the joint, and whether it is the bell or spigot end. As a result, the estimated number of broken wire wraps near the center of a pipe will be provided with greater confidence than broken wire wraps near the joints, especially near the bell end.

Effects of Joints. End effects refer to changes in the data signal near the end of a pipe (bell or spigot, if applicable) that are due to a variety of installation methods of the pipe joint itself. End effects do not refer to distress at the joint. Beveled spigots, pulled joints, mitered joints, butt straps, closure pieces, steel fittings, etc., will all affect the data signal at the end of a pipe in some way. Research in this specific area has provided methods for analysts to determine if the signal is due to an end effect, or true end distress. The differences are subtle, and examination of client records can provide the additional information necessary to conclude whether a particular data signal represents end effects or end distress. In the case where both end effects and end distress exist, identification and quantification of broken wire wraps is more challenging.

Non-contiguous Broken Wire Wraps. This occurs when broken wire wraps are scattered amongst non-broken wire wraps. Non-contiguous broken wire wraps are often the result of hydrogen embrittlement as opposed to corrosion, which results in a continuous region of broken wire wraps as the corrosion typically starts at a point and grows with time.

During the inspection, a broad magnetic field is projected onto the prestressing wire (several inches or centimeters wide); therefore, it is difficult to analyze individual prestressing wire wraps. When broken wire wraps are separated by non-broken wire wraps, the non-broken wire wraps can be masked by the distress signals and may appear broken depending on the distance from the broken and non-broken prestressing wire wraps. The minimum separation required to distinguish between two (2) regions with broken wire wraps depends on the pipe properties and the total number of broken wire wraps. Non-contiguous broken wire wraps may lead to a distress signal that is larger than the actual associated prestressing wire damage.

The estimated number of broken wire wraps assumes the distress region comprise of consecutive broken wire wraps. This assumption is the only assumption that can be made without additional information, which could be obtained from field verification. It is possible that some or all the break regions on a distressed pipe will contain intermittent or scattered broken wire wraps instead of consecutive broken wire wraps. In this case, the estimated number of broken wire wraps may be overestimated.

Background Signal Variations. The electromagnetic data signal is sensitive not only to physical differences in pipeline properties (wire diameter and spacing, cylinder thickness, etc.), but it is also sensitive to any magnetic differences in the steel components of the pipe. Pipe manufacturers may use different material suppliers for the various components of the pipes within a pipeline.

Even though two (2) pipes are manufactured the same physically, if the steel for the cylinder and the prestressing wire come from different suppliers, they will likely have slightly different magnetic properties, which will result in variations in the background signals.

Much like the fingerprint, every pipe in a pipeline, no matter how alike they are supposed to be, will exhibit a slightly different background signal. Since distress is quantified by measuring the distressed pipe signal relative to a background signal, any variations in background signals can affect the accuracy of the distress measurement and ultimately the estimates of the number of broken wire wraps.

Number of Break Regions. Results are predicted with greater accuracy for pipes containing single distressed regions than for pipes containing multiple distress regions. As the number of distress regions per pipe increases, or as these regions become closer together, the complexity of the interpretation increases. Distress regions can interact with each other from an electromagnetic standpoint to create signals of varying complexity. Distress regions can also span across a wider region in which case the distress region will be provided as positional range, and the estimated number of broken wire wraps may be provided depending on its complexity.

Other Factors. There are often overlaps amongst the key issues listed above and there may or may not be other factors related to these issues that decrease the level of confidence in the results presented in the report. Wide variations in manufacturing processes may not impact the structural performance of the pipe but can significantly affect the electromagnetic properties. The list of factors includes ones that are known, unknown, controllable, and uncontrollable. Some can be confirmed during excavation or inspection, and some can be eliminated by studying construction records, although errors in these records are common. In all cases, every effort is made to consider the various factors during analysis; however, it should be noted that the results provide an estimate of the broken wire wraps in a pipe section based on all the information available and assuming that the signal changes are caused by discontinuity in the prestressing wire.

APPENDIX E

Electromagnetic Pipe List

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2020
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

Pure Reference Number	Pipe Diameter (inches)	Low Station	Pipe Length (feet)	High Station	Reported Class	Break Region or Anomaly Location (feet from Upstream Station)	Number of Broken Wire Wraps by Region	Total Number of Broken Wire Wraps	Comments
Towards Insertion Point: 30" Valve & Well at Station 6+14, SBR 1									
10001	30	6+20	16	6+36	N/A				Pipe laying schedules not available.
10002	30	6+36	6	6+41	N/A				Pipe laying schedules not available.
N/A	30 / 36	6+41	3	6+44	A				30" X 36" Eccentric Reducer. Suspected material change. Pipe is reported with less certainty.
10003	36	6+44	16	6+60	A				Not analyzable from 12.0-16.0ft due to noise in the electromagnetic data. Pipe length is reported with less certainty.
10004	36	6+60	16	6+76	A				Not analyzable due to noise in the electromagnetic data. Pipe length is reported with less certainty.
10005	N/A	N/A	4	N/A	N/A				Not listed in pipe laying schedules. Data indicates ~4ft SP.
10006	36	6+76	16	6+92	A				
10007	36	6+92	16	7+08	A				
10008	36	7+08	16	7+25	B				
10009	36	7+25	16	7+41	B				
10010	36	7+41	16	7+57	B				
10011	36	7+57	16	7+73	B				
10012	36	7+73	16	7+88	C				
10013	36	7+88	16	8+04	C				
10014	36	8+04	16	8+20	C				
10015	36	8+20	16	8+36	C	2.0	5	5	
10016	36	8+36	16	8+52	B				
10017	36	8+52	16	8+68	B				
10018	36	8+68	16	8+85	B				
10019	36	8+85	16	9+01	B				
10020	36	9+01	16	9+17	A				
10021	36	9+17	16	9+33	A				
10022	36	9+33	16	9+49	A				
10023	36	9+49	16	9+65	A				
10024	36	9+65	16	9+81	A				
10025	36	9+81	16	9+97	A				
10026	36	9+97	16	10+13	A				
10027	36	10+13	16	10+29	A				
10028	36	10+29	16	10+45	A				
10029	36	10+45	16	10+61	A				
10030	36	10+61	16	10+77	A				
10031	36	10+77	16	10+93	A				
10032	36	10+93	16	11+09	A				
10033	36	11+09	16	11+25	A				
10034	36	11+25	16	11+41	A				
10035	36	11+41	16	11+57	A				
10036	36	11+57	16	11+73	A				
10037	36	11+73	16	11+89	A				
10038	36	11+89	16	12+05	A				
10039	36	12+05	16	12+21	A				
10040	36	12+21	16	12+37	A				
10041	36	12+37	16	12+53	A				
10042	36	12+53	16	12+70	A				
10043	36	12+70	16	12+86	A				
10044	36	12+86	16	13+02	A				
10045	36	13+02	16	13+18	A				
10046	36	13+18	16	13+34	A				
10047	36	13+34	16	13+50	A				
10048	36	13+50	16	13+66	B				
10049	36	13+66	16	13+82	B				
10050	36	13+82	16	13+98	B				
10051	36	13+98	16	14+14	B				
10052	36	14+14	16	14+30	B				
10053	36	14+30	16	14+46	B				
10054	36	14+46	16	14+62	B				
10055	36	14+62	16	14+78	B				
10056	36	14+78	16	14+94	B				
10057	36	14+94	16	15+10	B				
10058	36	15+10	16	15+26	B				
10059	36	15+26	16	15+42	B				
10060	36	15+42	16	15+58	B				
10061	36	15+58	16	15+74	B				
10062	36	15+74	16	15+90	B				
10063	36	15+90	16	16+06	B				
10064	36	16+06	16	16+22	B				
10065	36	16+22	16	16+38	B				
10066	36	16+38	16	16+54	A				
10067	36	16+54	16	16+70	A				
10068	36	16+70	16	16+86	A				
10069	36	16+86	16	17+02	A				
10070	36	17+02	16	17+18	A				
10071	36	17+18	16	17+34	A				
10072	36	17+34	16	17+50	A				
10073	36	17+50	16	17+66	A				
10074	36	17+66	16	17+82	A				
10075	36	17+82	16	17+98	A				
10076	36	17+98	16	18+14	A				
10077	36	18+14	16	18+30	A				
10078	36	18+30	16	18+46	A				
10079	36	18+46	16	18+62	A				
10080	36	18+62	16	18+78	A				
10081	36	18+78	16	18+94	A				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2020
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

10082	36	18+94	16	19+10	A				
10083	36	19+10	16	19+26	A				
10084	36	19+26	16	19+42	A				
10085	36	19+42	16	19+58	A				
10086	36	19+58	16	19+75	A				
10087	36	19+75	16	19+91	A				
10088	36	19+91	16	20+07	A				
10089	36	20+07	16	20+23	A				
10090	36	20+23	16	20+39	A				
10091	36	20+39	16	20+55	A				
10092	36	20+55	16	20+71	A				
10093	36	20+71	16	20+87	A				
10094	36	20+87	16	21+03	A				
10095	36	21+03	16	21+19	A				
10096	36	21+19	16	21+35	A				
10097	36	21+35	16	21+51	A				
10098	36	21+51	16	21+67	A				
10099	36	21+67	16	21+83	A				
10100	36	21+83	16	21+99	A				
10101	36	21+99	16	22+15	A				
10102	36	22+15	16	22+31	A				
10103	36	22+31	16	22+47	A				
10104	36	22+47	16	22+63	A				
10105	36	22+63	16	22+79	A				
10106	36	22+79	16	22+95	A				
10107	36	22+95	16	23+11	A				
10108	36	23+11	16	23+27	A				
10109	36	23+27	16	23+43	A				
10110	36	23+43	16	23+59	A				
10111	36	23+59	16	23+75	A				
10112	36	23+75	16	23+91	A				
10113	36	23+91	16	24+07	A				
10114	36	24+07	16	24+23	A				
10115	36	24+23	16	24+39	A				
10116	36	24+39	16	24+55	A				
10117	36	24+55	16	24+71	A				
10118	36	24+71	16	24+87	A				
10119	36	24+87	16	25+03	A				
10120	36	25+03	16	25+20	A				
10121	36	25+20	16	25+36	A				
10122	36	25+36	16	25+52	A				
10123	36	25+52	16	25+68	A				
10124	36	25+68	16	25+84	A				
10125	36	25+84	16	26+00	A				
10126	36	26+00	16	26+16	A				
10127	36	26+16	16	26+32	A				
10128	36	26+32	16	26+48	A				
10129	36	26+48	16	26+64	A				Suspected feature. **SBR 2**.
10130	36	26+64	16	26+80	A				
10131	36	26+80	16	26+96	A				
10132	36	26+96	16	27+12	A				
10133	36	27+12	16	27+28	A				
10134	36	27+28	16	27+44	A				
10135	36	27+44	16	27+60	A				
10136	36	27+60	16	27+76	A				
10137	36	27+76	16	27+92	A				Suspected tap.
10138	36	27+92	16	28+08	A				
10139	36	28+08	16	28+24	A				
10140	36	28+24	16	28+40	A				
10141	36	28+40	16	28+56	A				
10142	36	28+56	16	28+72	A				
10143	36	28+72	16	28+88	A				
10144	36	28+88	11	28+99	A				
10145	36	28+99	16	29+15	A				
N/A	36 / 30	29+15	3	29+18	A				36" X 30" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valves assembly extents.
N/A	30	29+18	17	29+36	A				30" Valve and Well Assembly (by others). Pipe is reported with less certainty due to tool stoppages. Suspected material change within valves assembly extents.
N/A	30 / 36	29+36	3	29+39	A				30" X 36" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valves assembly extents.
10146	36	29+39	16	29+55	A				
10147	36	29+55	16	29+71	A				
10148	36	29+71	16	29+87	A				
10149	36	29+87	16	30+03	A				
10150	36	30+03	16	30+19	A				
10151	36	30+19	16	30+35	A				
10152	36	30+35	16	30+51	A				
10153	36	30+51	16	30+67	A				
10154	36	30+67	16	30+83	A				
10155	36	30+83	16	30+99	A				
10156	36	30+99	16	31+15	A				
10157	36	31+15	16	31+31	A				
10158	36	31+31	16	31+47	A				
10159	36	31+47	16	31+63	A				
10160	36	31+63	16	31+79	A				
10161	36	31+79	16	31+95	A				
10162	36	31+95	16	32+11	A				
10163	36	32+11	16	32+27	A				
10164	36	32+27	16	32+43	A				
10165	36	32+43	16	32+59	A				
10166	36	32+59	16	32+75	A				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2020
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

10167	36	32+75	16	32+92	A				
10168	36	32+92	16	33+08	A				
10169	36	33+08	16	33+24	A				
10170	36	33+24	16	33+40	A				
10171	36	33+40	16	33+56	A				
10172	36	33+56	16	33+72	A				
10173	36	33+72	16	33+88	A				
10174	36	33+88	16	34+04	A				
10175	36	34+04	16	34+20	A				
10176	36	34+20	16	34+36	A				
10177	36	34+36	16	34+52	A				
10178	36	34+52	16	34+68	A				
10179	36	34+68	16	34+84	A				
10180	36	34+84	16	34+99	A				
10181	36	34+99	16	35+15	A				
10182	36	35+15	16	35+31	A				
10183	36	35+31	16	35+47	A				
10184	36	35+47	16	35+63	A				
10185	36	35+63	16	35+79	A				
10186	36	35+79	16	35+95	A				
10187	36	35+95	16	36+11	A				
10188	36	36+11	16	36+27	A				
10189	36	36+27	16	36+43	A				
10190	36	36+43	16	36+59	A				
10191	36	36+59	16	36+75	A				
10192	36	36+75	16	36+91	A				
10193	36	36+91	16	37+07	A				
10194	36	37+07	16	37+23	A				
10195	36	37+23	16	37+39	A				
10196	36	37+39	16	37+55	A				
10197	36	37+55	16	37+71	A				
10198	36	37+71	16	37+87	A				
10199	36	37+87	16	38+03	A				
10200	36	38+03	16	38+19	A				
10201	36	38+19	16	38+35	A	2.5	5	5	
10202	36	38+35	16	38+51	A				
10203	36	38+51	16	38+67	A				
10204	36	38+67	16	38+83	A				
10205	36	38+83	16	38+98	A				
10206	36	38+98	16	39+14	A				
10207	36	39+14	16	39+30	A				
10208	36	39+30	16	39+46	A				
10209	36	39+46	16	39+62	A				
10210	36	39+62	16	39+78	A				
10211	36	39+78	16	39+94	A				
10212	36	39+94	16	40+10	A				
10213	36	40+10	16	40+26	A				
10214	36	40+26	16	40+42	A				
10215	36	40+42	16	40+58	A				
10216	36	40+58	16	40+74	A				
10217	36	40+74	16	40+90	A				
10218	36	40+90	16	41+06	A				
10219	36	41+06	16	41+22	A				
10220	36	41+22	16	41+38	A				8" OL.
N/A	36 / 30	41+38	3	41+41	A				36" X 30" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30	41+41	17	41+59	A				30" Valve and Well Assembly (by others). Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30 / 36	41+59	3	41+62	A				30" X 36" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
10221	36	41+62	16	41+78	A				
10222	36	41+78	16	41+94	A				
10223	36	41+94	16	42+10	A				
10224	36	42+10	16	42+26	A				
10225	36	42+26	16	42+42	A				
10226	36	42+42	16	42+58	A				
10227	36	42+58	16	42+74	A				
10228	36	42+74	16	42+90	A				
10229	36	42+90	16	43+06	A				
10230	36	43+06	16	43+22	A				
10231	36	43+22	16	43+38	A				
10232	36	43+38	16	43+54	A				
10233	36	43+54	16	43+70	A				
10234	36	43+70	16	43+86	A				
10235	36	43+86	16	44+02	A				
10236	36	44+02	16	44+18	A				
10237	36	44+18	16	44+34	A				
10238	36	44+34	16	44+50	A				
10239	36	44+50	16	44+66	A				
10240	36	44+66	16	44+82	A				
10241	36	44+82	16	44+99	A				
10242	36	44+99	16	45+14	A				
10243	36	45+14	16	45+30	A				2-8" Tapping OL. **SBR 3.**
10244	36	45+30	16	45+46	A				
10245	36	45+46	16	45+62	A				
10246	36	45+62	16	45+78	A				
10247	36	45+78	16	45+94	A				
10248	36	45+94	16	46+10	A				
10249	36	46+10	16	46+26	A				
10250	36	46+26	16	46+42	A				
10251	36	46+42	16	46+58	A				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2020
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

10252	36	46+58	16	46+74	A				
10253	36	46+74	16	46+91	A				
10254	36	46+91	16	47+07	A				
10255	36	47+07	16	47+23	A				
10256	36	47+23	16	47+39	A				
10257	36	47+39	16	47+55	A				
10258	36	47+55	16	47+71	A				
10259	36	47+71	16	47+87	A				
10260	36	47+87	16	48+03	A				
10261	36	48+03	16	48+19	A				
10262	36	48+19	16	48+35	A				
10263	36	48+35	16	48+51	A				
10264	36	48+51	16	48+67	A				
10265	36	48+67	16	48+83	A				
10266	36	48+83	16	48+99	A				
10267	36	48+99	16	49+15	A				
10268	36	49+15	16	49+31	A				
10269	36	49+31	16	49+47	A				
10270	36	49+47	16	49+63	A				
10271	36	49+63	16	49+79	A				
10272	36	49+79	16	49+95	A				
10273	36	49+95	16	50+11	A				
10274	36	50+11	16	50+27	A				
10275	36	50+27	16	50+43	A				
10276	36	50+43	16	50+59	A				
10277	36	50+59	16	50+75	A				
10278	36	50+75	16	50+91	A				
10279	36	50+91	16	51+07	A				
10280	36	51+07	16	51+23	A				
10281	36	51+23	16	51+39	A				
10282	36	51+39	16	51+55	A				
10283	36	51+55	16	51+71	A				
10284	36	51+71	16	51+87	A				
10285	36	51+87	16	52+03	A				
10286	36	52+03	16	52+19	A				
10287	36	52+19	16	52+35	A				
10288	36	52+35	16	52+52	A				
10289	36	52+52	16	52+68	A				
10290	36	52+68	16	52+84	A				
10291	36	52+84	16	53+00	A				
10292	36	53+00	16	53+16	A				
10293	36	53+16	16	53+32	A				
10294	36	53+32	16	53+48	A				
10295	36	53+48	16	53+64	A				
10296	36	53+64	16	53+80	A				
10297	36	53+80	16	53+96	A				
10298	36	53+96	16	54+12	A				
10299	36	54+12	16	54+28	A				
10300	36	54+28	16	54+44	A				
10301	36	54+44	16	54+60	A				
10302	36	54+60	16	54+76	A				
10303	36	54+76	16	54+92	A				
10304	36	54+92	16	55+08	A				
10305	36	55+08	16	55+24	A				
10306	36	55+24	16	55+40	A				
10307	36	55+40	16	55+56	A				
10308	36	55+56	16	55+72	A				
10309	36	55+72	16	55+88	A				
10310	36	55+88	16	56+04	A				
10311	36	56+04	16	56+20	A				
10312	36	56+20	16	56+36	A				
10313	36	56+36	16	56+52	A				
10314	36	56+52	16	56+68	A				
10315	36	56+68	16	56+84	A				
10316	36	56+84	16	57+00	A				
10317	36	57+00	16	57+16	A				
10318	36	57+16	16	57+32	A				
10319	36	57+32	16	57+48	A				
10320	36	57+48	16	57+64	A				
10321	36	57+64	16	57+81	A				
10322	36	57+81	16	57+97	A				
10323	36	57+97	16	58+13	B				
10324	36	58+13	16	58+29	B	6.5	10	10	CFRP repair in March 2024.
10325	36	58+29	16	58+45	B				
10326	36	58+45	16	58+61	B				
10327	36	58+61	16	58+77	B	0.0-16.0	D	D	CFRP repair in March 2024.
10328	36	58+77	16	58+93	B				
10329	36	58+93	16	59+09	B				16" x 18" MH.
10330	36	59+09	16	59+25	B				
10331	36	59+25	16	59+41	B				
10332	36	59+41	16	59+57	A				8" Tapping OL. **SBR 4**.
10333	36	59+57	16	59+73	A				
10334	36	59+73	16	59+89	A				
10335	36	59+89	16	60+05	A				
10336	36	60+05	16	60+20	A				
10337	36	60+20	16	60+36	A				
10338	36	60+36	16	60+52	A				8" OL.
10339	36	60+52	16	60+68	A				
10340	36	60+68	16	60+84	A				
10341	36	60+84	16	61+00	A				
10342	36	61+00	16	61+16	A				
10343	36	61+16	16	61+32	A				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2020
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

10344	36	61+32	16	61+48	A				8" Tapping OL.
10345	36	61+48	16	61+64	A				
10346	36	61+64	16	61+80	A				
10347	36	61+80	16	61+96	A				
10348	36	61+96	16	62+12	A				
10349	36	62+12	16	62+28	A				
10350	36	62+28	16	62+44	A				
10351	36	62+44	16	62+60	A				
10352	36	62+60	16	62+76	A				
N/A	36 / 30	62+76	3	62+79	A				36" X 30" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30	62+79	18	62+97	A				30" Valve and Valve Vault Assembly (by others). Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30 / 36	62+97	3	63+00	A				30" X 36" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
10353	36	63+00	16	63+16	A				
10354	36	63+16	16	63+32	A				
10355	36	63+32	16	63+48	A				
N/A	36	63+48	6	**30+97**	A				36" X 36" X 36" TEE. Equation: 63+51.05BK = 31+00.00AH. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents. Refer to legend.
N/A	36 / 30	30+97	3	30+94	A				36" X 30" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30	30+94	17	30+76	A				30" Valve & Valve Well Assembly (by others). Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30 / 36	30+76	3	30+73	A				30" X 36" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
10356	36	30+73	16	30+57	A	4.5;10.0-16.0	5;25*	30*	The break region at 4.5 feet from upstream joint is reported with less certainty due to its proximity to the valve assembly. CFRP repair in March 2024.
10357	36	30+57	16	30+41	A				
10358	36	30+41	16	30+25	A				
10359	36	30+25	16	30+09	A				
10360	36	30+09	16	29+93	A				
10361	36	29+93	16	29+77	A				
10362	36	29+77	16	29+61	A				
10363	36	29+61	16	29+45	A				
10364	36	29+45	16	29+29	A				
10365	36	29+29	16	29+12	A				6" OL.
10366	36	29+12	16	28+96	A				16" X 18" MH.
10367	36	28+96	16	28+80	A	3.0;13.0	10;5	15	CFRP repair in March 2024.
10368	36	28+80	16	28+64	A				
10369	36	28+64	16	28+48	A				
10370	36	28+48	16	28+32	A				
10371	36	28+32	16	28+16	A	10.0	5	5	
10372	36	28+16	16	28+00	A				
10373	36	28+00	16	27+84	A				
10374	36	27+84	16	27+68	A				
10375	36	27+68	16	27+52	A				
10376	36	27+52	16	27+36	A	13.0	5	5	
10377	36	27+36	16	27+20	A				
10378	36	27+20	16	27+04	A				
10379	36	27+04	16	26+88	A				
10380	36	26+88	16	26+72	A				
10381	36	26+72	16	26+56	A				
10382	36	26+56	16	26+40	A				
10383	36	26+40	16	26+24	A				
10384	36	26+24	16	26+08	A				
10385	36	26+08	16	25+92	A				
10386	36	25+92	16	25+76	A				
10387	36	25+76	16	25+60	A				
10388	36	25+60	16	25+44	A				
10389	36	25+44	16	25+28	A				
10390	36	25+28	16	25+12	A				
10391	36	25+12	16	24+96	A				
10392	36	24+96	16	24+80	A				
10393	36	24+80	16	24+64	A				
10394	36	24+64	16	24+48	A				
10395	36	24+48	16	24+32	A				
10396	36	24+32	16	24+16	A				
10397	36	24+16	16	24+00	A				
10398	36	24+00	16	23+84	A				
10399	36	23+84	16	23+68	A				
10400	36	23+68	16	23+51	A				
10401	36	23+51	16	23+35	A				
10402	36	23+35	16	23+19	A				
10403	36	23+19	16	23+03	A				8" OL.
10404	36	23+03	16	22+87	A				
10405	36	22+87	16	22+71	A				
10406	36	22+71	16	22+55	A				8" Tapping OL.
10407	36	22+55	16	22+39	A				
10408	36	22+39	16	22+23	A				
10409	36	22+23	16	22+07	A				
10410	36	22+07	16	21+91	A				
10411	36	21+91	16	21+75	A				
10412	36	21+75	16	21+59	A				
10413	36	21+59	16	21+43	A				
10414	36	21+43	16	21+27	A				
10415	36	21+27	16	21+11	A				
10416	36	21+11	16	20+95	A				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2020
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

10417	36	20+95	16	20+79	A				
10418	36	20+79	16	20+63	A				
10419	36	20+63	16	20+47	A				
10420	36	20+47	16	20+31	A				
10421	36	20+31	16	20+15	A				8" Tapping OL.
10422	36	20+15	16	19+99	A				
10423	36	19+99	16	19+83	A				
10424	36	19+83	16	19+67	A				
10425	36	19+67	16	19+51	A				
10426	36	19+51	16	19+35	A				
10427	36	19+35	16	19+19	A				
10428	36	19+19	16	19+03	A				
10429	36	19+03	16	18+87	A				
10430	36	18+87	16	18+71	A				
10431	36	18+71	16	18+55	A				
10432	36	18+55	16	18+39	A				
10433	36	18+39	7	18+32	A				
N/A	36 / 30	18+32	3	18+29	A				36" X 30" Eccentric Reducer. Pipe reported with less certainty due to tool stoppages. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30	18+29	17	18+11	A				30" Valve & Valve Well Assembly (by others). **SBR 5**. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30 / 36	18+11	3	18+08	A				30" X 36" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
10434	36	18+08	16	17+92	A				
10435	36	17+92	16	17+76	A				
10436	36	17+76	16	17+60	A				
10437	36	17+60	16	17+44	A				8" OL.
10438	36	17+44	16	17+28	A				8" Tapping OL.
10439	36	17+28	16	17+12	A				
10440	36	17+12	16	16+96	A				
10441	36	16+96	16	16+80	A				
10442	36	16+80	16	16+64	A				
10443	36	16+64	16	16+48	A				
10444	36	16+48	16	16+32	A				
10445	36	16+32	16	16+16	A				
10446	36	16+16	16	16+00	A				
10447	36	16+00	16	15+84	A				
10448	36	15+84	16	15+68	A				
10449	36	15+68	16	15+52	A				
10450	36	15+52	16	15+36	A				
10451	36	15+36	16	15+20	A				16" X 18" MH.
10452	36	15+20	16	15+04	A				8" Tapping OL.
10453	36	15+04	16	14+88	A				
10454	36	14+88	16	14+72	A				
10455	36	14+72	16	14+56	A				
10456	36	14+56	16	14+40	A				
10457	36	14+40	16	14+24	A				
10458	36	14+24	16	14+08	A				
10459	36	14+08	16	13+92	A				
10460	36	13+92	16	13+76	A				
10461	36	13+76	16	13+59	A				
10462	36	13+59	16	13+43	A				
10463	36	13+43	16	13+27	A				
10464	36	13+27	16	13+11	A				
10465	36	13+11	16	12+95	A				
10466	36	12+95	16	12+79	A				
10467	36	12+79	16	12+63	A				
10468	36	12+63	16	12+47	A				
10469	36	12+47	16	12+31	A				
10470	36	12+31	16	12+15	A				
10471	36	12+15	16	11+99	A				
10472	36	11+99	16	11+83	A				
10473	36	11+83	16	11+67	A				
10474	36	11+67	16	11+51	A				
10475	36	11+51	16	11+35	A				
10476	36	11+35	16	11+19	A				
10477	36	11+19	16	11+03	A				
10478	36	11+03	16	10+87	A				8" OL.
10479	36	10+87	16	10+71	A				
10480	36	10+71	16	10+55	A				
10481	36	10+55	16	10+39	A				
10482	36	10+39	16	10+23	A				
10483	36	10+23	16	10+07	A				
10484	36	10+07	16	9+91	A				
10485	36	9+91	16	9+75	A				
10486	36	9+75	16	9+59	A				
10487	36	9+59	16	9+43	A				
10488	36	9+43	16	9+27	A				
10489	36	9+27	16	9+11	A				
10490	36	9+11	16	8+95	A				
10491	36	8+95	16	8+79	A				
10492	36	8+79	16	8+63	A				
10493	36	8+63	16	8+47	A				
10494	36	8+47	16	8+31	A				
10495	36	8+31	16	8+15	A				
10496	36	8+15	16	7+99	A				
10497	36	7+99	16	7+83	A				
10498	36	7+83	16	7+66	A				
10499	36	7+66	16	7+50	A				
10500	36	7+50	16	7+34	A				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2020
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

10501	36	7+34	16	7+18	A				
10502	36	7+18	16	7+02	A				
10503	36	7+02	16	6+86	A				
10504	36	6+86	16	6+70	A				
10505	36	6+70	16	6+54	A				
10506	36	6+54	16	6+38	A				
10507	36	6+38	16	6+22	A				
N/A	36	6+22	3	6+19	A				3ft SP in pipe laying schedules. Pipe does not exist in data.
10508	36	6+19	16	6+03	A				
N/A	36 / 30	6+03	3	6+00	A				36" x 30" Eccentric Reducer. Pipe reported with less certainty due to tool stoppages.
N/A	30	6+00	17	5+82	A				30" Valve & Valve Well Assembly (by others). **SBR 6.** Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30 / 36	5+82	3	5+79	A				36" x 30" Eccentric Reducer. Pipe reported with less certainty due to tool stoppages.
10509	36	5+79	4	5+75	A				
10510	36	5+75	16	5+59	A				
10511	36	5+59	16	5+43	A				16" OL.
10512	36	5+43	7	**4+91**	A				90° Elbow. Equation: 5+39.79BK = 4+88.00AH. Pipe is reported with less certainty. Refer to legend.
10513	36	4+91	16	5+08	A				
10514	36	5+08	3	5+11	A				
10515	36	5+11	16	5+27	A				8" OL.
10516	36	5+27	16	5+43	A				
10517	36	5+43	16	5+59	A				
N/A	36 / 30	5+59	3	5+62	A				36" X 30" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30	5+62	17	5+80	A				30" Valve & Valve Well Assembly (by others). Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
N/A	30 / 36	5+80	3	5+83	A				36" x 30" Eccentric Reducer. Pipe is reported with less certainty due to tool stoppages. Suspected material change within valve assembly extents.
10518	36	5+83	16	5+99	A				
10519	36	5+99	16	6+15	A				
10520	36	6+15	16	6+31	A				
10521	36	6+31	16	6+47	A				8" Tapping OL.
10522	36	6+47	16	6+63	A				
10523	36	6+63	16	6+79	A				
10524	36	6+79	16	6+95	A				
10525	36	6+95	16	7+11	A				
10526	36	7+11	16	7+27	A				
10527	36	7+27	16	7+43	A				
10528	36	7+43	16	7+59	A				
10529	36	7+59	16	7+75	A				
10530	36	7+75	16	7+91	A				
10531	36	7+91	16	8+07	A				8" Tapping OL.
10532	36	8+07	16	8+23	A				
10533	36	8+23	16	8+39	B				
10534	36	8+39	16	8+55	B				
10535	36	8+55	16	8+71	B				
10536	36	8+71	16	8+87	B				
10537	36	8+87	16	9+03	B				
10538	36	9+03	16	9+19	B				8" Tapping OL.
10539	36	9+19	16	9+35	B				
10540	36	9+35	16	9+51	B				
N/A	36	9+51	16	9+67	B				16ft STD in pipe laying schedules. Pipe does not exist in data.
N/A	36	9+67	15	9+83	B				15ft SP in pipe laying schedules. Pipe does not exist in data.
10541	36	9+83	1	9+84	B				15° Elbow.
10542	36	9+84	16	10+00	B				
10543	36	10+00	16	10+16	B				
10544	36	10+16	16	10+32	B				
10545	36	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD.
10546	36	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD.
10547	36	10+32	16	10+48	B				1-1/2" OL.
10548	36	10+48	16	10+64	B				
10549	36	10+64	16	10+80	B				
10550	36	10+80	16	10+96	B				
10551	36	10+96	16	11+12	B				
10552	36	11+12	16	11+28	B				
10553	36	11+28	16	11+44	B				8" OL.
10554	36	11+44	16	11+60	B				
10555	36	11+60	16	11+76	B				
10556	36	11+76	16	11+92	B				
10557	36	11+92	16	12+08	B				
10558	36	12+08	16	12+24	B				
10559	36	12+24	16	12+40	B				
10560	36	12+40	16	12+56	B				
10561	36	12+56	16	12+72	B				
10562	36	12+72	16	12+88	B				
10563	36	12+88	16	13+04	B				
10564	36	13+04	16	13+20	B				
10565	36	13+20	16	13+36	B				
10566	36	13+36	16	13+52	B				
10567	36	13+52	16	13+68	B				
10568	36	13+68	16	13+84	B				
10569	36	13+84	16	14+00	B				
10570	36	14+00	16	14+16	B				
10571	36	14+16	16	14+32	B				
10572	36	14+32	16	14+48	A				
10573	36	14+48	16	14+64	A				
10574	36	14+64	16	14+80	A				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2020
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

10575	36	14+80	16	14+96	A				
10576	36	14+96	16	15+12	A				
10577	36	15+12	16	15+28	A				
10578	36	15+28	16	15+44	A				
10579	36	15+44	16	15+60	A				
10580	36	15+60	16	15+76	A				
10581	36	15+76	16	15+93	A				
10582	36	15+93	16	16+09	A				
10583	36	16+09	16	16+25	A				
10584	36	16+25	16	16+41	A				
10585	36	16+41	16	16+57	A				
10586	36	16+57	16	16+73	A				
10587	36	16+73	16	16+89	A				
10588	36	16+89	16	17+05	A				
10589	36	17+05	16	17+21	A				
10590	36	17+21	16	17+37	A				
10591	36	17+37	16	17+53	A				8" OL.
10592	36	17+53	16	17+69	A				
10593	36	17+69	16	17+85	A				8" Tapping OL.
Towards 30" Valve at Station 17+96, SBR 7									

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2024
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

Pure Reference Number	Pipe Diameter (inches)	Low Station	Pipe Length (feet)	High Station	Reported Class	Break Region or Anomaly Location (feet from Upstream Station)	Number of Broken Wire Wraps by Region	Total Number of Broken Wire Wraps	Comments
Towards Tapping Saddle at 28400 Novi Road									
11001	36	32+79	16	32+95	A				Pipe is reported with less certainty from 0.0-11.0 feet due to tool movement related to insertion.
11002	36	32+95	16	33+11	A				
11003	36	33+11	16	33+27	A				
11004	36	33+27	16	33+43	A				
11005	36	33+43	16	33+59	A				
11006	36	33+59	16	33+75	A				
11007	36	33+75	16	33+91	A				
11008	36	33+91	16	34+07	A				
11009	36	34+07	16	34+23	A				
11010	36	34+23	16	34+39	A				
11011	36	34+39	16	34+55	A				
11012	36	34+55	16	34+71	A				
11013	36	34+71	16	34+87	A				
11014	36	34+87	16	35+03	A				
11015	36	35+03	16	35+19	A				
N/A	36	35+19	16	35+35	A				16ft STD in pipe laying schedules. Pipe does not exist in data.
11016	36	N/A	5	N/A	N/A				Not listed in pipe laying schedules. Data indicates ~5ft SP.
11017	36	35+35	16	35+51	A				
11018	36	35+51	16	35+67	A				
N/A	36	35+67	16	35+83	A				16ft STD in pipe laying schedules. Pipe does not exist in data.
11019	36	N/A	4	N/A	N/A				Not listed in pipe laying schedules. Data indicates ~4ft SP.
11020	36	35+83	16	35+99	A				
11021	36	35+99	16	36+16	A				
11022	36	36+16	16	36+32	A				
11023	36	36+32	16	36+48	A				
N/A	36	36+48	16	36+64	A				16ft STD with 8" OL in pipe laying schedules. Pipe does not exist in data.
11024	36	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD.
11025	36	36+64	16	36+80	A				
11026	36	36+80	16	36+95	A				
11027	36	36+95	16	37+11	A				
11028	36	37+11	16	37+27	A				
11029	36	37+27	16	37+43	A				
11030	36	37+43	16	37+59	A				
11031	36	37+59	16	37+75	A				
11032	36	37+75	16	37+91	A				
11033	36	37+91	16	38+07	A				
11034	36	38+07	16	38+23	A				
11035	36	38+23	16	38+39	A				
11036	36	38+39	16	38+55	A				
11037	36	38+55	16	38+71	A				
11038	36	38+71	16	38+87	A				
11039	36	38+87	16	39+03	A				
11040	36	39+03	16	39+19	A				
11041	36	39+19	16	39+35	A				
11042	36	39+35	16	39+51	A				
11043	36	39+51	16	39+67	A				
11044	36	39+67	16	39+83	A				
11045	36	39+83	16	39+99	A				
11046	36	39+99	16	40+15	A				
11047	36	40+15	16	40+31	A				
11048	36	40+31	16	40+47	A				
11049	36	40+47	16	40+63	A				
11050	36	40+63	16	40+79	A				
11051	36	40+79	16	40+95	A				
11052	36	40+95	16	41+11	A				
11053	36	41+11	16	41+27	A				
11054	36	41+27	16	41+43	A				
11055	36	41+43	16	41+59	A				
11056	36	41+59	16	41+75	A				
11057	36	41+75	16	41+91	A				
11058	36	41+91	16	42+07	A				
11059	36	42+07	16	42+23	A				
11060	36	42+23	16	42+39	A				
11061	36	42+39	16	42+55	A				
11062	36	42+55	16	42+71	A				
11063	36	42+71	16	42+87	A				
11064	36	42+87	16	43+03	A				1-1/2" OL.
11065	36	43+03	16	43+19	A				
11066	36	43+19	16	43+35	A				
11067	36	43+35	16	43+51	A				
11068	36	43+51	16	43+68	A				
11069	36	43+68	16	43+84	A				
11070	36	43+84	16	44+00	A				
11071	36	44+00	16	44+16	A				
11072	36	44+16	16	44+32	A				
11073	36	44+32	16	44+48	A				
11074	36	44+48	16	44+64	A				
11075	36	44+64	16	44+80	A				
11076	36	44+80	16	44+96	A				
11077	36	44+96	16	45+12	A				
11078	36	45+12	16	45+28	A				
11079	36	45+28	16	45+44	A				
11080	36	45+44	16	45+60	A				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2024
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

Pure Reference Number	Pipe Diameter (inches)	Low Station	Pipe Length (feet)	High Station	Reported Class	Break Region or Anomaly Location (feet from Upstream Station)	Number of Broken Wire Wraps by Region	Total Number of Broken Wire Wraps	Comments
11081	36	45+60	16	45+76	A				
11082	36	45+76	16	45+92	A				
11083	36	45+92	16	46+08	A				
11084	36	46+08	16	46+24	A				
11085	36	46+24	16	46+40	A				
11086	36	46+40	16	46+56	A				
11087	36	46+56	16	46+72	A				
11088	36	46+72	16	46+88	A				
11089	36	46+88	16	47+04	A				6" OL.
11090	36	47+04	16	47+20	A				
11091	36	47+20	16	47+36	A				
11092	36	47+36	16	47+52	A				
11093	36	47+52	16	47+68	A				
11094	36	47+68	16	47+84	A				
11095	36	47+84	16	48+00	A				
11096	36	48+00	16	48+16	A				
11097	36	48+16	16	48+32	A				
11098	36	48+32	16	48+48	A				
11099	36	48+48	16	48+64	A				
11100	36	48+64	16	48+80	A				
11101	36	48+80	16	48+96	A				
11102	36	48+96	16	49+12	A				
11103	36	49+12	16	49+28	A				
11104	36	49+28	16	49+44	A				
11105	36	49+44	16	49+60	A				
11106	36	49+60	16	49+76	A				
11107	36	49+76	16	49+92	A				
11108	36	49+92	16	50+08	A				
11109	36	50+08	16	50+24	A				
11110	36	50+24	16	50+40	A				
11111	36	50+40	16	50+56	A				
11112	36	50+56	16	50+72	A				
11113	36	50+72	16	50+88	A				
11114	36	50+88	16	51+04	A				
11115	36	51+04	16	51+20	A				
11116	36	51+20	16	51+36	A				
11117	36	51+36	16	51+53	A				8" OL.
11118	36	51+53	16	51+69	A				
11119	36	51+69	16	51+85	A				
N/A	36	51+85	5	51+90	A				5ft SP in pipe laying schedules. Pipe does not exist in data.
11120	36	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD.
11121	36	51+90	16	52+06	A				
11122	36	52+06	3	52+09	A				36" x 30" Eccentric Reducer.
11123	36	52+09	17	52+27	A				30" Valve & Valve Well Assembly.
11124	36	52+27	3	52+30	A				36" x 30" Eccentric Reducer.
11125	36	52+30	16	52+46	A				Pipe is reported with less certainty from 0.0-10.0 feet due to tool movement related to reducer.
N/A	36	52+46	16	52+62	A				16ft STD in pipe laying schedules. Pipe does not exist in data.
11126	36	52+62	10	52+72	A				
11127	36	0+00	20	0+20	184				10GA Cylinder. Encasement. Equation: 0+20.41BK = 0+19.69A..H. Refer to legend.
11128	36	0+20	20	0+40	184				
11129	36	0+40	20	0+60	184				
11130	36	0+60	20	0+80	184				
11131	36	0+80	20	1+00	184				
11132	36	1+00	20	1+20	184				
11133	36	1+20	20	1+40	184				
11134	36	1+40	20	1+60	184				
11135	36	1+60	20	1+80	184				
11136	36	1+80	20	2+00	184				
11137	36	2+00	20	2+20	184				
11138	36	2+20	20	2+40	184				
11139	36	2+40	20	2+60	184				
11140	36	2+60	20	2+80	184				
11141	36	2+80	20	3+00	184				
11142	36	3+00	20	3+20	184				
11143	36	3+20	20	3+40	184				
11144	36	3+40	20	3+61	184				
11145	36	3+61	17	3+77	184				
11146	36	3+77	20	3+97	184				
11147	36	3+97	20	4+17	184				
11148	36	4+17	5	4+23	184				36" X 24" TEE.
11149	36	4+23	10	4+33	184				
11150	36	4+33	20	4+53	184				
11151	36	4+53	20	4+73	184				
11152	36	4+73	20	4+93	184				
11153	36	4+93	20	5+13	184				
11154	36	5+13	2	5+15	184				36" X 20" TEE.
11155	36	5+15	5	5+20	184				36" X 30" Reducer.
11156	30	5+20	20	5+40	184				
11157	30	5+40	20	5+60	184				
11158	30	5+60	20	5+80	184				
11159	30	5+80	20	6+00	184				
11160	30	6+00	20	6+20	184				
11161	30	6+20	20	6+40	184				

City of Novi

Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2024

Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

Pure Reference Number	Pipe Diameter (inches)	Low Station	Pipe Length (feet)	High Station	Reported Class	Break Region or Anomaly Location (feet from Upstream Station)	Number of Broken Wire Wraps by Region	Total Number of Broken Wire Wraps	Comments
11162	30	6+40	20	6+60	184				
11163	30	6+60	20	6+80	184				
11164	30	6+80	20	7+00	184				
11165	30	7+00	20	7+20	184				
11166	30	7+20	20	7+40	184				
11167	30	7+40	20	7+60	184				
11168	30	7+60	20	7+80	184				
11169	30	7+80	20	8+00	184				
11170	30	8+00	20	8+20	184				2" OL.
11171	30	8+20	8	8+28	184				
11172	30	8+28	20	8+48	184				
11173	30	8+48	20	8+68	184				
11174	30	8+68	20	8+88	184				
11175	30	8+88	20	9+08	184				
11176	30	9+08	20	9+22	184				Equation: 9+27.88BK = 9+21.54AH. Refer to legend.
11177	30	9+22	20	9+42	184				
11178	30	9+42	3	9+45	184				30" X 24" Eccentric Reducer.
11179	30	9+45	14	9+59	184				Valve.
11180	30	9+59	3	9+62	184				30" X 24" Eccentric Reducer.
11181	30	9+62	20	9+82	184				
11182	30	9+82	20	10+02	184				
11183	30	10+02	20	10+22	184				
11184	30	10+22	20	10+42	184				
11185	30	10+42	20	10+62	184				
11186	30	10+62	20	10+82	184				
11187	30	10+82	20	11+02	184				12" Tapping OL.
11188	30	11+02	20	11+22	184				
11189	30	11+22	20	11+42	184				
11190	30	11+42	20	11+62	184				
11191	30	11+62	20	11+82	184				
11192	30	11+82	20	12+02	184				
11193	30	12+02	20	12+22	184				
11194	30	12+22	20	12+42	184				
11195	30	12+42	20	12+62	184				
11196	30	12+62	20	12+82	184				
11197	30	12+82	20	13+02	184				
11198	30	13+02	20	13+22	184				
11199	30	13+22	20	13+42	184				
11200	30	13+42	20	13+62	184				
11201	30	13+62	20	13+82	184				
11202	30	13+82	20	14+02	184				
11203	30	14+02	20	14+22	184				
11204	30	14+22	20	14+42	184				
11205	30	14+42	20	14+62	184				
11206	30	14+62	20	14+82	184				
11207	30	14+82	20	15+02	184				
11208	30	15+02	20	15+22	184				
11209	30	15+22	20	15+42	184				
11210	30	15+42	20	15+62	184				
11211	30	15+62	20	15+82	184				
11212	30	15+82	20	16+03	184				
11213	30	16+03	20	16+23	184				
11214	30	16+23	20	16+43	184				
11215	30	16+43	20	16+63	184				
11216	30	16+63	20	16+83	184				
11217	30	16+83	20	17+03	184				12" Tapping OL.
N/A	30	17+03	12	17+14	184				12ft SP in pipe laying schedules. Pipe does not exist in data.
11218	30	17+14	20	17+34	184				
11219	30	17+34	20	17+55	184				
11220	30	17+55	20	17+75	184				
11221	30	17+75	20	17+95	184				
11222	30	17+95	20	18+15	184				
11223	30	18+15	20	18+35	184				
11224	30	18+35	20	18+55	184				
11225	30	18+55	20	18+75	184				
11226	30	18+75	20	18+95	184				
11227	30	18+95	20	19+15	184				
11228	30	19+15	20	19+35	184				
11229	30	N/A	12	N/A	N/A				Not listed in pipe laying schedules. Data indicates 12ft SP.
11230	30	19+35	20	19+55	184				
11231	30	19+55	20	19+75	184				
11232	30	19+75	20	19+95	184				
11233	30	19+95	9	20+04	184				
11234	30	20+04	20	20+24	184				
11235	30	20+24	20	20+42	184				Equation: 20+43.45BK = 20+42.22AH. Refer to legend.
11236	30	20+42	20	20+62	184				
11237	30	20+62	20	20+82	184				
11238	30	20+82	20	21+02	184				
11239	30	21+02	20	21+22	184				
11240	30	21+22	20	21+42	184				
11241	30	21+42	20	21+62	184				
11242	30	21+62	20	21+82	184				
11243	30	21+82	20	22+02	184				
11244	30	22+02	20	22+22	184				
11245	30	22+22	20	22+42	184				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2024
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

Pure Reference Number	Pipe Diameter (inches)	Low Station	Pipe Length (feet)	High Station	Reported Class	Break Region or Anomaly Location (feet from Upstream Station)	Number of Broken Wire Wraps by Region	Total Number of Broken Wire Wraps	Comments
11246	30	22+42	20	22+62	184				
11247	30	22+62	20	22+82	184				
11248	30	22+82	20	23+02	184				
11249	30	23+02	20	23+23	184				12" Tapping OL.
11250	30	23+23	20	23+43	184				
11251	30	23+43	20	23+63	184				
11252	30	23+63	20	23+83	184				
11253	30	23+83	20	24+03	184				
11254	30	24+03	20	24+23	184				
11255	30	24+23	20	24+43	184				
11256	30	24+43	20	24+63	184				
11257	30	24+63	20	24+83	184				
11258	30	24+83	20	25+03	184				
11259	30	25+03	20	25+23	184				
11260	30	25+23	20	25+43	184				
11261	30	25+43	20	25+63	184				
11262	30	25+63	20	25+83	184				
11263	30	25+83	20	26+03	184				
11264	30	26+03	20	26+23	184				
11265	30	26+23	20	26+43	184				
11266	30	26+43	20	26+63	184				
11267	30	26+63	20	26+83	184				
11268	30	26+83	20	27+03	184				
N/A	30	27+03	20	27+23	184				20ft STD in pipe laying schedules. Pipe does not exist in data.
11269	30	N/A	20	N/A	N/A				Not listed in pipe laying schedules. Data indicates 20ft STD with OL.
11270	30	27+23	20	27+43	184				
11271	30	27+43	20	27+63	184				
11272	30	27+63	20	27+83	184				
11273	30	27+83	20	28+03	184				12" OL.
11274	30	28+03	3	28+07	184				30" X 24" Eccentric Reducer.
11275	30	28+07	14	28+20	184				Valve.
11276	30	28+20	3	28+23	184				30" X 24" Eccentric Reducer.
11277	30	28+23	20	28+43	184				
11278	30	28+43	20	28+63	184				10GA Cylinder. 8" BO.
11279	30	28+63	2	28+65	175-12				23° Elbow.
11280	30	28+65	20	28+85	175-12				
11281	30	28+85	20	29+05	175-12				
11282	30	29+05	17	29+21	175-12				
11283	30	29+21	20	29+41	175-12				
11284	30	29+41	2	29+37	175-12				23° Elbow. Equation: 29+42.06BK = 29+36.08AH.
11285	30	29+37	20	29+57	175-12				14" X 16" MH.
11286	30	29+57	20	29+77	175-12				
11287	30	29+77	20	29+97	175-12				
11288	30	29+97	20	30+17	175-12				
11289	30	30+17	12	30+28	175-12				
11290	30	30+28	12	30+40	175-12				
11291	30	30+40	20	30+60	175-12				
11292	30	30+60	20	30+80	175-12				
11293	30	30+80	20	31+00	175-12				
N/A	30	31+00	20	31+20	175-12				20ft STD in pipe laying schedules. Pipe does not exist in data.
11294	30	N/A	20	N/A	N/A				Not listed in pipe laying schedules. Data indicates 20ft STD with OL.
11295	30	31+20	20	31+40	175-12				
11296	30	31+40	2	31+41	175-12				23° Elbow.
11297	30	31+41	20	31+61	175-12				Pipe is reported with less certainty from 0.0-5.0 feet due to elbow related tool movement.
11298	30	31+61	20	31+81	175-12				
11299	30	31+81	16	31+98	175-12				
11300	30	31+98	20	32+17	175-12				
11301	30	32+17	20	32+37	175-12				
11302	30	32+37	20	32+57	175-12				
11303	30	32+57	2	32+50	175-12				23° Elbow. Equation: 32+58.04BK = 32+49.09AH. Refer to legend.
11304	30	32+50	20	32+70	175-12				
11305	30	32+70	20	32+90	175-12				
11306	30	32+90	20	33+10	175-12				
11307	30	33+10	20	33+30	175-12				
11308	30	33+30	20	33+50	175-12				
11309	30	33+50	20	33+70	175-12				
11310	30	33+70	14	33+84	175-12				
11311	30	33+84	20	34+04	175-12				
11312	30	34+04	20	34+23	175-12				
11313	30	34+23	20	34+43	175-12				
11314	30	34+43	20	34+63	175-12				1" OL.
11315	30	34+63	2	34+65	175-12				23° Elbow.
11316	30	34+65	20	34+83	175-12				Pipe is reported with less certainty from 0.0-9.0 feet due to elbow related tool movement.
11317	30	34+83	20	35+02	175-12				
N/A	30	35+02	11	35+12	175-12				11ft SP in pipe laying schedules. Pipe does not exist in data.
11318	30	35+12	2	35+13	175-12				23° Elbow.
11319	30	N/A	11	N/A	N/A				Not listed in pipe laying schedules. Data indicates 11ft SP.
11320	30	35+13	20	35+33	175-12				
11321	30	35+33	20	35+53	175-12				
11322	30	35+53	20	35+73	175-12				Steel casing.(Source from Plan and Profile Drawings). Refer to legend.
11323	30	35+73	20	35+93	175-12				Steel casing.(Source from Plan and Profile Drawings). Refer to legend.
11324	30	35+93	20	36+13	175-12				Steel casing.(Source from Plan and Profile Drawings). Refer to legend.
11325	30	36+13	20	36+33	175-12				Steel casing.(Source from Plan and Profile Drawings). Refer to legend.

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2024
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

Pure Reference Number	Pipe Diameter (inches)	Low Station	Pipe Length (feet)	High Station	Reported Class	Break Region or Anomaly Location (feet from Upstream Station)	Number of Broken Wire Wraps by Region	Total Number of Broken Wire Wraps	Comments
11326	30	36+33	20	36+53	175-12				Steel casing.(Source from Plan and Profile Drawings). Refer to legend.
11327	30	36+53	20	36+73	175-12				Steel casing.(Source from Plan and Profile Drawings). Refer to legend.
11328	30	36+73	20	36+93	175-12				Steel casing.(Source from Plan and Profile Drawings). Refer to legend.
11329	30	36+93	20	37+13	175-12				Steel casing.(Source from Plan and Profile Drawings). Refer to legend.
11330	30	37+13	20	37+33	175-12				Steel casing.(Source from Plan and Profile Drawings). Refer to legend.
11331	30	37+33	20	37+53	175-12				
N/A	30	37+53	16	37+69	175-12				16ft SP in pipe laying schedules. Pipe does not exist in data.
11332	30	N/A	20	N/A	N/A				Not listed in pipe laying schedules. Data indicates 20ft STD.
11333	30	37+69	20	37+89	175-12				8" OL.
11334	30	37+89	1	37+90	175-12				11° Elbow.
11335	30	37+90	20	38+10	175-12				Pipe is reported with less certainty from 0.0-11.0 feet due to elbow related tool movement.
11336	30	38+10	15	38+25	175-12				
11337	30	38+25	1	38+26	175-12				11° Elbow.
11338	30	38+26	20	38+46	175-12				
11339	30	38+46	20	38+65	175-12				
11340	30	38+65	20	38+85	175-12				
11341	30	38+85	20	39+05	175-12				
11342	30	39+05	20	39+25	175-12				
11343	30	39+25	20	39+45	175-12				
11344	30	39+45	20	39+65	175-12				
11345	30	39+65	20	39+85	175-12				
11346	30	39+85	20	40+05	175-12				
11347	30	40+05	20	40+25	175-12				
11348	30	40+25	20	40+45	175-12				
11349	30	40+45	17	40+62	175-12				
11350	30	40+62	20	40+82	175-12				
11351	30	40+82	20	41+02	175-12				
11352	30	41+02	20	41+22	175-12				
11353	30	41+22	20	41+42	175-12				
11354	30	41+42	20	41+62	175-12				
11355	30	41+62	20	41+82	175-12				
11356	30	41+82	20	42+02	175-12				
11357	30	42+02	20	42+23	175-12				
11358	30	42+23	20	42+43	175-12				
11359	30	42+43	20	42+63	175-12				
11360	30	42+63	20	42+72	175-12				Equation: 41+02.38BK = 40+92.10AH. Refer to legend.
11361	30	42+72	20	42+92	175-12				6" OL.
11362	30	42+92	12	43+04	175-12				
11363	30	43+04	20	43+24	175-12				
11364	30	43+24	20	43+44	175-12				
11365	30	43+44	20	43+64	175-12				
11366	30	43+64	20	43+84	175-12				
11367	30	N/A	20	N/A	N/A				Not listed in pipe laying schedules. Data indicates 20ft STD.
11368	30	N/A	20	N/A	N/A				Not listed in pipe laying schedules. Data indicates 20ft STD.
11369	30	43+84	20	44+04	175-12				16" X 14" MH.
N/A	30	44+04	20	44+24	175-12				20ft STD in pipe laying schedules. Pipe does not exist in data.
N/A	30	44+24	20	44+44	175-12				Equation: 44+44.20BK = 44+44.00AH. 20ft STD in pipe laying schedules. Pipe does not exist in data. Refer to legend.
11370	30	44+44	20	44+64	175-12				
11371	30	44+64	20	44+84	175-12				
11372	30	44+84	20	45+04	175-12				1" OL.
11373	30	45+04	20	45+24	175-12				
11374	30	45+24	20	45+44	175-12				
11375	30	45+44	20	45+64	175-12				
11376	30	45+64	20	45+84	175-12				
11377	30	45+84	20	46+04	175-12				
11378	30	46+04	20	46+24	175-12				
11379	30	46+24	20	46+44	175-12				
11380	30	46+44	20	46+64	175-12				
11381	30	46+64	20	46+84	175-12				
N/A	30	46+84	20	47+04	175-12				20ft STD in pipe laying schedules. Pipe does not exist in data.
11382	30	N/A	20	N/A	N/A				Not listed in pipe laying schedules. Data indicates 20ft STD with OL.
11383	30	47+04	20	47+24	175-12				
11384	30	47+24	20	47+44	175-12				
11385	30	47+44	20	47+64	175-12				
11386	30	47+64	20	47+84	175-12				
11387	30	47+84	20	48+04	175-12				
11388	30	48+04	20	48+24	175-12				
11389	30	48+24	20	48+44	175-12				
11390	30	48+44	20	48+64	175-12				
11391	30	48+64	20	48+84	175-12				
11392	30	48+84	20	49+04	175-12				
N/A	30	49+04	20	49+23	175-12				Equation: 48+23.92BK = 48+23.23AH. 20ft STD in pipe laying schedules. Pipe does not exist in data. Refer to legend.
11393	30	N/A	20	N/A	N/A				Not listed in pipe laying schedules. Data indicates 20ft STD with OL.
11394	30	49+23	6	49+29	175-12				
11395	30	49+29	20	49+49	175-12				
11396	30	49+49	20	49+69	175-12				
11397	30	49+69	20	49+89	175-12				
N/A	30	49+89	20	50+09	175-12				20ft STD in pipe laying schedules. Pipe does not exist in data.
11398	30	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates ~16ft SP.
11399	30	50+09	3	50+12	175-12				45° Elbow.
11400	30	50+12	20	50+32	175-12				Pipe is reported with less certainty from 0.0-10.0 feet due to elbow related tool movement.

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2024
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

Pure Reference Number	Pipe Diameter (inches)	Low Station	Pipe Length (feet)	High Station	Reported Class	Break Region or Anomaly Location (feet from Upstream Station)	Number of Broken Wire Wraps by Region	Total Number of Broken Wire Wraps	Comments
11401	30	50+32	20	50+52	175-12				8" Tapping OL.
11402	30	50+52	20	50+72	175-12				
11403	30	50+72	20	50+92	175-12				
11404	30	50+92	20	51+12	175-12				
11405	30	51+12	20	51+32	175-12				8" Tapping OL.
11406	30	51+32	5	51+00	175-12				45° Elbow. Equation: 51+34.65BK = 50+98.21AH. Refer to legend.
N/A	30	51+00	20	51+20	175-12				20ft STD in pipe laying schedules. Pipe does not exist in data.
11407	30	N/A	20	N/A	N/A				Not listed in pipe laying schedules. Data indicates 20ft STD with OL.
11408	30	51+20	20	51+40	175-12				
11409	30	51+40	20	51+60	175-12				
11410	30	51+60	20	51+80	175-12				
11411	30	51+80	20	52+00	175-12				16" X 14" MH.
11412	30	52+00	20	52+20	175-12				1" OL.
11413	30	52+20	20	52+40	175-12				
11414	30	52+40	20	52+60	175-12				
11415	30	52+60	20	52+80	175-12				1" OL.
11416	30	52+80	20	53+00	175-12				
11417	30	53+00	20	53+20	175-12				6" Tapping OL.
11418	30	53+20	20	53+40	175-12				
11419	30	53+40	20	53+60	175-12				6" Tapping OL.
11420	30	53+60	20	53+80	175-12				
11421	30	53+80	20	54+00	175-12				
11422	30	54+00	20	54+20	175-12				
11423	30	54+20	20	54+40	175-12				
11424	30	54+40	20	54+60	175-12				
11425	30	54+60	20	54+80	175-12				
11426	30	54+80	20	55+00	175-12				
11427	30	55+00	20	55+20	175-12				
11428	30	55+20	20	55+40	175-12				
11429	30	55+40	20	55+60	175-12				
11430	30	55+60	20	55+80	175-12				
11431	30	55+80	20	56+00	175-12				
11432	30	56+00	20	56+20	175-12				
11433	30	56+20	20	56+40	175-12				
11434	30	56+40	20	56+60	175-12				
11435	30	56+60	20	56+80	175-12				
11436	30	56+80	20	57+00	175-12				
11437	30	57+00	20	57+19	175-12				Equation: 57+19.46BK = 57+18.48AH. Refer to legend.
11438	30	57+19	20	57+39	175-12				
11439	30	57+39	20	57+59	175-12				
11440	30	57+59	20	57+79	175-12				
11441	30	57+79	20	57+99	175-12				
11442	30	57+99	20	58+18	175-12				
N/A	30	58+18	20	58+38	175-12				20ft STD in pipe laying schedules. Pipe does not exist in data.
11443	30	58+38	6	58+45	175-12				
11444	30	58+45	20	58+65	175-12				
11445	30	58+65	20	58+85	175-12				
11446	30	N/A	20	N/A	N/A				Not listed in pipe laying schedules. Data indicates 20ft STD.
11447	30	58+85	7	58+92	175-12				30" X 24" Eccentric Reducer.
11448	24	58+92	16	59+08	175-14				16" OL.
11449	24	59+08	16	59+24	175-14				
11450	24	59+24	16	59+40	175-14				
11451	24	59+40	16	59+56	175-14				
11452	24	59+56	16	59+72	175-14				
11453	24	59+72	16	59+88	175-14				
11454	24	59+88	16	60+04	175-14				
11455	24	60+04	16	60+20	175-14				1" OL.
11456	24	60+20	16	60+36	175-14				
11457	24	60+36	16	60+52	175-14				Equation: 60+52BK = 60+52AH. Refer to legend.
11458	24	60+52	16	60+68	175-14				
11459	24	60+68	16	60+84	175-14				
11460	24	60+84	16	61+00	175-14				
11461	24	61+00	16	61+16	175-14				2" OL.
11462	24	61+16	16	61+32	175-14				
11463	24	61+32	16	61+48	175-14				
11464	24	61+48	16	61+64	175-14				
11465	24	61+64	16	61+80	175-14				
11466	24	61+80	16	61+96	175-14				
11467	24	61+96	16	62+12	175-14				
11468	24	62+12	16	62+28	175-14				
11469	24	62+28	7	62+34	175-14				
11470	24	62+34	7	62+41	175-14				24" X 16" Reducer.
11471	24	62+41	14	62+55	175-14				Valve.
11472	24	62+55	7	62+62	175-14				24" X 16" Reducer.
11473	24	62+62	12	62+74	175-14				
11474	24	62+74	16	62+90	175-14				
11475	24	62+90	16	63+06	175-14				
11476	24	63+06	16	63+22	175-14				
11477	24	63+22	16	63+38	175-14				Equation: 63+38BK = 63+38AH. Refer to legend.
11478	24	63+38	16	63+54	175-14				
11479	24	63+54	16	63+70	175-14				12" OL.
11480	24	63+70	16	63+86	175-14				
11481	24	63+86	16	64+02	175-14				
11482	24	64+02	16	64+18	175-14				
11483	24	64+18	16	64+34	175-14				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2024
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

Pure Reference Number	Pipe Diameter (inches)	Low Station	Pipe Length (feet)	High Station	Reported Class	Break Region or Anomaly Location (feet from Upstream Station)	Number of Broken Wire Wraps by Region	Total Number of Broken Wire Wraps	Comments
11484	24	64+34	16	64+50	175-14				Pipe is reported with less certainty from 0.0-5.0 feet due to electromagnetic noise.
11485	24	64+50	16	64+66	175-14				
11486	24	64+66	16	64+82	175-14				
11487	24	64+82	16	64+98	175-14				
11488	24	64+98	16	65+14	175-14				
11489	24	65+14	16	65+30	175-14				
11490	24	65+30	16	65+46	175-14				
11491	24	65+46	16	65+62	175-14				
11492	24	65+62	16	65+78	175-14				
11493	24	65+78	16	65+94	175-14				
11494	24	65+94	16	66+10	175-14				
11495	24	66+10	16	66+26	175-14				
11496	24	66+26	16	66+42	175-14				
11497	24	66+42	16	66+58	175-14				
11498	24	66+58	16	66+74	175-14				
11499	24	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD.
11500	24	66+74	16	66+90	175-14				8" OL.
11501	24	66+90	16	67+06	175-14				
11502	24	67+06	16	67+22	175-14				
11503	24	67+22	16	67+38	175-14				
11504	24	67+38	16	67+54	175-14				
11505	24	67+54	16	67+70	175-14				
11506	24	67+70	16	67+86	175-14				
11507	24	67+86	16	68+02	175-14				
11508	24	68+02	16	68+18	175-14				
11509	24	68+18	16	68+35	175-14				
11510	24	68+35	16	68+51	175-14				
11511	24	68+51	16	68+67	175-14				
11512	24	68+67	16	68+83	175-14				
N/A	24	68+83	16	68+99	175-14				16ft STD in pipe laying schedules. Pipe does not exist in data.
11513	24	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD with OL.
11514	24	68+99	16	69+15	175-14				
11515	24	69+15	16	69+31	175-14				
11516	24	69+31	16	69+47	175-14				
11517	24	69+47	16	69+63	175-14				
N/A	24	69+63	2638	96+01	175-14				Pipes removed for realignment.
11518	24	N/A	2950	N/A	N/A				Ductile Iron realignment section. (Source: Client)
11519	24	96+01	16	96+17	175-14				
11520	24	96+17	16	96+33	175-14				
11521	24	96+33	16	96+49	175-14				
11522	24	96+49	16	96+65	175-14				
11523	24	96+65	16	96+81	175-14				
11524	24	96+81	16	96+97	175-14				
11525	24	96+97	16	97+13	175-14				
N/A	24	97+13	16	97+29	175-14				16ft STD in pipe laying schedules. Pipe does not exist in data.
11526	24	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD with OL.
11527	24	97+29	16	97+45	175-14				
11528	24	97+45	16	97+61	175-14				
11529	24	97+61	16	97+77	175-14				
11530	24	97+77	16	97+93	175-14				
11531	24	97+93	16	98+09	175-14				
11532	24	98+09	16	98+25	175-14				
11533	24	98+25	16	98+41	175-14				
11534	24	98+41	16	98+57	175-14				
11535	24	98+57	16	98+73	175-14				
11536	24	98+73	16	98+89	175-14				
11537	24	98+89	16	99+05	175-14				
11538	24	99+05	16	99+21	175-14				
11539	24	99+21	16	99+37	175-14				
11540	24	99+37	16	99+53	175-14				
11541	24	99+53	16	99+69	175-14				
11542	24	99+69	16	99+85	175-14				
11543	24	99+85	16	100+01	175-14				
11544	24	100+01	16	100+17	175-14				
11545	24	100+17	16	100+33	175-14				
11546	24	100+33	16	100+49	175-14				6" OL.
11547	24	100+49	16	100+65	175-14				
N/A	24	100+65	16	100+81	175-14				16ft STD in pipe laying schedules. Pipe does not exist in data.
11548	24	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD with OL.
11549	24	100+81	16	100+97	175-14				
11550	24	100+97	16	101+13	175-14				
11551	24	101+13	16	101+29	175-14				
N/A	24	101+29	16	101+45	175-14				16ft STD in pipe laying schedules. Pipe does not exist in data.
11552	24	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD with OL.
11553	24	101+45	16	101+61	175-14				
11554	24	101+61	16	101+77	175-14				
11555	24	101+77	16	101+93	175-14				
N/A	24	101+93	16	102+09	175-14				16ft STD in pipe laying schedules. Pipe does not exist in data.
N/A	24	102+09	16	102+25	175-14				16ft STD in pipe laying schedules. Pipe does not exist in data.
N/A	24	102+25	16	102+41	175-14				16ft STD in pipe laying schedules. Pipe does not exist in data.
11556	24	102+41	16	102+57	175-14				8" OL.
11557	24	102+57	16	102+73	175-14				
11558	24	102+73	16	102+89	175-14				
11559	24	102+89	16	103+05	175-14				

City of Novi
Novi Road PCCP Water Transmission Main

Electromagnetic Inspection Results - 2024
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Broken Wire Wraps

Pure Reference Number	Pipe Diameter (inches)	Low Station	Pipe Length (feet)	High Station	Reported Class	Break Region or Anomaly Location (feet from Upstream Station)	Number of Broken Wire Wraps by Region	Total Number of Broken Wire Wraps	Comments
11560	24	103+05	16	103+21	175-14				
11561	24	103+21	16	103+37	175-14				
11562	24	103+37	16	103+53	175-14				
11563	24	103+53	16	103+68	175-14				Equation: 103+69BK = 103+68AH. Refer to legend.
N/A	24	103+68	16	103+84	175-14				16ft STD in pipe laying schedules. Pipe does not exist in data.
11564	24	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD with OL.
11565	24	103+84	16	104+00	175-14				
11566	24	104+00	16	104+16	175-14				
11567	24	104+16	16	104+32	175-14				
N/A	24	104+32	16	104+48	175-14				16ft STD in pipe laying schedules. Pipe does not exist in data.
11568	24	N/A	16	N/A	N/A				Not listed in pipe laying schedules. Data indicates 16ft STD with OL.
11569	24	104+48	16	104+64	175-14				
11570	24	104+64	16	104+80	175-14				
11571	24	104+80	16	104+96	175-14				
11572	24	104+96	16	105+13	175-14				
11573	24	105+13	16	105+29	175-14				
11574	24	105+29	16	105+45	175-14				
11575	24	105+45	16	105+61	175-14				
11576	24	105+61	16	105+77	175-14				
11577	24	105+77	16	105+93	175-14				6" OL.
11578	24	105+93	16	106+09	175-14				
11579	24	106+09	16	106+25	175-14				
11580	24	106+25	16	106+41	175-14				
11581	24	106+41	16	106+57	175-14				
11582	24	106+57	16	106+73	175-14				
11583	24	106+73	16	106+89	175-14				
11584	24	106+89	16	107+05	175-14				
11585	24	107+05	16	107+21	175-14				
11586	24	107+21	16	107+37	175-14				
Towards Existing Tapping Saddle at 24206 Novi Road									

City of Novi

Novi Road PCCP Water Transmission Main

MH	Manhole.
OL	Outlet.
BO	Blowoff.
STD	Standard Length Pipe.
SP	Short Pipe.
CFRP	Carbon-Fiber Reinforced Polymer
	Pipes listed in laying schedules but not observed in data or pipes removed for replacement.

Station numbers in black font indicate numbers obtained directly from client's documents.
Station numbers in grey font indicate numbers calculated by Pure Technologies.

The steel casing causes a baseline shift in the electromagnetic signal. This change in baseline is clearly evident in the data and allows the data analysts to identify the start end of steel encasement. The shift in the signal does not affect Pure Technologies' ability to detect broken wire wraps in encased pipes. However, since Pure Technologies do not have calibration data for encased pipes in our calibration signal library, there is reduced certainty in quantifying the broken wire wraps. In addition, small number of broken wires wraps, if there are any, may be reported with reduced certainty in the immediate vicinity (+/-1 foot) of the point where the encasement starts and ends.

Station equations are used to handle changes or corrections in the linear measurement, such as when there is a need to adjust the stationing due to construction changes, alignment shifts, or other modifications.

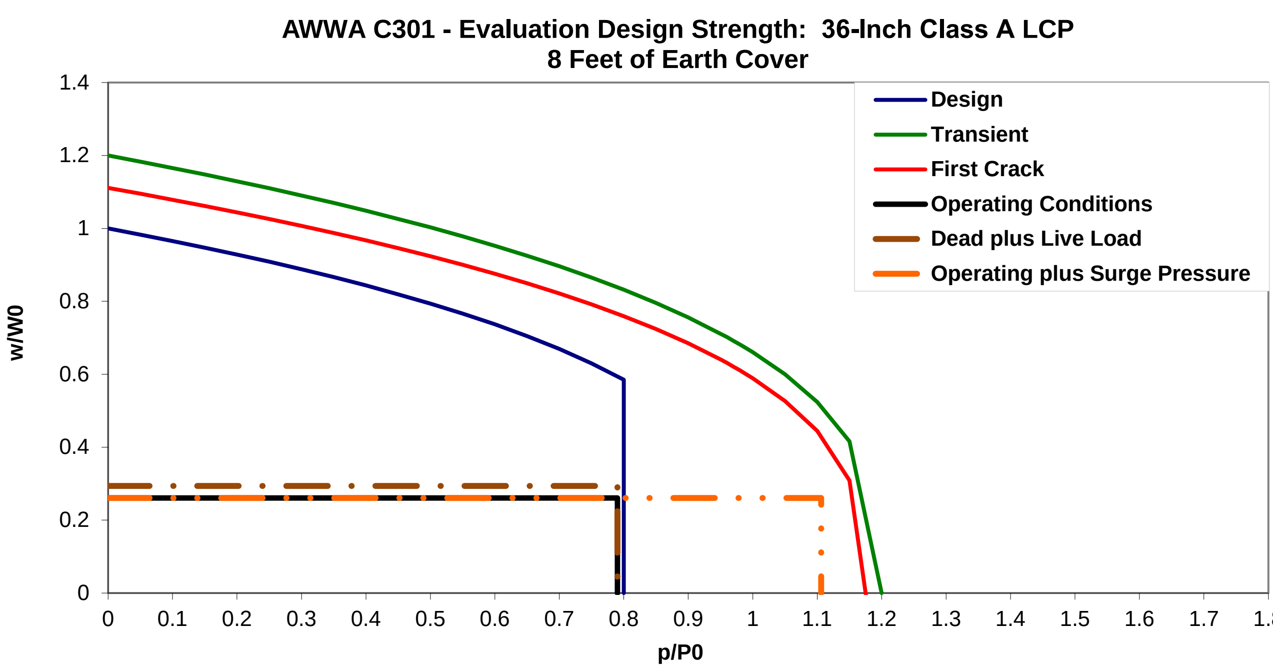
APPENDIX F

AWWA C301 and C304 Results

AWWA C-301 PCCP Design Analysis - Lined Cylinder Pipe 36-inch Diameter PCCP under 8 Feet of Earth Cover 45 degree bedding angle LCP	**Novi Road** **26-Jul-20** **Class A**

Pipe Dimensions		
Diameter of Pipe	**D**	36 in
Core Thickness	**tc**	2.25 in
Outside Diameter of Cylinder	**Dy**	40.6196 in
Cylinder Thickness	**ty**	0.0598 in
Diameter of Wire	**dw**	0.162 in
Specified Coating Thickness	**---**	1 in
Prestressed Wires Properties		
Area of Steel Wire	**As**	0.334 sq in/LF
Ultimate Strength of Wire	**fsu**	293,000 psi
Gross Wrapping Stress of Wire	**fsg**	219,750 psi
Wire Relaxation Loss Factor	**R1**	0.05
Wire Embedment Loss Factor	**R2**	0
Concrete Properties		
Concrete Core	**f'c**	5500 psi
Coating Mortar	**f'm**	6000 psi
Soil & Bedding Properties		
Height of Earth Cover	**H**	8 ft
Soil Density	**γs**	120 lb/cft
Coeff. of Lateral Earth Pressure	**Kμ'**	0.165
Clearance(Pipe & Trench Wall)	**x**	1.5 ft*
Trench Width	**Bd**	5.04 ft
Bedding Factor (Load Factor)	**Lf**	1.50
Transition Width	**Tw**	5.04 ft
Other Constants		
C-301 constants		
Initial Modular Ratio of Elasticity	**ni**	6 Es/Eci
Resultant Modular Ratio	**nr**	5 Es/Ecr
Concrete Core Creep Factor	**Cr**	1.5

Design Conditions (AWWA C-301)		
Working Pressure	**Pw**	175 psi
Surge/Water Hammer Press.	**Psp/Pwh**	70 psi
Test Pressure	**Pt**	245 psi
Live Load H-20		
Live Load Impact Factor	**If**	0%
Calculation		
Area of Concrete Core	**Ac**	26.28 sq in/LF
Area of Steel Cylinder	**Ay**	0.7176 sq in/LF
Weight of the Pipe	**Wp**	427.6 lb/LF
Weight of Water	**Ww**	441.1 lb/LF
W Dead (Earth Load)	**Wd**	2415.2 lb/LF
W live (H-20+Impact Factor)	**Wl**	306.0 lb/LF
Initial Conditions (C-301)		
Initial Wire Stress	**fsi**	195,926 psi
Initial Cylinder Stress	**fyi**	12,836 psi
Initial Concrete Core Stress	**fci**	2,139 psi
Concrete Strength at Wrap	**f'ci**	3,890 psi
Resultant Conditions (C-301)		
Resultant Wire Stress	**fsr**	185,230 psi
Resultant Cylinder Stress	**fyr**	23,532 psi
Resultant Concrete Core Stress	**fcr**	1,711 psi
Pressures (C-301)		
Zero Concrete Stress Press.	**P0**	221 psi
Elastic Limit Pressure	**Pl**	334 psi
Bursting Pressure	**Pb**	555 psi
Pipe's Strength (C-301)		
Three Edge Bearing Strength	**W001**	10,293 lb/LF
0.9*W001	**W0**	9,264 lb/LF



AWWA C-304 PCCP Design Analysis - Lined Cylinder Pipe		Novi Road
36-inch Diameter PCCP under 8 Feet of Earth Cover		26-Jul-2020
45 degree bedding angle	LCP	Class A

Serviceability

Limit State Criterion	Load Comb.	N1	M1	Strain or Stress	Limit		Criterion Satisfied
Full Pipe Circumference							
Produce Core Decompression	W1	41453.29	14562.99	175	168.7		Not Satisfied
(P≤P0)							
Produce Coating Cracking	WT1	58513.52	14562.99	245	242.1		Not Satisfied
P≤min(Pk',1.4P0)							
Invert & Crown							
Inside Core Tensile Strain	W1	41453.29	14562.99	1.06E-04	2.03E-04		Yes
εci ≤ 1.5*ε't							
Inside Core Tensile Strain	WT1	58513.52	14,563	1.18E-03	1.49E-03		Yes
εci ≤ ε'k	WT2	41288.7	15987.97	1.21E-04	1.49E-03		Yes
	FT1	64364.87	16019.29	1.10E-04	1.49E-03		Yes
Core to Cylinder Radial Tension	FW1	-1522.08	17374.94	-139	12	Psi	Yes
σr ≤ 12 psi	WT3	-1361.88	15987.97	-141	12	Psi	Yes
Springline							
Outer Core Tensile Strain	W1	40368.07	7724.582	7.56E-06	2.03E-04		Yes
εco ≤ 1.5*ε't							
Outer Coating Tensile Strain	W1	40368.07	7724.582	5.03E-04	9.28E-04		Yes
εmo ≤ 0.8*ε'km							
Outer Core Tensile Strain	WT1	57428.3	7,725	1.44E-04	1.49E-03		Yes
εco ≤ ε'k	WT2	40092	8487.516	1.45E-05	1.49E-03		Yes
	FT1	63171.13	8497.04	2.00E-04	1.49E-03		Yes
Outer Coating Tensile Strain	WT1	57428.3	7,725	6.65E-04	1.16E-03		Yes
εmo ≤ ε'km	WT2	40092	8487.516	5.20E-04	1.16E-03		Yes
	FT1	63171.13	8497.04	7.11E-04	1.16E-03		Yes
Inner Core Compression	W2	-2282.51	7724.582	2113.91	3025	Psi	Yes
fci ≤ 0.55f'c, fci ≤ 0.65f'c	WT3	-2558.58	8487.516	2176.29	3575	Psi	Yes

Elastic Limit

Limit State Criterion	Load Comb.	N1	M1	Strain or Stress	Limit	Criterion Satisfied
Invert & Crown						
Yielding of cylinder	WT1	58513.52	14562.99	2,413.31	33,000	Yes
.-fyr+n'*fcr+Δfy≤ fyy	WT2	41288.7	15987.97	-21,943.52	33,000	Yes
	FT1	64364.87	16019.29	-10,203.20	33,000	Yes
Onset of Tension in Cylinder	WT3	-1361.88	15,988	-28,455.68	0	Yes
.-fyr+n'*fcr+Δfy≤ 0						
Springline						
Wire Elastic Limit	FWT1	63,171	8,497	191,631	219,750	Yes
fs≤ fsg or .-fsr+nfcr+Δfs≤ fsg	FWT2	44,101	9,336	187,587	219,750	Yes
	FT2	69,488	9,347	194,524	219,750	Yes
Core Compression Limit	FWT1	63,171	8,497	273	4,125	Yes
fc ≤ 0.75f'c	FWT2	44,101	9,336	877	4,125	Yes

	Load Comb.	N2	M2		Limit	Criterion Satisfied
	FT2	69,488	9,347	153	4,125	Yes

Strength Limit

Limit State Criterion	Load Comb.	N2	M2	M2r, Fsr	Limit	Criterion Satisfied
Springline						
Wire-Yield Limit for	FWT3	74656.8	10041.96	18,563.32	145,831	Yes
$N_2 \geq N_k'$, $M_2 \leq M_{2sy}$	FWT4	52119.59	11033.77	11,033.77	38,213	Yes
fs≤ fsg or -fsr+nfcr+Δfs≤ fsy	FWT3	74656.8	10041.96	197,262.61	249,050	Yes
fs≤ fsg or -fsr+nfcr+Δfs≤ fsy	FWT4	52119.59	11033.77	189,717.39	249,050	Yes

Ultimate Moment

	Load Comb.	N2	M2	Strain or Stress	Limit	Criterion Satisfied
Core Crashing						
($M \leq M_{2ult}$)	FWT5	-4,204	13,885	13,885	74,923	Yes

Burst Pressure

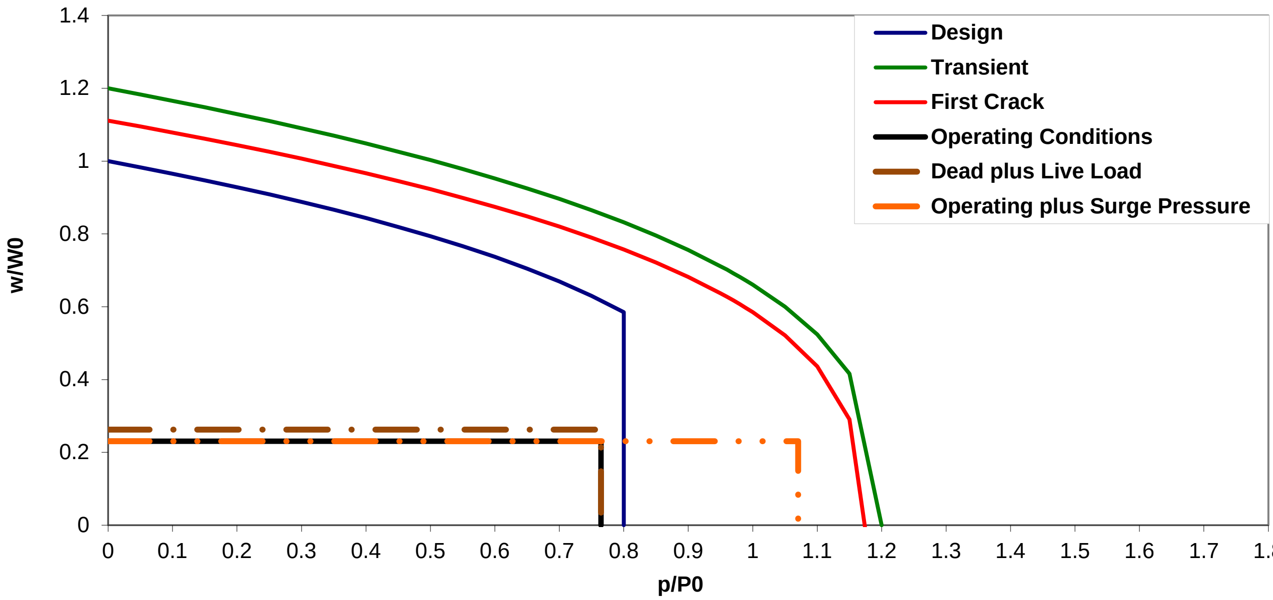
	Load Comb.	N	M	Strain or Stress	Limit	Criterion Satisfied
Burst Failure	FWT6	0	0	420	555	Yes

AWWA C-301 PCCP Design Analysis - Lined Cylinder Pipe	**Novi Road**
30-inch Diameter PCCP under 8 Feet of Earth Cover	**31-Jul-24**
45 degree bedding angle LCP	**Class #184**

Pipe Dimensions			
Diameter of Pipe	**D**	30	in
Core Thickness	**tc**	1.8152	in
Outside Diameter of Cylinder	**Dy**	33.75	in
Cylinder Thickness	**ty**	0.0598	in
Diameter of Wire	**dw**	0.192	in
Specified Coating Thickness	**---**	1	in
Prestressed Wires Properties			
Area of Steel Wire	**As**	0.350	sq in/LF
Ultimate Strength of Wire	**fsu**	252,000	psi
Gross Wrapping Stress of Wire	**fsg**	189,000	psi
Wire Relaxation Loss Factor	**R1**	0.05	
Wire Embedment Loss Factor	**R2**	0	
Concrete Properties			
Concrete Core	**f'c**	5500	psi
Coating Mortar	**f'm**	6000	psi
Soil & Bedding Properties			
Height of Earth Cover	**H**	8	ft
Soil Density	**γs**	120	lb/cft
Coeff. of Lateral Earth Pressure	**Kμ'**	0.165	
Clearance(Pipe & Trench Wall)	**x**	1	ft*
Trench Width	**Bd**	3.97	ft
Bedding Factor (Load Factor)	**Lf**	1.50	
Transition Width	**Tw**	5.67	ft
Other Constants			
C-301 constants			
Initial Modular Ratio of Elasticity	**ni**	6	Es/Eci
Resultant Modular Ratio	**nr**	5	Es/Ecr
Concrete Core Creep Factor	**Cr**	1.5	

Design Conditions (AWWA C-301)			
Working Pressure	**Pw**	175	psi
Surge/Water Hammer Press.	**Psp/Pwh**	70	psi
Test Pressure	**Pt**	245	psi
Live Load H-20			
Live Load Impact Factor	**If**	0%	
Calculation			
Area of Concrete Core	**Ac**	21.06	sq in/LF
Area of Steel Cylinder	**Ay**	0.7176	sq in/LF
Weight of the Pipe	**Wp**	312.5	lb/LF
Weight of Water	**Ww**	306.3	lb/LF
W Dead (Earth Load)	**Wd**	1855.4	lb/LF
W live (H-20+Impact Factor)	**Wl**	256.5	lb/LF
Initial Conditions (C-301)			
Initial Wire Stress	**fsi**	165,824	psi
Initial Cylinder Stress	**fyi**	13,726	psi
Initial Concrete Core Stress	**fci**	2,288	psi
Concrete Strength at Wrap	**f'ci**	4,159	psi
Resultant Conditions (C-301)			
Resultant Wire Stress	**fsr**	155,321	psi
Resultant Cylinder Stress	**fyr**	24,229	psi
Resultant Concrete Core Stress	**fcr**	1,755	psi
Pressures (C-301)			
Zero Concrete Stress Press.	**P0**	229	psi
Elastic Limit Pressure	**Pl**	360	psi
Bursting Pressure	**Pb**	620	psi
Pipe's Strength (C-301)			
Three Edge Bearing Strength	**W001**	8,940	lb/LF
0.9*W001	**W0**	8,046	lb/LF

AWWA C301 - Evaluation Design Strength: 30-Inch Class #184
LCP 8 Feet of Earth Cover



AWWA C-304 PCCP Design Analysis - Lined Cylinder Pipe		Novi Road
30-inch Diameter PCCP under 8 Feet of Earth Cover		30-Jul-24
45 degree bedding angle	LCP	Class #184

Serviceability

Limit State Criterion	Load Comb.	N1	M1	Strain or Stress	Limit		Criterion Satisfied
Full Pipe Circumference							
Produce Core Decompression	W1	34508.64	9203.691	175	174.9		Not Satisfied
(P≤P0)							
Produce Coating Cracking	WT1	48683.64	9203.691	245	250.6		Yes
P≤min(Pk',1.4P0)							
Invert & Crown							
Inside Core Tensile Strain	W1	34508.64	9203.691	5.82E-05	2.03E-04		Yes
εci ≤ 1.5*ε't							
Inside Core Tensile Strain	WT1	48683.64	9,204	3.81E-04	1.49E-03		Yes
εci ≤ ε'k	WT2	34370.65	10202.49	7.29E-05	1.49E-03		Yes
	FT1	53552	10124.06	9.35E-04	1.49E-03		Yes
Core to Cylinder Radial Tension	FW1	-1178.36	11009.67	-138	12	Psi	Yes
σr ≤ 12 psi	WT3	-1066.85	10202.49	-140	12	Psi	Yes
Springline							
Outer Core Tensile Strain	W1	33687.02	4882.055	-1.83E-05	2.03E-04		Yes
εco ≤ 1.5*ε't							
Outer Coating Tensile Strain	W1	33687.02	4882.055	4.92E-04	9.28E-04		Yes
εmo ≤ 0.8*ε'km							
Outer Core Tensile Strain	WT1	47862.02	4,882	1.17E-04	1.49E-03		Yes
εco ≤ ε'k	WT2	33455.56	5416.81	-1.21E-05	1.49E-03		Yes
	FT1	52648.22	5370.261	1.59E-04	1.49E-03		Yes
Outer Coating Tensile Strain	WT1	47862.02	4,882	6.81E-04	1.16E-03		Yes
εmo ≤ ε'km	WT2	33455.56	5416.81	5.11E-04	1.16E-03		Yes
	FT1	52648.22	5370.261	6.81E-04	1.16E-03		Yes
Inner Core Compression	W2	-1750.48	4882.055	2081.41	3025	Psi	Yes
fci ≤ 0.55f'c, fci ≤ 0.65f'c	WT3	-1981.94	5416.81	2144.83	3575	Psi	Yes

Elastic Limit

Limit State Criterion	Load Comb.	N1	M1	Strain or Stress	Limit	Criterion Satisfied
Invert & Crown						
Yielding of cylinder	WT1	48683.64	9203.691	-20,304.57	33,000	Yes
.-fyr+n'*fcr+Δfy≤ fyy	WT2	34370.65	10202.49	-22,731.56	33,000	Yes
	FT1	53552	10124.06	-739.54	33,000	Yes
Onset of Tension in Cylinder	WT3	-1066.85	10,202	-28,984.14	0	Yes
.-fyr+n'*fcr+Δfy≤ 0						
Springline						
Wire Elastic Limit	FWT1	52,648	5,370	163,926	189,000	Yes
fs≤ fsg or .-fsr+nfcr+Δfs≤ fsg	FWT2	36,801	5,958	160,254	189,000	Yes
	FT2	57,913	5,907	166,071	189,000	Yes
Core Compression Limit	FWT1	52,648	5,370	270	4,125	Yes
fc ≤ 0.75f'c	FWT2	36,801	5,958	874	4,125	Yes
	FT2	57,913	5,907	154	4,125	Yes

Strength Limit

Limit State Criterion	Load Comb.	N2	M2	M2, Fs	Limit	Criterion Satisfied
Springline						
Wire-Yield Limit for	FWT3	62220.62	6346.672	6,346.67	199,433	Yes
$N_2 \geq N_k'$, $M_2 \leq M_{2sy}$	FWT4	43492.23	7041.853	7,041.85	22,495	Yes
fs≤ fsg or -fsr+nfcr+Δfs≤ fsy	FWT3	62220.62	6346.672	168,130.50	214,200	Yes
fs≤ fsg or -fsr+nfcr+Δfs≤ fsy	FWT4	43492.23	7041.853	162,283.16	214,200	Yes

Ultimate Moment

	Load Comb.	N2	M2	Strain or Stress	Limit	Criterion Satisfied
Core Crashing						
($M \leq M_{2ult}$)	FWT5	-3,264	8,881	8,881	51,215	Yes

Burst Pressure

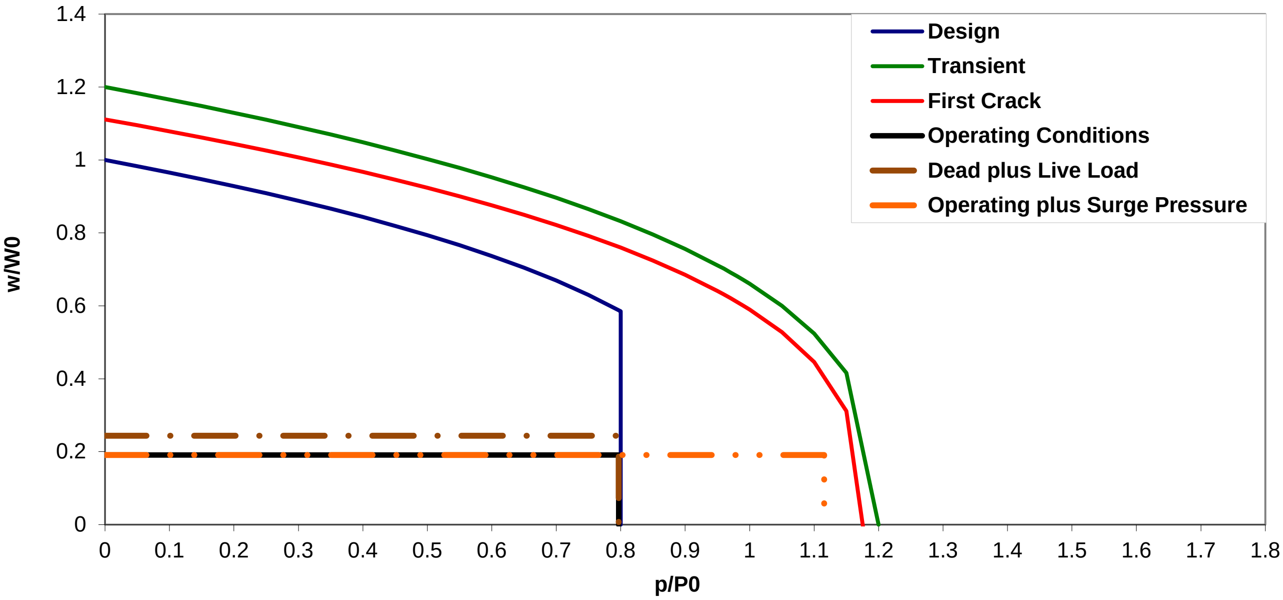
	Load Comb.	N	M	Strain or Stress	Limit	Criterion Satisfied
Burst Failure	FWT6	0	0	420	620	Yes
(P≤Pb)						

AWWA C-301 PCCP Design Analysis - Lined Cylinder Pipe		**Novi Road**
30-inch Diameter PCCP under 6 Feet of Earth Cover		**31-Jul-24**
45 degree bedding angle	LCP	**Class 175-12**

Pipe Dimensions		
Diameter of Pipe	**D**	30 in
Core Thickness	**tc**	1.8152 in
Outside Diameter of Cylinder	**Dy**	33.75 in
Cylinder Thickness	**ty**	0.0598 in
Diameter of Wire	**dw**	0.162 in
Specified Coating Thickness	**---**	1 in
Prestressed Wires Properties		
Area of Steel Wire	**As**	0.285 sq in/LF
Ultimate Strength of Wire	**fsu**	293,000 psi
Gross Wrapping Stress of Wire	**fsg**	219,750 psi
Wire Relaxation Loss Factor	**R1**	0.05
Wire Embedment Loss Factor	**R2**	0
Concrete Properties		
Concrete Core	**f'c**	5500 psi
Coating Mortar	**f'm**	6000 psi
Soil & Bedding Properties		
Height of Earth Cover	**H**	6 ft
Soil Density	**γs**	120 lb/cft
Coeff. of Lateral Earth Pressure	**Kμ'**	0.165
Clearance(Pipe & Trench Wall)	**x**	1 ft*
Trench Width	**Bd**	3.97 ft
Bedding Factor (Load Factor)	**Lf**	1.50
Transition Width	**Tw**	5.33 ft
Other Constants		
C-301 constants		
Initial Modular Ratio of Elasticity	**ni**	6 Es/Eci
Resultant Modular Ratio	**nr**	5 Es/Ecr
Concrete Core Creep Factor	**Cr**	1.5

Design Conditions (AWWA C-301)		
Working Pressure	**Pw**	175 psi
Surge/Water Hammer Press.	**Psp/Pwh**	70 psi
Test Pressure	**Pt**	245 psi
Live Load H-20		
Live Load Impact Factor	**If**	8%
Calculation		
Area of Concrete Core	**Ac**	21.06 sq in/LF
Area of Steel Cylinder	**Ay**	0.7176 sq in/LF
Weight of the Pipe	**Wp**	311.2 lb/LF
Weight of Water	**Ww**	306.3 lb/LF
W Dead (Earth Load)	**Wd**	1500.1 lb/LF
W live (H-20+Impact Factor)	**Wl**	414.9 lb/LF
Initial Conditions (C-301)		
Initial Wire Stress	**fsi**	195,580 psi
Initial Cylinder Stress	**fyi**	13,182 psi
Initial Concrete Core Stress	**fci**	2,197 psi
Concrete Strength at Wrap	**f'ci**	3,995 psi
Resultant Conditions (C-301)		
Resultant Wire Stress	**fsr**	185,249 psi
Resultant Cylinder Stress	**fyr**	23,514 psi
Resultant Concrete Core Stress	**fcr**	1,705 psi
Pressures (C-301)		
Zero Concrete Stress Press.	**P0**	220 psi
Elastic Limit Pressure	**Pl**	348 psi
Bursting Pressure	**Pb**	597 psi
Pipe's Strength (C-301)		
Three Edge Bearing Strength	**W001**	8,728 lb/LF
0.9*W001	**W0**	7,855 lb/LF

AWWA C301 - Evaluation Design Strength: 30-Inch Class 175-12
LCP 6 Feet of Earth Cover



AWWA C-304 PCCP Design Analysis - Lined Cylinder Pipe		Novi Road
30-inch Diameter PCCP under 6 Feet of Earth Cover		30-Jul-24
45 degree bedding angle	LCP	Class 175-12

Serviceability

Limit State Criterion	Load Comb.	N1	M1	Strain or Stress	Limit		Criterion Satisfied
Full Pipe Circumference							
Produce Core Decompression	W1	34699.87	7815.996	175	165.4		Not Satisfied
(P≤P0)							
Produce Coating Cracking	WT1	48874.87	7815.996	245	238.2		Not Satisfied
P≤min(Pk',1.4P0)							
Invert & Crown							
Inside Core Tensile Strain	W1	34699.87	7815.996	5.95E-05	2.03E-04		Yes
εci ≤ 1.5*ε't							
Inside Core Tensile Strain	WT1	48874.87	7,816	4.60E-04	1.49E-03		Yes
εci ≤ ε'k	WT2	34476.69	9431.5	8.33E-05	1.49E-03		Yes
	FT1	53762.36	8597.596	5.60E-04	1.49E-03		Yes
Core to Cylinder Radial Tension	FW1	-939.352	9276.151	-135	12	Psi	Yes
σr ≤ 12 psi	WT3	-960.814	9431.5	-135	12	Psi	Yes
Springline							
Outer Core Tensile Strain	W1	34007.95	4139.369	-3.53E-06	2.03E-04		Yes
εco ≤ 1.5*ε't							
Outer Coating Tensile Strain	W1	34007.95	4139.369	4.77E-04	9.28E-04		Yes
εmo ≤ 0.8*ε'km							
Outer Core Tensile Strain	WT1	48182.95	4,139	1.23E-04	1.49E-03		Yes
εco ≤ ε'k	WT2	33633.58	5004.307	7.22E-06	1.49E-03		Yes
	FT1	53001.24	4553.306	1.80E-04	1.49E-03		Yes
Outer Coating Tensile Strain	WT1	48182.95	4,139	5.96E-04	1.16E-03		Yes
εmo ≤ ε'km	WT2	33633.58	5004.307	5.09E-04	1.16E-03		Yes
	FT1	53001.24	4553.306	6.75E-04	1.16E-03		Yes
Inner Core Compression	W2	-1429.55	4139.369	1943.61	3025	Psi	Yes
fci ≤ 0.55f'c, fci ≤ 0.65f'c	WT3	-1803.92	5004.307	2048.01	3575	Psi	Yes

Elastic Limit

Limit State Criterion	Load Comb.	N1	M1	Strain or Stress	Limit	Criterion Satisfied
Invert & Crown						
Yielding of cylinder	WT1	48874.87	7815.996	-18,956.70	33,000	Yes
.-fyr+n'*fcr+Δfy≤ fyy	WT2	34476.69	9431.5	-21,679.31	33,000	Yes
	FT1	53762.36	8597.596	-4,915.88	33,000	Yes
Onset of Tension in Cylinder	WT3	-960.814	9,432	-27,954.77	0	Yes
.-fyr+n'*fcr+Δfy≤ 0						
Springline						
Wire Elastic Limit	FWT1	53,001	4,553	191,077	219,750	Yes
fs≤ fsg or .-fsr+nfcr+Δfs≤ fsg	FWT2	36,997	5,505	187,353	219,750	Yes
	FT2	58,301	5,009	193,678	219,750	Yes
Core Compression Limit	FWT1	53,001	4,553	98	4,125	Yes
fc ≤ 0.75f'c	FWT2	36,997	5,505	751	4,125	Yes
	FT2	58,301	5,009	-49	4,125	Yes

Strength Limit

Limit State Criterion	Load Comb.	N2	M2	M2, Fs	Limit	Criterion Satisfied
Springline						
Wire-Yield Limit for	FWT3	62637.83	5381.18	5,381.18	176,069	Yes
$N_2 \geq N_k'$, $M_2 \leq M_{2sy}$	FWT4	43723.66	6505.599	6,505.60	22,414	Yes
fs≤ fsg or -fsr+nfcr+Δfs≤ fsy	FWT3	62637.83	5381.18	196,212.33	249,050	Yes
fs≤ fsg or -fsr+nfcr+Δfs≤ fsy	FWT4	43723.66	6505.599	189,398.96	249,050	Yes

Ultimate Moment

	Load Comb.	N2	M2	Strain or Stress	Limit	Criterion Satisfied
Core Crashing						
($M \leq M_{2ult}$)	FWT5	-3,036	8,353	8,353	51,226	Yes

Burst Pressure

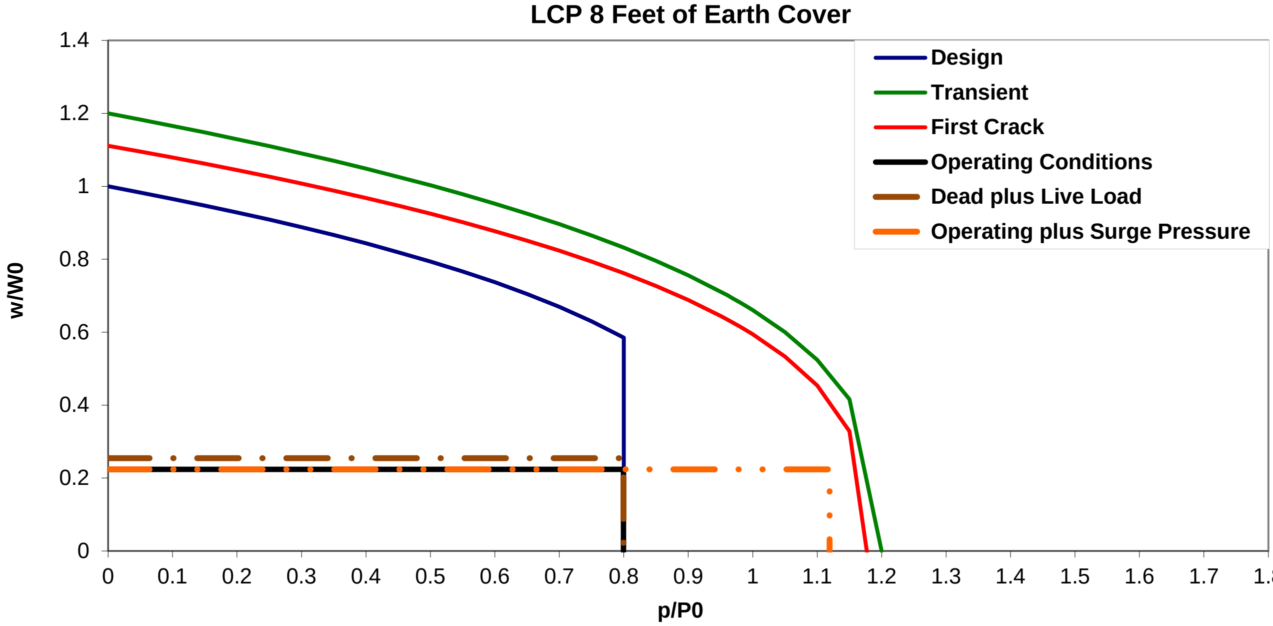
	Load Comb.	N	M	Strain or Stress	Limit	Criterion Satisfied
Burst Failure	FWT6	0	0	420	597	Yes
(P≤Pb)						

AWWA C-301 PCCP Design Analysis - Lined Cylinder Pipe	**Novi Road**
24-inch Diameter PCCP under 8 Feet of Earth Cover	**31-Jul-24**
45 degree bedding angle LCP	**Class 175-14**

Pipe Dimensions		
Diameter of Pipe	**D**	24 in
Core Thickness	**tc**	1.4402 in
Outside Diameter of Cylinder	**Dy**	27 in
Cylinder Thickness	**ty**	0.0598 in
Diameter of Wire	**dw**	0.162 in
Specified Coating Thickness	**---**	1 in
Prestressed Wires Properties		
Area of Steel Wire	**As**	0.237 sq in/LF
Ultimate Strength of Wire	**fsu**	293,000 psi
Gross Wrapping Stress of Wire	**fsg**	219,750 psi
Wire Relaxation Loss Factor	**R1**	0.05
Wire Embedment Loss Factor	**R2**	0
Concrete Properties		
Concrete Core	**f'c**	5500 psi
Coating Mortar	**f'm**	6000 psi
Soil & Bedding Properties		
Height of Earth Cover	**H**	8 ft
Soil Density	**γs**	120 lb/cft
Coeff. of Lateral Earth Pressure	**Kμ'**	0.165
Clearance(Pipe & Trench Wall)	**x**	1 ft*
Trench Width	**Bd**	3.41 ft
Bedding Factor (Load Factor)	**Lf**	1.50
Transition Width	**Tw**	4.83 ft
Other Constants		
C-301 constants		
Initial Modular Ratio of Elasticity	**ni**	6 Es/Eci
Resultant Modular Ratio	**nr**	5 Es/Ecr
Concrete Core Creep Factor	**Cr**	1.5

Design Conditions (AWWA C-301)		
Working Pressure	**Pw**	175 psi
Surge/Water Hammer Press.	**Psp/Pwh**	70 psi
Test Pressure	**Pt**	245 psi
Live Load H-20		
Live Load Impact Factor	**If**	0%
Calculation		
Area of Concrete Core	**Ac**	16.56 sq in/LF
Area of Steel Cylinder	**Ay**	0.7176 sq in/LF
Weight of the Pipe	**Wp**	218.5 lb/LF
Weight of Water	**Ww**	196.0 lb/LF
W Dead (Earth Load)	**Wd**	1517.2 lb/LF
W live (H-20+Impact Factor)	**Wl**	207.9 lb/LF
Initial Conditions (C-301)		
Initial Wire Stress	**fsi**	195,446 psi
Initial Cylinder Stress	**fyi**	13,317 psi
Initial Concrete Core Stress	**fci**	2,219 psi
Concrete Strength at Wrap	**f'ci**	4,035 psi
Resultant Conditions (C-301)		
Resultant Wire Stress	**fsr**	185,770 psi
Resultant Cylinder Stress	**fyr**	22,992 psi
Resultant Concrete Core Stress	**fcr**	1,662 psi
Pressures (C-301)		
Zero Concrete Stress Press.	**P0**	219 psi
Elastic Limit Pressure	**Pl**	370 psi
Bursting Pressure	**Pb**	659 psi
Pipe's Strength (C-301)		
Three Edge Bearing Strength	**W001**	7,533 lb/LF
0.9*W001	**W0**	6,780 lb/LF

AWWA C301 - Evaluation Design Strength: 24-Inch Class 175-14
LCP 8 Feet of Earth Cover



AWWA C-304 PCCP Design Analysis - Lined Cylinder Pipe		Novi Road
24-inch Diameter PCCP under 8 Feet of Earth Cover		30-Jul-24
45 degree bedding angle	LCP	Class 175-14

Serviceability

Limit State Criterion	Load Comb.	N1	M1	Strain or Stress	Limit		Criterion Satisfied
Full Pipe Circumference							
Produce Core Decompression	W1	27576.23	5833.473	175	162.3		Not Satisfied
(P≤P0)							
Produce Coating Cracking	WT1	38916.23	5833.473	245	235.6		Not Satisfied
P≤min(Pk',1.4P0)							
Invert & Crown							
Inside Core Tensile Strain	W1	27576.23	5833.473	4.66E-05	2.03E-04		Yes
εci ≤ 1.5*ε't							
Inside Core Tensile Strain	WT1	38916.23	5,833	3.33E-04	1.49E-03		Yes
εci ≤ ε'k	WT2	27464.38	6485.776	5.93E-05	1.49E-03		Yes
	FT1	42807.85	6416.82	8.23E-04	1.49E-03		Yes
Core to Cylinder Radial Tension	FW1	-977.801	7023.406	-123	12	Psi	Yes
σr ≤ 12 psi	WT3	-885.618	6485.776	-125	12	Psi	Yes
Springline							
Outer Core Tensile Strain	W1	26926.53	3096.324	6.27E-06	2.03E-04		Yes
εco ≤ 1.5*ε't							
Outer Coating Tensile Strain	W1	26926.53	3096.324	5.05E-04	9.28E-04		Yes
εmo ≤ 0.8*ε'km							
Outer Core Tensile Strain	WT1	38266.53	3,096	1.29E-04	1.49E-03		Yes
εco ≤ ε'k	WT2	26738.93	3445.566	1.22E-05	1.49E-03		Yes
	FT1	42093.18	3405.956	1.82E-04	1.49E-03		Yes
Outer Coating Tensile Strain	WT1	38266.53	3,096	6.26E-04	1.16E-03		Yes
εmo ≤ ε'km	WT2	26738.93	3445.566	5.27E-04	1.16E-03		Yes
	FT1	42093.18	3405.956	6.98E-04	1.16E-03		Yes
Inner Core Compression	W2	-1423.47	3096.324	1934.00	3025	Psi	Yes
fci ≤ 0.55f'c, fci ≤ 0.65f'c	WT3	-1611.07	3445.566	1998.15	3575	Psi	Yes

Elastic Limit

Limit State Criterion	Load Comb.	N1	M1	Strain or Stress	Limit	Criterion Satisfied
Invert & Crown						
Yielding of cylinder	WT1	38916.23	5833.473	-18,771.78	33,000	Yes
.-fyr+n'*fcr+Δfy≤ fyy	WT2	27464.38	6485.776	-21,206.31	33,000	Yes
	FT1	42807.85	6416.82	-1,734.89	33,000	Yes
Onset of Tension in Cylinder	WT3	-885.618	6,486	-27,122.89	0	Yes
.-fyr+n'*fcr+Δfy≤ 0						
Springline						
Wire Elastic Limit	FWT1	42,093	3,406	191,524	219,750	Yes
fs≤ fsg or .-fsr+nfcr+Δfs≤ fsg	FWT2	29,413	3,790	187,834	219,750	Yes
	FT2	46,303	3,747	193,772	219,750	Yes
Core Compression Limit	FWT1	42,093	3,406	165	4,125	Yes
fc ≤ 0.75f'c	FWT2	29,413	3,790	755	4,125	Yes
	FT2	46,303	3,747	33	4,125	Yes

Strength Limit

Limit State Criterion	Load Comb.	N2	M2	M2, Fs	Limit	Criterion Satisfied
Springline						
Wire-Yield Limit for	FWT3	49746.49	4025.221	4,025.22	127,113	Yes
$N_2 \geq N_k'$, $M_2 \leq M_{2sy}$	FWT4	34760.6	4479.235	4,479.24	11,649	Yes
fs≤ fsg or -fsr+nfcr+Δfs≤ fsy	FWT3	49746.49	4025.221	195,799.74	249,050	Yes
fs≤ fsg or -fsr+nfcr+Δfs≤ fsy	FWT4	34760.6	4479.235	189,814.49	249,050	Yes

Ultimate Moment

	Load Comb.	N2	M2	Strain or Stress	Limit	Criterion Satisfied
Core Crashing						
($M \leq M_{2ult}$)	FWT5	-2,653	5,653	5,653	34,126	Yes

Burst Pressure

	Load Comb.	N	M	Strain or Stress	Limit	Criterion Satisfied
Burst Failure	FWT6	0	0	420	659	Yes
(P≤Pb)						

APPENDIX G

FEA Methodology

G.1 Detailed FEA Methodology

The AWWA C304 Design Standard is a comprehensive tool used for the design of PCCP; however, it is not directly applicable for the evaluation of PCCP with broken prestressed wire wraps. FEA is an accurate method for modeling complex geometry under different loading conditions. Recent developments in FEA and increased computational speed allow for the analysis of complex nonlinear problems, which is required to provide accurate models of PCCP with broken prestressed wire wraps.

The FEA model has been developed by Pure Technologies to determine the structural consequence of broken prestressed wire wraps, based on the AWWA C301 and AWWA C304 Design Standards, by utilizing pipe design specifications, design parameters, and the assumed current condition of the prestressed wire wraps. In the analysis, the model of a pipe is subjected to internal pressure, pipe and fluid weights, and external loads while varying the number of broken wire wraps. A performance curve, displaying the effects of broken wire wraps, is formulated and used to determine the number of broken wraps required for the pipe to exceed theoretical Limits. It should be noted that in performing the structural analysis, the values used in the models were taken directly from the provided specifications and the applicable AWWA C301 Design Standard.

Significant increases in internal pressure and external earth and live loads cause higher tensile and bending stresses in the pipe wall, which may lead to broken wire wraps and increase stress in the remaining, adjacent wire wraps. As the stress increases, additional wire wraps could become discontinuous and allow the concrete core and steel cylinder to expand. This leads to load and stress redistribution in the pipe. To account for this change during the FEA, the prestressed wire, concrete core, and steel cylinder are modeled as a composite element to simulate the material interactions in an actual pipe. As the stress in the prestressed wire increases and the concrete core and steel cylinder expands, the response of the composite element becomes increasingly nonlinear, adding further complexity to the model.

Commercial finite element software (ABAQUS) was used to investigate the response of a PCCP under different loading conditions. The FEA model predicts the performance limits of a PCCP utilizing the tensile strengths of the prestressed wire, the steel cylinder, and the concrete core, as well as a plasticity algorithm that simulates concrete crushing in compression regions. The behavior of the concrete is particularly complex to model as, in the field, either cracking or crushing may occur once the ultimate strength of the concrete is exceeded. Cracking and crushing are determined along a failure surface, with cracks appearing when the principal stresses at the surface are in tension and crushing occurring when the principal stresses are in compression. The concrete core of a PCCP is modeled as part of the three-dimensional composite element, with additional adjustments made to predict the failure of brittle materials.

Analyzing PCCP with broken prestressed wire wraps adds even more complexity to the model. Broken wire wraps change the load and stress distribution in the pipe. Once concrete in tension begins to crack, its load carrying ability begins to decrease with additional strain. If the strain is high enough, the load carrying ability goes to zero. This means that loads must be transferred through the other components of the pipe. Figure G.1 shows a schematic of the Stress-Strain behavior of concrete from the AWWA C304-14 Design Standard. ABAQUS modeling software, by using its sophisticated material models, can handle this complex condition.

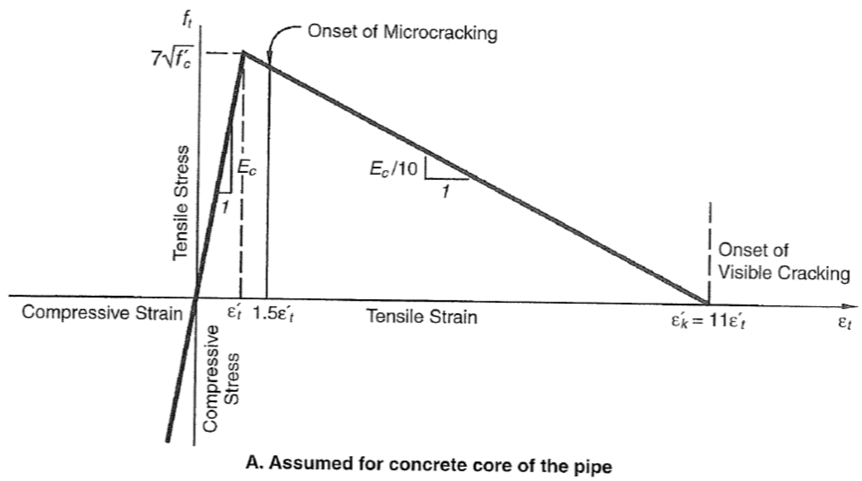


Figure G.1: Stress-Strain Relationship in the Concrete Core [AWWA 2007]

G.1.1 Performance Curve

The number of broken prestressed wire wraps that the specific pipe design will tolerate under operational and surge conditions can be determined using an FEA performance curve. An example of a performance curve for PCCP is shown in Figure I.2. Pure Technologies uses four (4) Limits, Micro Cracking (blue), Visible Cracking (green), Yield (yellow), and Strength (red), to classify the condition of a distressed PCCP. Note that although they have similar descriptions and values, these Limits are different from the Limits and Limiting Criteria used in the AWWA C304 analysis.

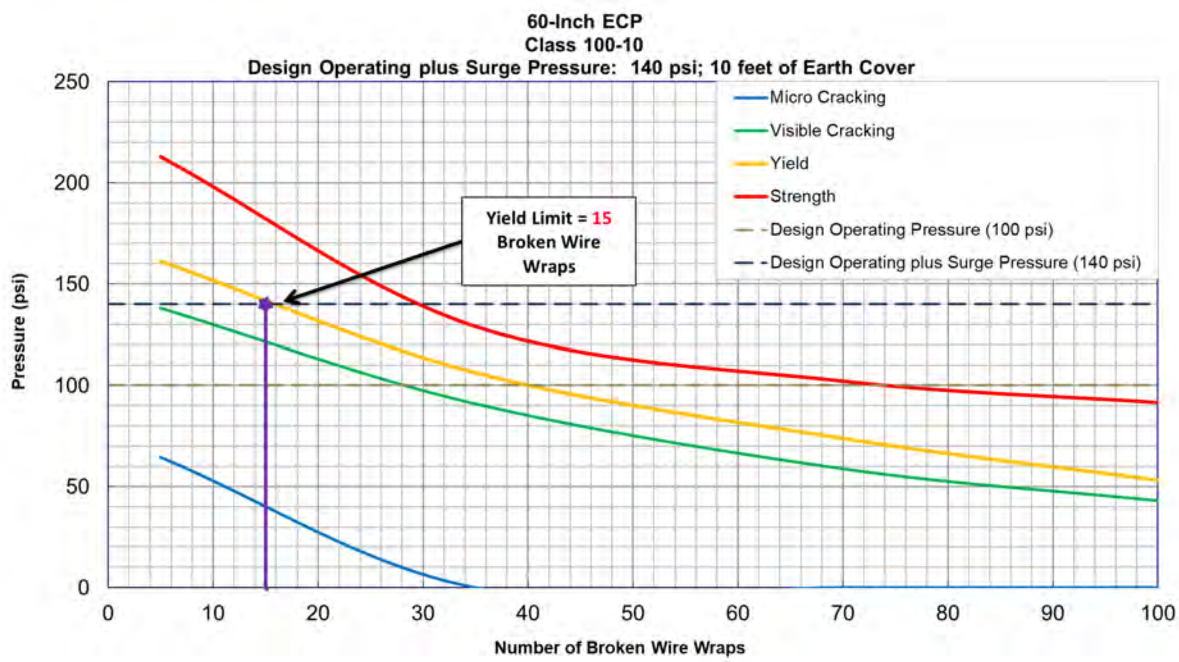


Figure G.2: Example Performance Curve

Table G.1 defines the Limits used by Pure Technologies to describe the predicted condition of a PCCP with a known quantity of broken wire wraps. The actual number of broken wire wraps required to reach these conditions varies due to pipe design and earth cover. These terms are referred to and used consistently throughout this report.

Table G.1: Predicted Condition of a Pipe with Broken Wire Wraps

Limit	Description
Micro Cracking	Micro cracking of the mortar coating or concrete core (defined by the strain associated with a crack that is greater than or equal to 0.001 inches wide)
Visible Cracking	Visible Cracking of the mortar coating or concrete core (defined by the strain associated with a crack that is greater than or equal to 0.002 inches wide)
Yield	Prestressed wire or steel cylinder reach their yield strength
Strength	Prestressed wire or steel cylinder reach their ultimate tensile strength

The Serviceability Limit described in AWWA C304 is represented in the performance curves by the Micro Cracking and Visible Cracking Limits. A pipe reaches the Micro Cracking Limit when strain in the mortar coating or concrete core exceeds the AWWA C304 tensile strain limit for micro cracking. Micro cracking in the mortar coating or concrete core is described as cracks greater than 0.001 inches wide and 12 inches in length and can be considered the preliminary level of damage in a PCCP. The Visible Cracking Limit is reached when the mortar coating or concrete core reach the strain associated with cracks greater than 0.002 inches wide and 12 inches in length.

When the mortar coating on the exterior of the pipe cracks, chloride ions present in the water may seep through the cracks, exposing the prestressed wire wraps to a corrosive environment. Corrosion can reduce the cross-sectional area of the prestressed wire, decreasing its load carrying ability and causing the wire wraps to break as the stress is increased. Individual wire wrap breaks also increase the amount of stress placed on the adjacent wire wraps. This increasing stress, as well as a persisting corrosive environment, will cause the adjacent wraps to break. While a long period may pass between initial and subsequent breaks, eventually the wire wraps will begin to fail at a faster rate as more stress is placed on the remaining wire wraps.

Prior to reaching the Yield Limit, the prestressed wire and steel cylinder elongate and deform elastically, meaning that after the load is removed, the components return to their original shape. Once the Yield Limit is reached in the steel cylinder, it undergoes plastic deformation, where it experiences large amounts of strain (elongation) in response to a relatively small increase in applied stress. The Strength Limit for the steel cylinder is the point at which the steel begins to elongate while experiencing lower stresses. This condition is also known as necking and immediately precedes the failure of the steel cylinder. The elongation experienced by the prestressed wire wraps due to loading beyond the Yield Limit eventually causes an individual wrap to break. The prestressed wire has a relatively brittle behavior compared to the steel cylinder, meaning that the wire wraps undergo less plastic deformation before they break. This situation often occurs simultaneously in adjacent wire wraps, especially as more prestressed wire wraps break, and the stress in the remaining wraps increases in response. Additionally, as more wire wrap breaks occur, the concrete core and steel cylinder can expand in response to the internal pressure. As the core expands, the concrete is placed in tension, which can cause structural cracking in the core if the stress becomes high enough.

The values used to represent the performance of the steel components in the field are based on the yield and ultimate strengths provided on the pipe design specifications sheet or the standard values in the relevant design standard if the pipe design is not available. The yield strength for the prestressed wire is typically 85 percent of its ultimate strength, while the yield strength of the steel cylinder is either denoted on the pipe design specification sheet or taken from the Design Standard in place at the time of production. The Yield Limit will be reached when either the steel cylinder or the steel prestressed wire reaches the yield strength. The ultimate strength of the prestressed wire is dictated by the gauge (diameter) and class of the wire, while the ultimate strength of the steel cylinder is determined by the grade of the steel. The Strength Limit is exceeded when one of the PCCP components reaches its ultimate strength, which, theoretically, will cause the failure of the pipe.

By evaluating the predicted structural condition of a pipe using FEA and analyzing all critical variables, a risk assessment of all distressed pipes can be performed to evaluate if and when a pipe should be rehabilitated.

G.1.2 Variables that Affect the FEA

Part of the structural analysis is to evaluate the risk of PCCP structural failure due to reduced structural capacity caused by broken prestressed wire wraps and concrete deterioration. The prestressed wire is a principal structural component of prestressed pipe. Each class of pipe installed in a pipeline is designed specifically for the maximum hydraulic operating pressure and earth cover expected along the route. Thus, any amount of broken wire wraps in a pipeline is a level of risk that should be carefully evaluated.

It is important to recognize that the structural analysis is subject to several complex variables that cannot be modeled with 100 percent certainty. To evaluate the modeling results and make recommendations on pipeline management, the variables affecting the structural model and associated risk, is important consideration that must be understood. The primary variables affecting the FEA are detailed below.

G.1.2.1 Effects of Pipe Cover

Earth cover loading significantly influences the number of broken wire wraps and prestressed pipe capacity. PCCP is designed based on a combined load design method where increasing the depth of earth cover over a pipe originally designed for a specific combination of pressure and earth cover has the effect of reducing the pipe’s capacity for internal operating pressure. For instance, if a pipe were originally designed for a working pressure of 100 psi and an earth cover of 10 feet, the allowable internal pressure would be reduced if the earth cover over the pipe were increased over the design earth cover.

Earth loads tend to apply flexural stresses to the extreme fibers of the concrete core at the springline, invert, and crown. High earth loads due to deep earth covers will impose high flexural stresses on the pipe’s concrete core. Under very high earth covers and relatively low internal pressures, prestressed pipe design is typically controlled by the external load. This situation often requires a thicker than standard concrete core to tolerate the high flexural stresses. The current AWWA C304 design method is especially sensitive to external loading, and this directly affects the results of a finite element analysis.

G.1.2.2 Effects of Wire Bond

When a prestressed wire wrap breaks, the tension in the wire is completely released at the point of breakage. The ends of the wire retract and are subjected to the friction forces applied to the wire by the mortar coating and the concrete core. These friction forces enable the wire to redevelop its tension over a relatively short distance from the point of breakage. The redevelopment length can vary up to several feet depending on the prestressed wire’s class and diameter as well as the condition and quality of the mortar coating. A sound mortar coating may not experience any delamination following a wire wrap break, in addition if the prestressed wire breaks and quickly redevelops tension, the structural consequence of the break is minimal. Conversely, a poor-quality mortar coating may crack or deteriorate following a wire wrap break and, in this case, the redevelopment length would be significantly longer.

For a specific wire diameter and class, the primary variable affecting the redevelopment length is the wire's bond to the mortar coating. If the coating is hard and remains well attached to the concrete core, wire bond will remain high and full tension in the wire will redevelop in a short distance from the point of breakage. When the coating becomes soft, cracks, or is delaminated from the core, the wire bond is reduced, and the redevelopment length is increased significantly. Also, if the mortar is under attack by aggressive soil and groundwater conditions surrounding the pipeline, wire bond is reduced.

In the field, a severely damaged pipe may not experience a catastrophic failure because wire bond is holding the pipe together. Since it is not practical to understand the actual wire bond for each wire wrap, a conservative assumption must be made for the FEA. The most conservative assumption for finite element analysis is to remove the broken wire wraps from the model all together; meaning that the Strength Limit on a performance curve will be reached at the ultimate strength limits of the PCCP components.

G.1.3 Field Observations versus Predicted Results

It is Pure Technologies' recommendation that caution be used when viewing the performance curves produced by the FEA. These curves are useful for evaluating the structural capacity of a distressed PCCP but modeling a complex condition like broken wire wraps is not an exact science. When opportunities arise to excavate and inspect pipes in the field, the actual condition should be compared to the estimated number of broken wire wraps, as well as the predicted results from the structural model, to determine if they are consistent with the observed conditions.

During previous excavations of prestressed concrete cylinder pipes, it has been observed that structural models generally produce results that are conservative. This level of conservatism is important because it provides allowances for extraordinary circumstances. Although a pipe can tolerate more broken prestressed wire wraps prior to reaching a particular Limit, the risk of failure can be alleviated by actively managing the pipeline.

APPENDIX H

Video Review

The City of Novi

36-, 30-, and 24-inch Novi Road Water Transmission Main

Video Review

Insertion at Station ~32+79 going West

NOTES:

1. Features in RED denotes that feature or anomaly is found or existing in Preliminary Markup Pipelist only.

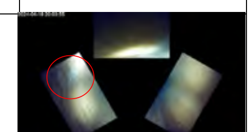
2. Features in ORANGE denotes that feature or anomaly is found or existing in Video only.

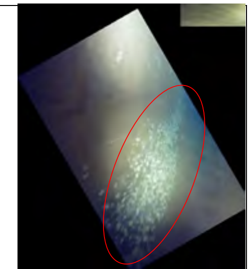
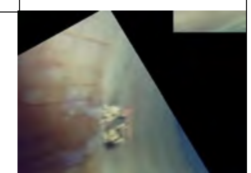
3. Features in BLUE denotes that feature or anomaly are found in video but Time Stamp is calculated because videos are not synced.

Video File Name	Pipe Detail	Kronos Comment	Kronos Video		PipeDiver Timestamp		Joint Number (PRN)	Video Comments	Video Screenshot
			Time Stamp	Time Stamp (s)	Date	Time			
18Apr2024_111543_00_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 13:49:33.	0:00:00	0.00	2024-04-18	13:49:33			
18Apr2024_111543_00_mp4.mp4	Bookmark	#B PipeDiver is being inserted inside the pipeline.	0:00:09	9.00	2024-04-18	13:49:42			
18Apr2024_111543_00_mp4.mp4	Bookmark	#B PipeDiver is inside the pipeline.	0:07:26	446.00	2024-04-18	13:56:59			
18Apr2024_111543_00_mp4.mp4	Bookmark	#B PipeDiver is not moving.	0:07:28	448.00	2024-04-18	13:57:01			
18Apr2024_111543_00_mp4.mp4	Bookmark	#B PipeDiver START.	0:11:08	668.00	2024-04-18	14:00:41			
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:11:09	669.00	2024-04-18	14:00:42	11001		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:11:18	678.00	2024-04-18	14:00:51	11002		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:11:26	686.00	2024-04-18	14:00:59	11003		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:11:34	694.00	2024-04-18	14:01:07	11004		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:11:42	702.00	2024-04-18	14:01:15	11005		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:11:50	710.00	2024-04-18	14:01:23	11006		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:11:58	718.00	2024-04-18	14:01:31	11007		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:12:07	727.00	2024-04-18	14:01:40	11008		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:12:15	735.00	2024-04-18	14:01:48	11009		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:12:26	746.00	2024-04-18	14:01:59	11010		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:12:36	756.00	2024-04-18	14:02:09	11011		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:12:46	766.00	2024-04-18	14:02:19	11012		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:12:57	777.00	2024-04-18	14:02:30	11013		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:13:07	787.00	2024-04-18	14:02:40	11014		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:13:18	798.00	2024-04-18	14:02:51	11015		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:13:29	809.00	2024-04-18	14:03:02	11016		
18Apr2024_111543_00_mp4.mp4	**Short Pipe**	**#SP**	**0:13:29**	**809.00**	**2024-04-18**	**14:03:02**	11016	**~5ft Short Pipe in the Pipe List.**	
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:13:32	812.00	2024-04-18	14:03:05	11017		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:13:43	823.00	2024-04-18	14:03:16	11018		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:13:54	834.00	2024-04-18	14:03:27	11019		
18Apr2024_111543_00_mp4.mp4	**Short Pipe**	**#SP**	**0:13:54**	**834.00**	**2024-04-18**	**14:03:27**	**11019**	**~4ft Short Pipe in the Pipe List.**	
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:13:57	837.00	2024-04-18	14:03:30	11020		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:14:06	846.00	2024-04-18	14:03:39	11021		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:14:15	855.00	2024-04-18	14:03:48	11022		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:14:23	863.00	2024-04-18	14:03:56	11023		
18Apr2024_111543_00_mp4.mp4	Joint of Interest	#JI	0:14:32	872.00	2024-04-18	14:04:05	11024		
18Apr2024_111543_00_mp4.mp4	**Standard Pipe**	**#STD**	**0:14:32**	**872.00**	**2024-04-18**	**14:04:05**	**11024**	**16ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:14:40	880.00	2024-04-18	14:04:13	11025		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:14:49	889.00	2024-04-18	14:04:22	11026		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:14:57	897.00	2024-04-18	14:04:30	11027		
18Apr2024_111543_00_mp4.mp4	Joint	#J	0:15:06	906.00	2024-04-18	14:04:39	11028		
18Apr2024_111543_00_mp4.mp4	Bookmark	#B End of Video 2024-04-18 14:04:41.	0:15:08	908.00	2024-04-18	14:04:41			
18Apr2024_111543_01_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 14:04:41.	0:00:00	0.00	2024-04-18	14:04:41			
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:00:06	6.00	2024-04-18	14:04:47	11029		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:00:15	15.00	2024-04-18	14:04:56	11030		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:00:23	23.00	2024-04-18	14:05:04	11031		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:00:32	32.00	2024-04-18	14:05:13	11032		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:00:41	41.00	2024-04-18	14:05:22	11033		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:00:49	49.00	2024-04-18	14:05:30	11034		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:00:58	58.00	2024-04-18	14:05:39	11035		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:01:07	67.00	2024-04-18	14:05:48	11036		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:01:16	76.00	2024-04-18	14:05:57	11037		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:01:25	85.00	2024-04-18	14:06:06	11038		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:01:34	94.00	2024-04-18	14:06:15	11039		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:01:43	103.00	2024-04-18	14:06:24	11040		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:01:52	112.00	2024-04-18	14:06:33	11041		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:02:01	121.00	2024-04-18	14:06:42	11042		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:02:09	129.00	2024-04-18	14:06:50	11043		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:02:18	138.00	2024-04-18	14:06:59	11044		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:02:27	147.00	2024-04-18	14:07:08	11045		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:02:35	155.00	2024-04-18	14:07:16	11046		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:02:44	164.00	2024-04-18	14:07:25	11047		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:02:53	173.00	2024-04-18	14:07:34	11048		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:03:01	181.00	2024-04-18	14:07:42	11049		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:03:10	190.00	2024-04-18	14:07:51	11050		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:03:18	198.00	2024-04-18	14:07:59	11051		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:03:27	207.00	2024-04-18	14:08:08	11052		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:03:35	215.00	2024-04-18	14:08:16	11053		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:03:44	224.00	2024-04-18	14:08:25	11054		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:03:52	232.00	2024-04-18	14:08:33	11055		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:04:00	240.00	2024-04-18	14:08:41	11056		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:04:09	249.00	2024-04-18	14:08:50	11057		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:04:18	258.00	2024-04-18	14:08:59	11058		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:04:27	267.00	2024-04-18	14:09:08	11059		
18Apr2024_111543_01_mp4.mp4	Bookmark	#B Video feed is not in sync, and is laggy/choppy/jumpy. Difficulty in locating joints and/or features.	0:04:36	276.00	2024-04-18	14:09:17			
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:04:36	276.00	2024-04-18	14:09:17	11060		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:04:45	285.00	2024-04-18	14:09:26	11061		
18Apr2024_111543_01_mp4.mp4	Bookmark	#B Video feed is now back to normal.	0:04:53	293.00	2024-04-18	14:09:34			
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:04:54	294.00	2024-04-18	14:09:35	11062		

18Apr2024_111543_01_mp4.mp4	Joint	#J	0:05:03	303.00	2024-04-18	14:09:44	11063		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:05:12	312.00	2024-04-18	14:09:53	11064		
	Offtake / Outlet	**#OL**		**0.00**	**2024-04-18**		**11064**	**1-1/2" Outlet in the Pipe List.**	
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:05:21	321.00	2024-04-18	14:10:02	11065		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:05:30	330.00	2024-04-18	14:10:11	11066		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:05:39	339.00	2024-04-18	14:10:20	11067		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:05:47	347.00	2024-04-18	14:10:28	11068		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:05:56	356.00	2024-04-18	14:10:37	11069		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:06:05	365.00	2024-04-18	14:10:46	11070		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:06:13	373.00	2024-04-18	14:10:54	11071		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:06:22	382.00	2024-04-18	14:11:03	11072		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:06:30	390.00	2024-04-18	14:11:11	11073		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:06:39	399.00	2024-04-18	14:11:20	11074		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:06:48	408.00	2024-04-18	14:11:29	11075		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:06:57	417.00	2024-04-18	14:11:38	11076		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:07:06	426.00	2024-04-18	14:11:47	11077		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:07:14	434.00	2024-04-18	14:11:55	11078		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:07:23	443.00	2024-04-18	14:12:04	11079		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:07:32	452.00	2024-04-18	14:12:13	11080		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:07:41	461.00	2024-04-18	14:12:22	11081		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:07:51	471.00	2024-04-18	14:12:32	11082		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:08:01	481.00	2024-04-18	14:12:42	11083		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:08:10	490.00	2024-04-18	14:12:51	11084		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:08:19	499.00	2024-04-18	14:13:00	11085		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:08:28	508.00	2024-04-18	14:13:09	11086		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:08:37	517.00	2024-04-18	14:13:18	11087		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:08:46	526.00	2024-04-18	14:13:27	11088		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:08:55	535.00	2024-04-18	14:13:36	11089		
18Apr2024_111543_01_mp4.mp4	**Offtake / Outlet**	**#OL-S Left Side.**	**0:09:01**	**541.00**	**2024-04-18**	**14:13:42**	**11089**	**6" Outlet in the Pipe List.**	
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:09:03	543.00	2024-04-18	14:13:44	11090		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:09:12	552.00	2024-04-18	14:13:53	11091		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:09:20	560.00	2024-04-18	14:14:01	11092		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:09:29	569.00	2024-04-18	14:14:10	11093		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:09:37	577.00	2024-04-18	14:14:18	11094		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:09:45	585.00	2024-04-18	14:14:26	11095		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:09:54	594.00	2024-04-18	14:14:35	11096		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:10:02	602.00	2024-04-18	14:14:43	11097		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:10:11	611.00	2024-04-18	14:14:52	11098		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:10:19	619.00	2024-04-18	14:15:00	11099		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:10:25	625.00	2024-04-18	14:15:06	11100		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:10:36	636.00	2024-04-18	14:15:17	11101		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:10:44	644.00	2024-04-18	14:15:25	11102		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:10:51	651.00	2024-04-18	14:15:32	11103		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:10:59	659.00	2024-04-18	14:15:40	11104		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:11:08	668.00	2024-04-18	14:15:49	11105		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:11:16	676.00	2024-04-18	14:15:57	11106		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:11:24	684.00	2024-04-18	14:16:05	11107		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:11:33	693.00	2024-04-18	14:16:14	11108		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:11:42	702.00	2024-04-18	14:16:23	11109		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:11:52	712.00	2024-04-18	14:16:33	11110		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:12:02	722.00	2024-04-18	14:16:43	11111		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:12:12	732.00	2024-04-18	14:16:53	11112		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:12:23	743.00	2024-04-18	14:17:04	11113		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:12:32	752.00	2024-04-18	14:17:13	11114		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:12:42	762.00	2024-04-18	14:17:23	11115		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:12:52	772.00	2024-04-18	14:17:33	11116		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:13:01	781.00	2024-04-18	14:17:42	11117		
18Apr2024_111543_01_mp4.mp4	**Offtake / Outlet**	**#OL-INV**	**0:13:04**	**784.00**	**2024-04-18**	**14:17:45**	**11117**	**8" Outlet in the Pipe List.**	
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:13:11	791.00	2024-04-18	14:17:52	11118		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:13:20	800.00	2024-04-18	14:18:01	11119		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:13:29	809.00	2024-04-18	14:18:10	11120		
18Apr2024_111543_01_mp4.mp4	**Standard Pipe**	**#STD**	**0:13:29**	**809.00**	**2024-04-18**	**14:18:10**	**11120**	**16ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:13:37	817.00	2024-04-18	14:18:18	11121		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:13:45	825.00	2024-04-18	14:18:26	11122		
18Apr2024_111543_01_mp4.mp4	**Reducer**	**#RED**	**0:13:46**	**826.00**	**2024-04-18**	**14:18:27**	**11122**	**36" x 30" Eccentric Reducer in the Pipe List.**	
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:13:46	826.00	2024-04-18	14:18:27	11123		
18Apr2024_111543_01_mp4.mp4	**Butterfly Valve**	**Possible #BFV.**	**0:13:49**	**829.00**	**2024-04-18**	**14:18:30**	**11123**	**30" Valve & Valve Well Assembly in the Pipe List.**	
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:13:53	833.00	2024-04-18	14:18:34	11124		
18Apr2024_111543_01_mp4.mp4	**Reducer**	**#RED**	**0:13:53**	**833.00**	**2024-04-18**	**14:18:34**	**11124**	**36" x 30" Eccentric Reducer in the Pipe List.**	
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:13:54	834.00	2024-04-18	14:18:35	11125		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:14:03	843.00	2024-04-18	14:18:44	11126		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:14:08	848.00	2024-04-18	14:18:49	11127		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:14:18	858.00	2024-04-18	14:18:59	11128		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:14:29	869.00	2024-04-18	14:19:10	11129		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:14:39	879.00	2024-04-18	14:19:20	11130		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:14:49	889.00	2024-04-18	14:19:30	11131		
18Apr2024_111543_01_mp4.mp4	Joint	#J	0:14:59	899.00	2024-04-18	14:19:40	11132		
18Apr2024_111543_01_mp4.mp4	Bookmark	#B End of Video 2024-04-18 14:19:41.	0:15:00	900.00	2024-04-18	14:19:41			
18Apr2024_111543_02_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 14:19:41.	0:00:00	0.00	2024-04-18	14:19:41			
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:00:09	9.00	2024-04-18	14:19:50	11133		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:00:20	20.00	2024-04-18	14:20:01	11134		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:00:30	30.00	2024-04-18	14:20:11	11135		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:00:41	41.00	2024-04-18	14:20:22	11136		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:00:52	52.00	2024-04-18	14:20:33	11137		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:01:02	62.00	2024-04-18	14:20:43	11138		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:01:13	73.00	2024-04-18	14:20:54	11139		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:01:24	84.00	2024-04-18	14:21:05	11140		

18Apr2024_111543_02_mp4.mp4	Joint	#J	0:01:35	95.00	2024-04-18	14:21:16	11141		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:01:46	106.00	2024-04-18	14:21:27	11142		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:01:56	116.00	2024-04-18	14:21:37	11143		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:02:07	127.00	2024-04-18	14:21:48	11144		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:02:18	138.00	2024-04-18	14:21:59	11145		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:02:27	147.00	2024-04-18	14:22:08	11146		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:02:37	157.00	2024-04-18	14:22:18	11147		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:02:48	168.00	2024-04-18	14:22:29	11148		
18Apr2024_111543_02_mp4.mp4	**T Connection**	**#TEE-S Left Side.**	**0:02:49**	**169.00**	**2024-04-18**	**14:22:30**	**11148**	**36" X 24" TEE in the Pipe List.**	
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:02:51	171.00	2024-04-18	14:22:32	11149		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:02:56	176.00	2024-04-18	14:22:37	11150		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:03:07	187.00	2024-04-18	14:22:48	11151		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:03:18	198.00	2024-04-18	14:22:59	11152		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:03:28	208.00	2024-04-18	14:23:09	11153		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:03:38	218.00	2024-04-18	14:23:19	11154		
18Apr2024_111543_02_mp4.mp4	**T Connection**	**#TEE-S Right Side.**	**0:03:39**	**219.00**	**2024-04-18**	**14:23:20**	**11154**	**36" X 20" TEE in the Pipe List.**	
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:03:40	220.00	2024-04-18	14:23:21	11155		
18Apr2024_111543_02_mp4.mp4	**Reducer**	**#RED**	**0:03:40**	**220.00**	**2024-04-18**	**14:23:21**	**11155**	**36" X 30" Reducer in the Pipe List.**	
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:03:41	221.00	2024-04-18	14:23:22	11156		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:03:48	228.00	2024-04-18	14:23:29	11157		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:03:54	234.00	2024-04-18	14:23:35	11158		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:04:01	241.00	2024-04-18	14:23:42	11159		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:04:07	247.00	2024-04-18	14:23:48	11160		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:04:14	254.00	2024-04-18	14:23:55	11161		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:04:21	261.00	2024-04-18	14:24:02	11162		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:04:28	268.00	2024-04-18	14:24:09	11163		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:04:35	275.00	2024-04-18	14:24:16	11164		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:04:42	282.00	2024-04-18	14:24:23	11165		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:04:48	288.00	2024-04-18	14:24:29	11166		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:04:55	295.00	2024-04-18	14:24:36	11167		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:05:02	302.00	2024-04-18	14:24:43	11168		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:05:09	309.00	2024-04-18	14:24:50	11169		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:05:15	315.00	2024-04-18	14:24:56	11170		
	Offtake / Outlet	**#OL**		**0.00**	**2024-04-18**		**11170**	**2" Outlet in the Pipe List. Not seen due to camera glitching/skipping.**	
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:05:22	322.00	2024-04-18	14:25:03	11171		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:05:25	325.00	2024-04-18	14:25:06	11172		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:05:28	328.00	2024-04-18	14:25:09	11173		
18Apr2024_111543_02_mp4.mp4	Joint of Interest	#JI	0:05:35	335.00	2024-04-18	14:25:16	11174		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:05:45	345.00	2024-04-18	14:25:26	11175		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:05:51	351.00	2024-04-18	14:25:32	11176		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:05:58	358.00	2024-04-18	14:25:39	11177		
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:06:05	365.00	2024-04-18	14:25:46	11178		
18Apr2024_111543_02_mp4.mp4	**Reducer**	**#RED**	**0:06:05**	**365.00**	**2024-04-18**	**14:25:46**	**11178**	**30" X 24" Eccentric Reducer in the Pipe List.**	
18Apr2024_111543_02_mp4.mp4	Joint	#J	0:06:06	366.00	2024-04-18	14:25:47	11179		
18Apr2024_111543_02_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:06:07	367.00	2024-04-18	14:25:48			
18Apr2024_111543_02_mp4.mp4	Bookmark	#B End of Video 2024-04-18 14:34:41.	0:15:00	900.00	2024-04-18	14:34:41			
18Apr2024_111543_03_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 14:34:41.	0:00:00	0.00	2024-04-18	14:34:41			
18Apr2024_111543_03_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	14:34:41			
18Apr2024_111543_03_mp4.mp4	Bookmark	#B End of Video 2024-04-18 14:49:41.	0:15:00	900.00	2024-04-18	14:49:41			
18Apr2024_111543_04_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 14:49:41.	0:00:00	0.00	2024-04-18	14:49:41			
18Apr2024_111543_04_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	14:49:41			
18Apr2024_111543_04_mp4.mp4	Bookmark	#B End of Video 2024-04-18 15:04:41.	0:15:00	900.00	2024-04-18	15:04:41			
18Apr2024_111543_05_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 15:04:41.	0:00:00	0.00	2024-04-18	15:04:41			
18Apr2024_111543_05_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	15:04:41			
18Apr2024_111543_05_mp4.mp4	Bookmark	#B End of Video 2024-04-18 15:19:41.	0:15:00	900.00	2024-04-18	15:19:41			
18Apr2024_111543_06_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 15:19:41.	0:00:00	0.00	2024-04-18	15:19:41			
18Apr2024_111543_06_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:01	1.00	2024-04-18	15:19:42			
18Apr2024_111543_06_mp4.mp4	Bookmark	#B End of Video 2024-04-18 15:34:41.	0:15:00	900.00	2024-04-18	15:34:41			
18Apr2024_111543_07_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 15:34:41.	0:00:00	0.00	2024-04-18	15:34:41			
18Apr2024_111543_07_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	15:34:41			
18Apr2024_111543_07_mp4.mp4	Bookmark	#B End of Video 2024-04-18 15:49:41.	0:15:00	900.00	2024-04-18	15:49:41			
18Apr2024_111543_08_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 15:49:41.	0:00:00	0.00	2024-04-18	15:49:41			
18Apr2024_111543_08_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	15:49:41			
18Apr2024_111543_08_mp4.mp4	Bookmark	#B End of Video 2024-04-18 16:04:41.	0:15:00	900.00	2024-04-18	16:04:41			
18Apr2024_111543_09_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 16:04:41.	0:00:00	0.00	2024-04-18	16:04:41			
18Apr2024_111543_09_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	16:04:41			
18Apr2024_111543_09_mp4.mp4	Bookmark	#B End of Video 2024-04-18 16:19:41.	0:15:00	900.00	2024-04-18	16:19:41			
18Apr2024_111543_10_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 16:19:41.	0:00:00	0.00	2024-04-18	16:19:41			
18Apr2024_111543_10_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	16:19:41			
18Apr2024_111543_10_mp4.mp4	Bookmark	#B End of Video 2024-04-18 16:34:41.	0:15:00	900.00	2024-04-18	16:34:41			
18Apr2024_111543_11_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 16:34:41.	0:00:00	0.00	2024-04-18	16:34:41			
18Apr2024_111543_11_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:01	1.00	2024-04-18	16:34:42			
18Apr2024_111543_11_mp4.mp4	Bookmark	#B End of Video 2024-04-18 16:49:41.	0:15:00	900.00	2024-04-18	16:49:41			
18Apr2024_111543_12_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 16:49:41.	0:00:00	0.00	2024-04-18	16:49:41			
18Apr2024_111543_12_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	16:49:41			
18Apr2024_111543_12_mp4.mp4	Bookmark	#B End of Video 2024-04-18 17:04:41.	0:15:00	900.00	2024-04-18	17:04:41			
18Apr2024_111543_13_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 17:04:41.	0:00:00	0.00	2024-04-18	17:04:41			
18Apr2024_111543_13_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	17:04:41			
18Apr2024_111543_13_mp4.mp4	Bookmark	#B End of Video 2024-04-18 17:19:41.	0:15:00	900.00	2024-04-18	17:19:41			
18Apr2024_111543_14_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 17:19:41.	0:00:00	0.00	2024-04-18	17:19:41			
18Apr2024_111543_14_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	17:19:41			
18Apr2024_111543_14_mp4.mp4	Bookmark	#B PipeDiver START (Reverse Direction).	0:10:59	659.00	2024-04-18	17:30:40		PipeDiver moved in Reverse Direction.	
18Apr2024_111543_14_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:11:06	666.00	2024-04-18	17:30:47			
18Apr2024_111543_14_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:11:48	708.00	2024-04-18	17:31:29			
18Apr2024_111543_14_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:12:31	751.00	2024-04-18	17:32:12			
18Apr2024_111543_14_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:13:07	787.00	2024-04-18	17:32:48			
18Apr2024_111543_14_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:13:43	823.00	2024-04-18	17:33:24			

18Apr2024_111543_14_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:14:32	872.00	2024-04-18	17:34:13			
18Apr2024_111543_14_mp4.mp4	Bookmark	#B End of Video 2024-04-18 17:34:41.	0:15:00	900.00	2024-04-18	17:34:41			
18Apr2024_111543_15_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 17:34:41.	0:00:00	0.00	2024-04-18	17:34:41			
18Apr2024_111543_15_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	17:34:41			
18Apr2024_111543_15_mp4.mp4	Bookmark	#B PipeDiver START (Normal Direction).	0:06:35	395.00	2024-04-18	17:41:16		PipeDiver moved in Normal Direction.	
18Apr2024_111543_15_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:07:12	432.00	2024-04-18	17:41:53			
18Apr2024_111543_15_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:07:55	475.00	2024-04-18	17:42:36			
18Apr2024_111543_15_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:08:24	504.00	2024-04-18	17:43:05			
18Apr2024_111543_15_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:08:46	526.00	2024-04-18	17:43:27			
18Apr2024_111543_15_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:09:06	546.00	2024-04-18	17:43:47			
18Apr2024_111543_15_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:09:11	551.00	2024-04-18	17:43:52			
18Apr2024_111543_15_mp4.mp4	Bookmark	#B End of Video 2024-04-18 17:49:41.	0:15:00	900.00	2024-04-18	17:49:41			
18Apr2024_111543_16_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 17:49:41.	0:00:00	0.00	2024-04-18	17:49:41			
18Apr2024_111543_16_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	17:49:41			
18Apr2024_111543_16_mp4.mp4	Bookmark	#B End of Video 2024-04-18 18:04:41.	0:15:00	900.00	2024-04-18	18:04:41			
18Apr2024_111543_17_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 18:04:41.	0:00:00	0.00	2024-04-18	18:04:41			
18Apr2024_111543_17_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	18:04:41			
18Apr2024_111543_17_mp4.mp4	Bookmark	#B PipeDiver START (Reverse Direction).	0:02:50	170.00	2024-04-18	18:07:31		PipeDiver moved in Reverse Direction.	
18Apr2024_111543_17_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:02:56	176.00	2024-04-18	18:07:37			
18Apr2024_111543_17_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:03:46	226.00	2024-04-18	18:08:27			
18Apr2024_111543_17_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:04:33	273.00	2024-04-18	18:09:14			
18Apr2024_111543_17_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:05:05	305.00	2024-04-18	18:09:46			
18Apr2024_111543_17_mp4.mp4	Joint	#J seen in 18Apr2024_111543_02_mp4.mp4.	0:05:34	334.00	2024-04-18	18:10:15			
18Apr2024_111543_17_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:06:13	373.00	2024-04-18	18:10:54			
18Apr2024_111543_17_mp4.mp4	Bookmark	#B End of Video 2024-04-18 18:19:41.	0:15:00	900.00	2024-04-18	18:19:41			
18Apr2024_111543_18_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 18:19:41.	0:00:00	0.00	2024-04-18	18:19:41			
18Apr2024_111543_18_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	18:19:41			
18Apr2024_111543_18_mp4.mp4	Bookmark	#B PipeDiver START (Normal Direction).	0:03:27	207.00	2024-04-18	18:23:08		PipeDiver moved in Normal Direction.	
18Apr2024_111543_18_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:08:17	497.00	2024-04-18	18:27:58			
18Apr2024_111543_18_mp4.mp4	Bookmark	#B End of Video 2024-04-18 18:34:41.	0:15:00	900.00	2024-04-18	18:34:41			
18Apr2024_111543_19_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 18:34:41.	0:00:00	0.00	2024-04-18	18:34:41			
18Apr2024_111543_19_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	18:34:41			
18Apr2024_111543_19_mp4.mp4	Bookmark	#B PipeDiver START (Reverse Direction).	0:10:20	620.00	2024-04-18	18:45:01		PipeDiver moved in Reverse Direction.	
18Apr2024_111543_19_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:14:11	851.00	2024-04-18	18:48:52			
18Apr2024_111543_19_mp4.mp4	Bookmark	#B End of Video 2024-04-18 18:49:41.	0:15:00	900.00	2024-04-18	18:49:41			
18Apr2024_111543_20_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 18:49:41.	0:00:00	0.00	2024-04-18	18:49:41			
18Apr2024_111543_20_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	18:49:41			
18Apr2024_111543_20_mp4.mp4	Bookmark	#B PipeDiver START (Normal Direction).	0:04:27	267.00	2024-04-18	18:54:08		PipeDiver moved in Normal Direction.	
18Apr2024_111543_20_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:13:40	820.00	2024-04-18	19:03:21			
18Apr2024_111543_20_mp4.mp4	Bookmark	#B End of Video 2024-04-18 19:04:41.	0:15:00	900.00	2024-04-18	19:04:41			
18Apr2024_111543_21_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 19:04:41.	0:00:00	0.00	2024-04-18	19:04:41			
18Apr2024_111543_21_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	19:04:41			
18Apr2024_111543_21_mp4.mp4	Bookmark	#B PipeDiver START (Reverse Direction).	0:12:50	770.00	2024-04-18	19:17:31		PipeDiver moved in Reverse Direction.	
18Apr2024_111543_21_mp4.mp4	Bookmark	#B End of Video 2024-04-18 19:19:41.	0:15:00	900.00	2024-04-18	19:19:41			
18Apr2024_111543_22_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 19:19:41.	0:00:00	0.00	2024-04-18	19:19:41			
18Apr2024_111543_22_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:04:42	282.00	2024-04-18	19:24:23			
18Apr2024_111543_22_mp4.mp4	Bookmark	#B PipeDiver START (Normal Direction).	0:07:44	464.00	2024-04-18	19:32:07		PipeDiver moved in Normal Direction.	
18Apr2024_111543_22_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:11:39	699.00	2024-04-18	19:43:46			
18Apr2024_111543_22_mp4.mp4	Bookmark	#B End of Video 2024-04-18 19:34:41.	0:15:00	900.00	2024-04-18	19:58:46			
18Apr2024_111543_23_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 19:34:41.	0:00:00	0.00	2024-04-18	19:34:41			
18Apr2024_111543_23_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	19:34:41			
18Apr2024_111543_23_mp4.mp4	Bookmark	#B End of Video 2024-04-18 19:49:41.	0:15:00	900.00	2024-04-18	19:49:41			
18Apr2024_111543_24_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 19:49:41.	0:00:00	0.00	2024-04-18	19:49:41			
18Apr2024_111543_24_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	19:49:41			
18Apr2024_111543_24_mp4.mp4	Bookmark	#B PipeDiver START (Reverse Direction).	0:01:12	72.00	2024-04-18	19:50:53		PipeDiver moved in Reverse Direction.	
18Apr2024_111543_24_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:07:34	454.00	2024-04-18	19:57:15			
18Apr2024_111543_24_mp4.mp4	Bookmark	#B PipeDiver START (Normal Direction).	0:11:17	677.00	2024-04-18	20:00:58		PipeDiver moved in Normal Direction.	
18Apr2024_111543_24_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:12:24	744.00	2024-04-18	20:02:05	11166	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_24_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:13:02	782.00	2024-04-18	20:02:43	11167	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_24_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:13:29	809.00	2024-04-18	20:03:10	11168	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_24_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:13:52	832.00	2024-04-18	20:03:33	11169	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_24_mp4.mp4	**Material Buildup**	**Possible #TUB @ 9:00.**	**0:14:14**	**854.00**	**2024-04-18**	**20:03:55**		**Possible material buildup seen.**	
18Apr2024_111543_24_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:14:15	855.00	2024-04-18	20:03:56	11170	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_24_mp4.mp4	**Tuberculation**	**Possible #TUB.**	**0:14:17**	**857.00**	**2024-04-18**	**20:03:58**			
18Apr2024_111543_24_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:14:25	865.00	2024-04-18	20:04:06	11171	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_24_mp4.mp4	**Tuberculation**	**Possible #TUB.**	**0:14:41**	**881.00**	**2024-04-18**	**20:04:22**			
18Apr2024_111543_24_mp4.mp4	**Tuberculation**	**Possible #TUB.**	**0:14:53**	**893.00**	**2024-04-18**	**20:04:34**			
18Apr2024_111543_24_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:14:48	888.00	2024-04-18	20:04:29	11172	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_24_mp4.mp4	Bookmark	#B End of Video 2024-04-18 20:04:41.	0:15:00	900.00	2024-04-18	20:04:41			
18Apr2024_111543_25_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 20:04:41.	0:00:00	0.00	2024-04-18	20:04:41			
18Apr2024_111543_25_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:00:09	9.00	2024-04-18	20:04:50	11173	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_25_mp4.mp4	Longitudinal Cracking	Possible #LC-1 @9:00.	0:00:18	18.00	2024-04-18	20:04:59			

18Apr2024_111543_25_mp4.mp4	Tuberculation	#TUB	0:00:19	19.00	2024-04-18	20:05:00		Possible discoloration seen.	
18Apr2024_111543_25_mp4.mp4	Longitudinal Cracking	Possible #LC-2 @9:00.	0:00:22	22.00	2024-04-18	20:05:03			
18Apr2024_111543_25_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:00:26	26.00	2024-04-18	20:05:07	11174	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_25_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:00:42	42.00	2024-04-18	20:05:23	11175	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_25_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:00:57	57.00	2024-04-18	20:05:38	11176	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_25_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4.mp4.	0:01:09	69.00	2024-04-18	20:05:50	11177	Same with the Joint seen in 18Apr2024_111543_02_mp4.mp4.	
18Apr2024_111543_25_mp4.mp4	**Reducer**	**#RED in 18Apr2024_111543_02_mp4.mp4 @ 06:05.**	**0:01:10**	**70.00**	**2024-04-18**	**20:05:51**	**11178**	**30" X 24" Eccentric Reducer in the Pipe List. Same with RED in 18Apr2024_111543_02_mp4.mp4 @ 06:05.**	
18Apr2024_111543_25_mp4.mp4	Joint	#J Joint seen in 18Apr2024_111543_02_mp4 @ 06:06.	0:01:11	71.00	2024-04-18	20:05:52	11179		
18Apr2024_111543_25_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:01:13	73.00	2024-04-18	20:05:54			
18Apr2024_111543_25_mp4.mp4	Bookmark	#B PipeDiver START.	0:01:17	77.00	2024-04-18	20:05:58			
18Apr2024_111543_25_mp4.mp4	**Butterfly Valve**	**Possible #BFV.**	**0:01:20**	**80.00**	**2024-04-18**	**20:06:01**	**11179**	**Valve in the Pipe List.**	
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:01:22	82.00	2024-04-18	20:06:03	11180		
18Apr2024_111543_25_mp4.mp4	**Reducer**	**#RED**	**0:01:22**	**82.00**	**2024-04-18**	**20:06:03**	**11180**	**30" X 24" Eccentric Reducer in the Pipe List.**	
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:01:23	83.00	2024-04-18	20:06:04	11181		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:01:32	92.00	2024-04-18	20:06:13	11182		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:01:40	100.00	2024-04-18	20:06:21	11183		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:01:48	108.00	2024-04-18	20:06:29	11184		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:01:56	116.00	2024-04-18	20:06:37	11185		
18Apr2024_111543_25_mp4.mp4	Joint of Interest	#JI	0:02:04	124.00	2024-04-18	20:06:45	11186		
18Apr2024_111543_25_mp4.mp4	Joint of Interest	#JI	0:02:14	134.00	2024-04-18	20:06:55	11187		
18Apr2024_111543_25_mp4.mp4	**Offtake / Outlet**	**#OL @ 3:00.**	**0:02:19**	**139.00**	**2024-04-18**	**20:07:00**	**11187**	**12" Tapping Outlet in the Pipe List.**	
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:02:21	141.00	2024-04-18	20:07:02	11188		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:02:29	149.00	2024-04-18	20:07:10	11189		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:02:37	157.00	2024-04-18	20:07:18	11190		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:02:45	165.00	2024-04-18	20:07:26	11191		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:02:53	173.00	2024-04-18	20:07:34	11192		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:03:01	181.00	2024-04-18	20:07:42	11193		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:03:10	190.00	2024-04-18	20:07:51	11194		
18Apr2024_111543_25_mp4.mp4	Rust/Corrosion	Possible #TUB or Unknown Feature.	0:03:10	190.00	2024-04-18	20:07:51		Possible protrusion into the pipe.	
18Apr2024_111543_25_mp4.mp4	Longitudinal Cracking	Possible #LC-1 @9:00.	0:03:10	190.00	2024-04-18	20:07:51			
18Apr2024_111543_25_mp4.mp4	Longitudinal Cracking	Possible #LC-1 @9:00.	0:03:18	198.00	2024-04-18	20:07:59			
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:03:18	198.00	2024-04-18	20:07:59	11195		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:03:27	207.00	2024-04-18	20:08:08	11196		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:03:35	215.00	2024-04-18	20:08:16	11197		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:03:43	223.00	2024-04-18	20:08:24	11198		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:03:51	231.00	2024-04-18	20:08:32	11199		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:03:59	239.00	2024-04-18	20:08:40	11200		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:04:07	247.00	2024-04-18	20:08:48	11201		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:04:15	255.00	2024-04-18	20:08:56	11202		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:04:23	263.00	2024-04-18	20:09:04	11203		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:04:31	271.00	2024-04-18	20:09:12	11204		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:04:39	279.00	2024-04-18	20:09:20	11205		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:04:47	287.00	2024-04-18	20:09:28	11206		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:04:55	295.00	2024-04-18	20:09:36	11207		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:05:03	303.00	2024-04-18	20:09:44	11208		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:05:12	312.00	2024-04-18	20:09:53	11209		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:05:20	320.00	2024-04-18	20:10:01	11210		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:05:28	328.00	2024-04-18	20:10:09	11211		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:05:37	337.00	2024-04-18	20:10:18	11212		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:05:45	345.00	2024-04-18	20:10:26	11213		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:05:53	353.00	2024-04-18	20:10:34	11214		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:06:01	361.00	2024-04-18	20:10:42	11215		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:06:09	369.00	2024-04-18	20:10:50	11216		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:06:17	377.00	2024-04-18	20:10:58	11217		
18Apr2024_111543_25_mp4.mp4	**Offtake / Outlet**	**#OL @ 3:00.**	**0:06:19**	**379.00**	**2024-04-18**	**20:11:00**	**11217**	**12" Tapping Outlet in the Pipe List.**	
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:06:25	385.00	2024-04-18	20:11:06	11218		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:06:33	393.00	2024-04-18	20:11:14	11219		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:06:42	402.00	2024-04-18	20:11:23	11220		

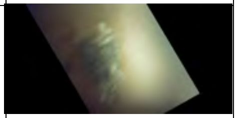
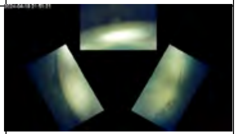
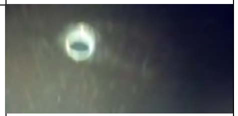
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:06:50	410.00	2024-04-18	20:11:31	11221		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:06:58	418.00	2024-04-18	20:11:39	11222		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:07:06	426.00	2024-04-18	20:11:47	11223		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:07:15	435.00	2024-04-18	20:11:56	11224		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:07:23	443.00	2024-04-18	20:12:04	11225		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:07:31	451.00	2024-04-18	20:12:12	11226		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:07:39	459.00	2024-04-18	20:12:20	11227		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:07:48	468.00	2024-04-18	20:12:29	11228		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:07:56	476.00	2024-04-18	20:12:37	11229		
18Apr2024_111543_25_mp4.mp4	**Short Pipe**	**#SP**	**0:07:57**	**477.00**	**2024-04-18**	**20:12:38**	**11229**	**12ft Short Pipe in the Pipe List.**	
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:08:01	481.00	2024-04-18	20:12:42	11230		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:08:10	490.00	2024-04-18	20:12:51	11231		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:08:18	498.00	2024-04-18	20:12:59	11232		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:08:27	507.00	2024-04-18	20:13:08	11233		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:08:30	510.00	2024-04-18	20:13:11	11234		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:08:39	519.00	2024-04-18	20:13:20	11235		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:08:47	527.00	2024-04-18	20:13:28	11236		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:08:55	535.00	2024-04-18	20:13:36	11237		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:09:03	543.00	2024-04-18	20:13:44	11238		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:09:11	551.00	2024-04-18	20:13:52	11239		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:09:20	560.00	2024-04-18	20:14:01	11240		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:09:28	568.00	2024-04-18	20:14:09	11241		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:09:36	576.00	2024-04-18	20:14:17	11242		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:09:44	584.00	2024-04-18	20:14:25	11243		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:09:52	592.00	2024-04-18	20:14:33	11244		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:10:00	600.00	2024-04-18	20:14:41	11245		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:10:07	607.00	2024-04-18	20:14:48	11246		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:10:15	615.00	2024-04-18	20:14:56	11247		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:10:22	622.00	2024-04-18	20:15:03	11248		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:10:30	630.00	2024-04-18	20:15:11	11249		
18Apr2024_111543_25_mp4.mp4	**Offtake / Outlet**	**#OL @ 3:00.**	**0:10:32**	**632.00**	**2024-04-18**	**20:15:13**	**11249**	**12" Tapping Outlet in the Pipe List.**	
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:10:38	638.00	2024-04-18	20:15:19	11250		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:10:46	646.00	2024-04-18	20:15:27	11251		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:10:54	654.00	2024-04-18	20:15:35	11252		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:11:02	662.00	2024-04-18	20:15:43	11253		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:11:10	670.00	2024-04-18	20:15:51	11254		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:11:18	678.00	2024-04-18	20:15:59	11255		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:11:26	686.00	2024-04-18	20:16:07	11256		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:11:34	694.00	2024-04-18	20:16:15	11257		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:11:42	702.00	2024-04-18	20:16:23	11258		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:11:50	710.00	2024-04-18	20:16:31	11259		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:11:58	718.00	2024-04-18	20:16:39	11260		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:12:06	726.00	2024-04-18	20:16:47	11261		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:12:14	734.00	2024-04-18	20:16:55	11262		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:12:23	743.00	2024-04-18	20:17:04	11263		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:12:31	751.00	2024-04-18	20:17:12	11264		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:12:39	759.00	2024-04-18	20:17:20	11265		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:12:47	767.00	2024-04-18	20:17:28	11266		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:12:55	775.00	2024-04-18	20:17:36	11267		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:13:03	783.00	2024-04-18	20:17:44	11268		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:13:11	791.00	2024-04-18	20:17:52	11269		
18Apr2024_111543_25_mp4.mp4	**Standard Pipe**	**#STD**	**0:13:11**	**791.00**	**2024-04-18**	**20:17:52**	**11269**	**20ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_25_mp4.mp4	**Offtake / Outlet**	**#OL @ 8:00.**	**0:13:13**	**793.00**	**2024-04-18**	**20:17:54**	**11269**	**Outlet in the Pipe List.**	
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:13:19	799.00	2024-04-18	20:18:00	11270		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:13:27	807.00	2024-04-18	20:18:08	11271		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:13:35	815.00	2024-04-18	20:18:16	11272		
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:13:43	823.00	2024-04-18	20:18:24	11273		
18Apr2024_111543_25_mp4.mp4	**Offtake / Outlet**	**#OL @ 3:00.**	**0:13:50**	**830.00**	**2024-04-18**	**20:18:31**	**11273**	**12" Outlet in the Pipe List.**	
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:13:50	830.00	2024-04-18	20:18:31	11274		
18Apr2024_111543_25_mp4.mp4	**Reducer**	**#RED**	**0:13:51**	**831.00**	**2024-04-18**	**20:18:32**	**11274**	**30" X 24" Eccentric Reducer in the Pipe List.**	
18Apr2024_111543_25_mp4.mp4	Joint	#J	0:13:52	832.00	2024-04-18	20:18:33	11275		
18Apr2024_111543_25_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:13:53	833.00	2024-04-18	20:18:34		PipeDiver STOP.	
18Apr2024_111543_25_mp4.mp4	Bookmark	#B End of Video 2024-04-18 20:19:41.	0:15:00	900.00	2024-04-18	20:19:41			
18Apr2024_111543_26_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 20:19:41.	0:00:00	0.00	2024-04-18	20:19:41			
18Apr2024_111543_26_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	20:19:41			
18Apr2024_111543_26_mp4.mp4	Bookmark	#B End of Video 2024-04-18 20:34:42.	0:15:00	900.00	2024-04-18	20:34:41			
18Apr2024_111543_27_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 20:34:41.	0:00:00	0.00	2024-04-18	20:34:41			
18Apr2024_111543_27_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	20:34:41			
18Apr2024_111543_27_mp4.mp4	Bookmark	#B End of Video 2024-04-18 20:49:41.	0:15:00	900.00	2024-04-18	20:49:41			
18Apr2024_111543_28_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 20:49:41.	0:00:00	0.00	2024-04-18	20:49:41			
18Apr2024_111543_28_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	20:49:41			
18Apr2024_111543_28_mp4.mp4	Bookmark	#B PipeDiver START (Reverse Direction).	0:14:51	891.00	2024-04-18	21:04:32		PipeDiver moved in Reverse Direction.	
18Apr2024_111543_28_mp4.mp4	**Offtake / Outlet**	**#OL same with 0:13:50 of Video 18Apr2024_111543_25_mp4.**	**0:14:59**	**899.00**	**2024-04-18**	**21:04:40**		**Outlet is the same with 0:13:50 of 18Apr2024_111543_25_mp4.**	
18Apr2024_111543_28_mp4.mp4	Bookmark	#B End of Video 2024-04-18 21:04:41.	0:15:00	900.00	2024-04-18	21:04:41			
18Apr2024_111543_29_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 21:04:41.	0:00:00	0.00	2024-04-18	21:04:41			
18Apr2024_111543_29_mp4.mp4	**Offtake / Outlet**	**#OL Same with 0:13:13 of video 18Apr2024_111543_25_mp4.**	**0:02:44**	**164.00**	**2024-04-18**	**21:07:25**		**Outlet is the same with 0:13:13 of video 18Apr2024_111543_25_mp4.**	
18Apr2024_111543_29_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:07:20	440.00	2024-04-18	21:12:01			
18Apr2024_111543_29_mp4.mp4	Bookmark	#B PipeDiver START (Normal Direction).	0:10:43	643.00	2024-04-18	21:15:24		PipeDiver moved in Normal Direction.	
18Apr2024_111543_29_mp4.mp4	**Offtake / Outlet**	**#OL Same with 0:13:13 of video 18Apr2024_111543_25_mp4.**	**0:14:26**	**866.00**	**2024-04-18**	**21:19:07**		**Outlet is the same with 0:13:13 of video 18Apr2024_111543_25_mp4.**	
18Apr2024_111543_29_mp4.mp4	Bookmark	#B End of Video 2024-04-18 21:19:41.	0:15:00	900.00	2024-04-18	21:19:41			
18Apr2024_111543_30_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 21:19:41.	0:00:00	0.00	2024-04-18	21:19:41			
18Apr2024_111543_30_mp4.mp4	**Offtake / Outlet**	**#OL same with 0:13:50 of 18Apr2024_111543_25_mp4.**	**0:01:09**	**69.00**	**2024-04-18**	**21:20:50**		**Outlet is the same with 0:13:50 of 18Apr2024_111543_25_mp4.**	
18Apr2024_111543_30_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:01:16	76.00	2024-04-18	21:20:57			
18Apr2024_111543_30_mp4.mp4	Bookmark	#B PipeDiver START.	0:02:17	137.00	2024-04-18	21:21:58		PipeDiver moved in Normal Direction.	
18Apr2024_111543_30_mp4.mp4	**Butterfly Valve**	**Possible #BFV.**	**0:02:18**	**138.00**	**2024-04-18**	**21:21:59**	**11275**	**Valve in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:02:21	141.00	2024-04-18	21:22:02	11276		
18Apr2024_111543_30_mp4.mp4	**Reducer**	**#RED**	**0:02:21**	**141.00**	**2024-04-18**	**21:22:02**	**11276**	**30" X 24" Eccentric Reducer in the Pipe List.**	

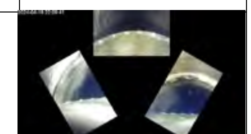
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:02:22	142.00	2024-04-18	21:22:03	11277		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:02:29	149.00	2024-04-18	21:22:10	11278		
18Apr2024_111543_30_mp4.mp4	**Blow Off**	**#BO**	**0:02:36**	**156.00**	**2024-04-18**	**21:22:17**	**11278**	**8" Blow-Off in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:02:37	157.00	2024-04-18	21:22:18	11279		
18Apr2024_111543_30_mp4.mp4	**Elbow/Bend**	**#EL**	**0:02:37**	**157.00**	**2024-04-18**	**21:22:18**	**11279**	**23° Elbow in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:02:38	158.00	2024-04-18	21:22:19	11280		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:02:46	166.00	2024-04-18	21:22:27	11281		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:02:54	174.00	2024-04-18	21:22:35	11282		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:03:01	181.00	2024-04-18	21:22:42	11283		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:03:09	189.00	2024-04-18	21:22:50	11284		
18Apr2024_111543_30_mp4.mp4	**Elbow/Bend**	**#EL**	**0:03:09**	**189.00**	**2024-04-18**	**21:22:50**	**11284**	**23° Elbow in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:03:10	190.00	2024-04-18	21:22:51	11285		
	Manhole	**#MH**		**0.00**	**2024-04-18**		**11285**	**14" X 16" Manhole in the Pipe List. Not seen in the videos due to camera glitch/skip.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:03:21	201.00	2024-04-18	21:23:02	11286		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:03:31	211.00	2024-04-18	21:23:12	11287		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:03:40	220.00	2024-04-18	21:23:21	11288		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:03:44	224.00	2024-04-18	21:23:25	11289		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:03:49	229.00	2024-04-18	21:23:30	11290		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:03:56	236.00	2024-04-18	21:23:37	11291		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:03:56	236.00	2024-04-18	21:23:37	11292		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:04:03	243.00	2024-04-18	21:23:44	11293		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:04:11	251.00	2024-04-18	21:23:52	11294		
18Apr2024_111543_30_mp4.mp4	**Standard Pipe**	**#STD**	**0:04:11**	**251.00**	**2024-04-18**	**21:23:52**	**11294**	**20ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	**Offtake / Outlet**	**#OL-CR**	**0:04:14**	**254.00**	**2024-04-18**	**21:23:55**	**11294**	**Outlet in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:04:18	258.00	2024-04-18	21:23:59	11295		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:04:26	266.00	2024-04-18	21:24:07	11296		
18Apr2024_111543_30_mp4.mp4	**Elbow/Bend**	**#EL**	**0:04:26**	**266.00**	**2024-04-18**	**21:24:07**	**11296**	**23° Elbow in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:04:27	267.00	2024-04-18	21:24:08	11297		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:04:35	275.00	2024-04-18	21:24:16	11298		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:04:43	283.00	2024-04-18	21:24:24	11299		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:04:50	290.00	2024-04-18	21:24:31	11300		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:04:58	298.00	2024-04-18	21:24:39	11301		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:05:06	306.00	2024-04-18	21:24:47	11302		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:05:13	313.00	2024-04-18	21:24:54	11303		
18Apr2024_111543_30_mp4.mp4	**Elbow/Bend**	**#EL**	**0:05:13**	**313.00**	**2024-04-18**	**21:24:54**	**11303**	**23° Elbow in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:05:14	314.00	2024-04-18	21:24:55	11304		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:05:22	322.00	2024-04-18	21:25:03	11305		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:05:30	330.00	2024-04-18	21:25:11	11306		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:05:38	338.00	2024-04-18	21:25:19	11307		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:05:46	346.00	2024-04-18	21:25:27	11308		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:05:55	355.00	2024-04-18	21:25:36	11309		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:06:03	363.00	2024-04-18	21:25:44	11310		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:06:08	368.00	2024-04-18	21:25:49	11311		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:06:16	376.00	2024-04-18	21:25:57	11312		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:06:23	383.00	2024-04-18	21:26:04	11313		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:06:31	391.00	2024-04-18	21:26:12	11314		
	Offtake / Outlet	**#OL**		**0.00**	**2024-04-18**		**11314**	**1" Outlet in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:06:39	399.00	2024-04-18	21:26:20	11315		
18Apr2024_111543_30_mp4.mp4	**Elbow/Bend**	**#EL**	**0:06:39**	**399.00**	**2024-04-18**	**21:26:20**	**11315**	**23° Elbow in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:06:40	400.00	2024-04-18	21:26:21	11316		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:06:48	408.00	2024-04-18	21:26:29	11317		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:06:55	415.00	2024-04-18	21:26:36	11318		
18Apr2024_111543_30_mp4.mp4	**Elbow/Bend**	**#EL**	**0:06:55**	**415.00**	**2024-04-18**	**21:26:36**	**11318**	**23° Elbow in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:06:56	416.00	2024-04-18	21:26:37	11319		
18Apr2024_111543_30_mp4.mp4	**Short Pipe**	**#SP**	**0:06:57**	**417.00**	**2024-04-18**	**21:26:38**	**11319**	**11ft Short Pipe in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:07:00	420.00	2024-04-18	21:26:41	11320		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:07:09	429.00	2024-04-18	21:26:50	11321		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:07:16	436.00	2024-04-18	21:26:57	11322		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:07:17	437.00	2024-04-18	21:26:58	11323		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:07:25	445.00	2024-04-18	21:27:06	11324		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:07:33	453.00	2024-04-18	21:27:14	11325		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:07:41	461.00	2024-04-18	21:27:22	11326		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:07:49	469.00	2024-04-18	21:27:30	11327		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:07:58	478.00	2024-04-18	21:27:39	11328		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:08:06	486.00	2024-04-18	21:27:47	11329		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:08:14	494.00	2024-04-18	21:27:55	11330		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:08:22	502.00	2024-04-18	21:28:03	11331		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:08:30	510.00	2024-04-18	21:28:11	11332		
18Apr2024_111543_30_mp4.mp4	**Standard Pipe**	**#STD**	**0:08:30**	**510.00**	**2024-04-18**	**21:28:11**	**11332**	**20ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:08:38	518.00	2024-04-18	21:28:19	11333		
	Offtake / Outlet	**#OL**	**0:08:38**	**518.00**	**2024-04-18**		**11333**	**8" Outlet in the Pipe List. Not seen due to camera glitching/skipping.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:08:45	525.00	2024-04-18	21:28:26	11334		
18Apr2024_111543_30_mp4.mp4	**Elbow/Bend**	**#EL**	**0:08:46**	**526.00**	**2024-04-18**	**21:28:27**	**11334**	**11° Elbow in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:08:52	532.00	2024-04-18	21:28:33	11335		
18Apr2024_111543_30_mp4.mp4	Joint of Interest	#JI	0:09:00	540.00	2024-04-18	21:28:41	11336		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:09:07	547.00	2024-04-18	21:28:48	11337		
	Elbow/Bend	**#EL**		**0.00**	**2024-04-18**		**11337**	**11° Elbow in the Pipe List. Not seen due to camera glitching/skipping.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:09:13	553.00	2024-04-18	21:28:54	11338		
18Apr2024_111543_30_mp4.mp4	Joint of Interest	#JI	0:09:18	558.00	2024-04-18	21:28:59	11339		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:09:23	563.00	2024-04-18	21:29:04	11340		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:09:30	570.00	2024-04-18	21:29:11	11341		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:09:38	578.00	2024-04-18	21:29:19	11342		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:09:45	585.00	2024-04-18	21:29:26	11343		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:09:52	592.00	2024-04-18	21:29:33	11344		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:09:59	599.00	2024-04-18	21:29:40	11345		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:10:07	607.00	2024-04-18	21:29:48	11346		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:10:14	614.00	2024-04-18	21:29:55	11347		

pure TECHNOLOGIES
a xylem brand

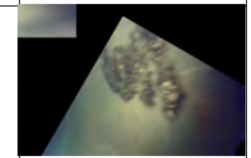
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:10:21	621.00	2024-04-18	21:30:02	11348		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:10:29	629.00	2024-04-18	21:30:10	11349		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:10:35	635.00	2024-04-18	21:30:16	11350		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:10:43	643.00	2024-04-18	21:30:24	11351		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:10:51	651.00	2024-04-18	21:30:32	11352		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:10:59	659.00	2024-04-18	21:30:40	11353		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:11:07	667.00	2024-04-18	21:30:48	11354		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:11:14	674.00	2024-04-18	21:30:55	11355		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:11:22	682.00	2024-04-18	21:31:03	11356		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:11:30	690.00	2024-04-18	21:31:11	11357		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:11:37	697.00	2024-04-18	21:31:18	11358		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:11:45	705.00	2024-04-18	21:31:26	11359		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:11:53	713.00	2024-04-18	21:31:34	11360		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:12:01	721.00	2024-04-18	21:31:42	11361		
18Apr2024_111543_30_mp4.mp4	**Offtake / Outlet**	**#OL @ 3:00.**	**0:12:07**	**727.00**	**2024-04-18**	**21:31:48**	**11361**	**6" Outlet in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:12:08	728.00	2024-04-18	21:31:49	11362		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:12:13	733.00	2024-04-18	21:31:54	11363		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:12:21	741.00	2024-04-18	21:32:02	11364		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:12:29	749.00	2024-04-18	21:32:10	11365		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:12:37	757.00	2024-04-18	21:32:18	11366		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:12:45	765.00	2024-04-18	21:32:26	11367		
18Apr2024_111543_30_mp4.mp4	**Standard Pipe**	**#STD**	**0:12:45**	**765.00**	**2024-04-18**	**21:32:26**	**11367**	**20ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:12:53	773.00	2024-04-18	21:32:34	11368		
18Apr2024_111543_30_mp4.mp4	**Standard Pipe**	**#STD**	**0:12:53**	**773.00**	**2024-04-18**	**21:32:34**	**11368**	**20ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:13:00	780.00	2024-04-18	21:32:41	11369		
18Apr2024_111543_30_mp4.mp4	**Manhole**	**#MH @ 12:00.**	**0:13:04**	**784.00**	**2024-04-18**	**21:32:45**	**11369**	**16" X 14" Manhole in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:13:08	788.00	2024-04-18	21:32:49	11370		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:13:16	796.00	2024-04-18	21:32:57	11371		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:13:24	804.00	2024-04-18	21:33:05	11372		
	Offtake / Outlet	**#OL**		**0.00**	**2024-04-18**		**11372**	**1" Outlet in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:13:32	812.00	2024-04-18	21:33:13	11373		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:13:40	820.00	2024-04-18	21:33:21	11374		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:13:47	827.00	2024-04-18	21:33:28	11375		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:13:55	835.00	2024-04-18	21:33:36	11376		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:14:03	843.00	2024-04-18	21:33:44	11377		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:14:11	851.00	2024-04-18	21:33:52	11378		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:14:18	858.00	2024-04-18	21:33:59	11379		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:14:26	866.00	2024-04-18	21:34:07	11380		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:14:33	873.00	2024-04-18	21:34:14	11381		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:14:41	881.00	2024-04-18	21:34:22	11382		
18Apr2024_111543_30_mp4.mp4	**Standard Pipe**	**#STD**	**0:14:41**	**881.00**	**2024-04-18**	**21:34:22**	**11382**	**20ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	**Offtake / Outlet**	**#OL @ 9:00.**	**0:14:48**	**888.00**	**2024-04-18**	**21:34:29**	**11382**	**Outlet in the Pipe List.**	
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:14:49	889.00	2024-04-18	21:34:30	11383		
18Apr2024_111543_30_mp4.mp4	Joint	#J	0:14:56	896.00	2024-04-18	21:34:37	11384		
18Apr2024_111543_30_mp4.mp4	Bookmark	#B End of Video 2024-04-18 21:34:41.	0:15:00	900.00	2024-04-18	21:34:41			
18Apr2024_111543_31_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 21:34:41.	0:00:00	0.00	2024-04-18	21:34:41			
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:00:04	4.00	2024-04-18	21:34:45	11385		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:00:11	11.00	2024-04-18	21:34:52	11386		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:00:19	19.00	2024-04-18	21:35:00	11387		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:00:26	26.00	2024-04-18	21:35:07	11388		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:00:34	34.00	2024-04-18	21:35:15	11389		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:00:41	41.00	2024-04-18	21:35:22	11390		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:00:49	49.00	2024-04-18	21:35:30	11391		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:00:56	56.00	2024-04-18	21:35:37	11392		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:01:04	64.00	2024-04-18	21:35:45	11393		
18Apr2024_111543_31_mp4.mp4	**Standard Pipe**	**#STD**	**0:01:04**	**64.00**	**2024-04-18**	**21:35:45**	**11393**	**20ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 3:00.**	**0:01:10**	**70.00**	**2024-04-18**	**21:35:51**	**11393**	**Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:01:12	72.00	2024-04-18	21:35:53	11394		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:01:14	74.00	2024-04-18	21:35:55	11395		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:01:22	82.00	2024-04-18	21:36:03	11396		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:01:30	90.00	2024-04-18	21:36:11	11397		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:01:38	98.00	2024-04-18	21:36:19	11398		
18Apr2024_111543_31_mp4.mp4	**Short Pipe**	**#SP**	**0:01:38**	**98.00**	**2024-04-18**	**21:36:19**	**11398**	**~16ft Short Pipe in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:01:43	103.00	2024-04-18	21:36:24	11399		
18Apr2024_111543_31_mp4.mp4	**Elbow/Bend**	**#EL**	**0:01:43**	**103.00**	**2024-04-18**	**21:36:24**	**11399**	**45° Elbow in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:01:45	105.00	2024-04-18	21:36:26	11400		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:01:53	113.00	2024-04-18	21:36:34	11401		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 3:00.**	**0:01:59**	**119.00**	**2024-04-18**	**21:36:40**	**11401**	**8" Tapping Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:02:00	120.00	2024-04-18	21:36:41	11402		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:02:08	128.00	2024-04-18	21:36:49	11403		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:02:16	136.00	2024-04-18	21:36:57	11404		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:02:24	144.00	2024-04-18	21:37:05	11405		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 8:00.**	**0:02:28**	**148.00**	**2024-04-18**	**21:37:09**	**11405**	**8" Tapping Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:02:31	151.00	2024-04-18	21:37:12	11406		
18Apr2024_111543_31_mp4.mp4	**Elbow/Bend**	**#EL**	**0:02:31**	**151.00**	**2024-04-18**	**21:37:12**	**11406**	**45° Elbow in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:02:33	153.00	2024-04-18	21:37:14	11407		
18Apr2024_111543_31_mp4.mp4	**Standard Pipe**	**#STD**	**0:02:33**	**153.00**	**2024-04-18**	**21:37:14**	**11407**	**20ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 8:00.**	**0:02:37**	**157.00**	**2024-04-18**	**21:37:18**	**11407**	**Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:02:40	160.00	2024-04-18	21:37:21	11408		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:02:48	168.00	2024-04-18	21:37:29	11409		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:02:55	175.00	2024-04-18	21:37:36	11410		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:03:03	183.00	2024-04-18	21:37:44	11411		
18Apr2024_111543_31_mp4.mp4	**Manhole**	**#MH**	**0:03:10**	**190.00**	**2024-04-18**	**21:37:51**	**11411**	**16" X 14" Manhole in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:03:11	191.00	2024-04-18	21:37:52	11412		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 8:00.**	**0:03:19**	**199.00**	**2024-04-18**	**21:38:00**	**11412**	**1" Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:03:19	199.00	2024-04-18	21:38:00	11413		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:03:27	207.00	2024-04-18	21:38:08	11424		

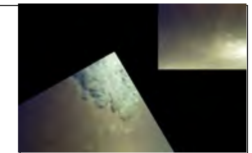
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:03:35	215.00	2024-04-18	21:38:16	11425		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 8:00.**	**0:03:42**	**222.00**	**2024-04-18**	**21:38:23**	**11415**	**1" Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:03:42	222.00	2024-04-18	21:38:23	11416		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:03:50	230.00	2024-04-18	21:38:31	11417		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 3:00.**	**0:03:52**	**232.00**	**2024-04-18**	**21:38:33**	**11417**	**6" Tapping Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:03:55	235.00	2024-04-18	21:38:36	11418		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:04:03	243.00	2024-04-18	21:38:44	11419		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 8:00.**	**0:04:07**	**247.00**	**2024-04-18**	**21:38:48**	**11419**	**6" Tapping Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:04:11	251.00	2024-04-18	21:38:52	11420		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:04:20	260.00	2024-04-18	21:39:01	11421		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:04:29	269.00	2024-04-18	21:39:10	11422		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:04:38	278.00	2024-04-18	21:39:19	11423		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:04:48	288.00	2024-04-18	21:39:29	11424		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:04:57	297.00	2024-04-18	21:39:38	11425		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:05:06	306.00	2024-04-18	21:39:47	11426		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:05:15	315.00	2024-04-18	21:39:56	11427		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:05:25	325.00	2024-04-18	21:40:06	11428		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:05:34	334.00	2024-04-18	21:40:15	11429		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:05:43	343.00	2024-04-18	21:40:24	11430		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:05:52	352.00	2024-04-18	21:40:33	11431		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:06:01	361.00	2024-04-18	21:40:42	11432		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:06:10	370.00	2024-04-18	21:40:51	11433		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:06:20	380.00	2024-04-18	21:41:01	11434		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:06:30	390.00	2024-04-18	21:41:11	11435		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:06:41	401.00	2024-04-18	21:41:22	11436		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:06:51	411.00	2024-04-18	21:41:32	11437		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:07:03	423.00	2024-04-18	21:41:44	11438		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:07:15	435.00	2024-04-18	21:41:56	11439		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:07:27	447.00	2024-04-18	21:42:08	11440		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:07:39	459.00	2024-04-18	21:42:20	11441		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:07:51	471.00	2024-04-18	21:42:32	11442		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:08:03	483.00	2024-04-18	21:42:44	11443		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:08:05	485.00	2024-04-18	21:42:46	11444		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:08:17	497.00	2024-04-18	21:42:58	11445		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:08:29	509.00	2024-04-18	21:43:10	11446		
18Apr2024_111543_31_mp4.mp4	**Standard Pipe**	**#STD**	**0:08:30**	**510.00**	**2024-04-18**	**21:43:11**	**11446**	**20ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:08:41	521.00	2024-04-18	21:43:22	11447		
18Apr2024_111543_31_mp4.mp4	**Reducer**	**#RED**	**0:08:41**	**521.00**	**2024-04-18**	**21:43:22**	**11447**	**30" X 24" Eccentric Reducer in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:08:44	524.00	2024-04-18	21:43:25	11448		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL 9:00 and 3:00 Possible Cross.**	**0:08:45**	**525.00**	**2024-04-18**	**21:43:26**	**11448**	**16" Outlet in the Pipe List. Possible Cross seen.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:08:50	530.00	2024-04-18	21:43:31	11449		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:08:56	536.00	2024-04-18	21:43:37	11450		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:09:02	542.00	2024-04-18	21:43:43	11451		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:09:09	549.00	2024-04-18	21:43:50	11452		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:09:16	556.00	2024-04-18	21:43:57	11453		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:09:22	562.00	2024-04-18	21:44:03	11454		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:09:29	569.00	2024-04-18	21:44:10	11455		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 9:00.**	**0:09:35**	**575.00**	**2024-04-18**	**21:44:16**	**11455**	**1" Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:09:36	576.00	2024-04-18	21:44:17	11456		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:09:43	583.00	2024-04-18	21:44:24	11457		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:09:50	590.00	2024-04-18	21:44:31	11458		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:09:57	597.00	2024-04-18	21:44:38	11459		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:10:05	605.00	2024-04-18	21:44:46	11460		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:10:12	612.00	2024-04-18	21:44:53	11461		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 9:00.**	**0:10:19**	**619.00**	**2024-04-18**	**21:45:00**	**11461**	**2" Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:10:20	620.00	2024-04-18	21:45:01	11462		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:10:28	628.00	2024-04-18	21:45:09	11463		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:10:35	635.00	2024-04-18	21:45:16	11464		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:10:43	643.00	2024-04-18	21:45:24	11465		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:10:51	651.00	2024-04-18	21:45:32	11466		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:10:59	659.00	2024-04-18	21:45:40	11467		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:11:08	668.00	2024-04-18	21:45:49	11468		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:11:16	676.00	2024-04-18	21:45:57	11469		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:11:19	679.00	2024-04-18	21:46:00	11470		
18Apr2024_111543_31_mp4.mp4	**Reducer**	**#RED**	**0:11:19**	**679.00**	**2024-04-18**	**21:46:00**	**11470**	**24" X 16" Reducer in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:11:20	680.00	2024-04-18	21:46:01	11471		
18Apr2024_111543_31_mp4.mp4	**Butterfly Valve**	**Possible #BFV.**	**0:11:20**	**680.00**	**2024-04-18**	**21:46:01**	**11471**	**Valve in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:11:21	681.00	2024-04-18	21:46:02	11472		
18Apr2024_111543_31_mp4.mp4	**Reducer**	**#RED**	**0:11:21**	**681.00**	**2024-04-18**	**21:46:02**	**11472**	**24" X 16" Reducer in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:11:24	684.00	2024-04-18	21:46:05	11473		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:11:30	690.00	2024-04-18	21:46:11	11474		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:11:39	699.00	2024-04-18	21:46:20	11475		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:11:47	707.00	2024-04-18	21:46:28	11476		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:11:56	716.00	2024-04-18	21:46:37	11477		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:12:04	724.00	2024-04-18	21:46:45	11478		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:12:11	731.00	2024-04-18	21:46:52	11479		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 3:00.**	**0:12:18**	**738.00**	**2024-04-18**	**21:46:59**	**11479**	**12" Outlet in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:12:19	739.00	2024-04-18	21:47:00	11480		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:12:27	747.00	2024-04-18	21:47:08	11481		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:12:34	754.00	2024-04-18	21:47:15	11482		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:12:42	762.00	2024-04-18	21:47:23	11483		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:12:49	769.00	2024-04-18	21:47:30	11484		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:12:56	776.00	2024-04-18	21:47:37	11485		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:13:03	783.00	2024-04-18	21:47:44	11486		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:13:10	790.00	2024-04-18	21:47:51	11487		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:13:17	797.00	2024-04-18	21:47:58	11488		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:13:24	804.00	2024-04-18	21:48:05	11489		

18Apr2024_111543_31_mp4.mp4	Joint	#J	0:13:31	811.00	2024-04-18	21:48:12	11490		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:13:37	817.00	2024-04-18	21:48:18	11491		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:13:44	824.00	2024-04-18	21:48:25	11492		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:13:51	831.00	2024-04-18	21:48:32	11493		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:13:57	837.00	2024-04-18	21:48:38	11494		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:14:04	844.00	2024-04-18	21:48:45	11495		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:14:10	850.00	2024-04-18	21:48:51	11496		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:14:17	857.00	2024-04-18	21:48:58	11497		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:14:24	864.00	2024-04-18	21:49:05	11498		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:14:30	870.00	2024-04-18	21:49:11	11499		
18Apr2024_111543_31_mp4.mp4	**Standard Pipe**	**#STD**	**0:14:30**	**870.00**	**2024-04-18**	**21:49:11**	**11499**	**16ft Standard Length Pipe in the Pipe List.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:14:37	877.00	2024-04-18	21:49:18	11500		
18Apr2024_111543_31_mp4.mp4	**Offtake / Outlet**	**#OL @ 8:00.**	**0:14:39**	**879.00**	**2024-04-18**	**21:49:20**	**11500**	**8" Outlet in the Pipe List. Not seen due to camera glitching/skipping.**	
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:14:44	884.00	2024-04-18	21:49:25	11501		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:14:51	891.00	2024-04-18	21:49:32	11503		
18Apr2024_111543_31_mp4.mp4	Joint	#J	0:14:58	898.00	2024-04-18	21:49:39	11503		
18Apr2024_111543_31_mp4.mp4	Bookmark	#B End of Video 2024-04-18 21:49:41.	0:15:00	900.00	2024-04-18	21:49:41			
18Apr2024_111543_32_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 21:49:41.	0:00:00	0.00	2024-04-18	21:49:41			
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:00:04	4.00	2024-04-18	21:49:45	11504		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:00:11	11.00	2024-04-18	21:49:52	11505		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:00:18	18.00	2024-04-18	21:49:59	11506		
18Apr2024_111543_32_mp4.mp4	**Chipping**	**Possible #CHP @ 8:00.**	**0:00:19**	**19.00**	**2024-04-18**	**21:50:00**		**Visual anomaly.**	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:00:25	25.00	2024-04-18	21:50:06	11507		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:00:31	31.00	2024-04-18	21:50:12	11508		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:00:38	38.00	2024-04-18	21:50:19	11509		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:00:45	45.00	2024-04-18	21:50:26	11510		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:00:52	52.00	2024-04-18	21:50:33	11511		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:00:59	59.00	2024-04-18	21:50:40	11512		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:01:05	65.00	2024-04-18	21:50:46	11513		
18Apr2024_111543_32_mp4.mp4	**Standard Pipe**	**#STD**	**0:01:05**	**65.00**	**2024-04-18**	**21:50:46**	**11513**	**16ft Standard Length Pipe in the Pipe List.**	
	Offtake / Outlet	**#OL**		**0.00**	**2024-04-18**		**11513**	**Outlet in Pipe List. Not seen due to camera glitching/skipping.**	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:01:12	72.00	2024-04-18	21:50:53	11514		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:01:17	77.00	2024-04-18	21:50:58	11515		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:01:23	83.00	2024-04-18	21:51:04	11516		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:01:33	93.00	2024-04-18	21:51:14	11517		
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:01:40	100.00	2024-04-18	21:51:21	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	**Bookmark**	**#B PipeDiver STOP.**	**0:01:41**	**101.00**	**2024-04-18**	**21:51:22**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Bookmark**	**#B PipeDiver START.**	**0:01:56**	**116.00**	**2024-04-18**	**21:51:37**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:01:57**	**117.00**	**2024-04-18**	**21:51:38**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Bookmark**	**#B PipeDiver STOP.**	**0:02:02**	**122.00**	**2024-04-18**	**21:51:43**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Bookmark**	**#B PipeDiver START.**	**0:02:04**	**124.00**	**2024-04-18**	**21:51:45**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Offtake / Outlet**	**#OL-CR**	**0:02:06**	**126.00**	**2024-04-18**	**21:51:47**	**11518**	**Possible Outlet.**	
18Apr2024_111543_32_mp4.mp4	**Butterfly Valve**	**#BFV**	**0:02:06**	**126.00**	**2024-04-18**	**21:51:47**	**11518**	**Possible BFV seen.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:07**	**127.00**	**2024-04-18**	**21:51:48**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:08**	**128.00**	**2024-04-18**	**21:51:49**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Elbow/Bend**	**#EL**	**0:02:09**	**129.00**	**2024-04-18**	**21:51:50**	**11518**	**Elbow/Bend seen.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:10**	**130.00**	**2024-04-18**	**21:51:51**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:10**	**130.00**	**2024-04-18**	**21:51:51**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:12**	**132.00**	**2024-04-18**	**21:51:53**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:13**	**133.00**	**2024-04-18**	**21:51:54**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Debris and Sedimentation**	**#DEB and #SED.**	**0:02:17**	**137.00**	**2024-04-18**	**21:51:58**	**11518**	**Possible Debris and Sediments seen.**	
18Apr2024_111543_32_mp4.mp4	**Elbow/Bend**	**#EL**	**0:02:17**	**137.00**	**2024-04-18**	**21:51:58**	**11518**	**Elbow/Bend seen.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:17**	**137.00**	**2024-04-18**	**21:51:58**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:18**	**138.00**	**2024-04-18**	**21:51:59**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:20**	**140.00**	**2024-04-18**	**21:52:01**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:20**	**140.00**	**2024-04-18**	**21:52:01**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:32**	**152.00**	**2024-04-18**	**21:52:13**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:02:46**	**166.00**	**2024-04-18**	**21:52:27**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:03:00**	**180.00**	**2024-04-18**	**21:52:41**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:03:13**	**193.00**	**2024-04-18**	**21:52:54**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:03:26**	**206.00**	**2024-04-18**	**21:53:07**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:03:39**	**219.00**	**2024-04-18**	**21:53:20**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:03:53**	**233.00**	**2024-04-18**	**21:53:34**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:04:07**	**247.00**	**2024-04-18**	**21:53:48**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:04:08**	**248.00**	**2024-04-18**	**21:53:49**	**11518**	**Ductile Iron realignment section in the Pipe List.**	
18Apr2024_111543_32_mp4.mp4	**Joint**	**#J**	**0:04:09**	**249.00**	**2024-04-18**	**21:53:50**	**11518**	**Ductile Iron realignment section in the Pipe List.**	

18Apr2024_111543_32_mp4.mp4	Debris and Sedimentation	#DEB and #SED.	0:04:09	249.00	2024-04-18	21:53:50	11518	Possible Debris and Sediments seen.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:04:10	250.00	2024-04-18	21:53:51	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Offtake / Outlet	#OL @ 3:00.	0:04:11	251.00	2024-04-18	21:53:52	11518	Outlet seen.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:04:12	252.00	2024-04-18	21:53:53	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Elbow/Bend	#EL	0:04:14	254.00	2024-04-18	21:53:55	11518	Elbow/Bend seen.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:04:15	255.00	2024-04-18	21:53:56	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:04:18	258.00	2024-04-18	21:53:59	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:04:27	267.00	2024-04-18	21:54:08	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Elbow/Bend	#EL	0:04:27	267.00	2024-04-18	21:54:08	11518	Elbow/Bend seen.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:04:27	267.00	2024-04-18	21:54:08	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:04:37	277.00	2024-04-18	21:54:18	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:04:47	287.00	2024-04-18	21:54:28	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:04:56	296.00	2024-04-18	21:54:37	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:05:05	305.00	2024-04-18	21:54:46	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:05:15	315.00	2024-04-18	21:54:56	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:05:24	324.00	2024-04-18	21:55:05	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:05:33	333.00	2024-04-18	21:55:14	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:05:42	342.00	2024-04-18	21:55:23	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:05:51	351.00	2024-04-18	21:55:32	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:06:00	360.00	2024-04-18	21:55:41	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:06:09	369.00	2024-04-18	21:55:50	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:06:18	378.00	2024-04-18	21:55:59	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:06:27	387.00	2024-04-18	21:56:08	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:06:35	395.00	2024-04-18	21:56:16	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:06:44	404.00	2024-04-18	21:56:25	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Elbow/Bend	#EL	0:06:44	404.00	2024-04-18	21:56:25	11518	Elbow/Bend seen.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:06:45	405.00	2024-04-18	21:56:26	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:06:53	413.00	2024-04-18	21:56:34	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:06:58	418.00	2024-04-18	21:56:39	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:07:01	421.00	2024-04-18	21:56:42	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:07:04	424.00	2024-04-18	21:56:45	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:07:05	425.00	2024-04-18	21:56:46	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Joint	#J	0:07:14	434.00	2024-04-18	21:56:55	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:07:20	440.00	2024-04-18	21:57:01	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_32_mp4.mp4	Bookmark	#B End of Video 2024-04-18 22:04:41.	0:15:00	900.00	2024-04-18	22:04:41		Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 22:04:41.	0:00:00	0.00	2024-04-18	22:04:41		Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:00	0.00	2024-04-18	22:04:41	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Offtake / Outlet	#OL-CR	0:04:51	291.00	2024-04-18	22:09:32	11518	Outlet seen.	
18Apr2024_111543_33_mp4.mp4	Bookmark	#B PipeDiver START.	0:04:57	297.00	2024-04-18	22:09:38	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Butterfly Valve	#BFV	0:04:58	298.00	2024-04-18	22:09:39	11518	Possible BFV seen.	
18Apr2024_111543_33_mp4.mp4	Offtake / Outlet	#OL-CR	0:05:01	301.00	2024-04-18	22:09:42	11518	Outlet seen.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:05:03	303.00	2024-04-18	22:09:44	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:05:05	305.00	2024-04-18	22:09:46	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	T Connection	Possible #TEE.	0:05:06	306.00	2024-04-18	22:09:47	11518	Possible Tee seen.	
18Apr2024_111543_33_mp4.mp4	Debris	#DEB @ 9:00.	0:05:06	306.00	2024-04-18	22:09:47	11518	Possible Debris seen.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:05:06	306.00	2024-04-18	22:09:47	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:05:16	316.00	2024-04-18	22:09:57	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:05:26	326.00	2024-04-18	22:10:07	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:05:35	335.00	2024-04-18	22:10:16	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:05:45	345.00	2024-04-18	22:10:26	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:05:55	355.00	2024-04-18	22:10:36	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:06:04	364.00	2024-04-18	22:10:45	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:06:13	373.00	2024-04-18	22:10:54	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:06:22	382.00	2024-04-18	22:11:03	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:06:31	391.00	2024-04-18	22:11:12	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:06:41	401.00	2024-04-18	22:11:22	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:06:50	410.00	2024-04-18	22:11:31	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:07:01	421.00	2024-04-18	22:11:42	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:07:10	430.00	2024-04-18	22:11:51	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:07:20	440.00	2024-04-18	22:12:01	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:07:30	450.00	2024-04-18	22:12:11	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:07:39	459.00	2024-04-18	22:12:20	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:07:49	469.00	2024-04-18	22:12:30	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:07:59	479.00	2024-04-18	22:12:40	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:08:07	487.00	2024-04-18	22:12:48	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Offtake / Outlet	#OL @ 3:00.	0:08:08	488.00	2024-04-18	22:12:49	11518	Outlet seen.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:08:08	488.00	2024-04-18	22:12:49	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:08:10	490.00	2024-04-18	22:12:51	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:08:20	500.00	2024-04-18	22:13:01	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:08:29	509.00	2024-04-18	22:13:10	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:08:39	519.00	2024-04-18	22:13:20	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:08:48	528.00	2024-04-18	22:13:29	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:08:58	538.00	2024-04-18	22:13:39	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:09:00	540.00	2024-04-18	22:13:41	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	T Connection	#TEE @ 9:00.	0:09:01	541.00	2024-04-18	22:13:42	11518	Possible Tee seen.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:09:02	542.00	2024-04-18	22:13:43	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:09:11	551.00	2024-04-18	22:13:52	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:09:20	560.00	2024-04-18	22:14:01	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:09:30	570.00	2024-04-18	22:14:11	11518	Ductile Iron realignment section in the Pipe List.	

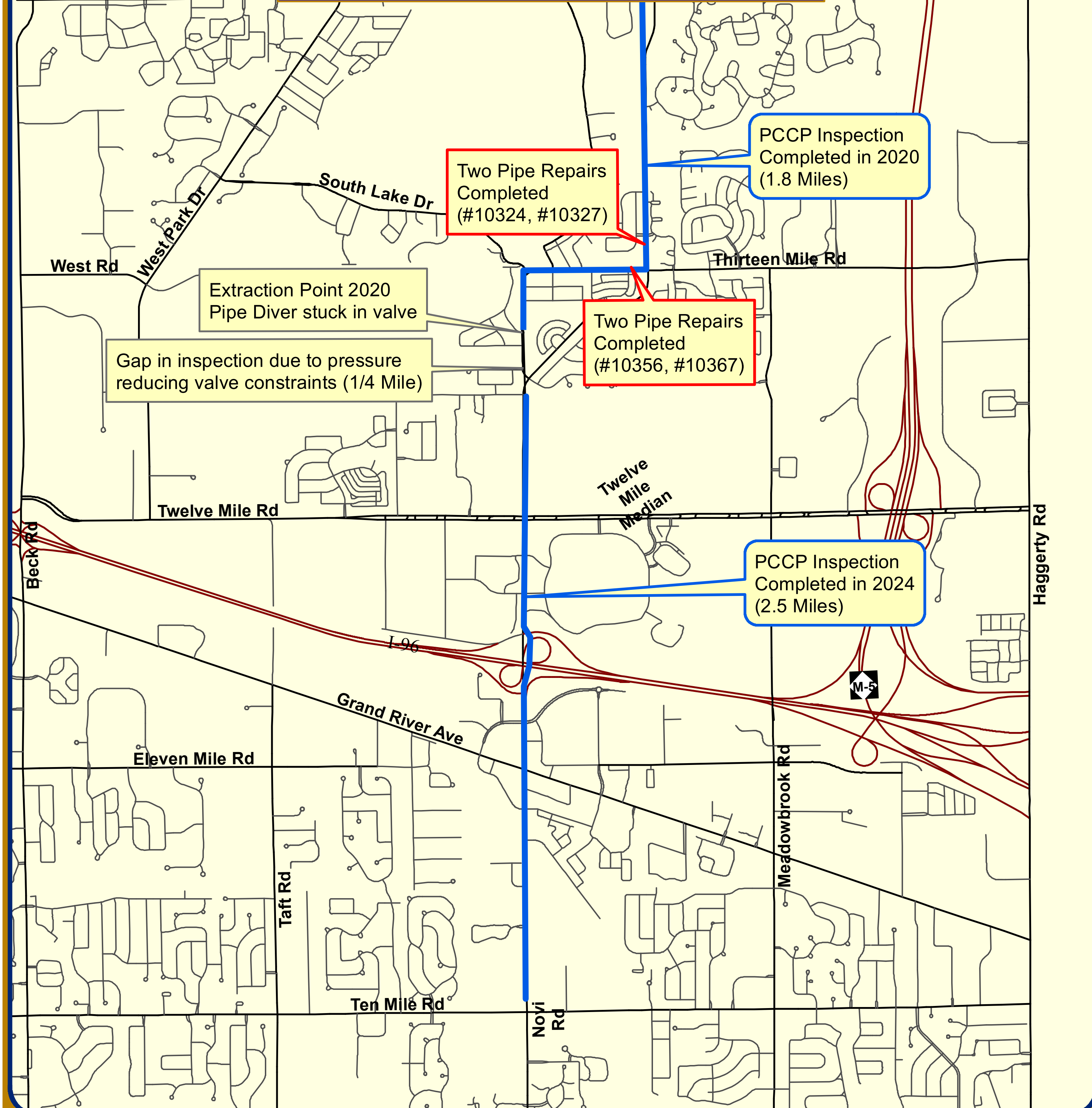
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:09:40	580.00	2024-04-18	22:14:21	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:09:49	589.00	2024-04-18	22:14:30	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:09:59	599.00	2024-04-18	22:14:40	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:10:09	609.00	2024-04-18	22:14:50	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:10:18	618.00	2024-04-18	22:14:59	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:10:23	623.00	2024-04-18	22:15:04	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Offtake / Outlet	#OL @ 3:00.	0:10:24	624.00	2024-04-18	22:15:05	11518	Outlet seen.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:10:24	624.00	2024-04-18	22:15:05	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:10:27	627.00	2024-04-18	22:15:08	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:10:36	636.00	2024-04-18	22:15:17	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:10:46	646.00	2024-04-18	22:15:27	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:10:56	656.00	2024-04-18	22:15:37	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:11:07	667.00	2024-04-18	22:15:48	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:11:17	677.00	2024-04-18	22:15:58	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:11:27	687.00	2024-04-18	22:16:08	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:11:37	697.00	2024-04-18	22:16:18	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:11:47	707.00	2024-04-18	22:16:28	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:11:57	717.00	2024-04-18	22:16:38	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:12:07	727.00	2024-04-18	22:16:48	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:12:17	737.00	2024-04-18	22:16:58	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:12:27	747.00	2024-04-18	22:17:08	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:12:36	756.00	2024-04-18	22:17:17	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:12:46	766.00	2024-04-18	22:17:27	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:12:55	775.00	2024-04-18	22:17:36	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:13:06	786.00	2024-04-18	22:17:47	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:13:15	795.00	2024-04-18	22:17:56	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Offtake / Outlet	#OL @ 3:00.	0:13:15	795.00	2024-04-18	22:17:56	11518	Outlet seen.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:13:16	796.00	2024-04-18	22:17:57	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:13:22	802.00	2024-04-18	22:18:03	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:13:31	811.00	2024-04-18	22:18:12	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:13:41	821.00	2024-04-18	22:18:22	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:13:51	831.00	2024-04-18	22:18:32	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:14:01	841.00	2024-04-18	22:18:42	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:14:11	851.00	2024-04-18	22:18:52	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:14:20	860.00	2024-04-18	22:19:01	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:14:30	870.00	2024-04-18	22:19:11	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:14:39	879.00	2024-04-18	22:19:20	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:14:47	887.00	2024-04-18	22:19:28	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Offtake / Outlet	#OL @ 9:00.	0:14:47	887.00	2024-04-18	22:19:28	11518	Outlet seen.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:14:48	888.00	2024-04-18	22:19:29	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Joint	#J	0:14:50	890.00	2024-04-18	22:19:31	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_33_mp4.mp4	Bookmark	#B End of Video 2024-04-18 22:19:41.	0:15:00	900.00	2024-04-18	22:19:41		Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 22:19:41.	0:00:00	0.00	2024-04-18	22:19:41		Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:00:00	0.00	2024-04-18	22:19:41	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:00:09	9.00	2024-04-18	22:19:50	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:00:18	18.00	2024-04-18	22:19:59	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:00:28	28.00	2024-04-18	22:20:09	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:00:38	38.00	2024-04-18	22:20:19	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:00:48	48.00	2024-04-18	22:20:29	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:00:57	57.00	2024-04-18	22:20:38	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:01:06	66.00	2024-04-18	22:20:47	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:01:17	77.00	2024-04-18	22:20:58	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:01:26	86.00	2024-04-18	22:21:07	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Offtake / Outlet	#OL @ 9:00.	0:01:27	87.00	2024-04-18	22:21:08	11518	Outlet seen.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:01:27	87.00	2024-04-18	22:21:08	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:01:36	96.00	2024-04-18	22:21:17	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:01:46	106.00	2024-04-18	22:21:27	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:01:56	116.00	2024-04-18	22:21:37	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:02:06	126.00	2024-04-18	22:21:47	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:02:16	136.00	2024-04-18	22:21:57	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:02:25	145.00	2024-04-18	22:22:06	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:02:35	155.00	2024-04-18	22:22:16	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Offtake / Outlet	#OL @ 8:00.	0:02:42	162.00	2024-04-18	22:22:23	11518	Outlet seen.	
18Apr2024_111543_34_mp4.mp4	Debris	#DEB	0:02:44	164.00	2024-04-18	22:22:25	11518	Debris seen.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:02:45	165.00	2024-04-18	22:22:26	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:02:55	175.00	2024-04-18	22:22:36	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:03:06	186.00	2024-04-18	22:22:47	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:03:16	196.00	2024-04-18	22:22:57	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:03:27	207.00	2024-04-18	22:23:08	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:03:37	217.00	2024-04-18	22:23:18	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:03:47	227.00	2024-04-18	22:23:28	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:03:56	236.00	2024-04-18	22:23:37	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:03:57	237.00	2024-04-18	22:23:38	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Offtake / Outlet	#OL @ 3:00.	0:03:58	238.00	2024-04-18	22:23:39	11518	Outlet seen.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:03:59	239.00	2024-04-18	22:23:40	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:04:00	240.00	2024-04-18	22:23:41	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:04:01	241.00	2024-04-18	22:23:42	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:04:01	241.00	2024-04-18	22:23:42	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:04:02	242.00	2024-04-18	22:23:43	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:04:12	252.00	2024-04-18	22:23:53	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:04:22	262.00	2024-04-18	22:24:03	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:04:31	271.00	2024-04-18	22:24:12	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:04:42	282.00	2024-04-18	22:24:23	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:04:52	292.00	2024-04-18	22:24:33	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Bookmark	#B PipeDiver START.	0:05:03	303.00	2024-04-18	22:24:44	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:05:08	308.00	2024-04-18	22:24:49	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Offtake / Outlet	#OL-CR	0:05:12	312.00	2024-04-18	22:24:53	11518	Outlet seen.	

18Apr2024_111543_34_mp4.mp4	Butterfly Valve	#BFV	0:05:13	313.00	2024-04-18	22:24:54	11518	Possible BFV seen.	
18Apr2024_111543_34_mp4.mp4	Offtake / Outlet	#OL-CR	0:05:15	315.00	2024-04-18	22:24:56	11518	Outlet seen.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:05:16	316.00	2024-04-18	22:24:57	11518	Ductile Iron realignment section in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:05:17	317.00	2024-04-18	22:24:58	11519		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:05:24	324.00	2024-04-18	22:25:05	11520		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:05:31	331.00	2024-04-18	22:25:12	11521		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:05:38	338.00	2024-04-18	22:25:19	11522		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:05:45	345.00	2024-04-18	22:25:26	11523		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:05:51	351.00	2024-04-18	22:25:32	11524		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:05:58	358.00	2024-04-18	22:25:39	11525		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:06:05	365.00	2024-04-18	22:25:46	11526		
18Apr2024_111543_34_mp4.mp4	Standard Pipe	#STD	0:06:05	365.00	2024-04-18	22:25:46	11526	16ft Standard Length Pipe in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Manhole	Possible #MH.	0:06:07	367.00	2024-04-18	22:25:48	11526	Outlet in the Pipe List. Possible Manhole.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:06:11	371.00	2024-04-18	22:25:52	11527		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:06:18	378.00	2024-04-18	22:25:59	11528		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:06:24	384.00	2024-04-18	22:26:05	11529		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:06:31	391.00	2024-04-18	22:26:12	11530		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:06:38	398.00	2024-04-18	22:26:19	11531		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:06:44	404.00	2024-04-18	22:26:25	11532		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:06:51	411.00	2024-04-18	22:26:32	11533		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:06:58	418.00	2024-04-18	22:26:39	11534		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:07:04	424.00	2024-04-18	22:26:45	11535		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:07:11	431.00	2024-04-18	22:26:52	11536		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:07:18	438.00	2024-04-18	22:26:59	11537		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:07:24	444.00	2024-04-18	22:27:05	11538		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:07:31	451.00	2024-04-18	22:27:12	11539		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:07:38	458.00	2024-04-18	22:27:19	11540		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:07:45	465.00	2024-04-18	22:27:26	11541		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:07:51	471.00	2024-04-18	22:27:32	11542		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:07:59	479.00	2024-04-18	22:27:40	11543		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:08:05	485.00	2024-04-18	22:27:46	11544		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:08:13	493.00	2024-04-18	22:27:54	11545		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:08:20	500.00	2024-04-18	22:28:01	11546		
18Apr2024_111543_34_mp4.mp4	Offtake / Outlet	#OL @ 9:00.	0:08:25	505.00	2024-04-18	22:28:06	11546	6" Outlet in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:08:27	507.00	2024-04-18	22:28:08	11547		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:08:34	514.00	2024-04-18	22:28:15	11548		
18Apr2024_111543_34_mp4.mp4	Standard Pipe	#STD	0:08:34	514.00	2024-04-18	22:28:15	11548	16ft Standard Length Pipe in the Pipe List.	
	Offtake / Outlet	#OL		0.00	2024-04-18		11548	Outlet in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:08:48	528.00	2024-04-18	22:28:29	11549		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:08:55	535.00	2024-04-18	22:28:36	11550		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:09:02	542.00	2024-04-18	22:28:43	11551		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:09:08	548.00	2024-04-18	22:28:49	11552		
18Apr2024_111543_34_mp4.mp4	Standard Pipe	#STD	0:09:08	548.00	2024-04-18	22:28:49	11552	16ft Standard Length Pipe in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Tuberculation	Possible #TUB @ 3:00.	0:09:09	549.00	2024-04-18	22:28:50		Possible material buildup seen.	
	Offtake / Outlet	#OL		0.00	2024-04-18		11552	Outlet in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:09:10	550.00	2024-04-18	22:28:51	11553		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:09:17	557.00	2024-04-18	22:28:58	11554		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:09:24	564.00	2024-04-18	22:29:05	11555		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:09:31	571.00	2024-04-18	22:29:12	11556		
18Apr2024_111543_34_mp4.mp4	Offtake / Outlet	#OL @ 4:00.	0:09:35	575.00	2024-04-18	22:29:16	11556	8" Outlet in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:09:38	578.00	2024-04-18	22:29:19	11557		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:09:45	585.00	2024-04-18	22:29:26	11558		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:09:52	592.00	2024-04-18	22:29:33	11559		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:09:59	599.00	2024-04-18	22:29:40	11560		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:10:06	606.00	2024-04-18	22:29:47	11561		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:10:13	613.00	2024-04-18	22:29:54	11562		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:10:20	620.00	2024-04-18	22:30:01	11563		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:10:27	627.00	2024-04-18	22:30:08	11564		
18Apr2024_111543_34_mp4.mp4	Standard Pipe	#STD	0:10:27	627.00	2024-04-18	22:30:08	11564	16ft Standard Length Pipe in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Offtake / Outlet	#OL @ 9:00.	0:10:32	632.00	2024-04-18	22:30:13	11564	Outlet in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:10:35	635.00	2024-04-18	22:30:16	11565		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:10:42	642.00	2024-04-18	22:30:23	11566		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:10:51	651.00	2024-04-18	22:30:32	11567		
18Apr2024_111543_34_mp4.mp4	Joint of Interest	#JI	0:10:59	659.00	2024-04-18	22:30:40	11568		
18Apr2024_111543_34_mp4.mp4	Standard Pipe	#STD	0:11:00	660.00	2024-04-18	22:30:41	11568	16ft Standard Length Pipe in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Offtake / Outlet	#OL @ 3:00.	0:11:03	663.00	2024-04-18	22:30:44	11568	Outlet in the Pipe List.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:11:08	668.00	2024-04-18	22:30:49	11569		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:11:16	676.00	2024-04-18	22:30:57	11570		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:11:25	685.00	2024-04-18	22:31:06	11571		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:11:34	694.00	2024-04-18	22:31:15	11572		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:11:44	704.00	2024-04-18	22:31:25	11573		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:11:55	715.00	2024-04-18	22:31:36	11574		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:12:08	728.00	2024-04-18	22:31:49	11575		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:12:21	741.00	2024-04-18	22:32:02	11576		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:12:35	755.00	2024-04-18	22:32:16	11577		

18Apr2024_111543_34_mp4.mp4	Tuberculation	#TUB @ 9:00.	0:12:39	759.00	2024-04-18	22:32:20		Possible material buildup observed.	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:12:49	769.00	2024-04-18	22:32:30	11577		
	Offtake / Outlet	**#OL**		**0.00**	**2024-04-18**		**11577**	**6" Outlet in the Pipe List.**	
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:13:05	785.00	2024-04-18	22:32:46	11578		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:13:21	801.00	2024-04-18	22:33:02	11579		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:13:38	818.00	2024-04-18	22:33:19	11580		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:13:54	834.00	2024-04-18	22:33:35	11581		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:14:09	849.00	2024-04-18	22:33:50	11582		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:14:23	863.00	2024-04-18	22:34:04	11583		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:14:37	877.00	2024-04-18	22:34:18	11584		
18Apr2024_111543_34_mp4.mp4	Joint	#J	0:14:50	890.00	2024-04-18	22:34:31	11585		
18Apr2024_111543_34_mp4.mp4	Bookmark	#B End of Video 2024-04-18 22:34:41.	0:15:00	900.00	2024-04-18	22:34:41			
18Apr2024_111543_35_mp4.mp4	Bookmark	#B Start of Video 2024-04-18 22:34:41.	0:00:00	0.00	2024-04-18	22:34:41			
18Apr2024_111543_35_mp4.mp4	Joint	#J	0:00:03	3.00	2024-04-18	22:34:44	11586		
18Apr2024_111543_35_mp4.mp4	Bookmark	#B PipeDiver STOP.	0:00:08	8.00	2024-04-18	22:34:49			
18Apr2024_111543_35_mp4.mp4	Bookmark	#B End of Video 2024-04-18 22:35:43.	0:01:01	61.00	2024-04-18	22:35:42			

PCCP Transmission Main Inspection

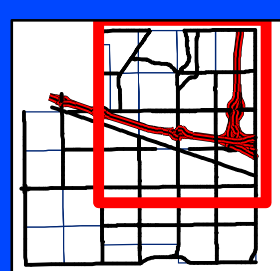
Pipe Diver



Map Author: Croy
Date: August 2024
Project: PCCP Inspection
Version #: v2.0

MAP INTERPRETATION NOTICE

Map information depicted is not intended to replace or substitute for any official or primary source. This map was intended to meet National Map Accuracy Standards and use the most recent, accurate sources available to the people of the City of Novi. Boundary measurements and area calculations are approximate and should not be construed as survey measurements performed by a licensed Michigan Surveyor as defined in Michigan Public Act 132 of 1970 as amended. Please contact the City GIS Manager to confirm source and accuracy information related to this map.



City of Novi
Engineering Division
Department of Public Services
26300 Lee BeGole Drive
Novi, MI 48375
cityofnovi.org

Feet
0 600 1,200 2,400 3,600
1 inch = 2,936 feet

MEMORANDUM

TO: ERICK W. ZINSER
DIRECTOR OF PUBLIC SAFETY / CHIEF OF POLICE

FROM: JASON A. MEIER, COMMANDER

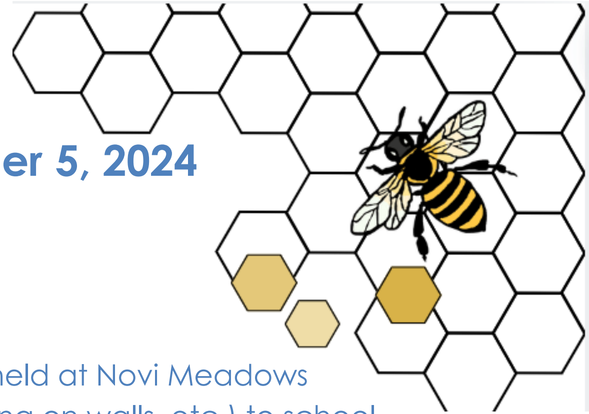
SUBJECT: STUFF A SQUAD CAR

DATE: DECEMBER 5, 2024

cityofnovi.org

On the recent weekend days of November 23rd, 24th, 30th and December 1st, the Novi Police Department partnered with Walmart to host our annual Stuff a Squad Car event.

Officers volunteered their time to stand outside of Walmart and collect new, unwrapped toys to benefit Toys for Tots. The event was a huge success, with the collection of well over a thousand toys. The local chapter recognized the Novi Police Department as, once again, the largest donator in the area.



Buzz Report

December 5, 2024

Hot Topics:

- **Incident at Novi Meadows (new)**
  On December 3rd, while PRCS basketball activities were being held at Novi Meadows upper elementary school, damages (broken exit lighting, drawing on walls, etc.) to school facilities occurred during a team's basketball practice. A message has been sent to the team regarding the matter, which was also captured on the school's surveillance system. PRCS and the schools will work together to ensure the necessary repairs are made.

- **Trains/Railroad Crossings**
  A resident has recently been reaching out with concerns about the Railroad Crossing Located just north of the Beck and West Road intersection. The trains that utilize that crossing, as well as others within City limits, do not provide schedules. These trains are ultimately overseen by the Federal government and any fines for stopped/delayed traffic at the crossings would ultimately be assessed and paid to them.

Frequently Asked Questions:

Q: With the planned improvements to 9 Mile Road between Meadowbrook and Haggarty when will the trees be removed?

A: Endangered species protections require the trees to be removed prior to March 31, 2025, to avoid disturbing bat nesting areas. The City's tree contractor will remove the trees this winter