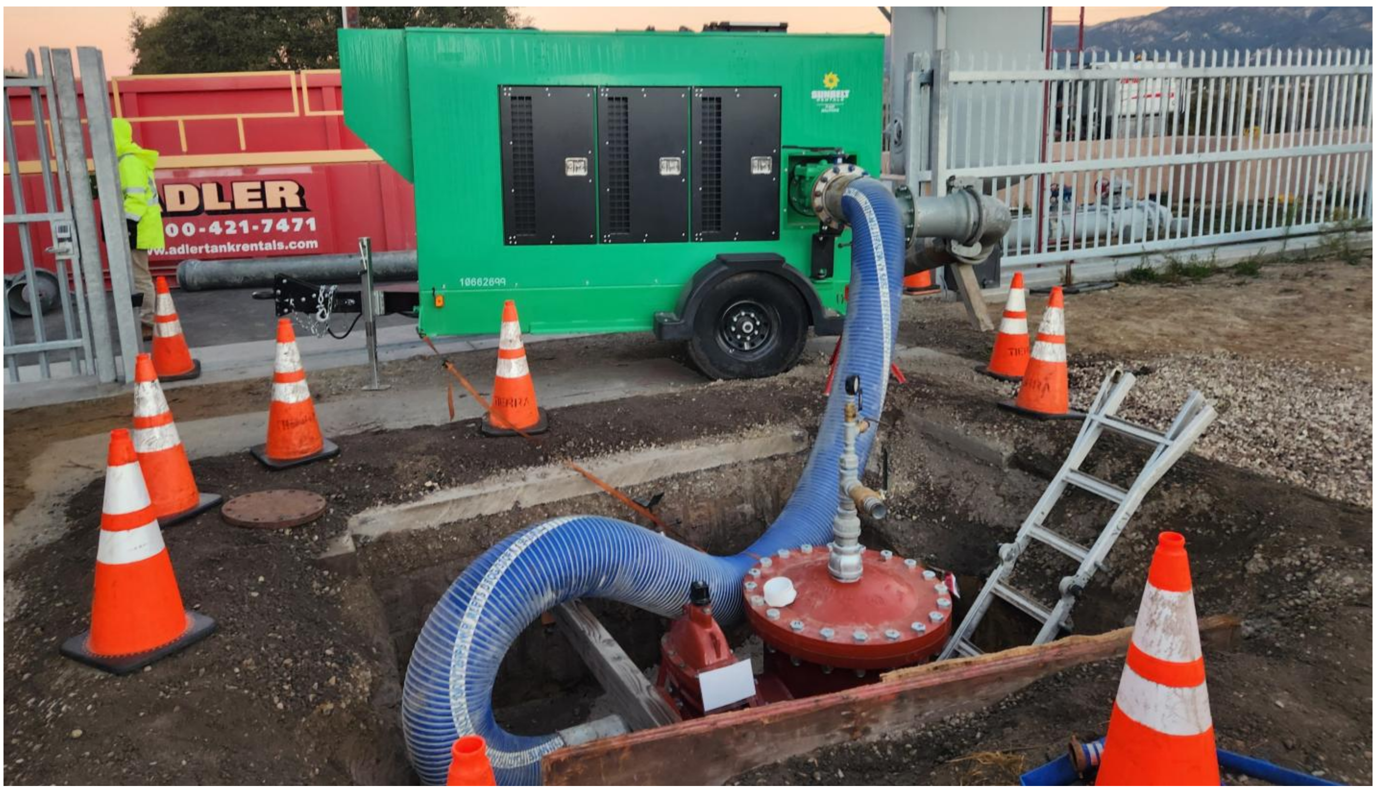
GOLETA WEST SANITARY DISTRICT

FORCE MAIN INSPECTION SUMMARY AND RECOMMENDATIONS

FINAL REPORT



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January 2026

Goleta West Sanitary District

FORCE MAIN INSPECTION SUMMARY AND RECOMMENDATIONS

January 16, 2026

Prepared by:

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CIVIL
STATE OF CALIFORNIA

Nicholas Panofsky, PE No. C75006

Contents

Section 1. Project Background

The Goleta West Sanitary District (District), located in Goleta, CA, operates two wastewater force mains conveying raw wastewater from the pump station at the District Office to the Goleta Sanitary District's wastewater treatment plant (WWTP). The existing 18-in.-diameter asbestos cement (AC) force main was constructed in 1963, with a typical expected lifespan of 70 years, and the existing 24-in. diameter ductile iron (D.I.) force main was constructed in 1978, with a typical lifespan of 100 years under ideal installation conditions.

1.1. Project Goals

The District wishes to mitigate the risk of failure for the aging wastewater force mains. The District contracted MNS Engineers, Inc. (MNS) to assist the District in reviewing and evaluating inspection technologies, guiding a condition assessment, analyzing results, and developing high level recommendations for rehabilitation, and/or replacement of the existing force mains. This Report summarizes the force-main-related work completed to date and provides recommendations for the future management of the existing force mains.

1.2. Existing Facilities

The two existing force mains follow parallel alignments as shown in Figure 1-1. The alignments begin at the Goleta West Sanitary District and extend through the Goleta Slough State Marine Conservation Area (SMCA), the City of Santa Barbara Municipal Airport, the Southern California Gas Company's La Goleta Storage Field, and the Goleta Sanitary District.

Based on information discussed in this Report, the existing 24-in. D.I. force main has likely reached, or is very near, the end of its useful service life. The condition of the existing 18-in. AC force main was not determined conclusively; however, based on its age, the 18-in. AC force main is also expected to be nearing the end of its useful service life.

In July of 2005 a leak was discovered and repaired on the 18-in. AC force main. The damaged pipe is presumed to have been caused by previous excavation work in the area which was never reported to the District, likely while flow was on the 24-in. D.I. force main.

In February 2024, and again in October 2024, the existing 24-in. D.I. force main experienced a failure, resulting in sanitary sewer spills. Photographs of excavated failed pipe segments are provided as Figure 1-2 and Figure 1-3.

C:\Box\Projects\GOWSD Goleta West Sanitary Dist\GOWSD 220149 Sewer Assessment\2 Eng\CAD\Exhibits\Final Rec TM - New FM Alignments.dwg

Thu 18.Dec.25 01:57:59 PM

MNS

EXISTING FORCE MAINS ALIGNMENT

FORCE MAIN INSPECTION SUMMARY AND RECOMMENDATIONS
GOLETA WEST SANITARY DISTRICT

FIGURE NUMBER
1-1

Figure 1-2. Ductile iron pipe section removed from the February 2024 spill site. Entire sections of pipe wall had deteriorated, revealing the inside of the pipe behind.

Figure 1-3. Failed ductile iron pipe hot tap adapter removed from the October 2024 spill site

Section 2. Summary of Completed Work

This section summarizes work completed to evaluate the condition of the existing force mains.

2.1. Condition Assessment – MNS

MNS recommended that the District inspect their sewer force mains using non-destructive methods as an initial step to determine if additional inspection or other actions are needed in the near term to understand and potentially extend the remaining useful life of these assets.

2.1.1. Force Main Inspection Via Non-Destructive Methods

MNS documented available non-destructive pipeline inspection technologies to determine the most suitable and applicable approach for assessing the existing force mains. For the 18-in AC force main, an acoustic inspection was recommended. This inspection is achieved using a free-swimming acoustic sensing ball deployed into the force main to traverse its length while listening for air pockets or leaks. For the 24-in D.I. force main, an acoustic inspection, followed by an electromagnetic inspection was recommended. The electromagnetic inspection is achieved using a free-floating pig with electromagnetic sensors to determine potential localized instances of wall thickness loss. Electromagnetic inspection is only applicable for ferrous pipe materials, such as D.I.P., so was not recommended for the 18-in. AC force main.

MNS procured proposals from two pipeline inspection companies which both use similar technologies for pipeline condition assessments. The two companies, Pure Technologies (Xylem) and PICA, both proposed to inspect the existing force mains using the approach described above. The District and MNS elected to partner with Xylem, primarily due to reduced risk of the electromagnetic inspection tool becoming stuck in the force main. Xylem's electromagnetic inspection tool has a greater ability to pass through areas of reduced diameter, accumulated sludge, or other protrusions into the force main.

2.2. Condition Assessment Report – Xylem

Xylem performed an acoustic listening ball inspection of both of the District's existing force mains. Xylem also performed an electromagnetic inspection of the District's 24-in. D.I. force main. The results of these inspections are summarized in the following sections. Xylem's full inspection reports documenting the results of these inspections are provided as Appendices A through C.

2.2.1. SmartBall

In December, 2024, Xylem performed an acoustic sensing ball (SmartBall) inspection of both of the District's existing force mains. The goal of the examination was to locate possible force main leaks and air pockets which could indicate areas at elevated risk for localized pipe corrosion due to hydrogen sulfide (H_2S) gas exposure.

The SmartBall inspections concluded that no acoustic events resembling leaks were detected on either of the District's force mains, but several instances of gas pockets and entrained air were detected on each force main. Xylem's report in Appendix A provides detailed information regarding the SmartBall inspections and their results.

2.2.2. PipeDiver

In addition to the SmartBall acoustic inspection, in December, 2024 and January, 2025, Xylem performed electromagnetic inspections of the District's 24-in. D.I. force main using their free-swimming platform PipeDiver tool, which uses an electromagnetic field that interacts with the metallic pipe wall to identify pipes with indications of potential wall loss.

Of the 493 pipe segments and two partial 24-in. D.I. pipe segments inspected by the PipeDiver platform, one pipe segment exhibited electromagnetic anomalies consistent with significant pipe wall loss. At the identified location, the inspection indicated an area of 20 square inches with a wall loss of approximately 60% of the pipe wall's original thickness. Xylem's PipeDiver report, in Appendix B provides additional information regarding the PipeDiver inspection and results.

2.2.3. Condition Assessment Report

Xylem provided a third document summarizing their inspection results and providing further structural evaluation of the District's 24-in. DI force main. Using the American Water Works Association's (AWWA) C150 Standard and a finite element analysis, Xylem determined that the localized wall loss detected on the 24-in. DI force main puts the pipe at risk of failure. Xylem ultimately recommended repair or replacement of the DI pipe segment showing wall loss, replacement of both force mains' air release valves (ARVs), and pipe re-inspection every 7-10 years. Xylem's full Condition Assessment Report is provided in Appendix C.

2.3. Physical Inspection – Goleta West Sanitary District

To corroborate Xylem's inspection results, the District physically unearthed and removed one segment of 24-in. D.I. pipe and one segment of 18-in. AC pipe for visual inspection during August and September of 2025. The removed D.I. segment was the segment identified by the PipeDiver inspection as exhibiting signs of significant wall loss. The removed AC segment was located in a segment indicated by the SmartBall inspection to exhibit signs of a 17-ft-long gas pocket. As part of their inspection scope of work, Xylem provided the District with dig sheets, indicating what segments of pipe to remove (Figure 2-1, Figure 2-2).

2.3.1. Physical Inspection / Excavation Results

From the physical data available, the existing 18-in. AC force main appears not to exhibit significant corrosion. However, no information regarding the condition of the AC force main joints' gaskets is available, while the gaskets are considered the most likely points of failure; the actual condition of the existing AC pipe is difficult to determine based on available data.

Physical observation of the excavated segment of 24-in D.I.P. force main clearly showed multiple instances of significant corrosion. While the most significant observed corrosion was at the location indicated by the PipeDiver inspection, other instances of corrosion were observed at other locations physically uncovered. The PipeDiver inspection tool's reported minimum resolution for observing wall loss is approximately 20 square inches, meaning that the tool will not identify corrosion or pitting over an area less than 20 square inches. Due to this resolution limitation, there is a potential that there are other locations along the 24-in D.I.P. force main which are at risk of failure in the short term, but which were not observed by the PipeDiver tool.

Photographs of removed pipe segments exhibiting significant corrosion are provided as Figure 2-3 and Figure 2-4.

GOLETA WEST SANITARY DISTRICT
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18" Asbestos Concrete Goleta Force Main

Gas Pocket #1 | DIG SHEET

Map Date: 06/11/2025

Legend

- Entry Port
- Gate Valve
- Gas Pocket
- 18-inch Asbestos Concrete

Feature of Interest Coordinates

Feature	X (Feet)	Y (Feet)
Insertion/TL 01	6003161.887	1981343.382
Start of Gas Pocket	6003168.390	1981443.688
End of Gas Pocket	6003174.973	1981460.131
TL 03	6003223.572	1981581.512

CRS: NAD 1983 California V 0405

Supplied coordinates are for reference only.
Please refer to dig instructions for proper usage of coordinates.

Distance to Gas Pocket

Feature	Insertion/TL 01	TL 03
Start of Gas Pocket	127 feet	~148 feet
End of Gas Pocket	~144 feet	131 feet

N
0 25 50
Feet

Contact Information

Project Manager: Brian Hext
Contact Number: +1 (858) 354-2448
Email: Brian.Hext@Xylem.com

BEFORE YOU DIG:

Please contact the Xylem Project Manager prior to excavating or conducting repairs. Read and understand the locating procedures outlined in the associated report. Measure from both the upstream and downstream features. Notify Xylem of any uncertainties in the associated report or this dig sheet.

Data Sources

Pipeline Mapping: Goleta West Sanitary District Record Drawings
GPS Equipment Accuracy: ~3 Feet

Leak locations are derived from Xylem's proprietary tools and methods. Please see the associated technology report for more details.

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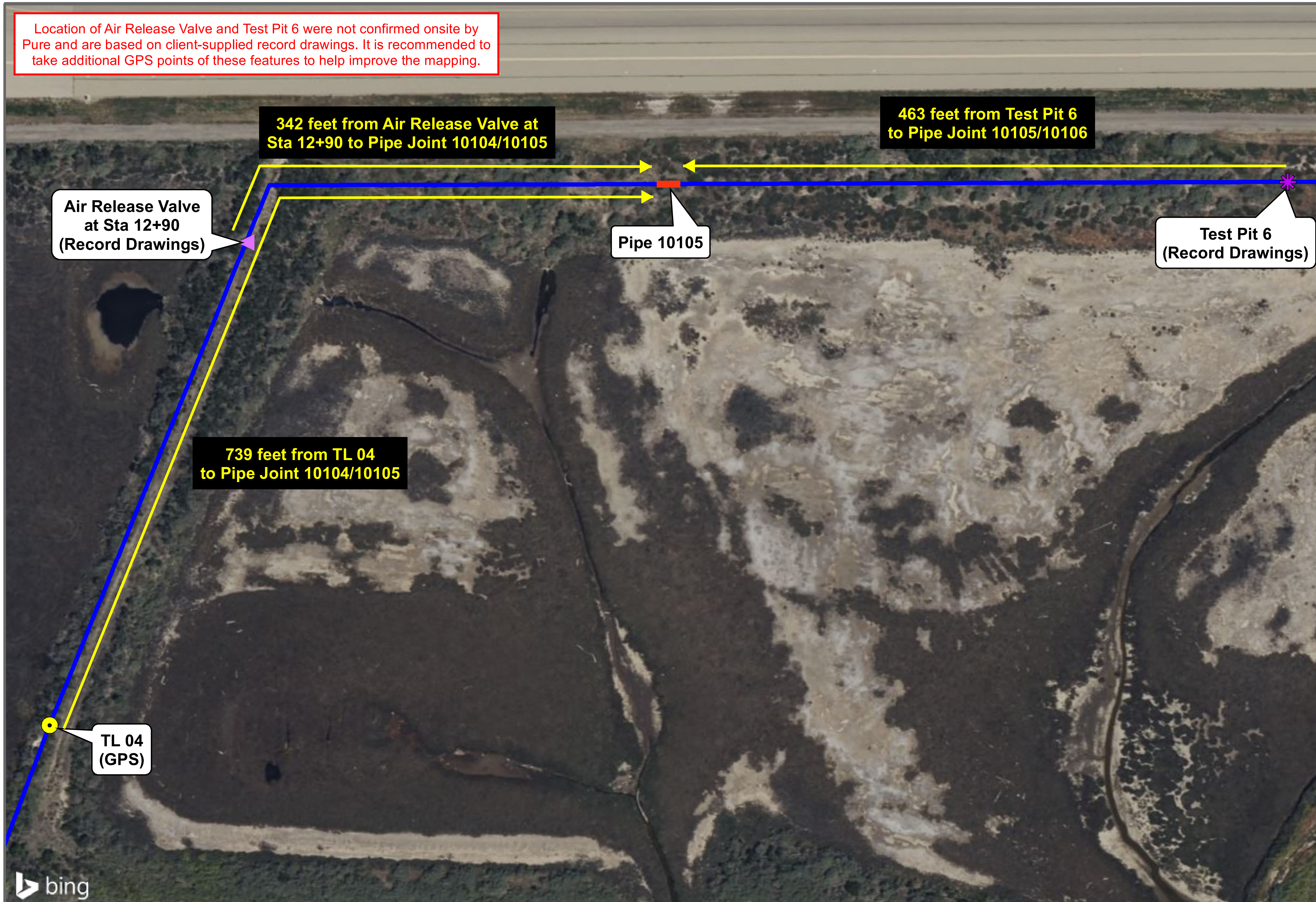

GOLETA WEST SANITARY DISTRICT
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24" Ductile Iron Goleta Force Main

Pipe 10105 | DIG SHEET

Map Date: 06/11/2025

Legend

- Exposed Pipe
- Air Release Valve
- Test Pit
- Target Pipe Section
- 24-inch Ductile Iron

Feature of Interest Coordinates

Feature	X (Feet)	Y (Feet)
TL 04	6003446.884	1982170.337
Joint 10104/10105	6003909.451	1982582.593
Joint 10105/10106	6003927.649	1982582.656
Test Pit 6	6004390.220	1982584.257

CRS: NAD 1983 California V 0405

Supplied coordinates are for reference only.
Please refer to dig instructions for proper usage of coordinates.

Distance to Pipe Joint

Feature	TL 04	Test Pit 6
Joint 10104/10105	739 feet	481 feet
Joint 10105/10106	758 feet	463 feet

N

0 50 100 150
Feet

Contact Information

Project Manager: Brian Hext
Contact Number: +1 (858) 354-2448
Email: Brian.Hext@Xylem.com

BEFORE YOU DIG:

Please contact the Xylem Project Manager prior to excavating or conducting repairs. Read and understand the locating procedures outlined in the associated report. Measure from both the upstream and downstream features. Notify Xylem of any uncertainties in the associated report or this dig sheet.

Data Sources

Pipeline Mapping: Goleta West Sanitary District Record Drawings
GPS Equipment Accuracy: ~3 Feet

Leak locations are derived from Xylem's proprietary tools and methods. Please see the associated technology report for more details.

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Figure 2-3. Corroded segment of ductile iron pipe removed per Xylem's dig sheet recommendations – Photograph 1 of 2.

Figure 2-4. Corroded segment of ductile iron pipe removed per Xylem's dig sheet recommendations - Photograph 2 of 2

2.4. Soil Corrosivity Investigation – HDR

In May of 2024, HDR, Inc. (HDR) performed a soil corrosivity study at the location of the February, 2024, 24-in. DI force main failure. In December 2025, HDR produced an updated soil corrosivity report using data from the location of the February, 2024, 24-in. DI force main failure and other accessible locations along the force main alignments. HDR's reports classified the soil as "corrosive" to "severely corrosive" along the alignment's entire length. This soil classification, coupled with apparent cracks in the pipe's protective wrapping and lack of taping at wrapped joints, led HDR to conclude that undetected corrosion damage is very likely to exist elsewhere on the pipes. HDR's 2025 Soil Corrosivity Investigation Report is provided as Appendix D.

2.5. Environmental Constraints Memorandum – Rincon Consultants, Inc.

In February 2023, as a subconsultant to MNS, Rincon Consultants, Inc. (Rincon) prepared an Environmental Constraints Memorandum detailing the likely environmental studies and permitting requirements for a force main rehabilitation project along a similar alignment to the existing. The project site is located in the California Coastal Zone and highly sensitive for biological and cultural resources, Rincon estimates that environmental studies and permitting could cost as much as $440,000 and take as long as two years to complete. The full Rincon Environmental Constraints Memorandum is provided as Appendix E.

Section 3. Conclusions and Recommendations

Due to the age of the District's existing sewer force mains, recent failures, Xylem's inspection results, HDR's soil corrosivity report, and extensive visible corrosion in multiple locations, MNS concludes that the 24-in D.I.P force main is at the end of its 48-year service life and has a high risk of future failures.

The 18-inch diameter asbestos-cement (AC) pipe has been in service since 1963 – over 60 years. According to Exponent.com, "The Chrysotile Institute estimates AC pipe lifespan at 70 years, but actual service life depends largely on pipe condition and working environment." Therefore, the life of the existing 18-inch pipe is nearly exhausted.

Less information is available to determine the actual remaining useful life of the 18-in AC force main, compared to that of the 24-in. D.I. force main. The 2005 failure, thought to have been caused by another entity damaging the pipe, and the pipe nearing the end of its service life indicates there is some potential future risk of failure. Failures of AC pipe often occur at joints, rather than along the pipe barrel, and therefore it is very challenging to determine probability of failure.

With the existing force mains at or near the end of their service lives, the District should determine an appropriate approach to rehabilitating or replacing these assets. Considering that the design, permitting, and funding timelines for a pipeline improvement project would take two years or longer to complete, and up to an additional year for construction of the selected solution, the existing force mains must remain active for three or more years. MNS recommends that the District evaluate and select preferred rehabilitation or replacement options for both existing wastewater force mains as soon as feasibly possible.

3.1. Pipeline Improvement Alternatives

A variety of alternative approaches to rehabilitating the existing force mains are available and should be considered to determine the alternative which provides the greatest long term value to the District. The following sections briefly discuss potential pipeline improvement alternatives. MNS recommends these alternatives be evaluated using a variety of evaluation metrics including implementation cost, estimated useful life, permitting requirements, and other metrics as deemed appropriate. With all of these options, installation of appropriately located and sized air release valves and remote monitoring of the force mains may be recommended.

3.1.1. Pipe Lining / Rehabilitation

The useful life of the existing sewer force mains could be extended by installing an internal liner within the pipes. A cured-in-place-pipe (CIPP) structural liner or flexible liner such as manufactured by Primus Line could be considered.

Pipe lining is likely the lowest-cost rehabilitation option discussed in this Report. However, pipe liners could reduce the hydraulic conveyance capacity of the existing force mains and may not last as long as other options discussed. Lining would require approximately ten access pit excavations to install and would not address current challenges associated with access to the force mains within a highly environmentally sensitive location.

3.1.2. Pipe Bursting

Pipe bursting is a trenchless method used to replace old or damaged pipes without the need for extensive excavation. In this process, a bursting tool, typically pulled by a pneumatic or hydraulic device, is inserted into the existing pipe. The tool fractures the old pipe while simultaneously pulling a new pipe into place behind it. HDPE is the most common material used in pipe bursting applications and would be the recommended material for pipe bursting in this application.

Pipe bursting is suitable for replacement of AC pipe. Pipe bursting is not recommended for replacement of D.I. pipe, as it carries a greater risk of non-uniform splitting and causing damage or other installation challenges for the new pipe.

Pipe bursting is likely a middle-cost improvement technology and would likely require less extensive environmental permitting compared to an open-cut replacement option, due to the lack of required continuous trenching. When installing a new pipe by pipe bursting, the new pipe installed follows the line and grade of the existing pipe, resulting in the inability to relocate pipes to more accessible locations. Pipe bursting would not address current challenges associated with access to the force mains and the force mains being within a highly environmentally sensitive location.

3.1.3. Open-Cut Replacement

The force mains could be replaced entirely by two new parallel force mains in a common trench using traditional open-cut trenching methods. Several material options exist for installation by open cut; however, PVC or HDPE materials would be preferred due to their corrosion resistance in the corrosive soils in the project area. Open-cut installation would allow the new force mains to follow any feasible alignment selected by the District. An open-cut replacement is likely a middle-cost solution but could also add the benefit of an updated force main alignment, which could significantly ease future operations, maintenance, and environmental concerns.

After an open-cut replacement, the existing force mains not requiring removal would likely be abandoned in place via filling partially or completely with low-density concrete or other material.

3.1.4. Horizontal Directional Drilling

New force mains could be installed by a combination of open trench construction and trenchless construction. Horizontal directional drilling (HDD) is one of several available trenchless technologies available for trenchless pipe installation and is anticipated to be the most suitable for this application. Similar to open-trench construction, using HDD would allow the force mains to be installed along a new alignment. HDPE pipe is anticipated to be the most suitable pipe material for this application if installed using HDD.

Trenchless installation would significantly reduce environmental impacts of the installation, as the pipe would be installed under environmentally sensitive habitat with minimal disturbance. HDD installation would result in segments of the new force mains to be installed at a significant depth, at which future surface access would be impractical.

3.2. Next Steps

MNS recommends retaining a qualified consultant to prepare a technical memorandum developing and evaluating alternatives to provide engineering recommendations for future management of the District's wastewater force main assets.

Section 4. Appendices

Appendix A - SmartBall Inspection Report – Xylem

xylem
Let's Solve Water

SmartBall® Inspection Report

18-Inch Asbestos Concrete & 24-Inch Ductile Iron Pipe

MNS Engineers, Inc. and Goleta West Sanitary District

Version 2.0 – February 2025
(final)

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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:

February 20, 2025

Brian Hext — 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:

February 20, 2025

Carley Williamson — 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:

February 20, 2025

Daniel DeFever, PE — 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:

February 20, 2025

Bryon Boyd — Date
Contractual Reviewer

Confidentiality Clause

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Appendices

Executive Summary

MNS Engineers, Inc. (MNS Engineers) retained the services of Pure Technologies, a Xylem brand (Pure Technologies), to perform two (2) SmartBall® inspections of the 18-Inch Asbestos Concrete Pipe (ACP) line and 24-Inch Ductile Iron Pipe (DIP) line, both owned by Goleta West Sanitary District (GWSD), on December 10, 2024. The scope of the SmartBall inspection included leak detection and gas pocket detection. The SmartBall inspection details and results are presented in Table ES.1.

Table ES.1: SmartBall Inspection Details and Results		
Pipeline Name	18-Inch Asbestos Concrete Pipe	24-Inch Ductile Iron Pipe
Pipe Material:	ACP	DIP
Diameter of Pipe:	18 inches	24 inches
Product:	Wastewater	Wastewater
Inspection Start Location:	24-inch Blind Flange at GWSD Yard (Insertion/TL #1)	24-inch Blind Flange at GWSD Yard (Insertion/TL #1)
Inspection End Location:	Weir Well inside Wastewater Treatment Plant (Extraction/TL#7)	Weir Well inside Wastewater Treatment Plant (Extraction/TL#12)
Total Length Inspected:	9,094 feet	9,107 feet
Duration of the Inspection:	1 hour, 30 minutes	1 hour, 57 minutes
Average SmartBall Velocity:	1.7 feet/second	1.3 feet/second
Total Number of Leaks:	0	0
Total Number of Acoustic Anomalies:	0	1
Total Number of Static Air Pocket/Trapped Gas Events:	1	9
Total Number of Gas Slugs:	4	1
Total Number of Entrained Air Events:	0	2

A summary of results from the SmartBall inspection are presented in Table ES.2 and Table ES.3.

Table ES.2: Summary of Air Events (18-Inch Asbestos Concrete Pipe)			
Acoustic Event Number	**Length [feet]**	**Distance from Insertion (Start of Event) [feet]**	**Distance from Insertion (End of Event) [feet]**
Gas Slug #1	~41	42	83
Gas Slug #2	~9	118	127
Gas Pocket #1	~18	127	145
Gas Slug #3	~40	155	195
Gas Slug #4	28	8,996	9,024

Table ES.3: Summary of Air Events (24-Inch Ductile Iron Pipe)			
Acoustic Event Number	**Length [feet]**	**Distance from Insertion (Start of Event) [feet]**	**Distance from Insertion (End of Event) [feet]**
Gas Pocket #1	~50	717	767
Gas Pocket #2	~13	2,544	2,556
Entrained Air #1	~10	2,620	2,630
Entrained Air #2	~81	2,828	2,909
Gas Pocket #3	~15	2,909	2,925
Gas Pocket #4	~22	2,929	2,951
Gas Pocket #5	~7	3,600	3,607
Gas Pocket #6	~11	4,576	4,587
Gas Pocket #7	~38	7,008	7,045
Gas Pocket #8	~17	8,714	8,731
Gas Slug #1	~250	8,773	9,024
Gas Pocket #9	~23	9,024	9,048

Details and properties of the acoustic events identified in this report can be found in Section 4 and Appendix C.

1. Project Background

The approximate pipeline locations are shown in Figure 1.1 and Figure 1.2. Flow proceeds from Insertion to Extraction. The upstream direction is defined as being toward Insertion, while the downstream direction is defined as being toward Extraction.

Figure 1.1: Aerial View of 18-Inch Asbestos Concrete Pipe

Figure 1.2: Aerial View of 24-Inch Ductile Iron Pipe

2. SmartBall Inspection Details

2.1. Insertion

The SmartBall tool was inserted into the pipelines at a 24-inch Blind Flange at the Goleta West Sanitary District (GWSD) Yard. Figure 2.1 shows the tool being placed into the pipeline for the first inspection. Once placed in the pipe, the flange was then closed and a pump was utilized to propel the tool past the H crossover valve vault.

Figure 2.1: SmartBall Tool Being Placed into 24-inch Blind Flange at GWSD Yard

2.2. Extraction

The SmartBall tool was extracted at the Weir Well inside the Wastewater Treatment Plant. The extraction was completed using a net as seen in Figure 2.2. While the retrieval of the tool for the first run of the SmartBall went to plan, the first attempt to retrieve the tool for the second run with the custom net and a fish net failed. It was then decided to backflow to move the tool back out of the well and reset net and retry. This also failed and it was determined the following day to pump down the well with an external pump and the SmartBall tool was then retrieved.

Figure 2.2: SmartBall Extraction Net Being Placed into Position

2.3. Tracking

Pure Technologies' proprietary tracking devices were used to track the SmartBall inspection tool during the inspections. The tracking devices were connected to sensors attached to the pipeline at Tracking Locations (TL) listed in Table 2.1 and Table 2.2.

Table 2.1: SmartBall Receiver Tracking Locations (18-Inch Asbestos Concrete Pipe)

Tracking Location Number	Distance from Insertion [feet]	Passage Time [hh:mm:ss]	Location Description	GPS Coordinates
TL #1	0	1:21:21 PM	10-inch Gate Valve (Insertion)	34.422670, -119.852101
TL #2	31	Tracking Not Acquired	Vault	34.422699, -119.852198
TL #3	276	1:44:09 PM	Manhole – Exposed Pipe	34.423327, -119.851911
TL #4	7,095	2:36:19 PM	Manhole – Exposed Pipe	34.419845, -119.835720
TL #5	7,767	2:41:18 PM	Manhole – Exposed Pipe	34.421291, -119.835076
TL #6	9,007	2:50:30 PM	Meter Vault – Exposed Pipe	34.422700, -119.832614
TL #7	9,094	2:51:47 PM	Weir Well inside Wastewater Treatment Plant (Extraction)	34.422734, -119.832340

Table 2.2: SmartBall Receiver Tracking Locations (24-Inch Ductile Iron Pipe)				
Tracking Location Number	**Distance from Insertion [feet]**	**Passage Time [hh:mm:ss]**	**Location Description**	**GPS Coordinates**
TL #1	0	10:10:14 AM	10-inch Gate Valve (Insertion)	34.422677, -119.852096
TL #2	27	10:12:44 AM	Vault	34.422703, -119.852180
TL #3	250	10:23:21 AM	Manhole – Exposed Pipe	34.423275, -119.851910
TL #4	902	10:31:34 AM	Exposed Pipe	34.424956, -119.851207
TL #5	3,111	10:58:49 AM	Exposed Pipe	34.425806, -119.845018
TL #6	4,579	11:16:27 AM	Exposed Pipe	34.423041, -119.841537
TL #7	5,284	11:24:56 AM	Exposed Pipe	34.421745, -119.839799
TL #8	7,110	11:46:40 AM	Manhole – Exposed Pipe	34.419825, -119.835711
TL #9	7,805	11:55:07 AM	Manhole – Exposed Pipe	34.421315, -119.835062
TL #10	8,637	Tracking Not Acquired	Excavation – Exposed Pipe	34.422624, -119.833856
TL #11	9,023	12:06:53 PM	Meter Vault – Exposed Pipe	34.422692, -119.832603
TL #12	9,107	12:07:52 PM	Weir Well inside Wastewater Treatment Plant (Extraction)	34.422734, -119.832340

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 MNS Engineers. The Tracking Locations are further detailed in Appendix B.

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 2.3 and 2.4. The slope of the black line indicates the instantaneous velocity of the SmartBall inspection tool.

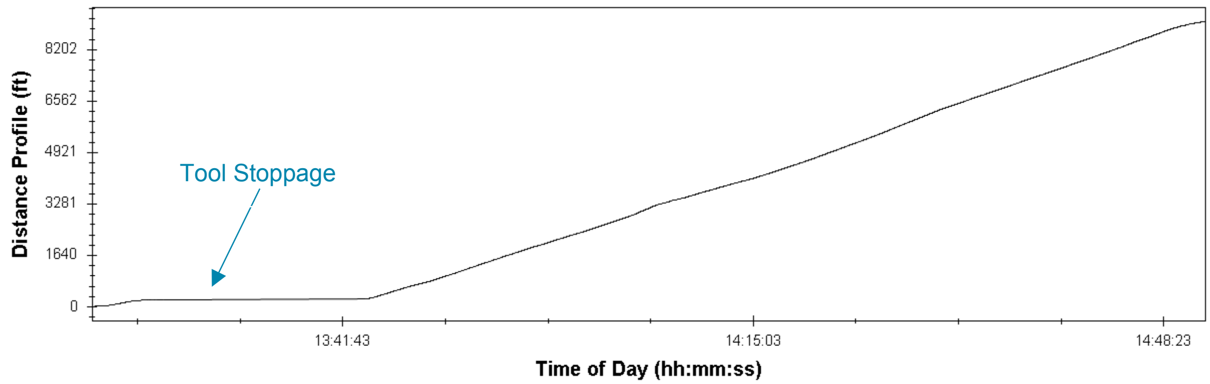


Figure 2.3: Distance traveled by SmartBall tool versus Time of Day during the 18-Inch ACP

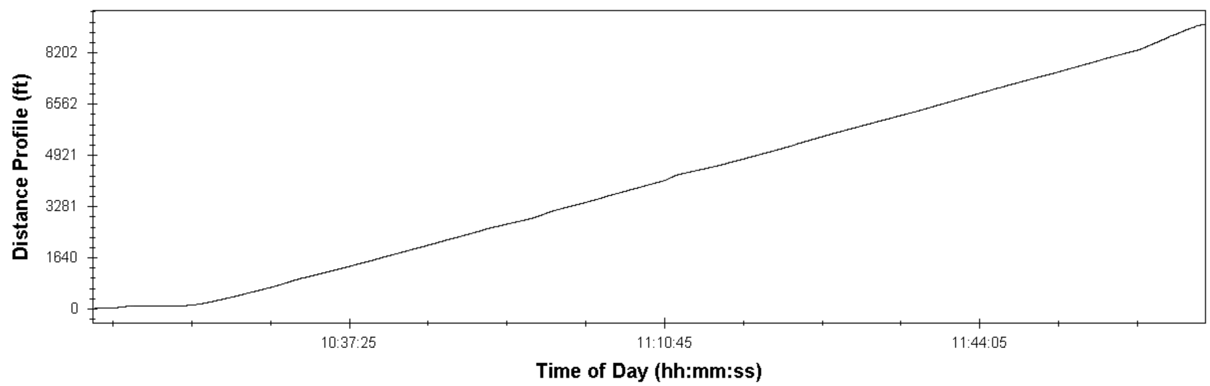


Figure 2.4: Distance traveled by SmartBall tool versus Time of Day during the 24-Inch Ductile Iron Pipe

3. Summary of Acoustic Events

3.1. Acoustic Data Results

The data collected by the SmartBall inspection tool was internally peer reviewed to verify that all acoustic events were detected and accurately classified. There were no acoustic events resembling leaks detected during the inspection.

3.1.1. Acoustic Anomaly

Table 3.1 provides a detailed summary of each acoustic anomaly detected by the SmartBall.

Table 3.1: Summary of Acoustic Anomalies (24-Inch Ductile Iron Pipe)					
Acoustic Anomaly Number	**Time of Tool Pass**	**Nearest Tracking Feature**	**Distance from Nearest Tracking Feature**	**Comments**	**Confidence in Location**
Acoustic Anomaly #1	11:56:30 AM	Manhole – Exposed Pipe	118 feet downstream of Manhole – Exposed Pipe (TL #9)	Acoustic signal suspected external to pipeline, potentially from nearby roadway or airport. No anomaly was detected during the 18-inch ACP in this area.	High

Confidence in Location

- *High – Acoustic event is within tracking data, OR a nearby feature is visible in both the data and field and rolling motion of the inspection tool is consistent.*
- *Medium – Acoustic event is outside the tracking data and either the rolling motion of inspection tool is consistent or a nearby feature is visible in both the data and field.*
- *Low – Acoustic event is outside of tracking data and rolling motion of the tool is inconsistent OR discrepancies in pipeline alignment between SmartBall data and client supplied information.*

3.1.2. Air Events

Table 3.2 and Table 3.3 provides a detailed summary of the gas pocket and migratory acoustic events detected during the inspection by the SmartBall technology. It is important to note that the presence and capacity of events detected during the inspection may change under varying operating conditions.

Table 3.2: Summary of Air Events (18-Inch Asbestos Concrete Pipe)

Gas Pocket, Gas Slug, Entrained Air	Length [feet]	Distance from Insertion (Start of Pocket) [feet]	Distance from Insertion (End of Pocket) [feet]	Nearest Tracking Feature	Distance from Nearest Tracking Feature	Confidence in Location
Gas Slug #1	~41	42	83	10-inch Gate Valve (Insertion)	41 feet downstream of 10-inch Gate Valve (Insertion/TL #1)	Medium
Gas Slug #2	~9	118	127	10-inch Gate Valve (Insertion)	118 feet downstream of 10-inch Gate Valve (Insertion/TL #1)	Medium
Gas Pocket #1	~18	127	145	10-inch Gate Valve (Insertion)	127 feet downstream of 10-inch Gate Valve (Insertion/TL #1)	Medium
Gas Slug #3	~40	155	195	Manhole – Exposed Pipe	121 feet upstream of Manhole – Exposed Pipe (TL #3)	Medium
Gas Slug #4	28	8,996	9,024	Meter Vault – Exposed Pipe	11 feet upstream of Meter Vault – Exposed Pipe (TL #6)	Medium

Table 3.3: Summary of Air Events (24-Inch Ductile Iron Pipe)

Gas Pocket, Gas Slug, Entrained Air	Length [feet]	Distance from Insertion (Start of Pocket) [feet]	Distance from Insertion (End of Pocket) [feet]	Nearest Tracking Feature	Distance from Nearest Tracking Feature	Confidence in Location
Gas Pocket #1	~50	717	767	Exposed Pipe	185 feet upstream of Exposed Pipe (TL#4)	Medium
Gas Pocket #2	~13	2,544	2,556	Exposed Pipe	567 feet upstream of Exposed Pipe (TL#5)	Medium
Entrained Air #1	~10	2,620	2,630	Exposed Pipe	491 feet upstream of Exposed Pipe (TL#5)	Medium
Entrained Air #2	~81	2,828	2,909	Exposed Pipe	282 feet upstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #3	~15	2,909	2,925	Exposed Pipe	201 feet upstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #4	~22	2,929	2,951	Exposed Pipe	182 feet upstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #5	~7	3,600	3,607	Exposed Pipe	489 feet downstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #6	~11	4,576	4,587	Exposed Pipe	3 feet upstream of Exposed Pipe (TL #6)	Medium
Gas Pocket #7	~38	7,008	7,045	Manhole - Exposed Pipe	103 feet upstream of Manhole - Exposed Pipe (TL #8)	Medium

Table 3.3: Summary of Air Events (24-Inch Ductile Iron Pipe)

Gas Pocket, Gas Slug, Entrained Air	Length [feet]	Distance from Insertion (Start of Pocket) [feet]	Distance from Insertion (End of Pocket) [feet]	Nearest Tracking Feature	Distance from Nearest Tracking Feature	Confidence in Location
Gas Pocket #8	~17	8,714	8,731	Meter Vault – Exposed Pipe	310 feet upstream of Meter Vault – Exposed Pipe (TL #11)	Medium
Gas Slug #1	~250	8,773	9,024	Meter Vault – Exposed Pipe	250 feet upstream of Meter Vault – Exposed Pipe (TL #11)	Medium
Gas Pocket #9	~23	9,024	9,048	Meter Vault – Exposed Pipe	1 foot downstream of Meter Vault – Exposed Pipe (TL #11)	Medium

Confidence in Location

- *High – Acoustic event is within tracking data, OR a nearby feature is visible in both the data and field and rolling motion of the inspection tool is consistent.*
- *Medium – Acoustic event is outside the tracking data and either the rolling motion of inspection tool is consistent or a nearby feature is visible in both the data and field.*
- *Low – Acoustic event is outside of tracking data and rolling motion of the tool is inconsistent OR discrepancies in pipeline alignment between SmartBall data and client supplied information.*

3.2. Aerial View of Events

Figure 3.1 and Figure 3.2 show an aerial overview of the inspection results.

Figure 3.1: Aerial View of 18-Inch Asbestos Concrete Pipe with Location of Results

Figure 3.2: Aerial View of 24-Inch Ductile Iron Pipe with Location of Results

4. Conclusions

Based on analysis of the data recorded during the SmartBall inspections, Pure Technologies concludes the following:

- There were no acoustic events resembling leaks detected during the inspections.
- There was one (1) acoustic anomaly identified on the 24-inch DIP. Based on the acoustic signal, this anomaly is suspected to be external to the pipeline, potentially from the nearby roadway or airport. No anomaly was detected during the 18-inch ACP inspection in this area.
- Several gas pockets, gas slugs, and entrained air events were detected throughout both pipelines. While the presence and capacity of entrained air and gas slugs detected during the inspection may change under varying operating conditions, note that these events and static gas pockets can contribute to the formation of Hydrogen Sulfide gas (H_2S), which is the number one cause of failure in Force Mains. It is recommended that the locations of the static gas pockets be reviewed, and all associated air release valves are checked to ensure proper functionality.
  - See Appendix C, Section C.2.2 for more details on acoustic events representing entrained air, gas slugs, and fully developed air pockets.

APPENDIX A

Acoustic Event Details

Details of acoustic events of interest detected during the SmartBall inspection 18-Inch Asbestos Concrete Pipe are provided below.

Site of Interest #1 – Gas Slug #1 (18-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	41 feet downstream of 10-inch Gate Valve (Insertion/TL #1)
Time Since Insertion (Start of Event):	00:01:35
Time Since Insertion (End of Event):	00:02:15
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	01:22:57 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	01:23:36 PM

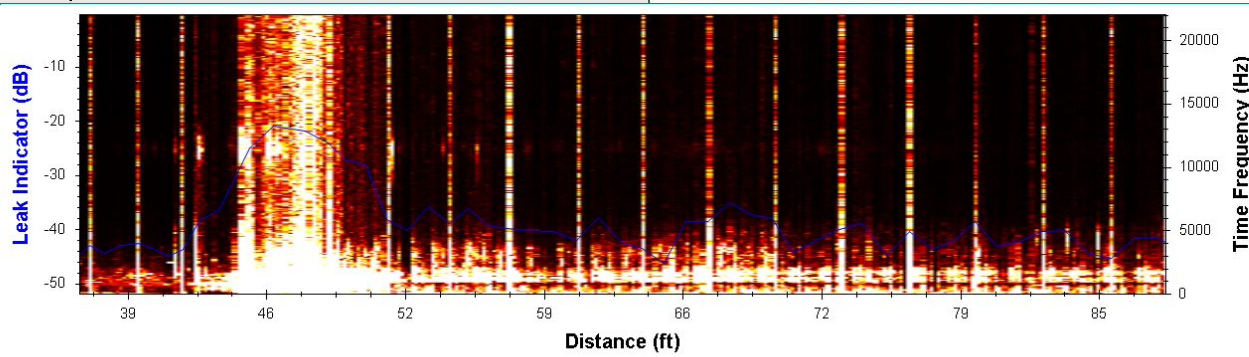


Figure A.1: Acoustic Intensity of Event

Site of Interest #2 – Gas Slug #2 (18-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	118 feet downstream of 10-inch Gate Valve (Insertion/TL #1)
Time Since Insertion (Start of Event):	00:02:48
Time Since Insertion (End of Event):	00:02:56
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	01:24:09 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	01:24:17 PM

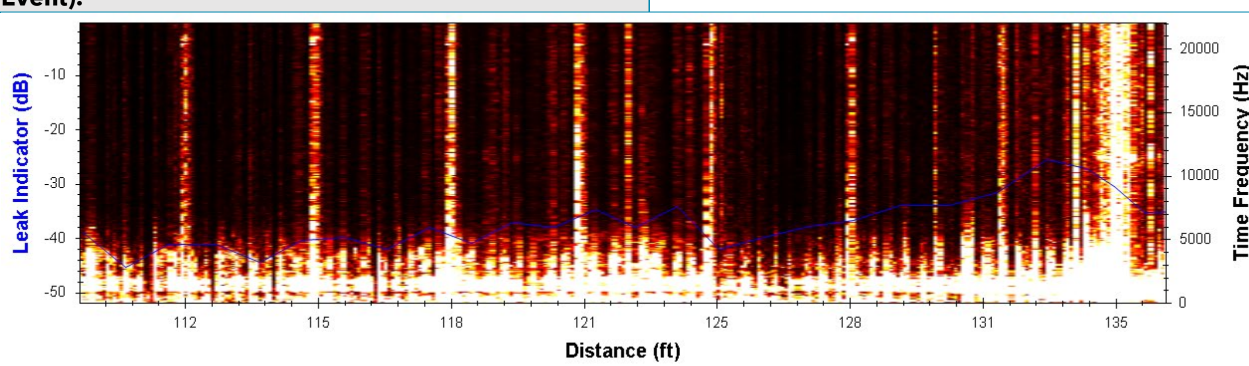


Figure A.2: Acoustic Intensity of Event

Site of Interest #3 - Gas Pocket #1 (18-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	127 feet downstream of 10-inch Gate Valve (Insertion/TL #1)
Time Since Insertion (Start of Event):	00:02:56
Time Since Insertion (End of Event):	00:03:14
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	01:24:18 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	01:24:35 PM

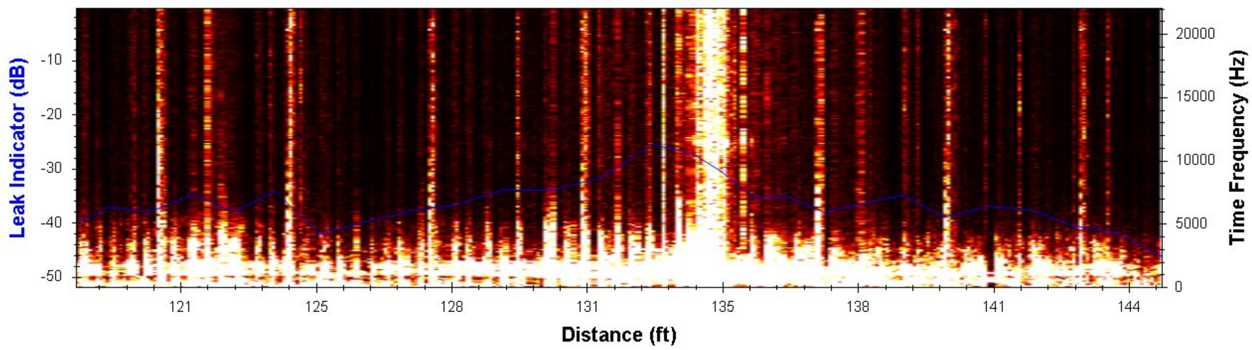


Figure A.3: Acoustic Intensity of Event

Site of Interest #4 – Gas Slug #3 (18-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	121 feet upstream of Manhole – Exposed Pipe (TL #3)
Time Since Insertion (Start of Event):	00:03:27
Time Since Insertion (End of Event):	00:05:18
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	01:24:48 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	01:26:39 PM

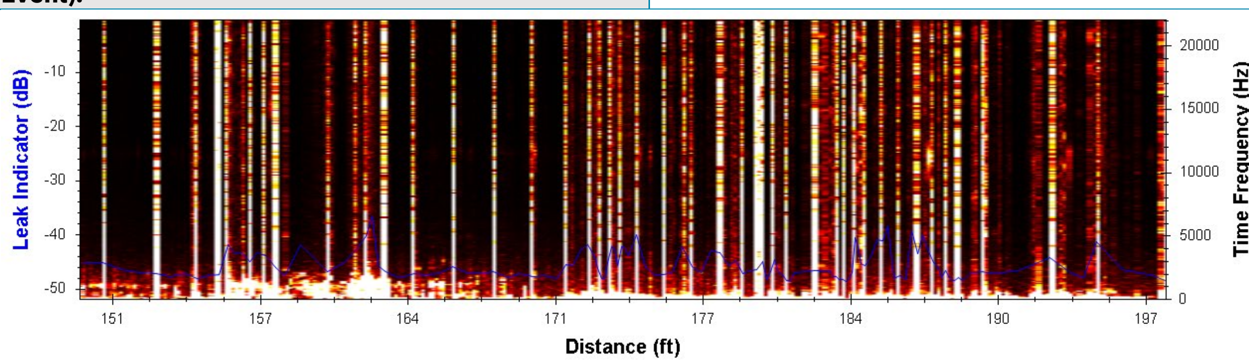


Figure A.4: Acoustic Intensity of Event

Site of Interest #5 – Gas Slug #4 (18-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	11 feet upstream of Meter Vault – Exposed Pipe (TL#6)
Time Since Insertion (Start of Event):	01:29:02
Time Since Insertion (End of Event):	01:29:24
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	02:50:24 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	02:50:45 PM

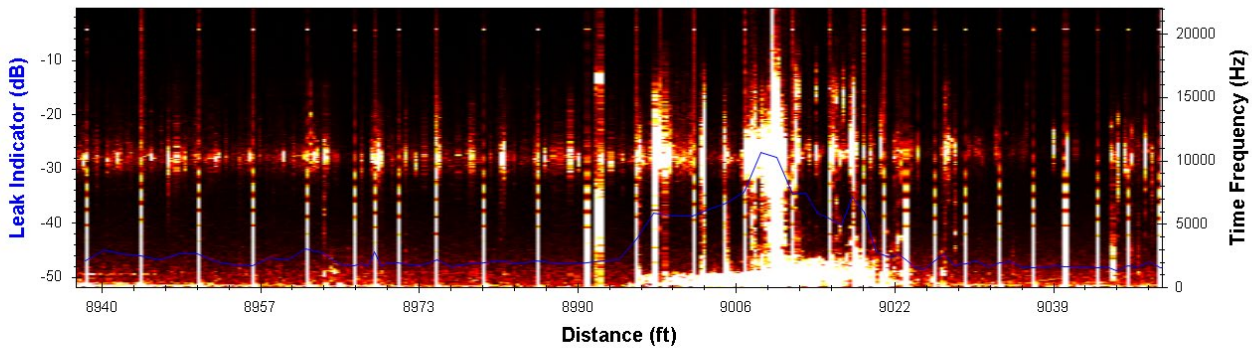


Figure A.5: Acoustic Intensity of Event

Details of acoustic events of interest detected during the SmartBall inspection 24-Inch Ductile Iron Pipe are provided below.

Site of Interest #1 - Gas Pocket #1 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	185 feet upstream of Exposed Pipe (TL#4)
Time Since Insertion (Start of Event):	00:19:22
Time Since Insertion (End of Event):	00:19:56
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:29:37 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:30:11 AM

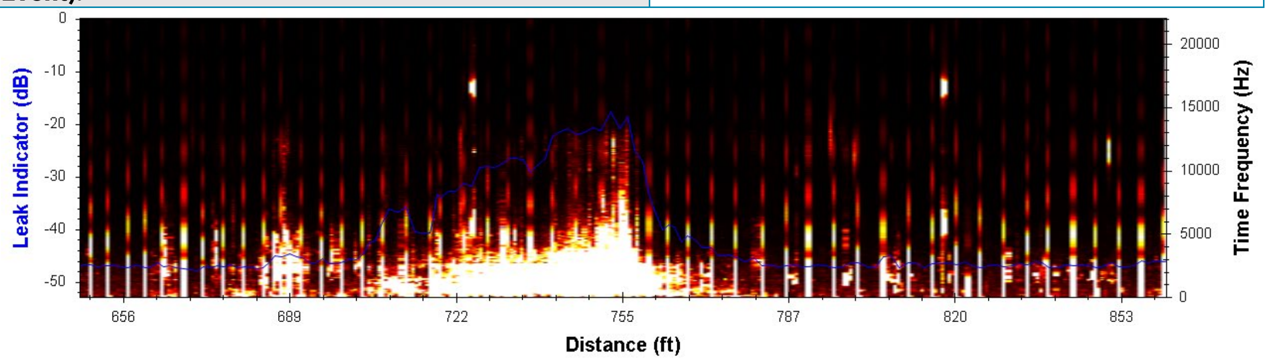


Figure A.6: Acoustic Intensity of Event

Site of Interest #2 - Gas Pocket #2 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	567 feet upstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:41:39
Time Since Insertion (End of Event):	00:41:48
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:51:54 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:52:03 AM

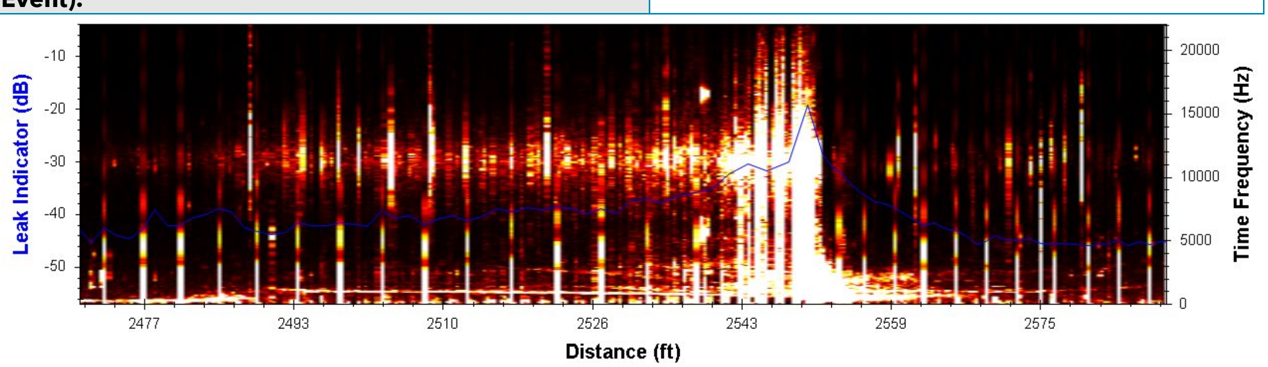


Figure A.7: Acoustic Intensity of Event

Site of Interest #3 - Entrained Air #1 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	491 feet upstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:42:40
Time Since Insertion (End of Event):	00:42:49
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:52:55 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:53:04 AM

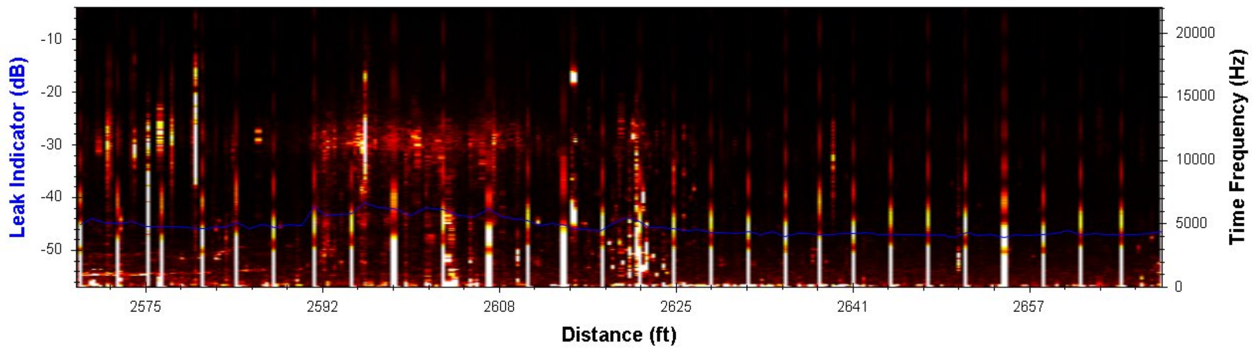


Figure A.8: Acoustic Intensity of Event

Site of Interest #4 - Entrained Air #2 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	282 feet upstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:45:37
Time Since Insertion (End of Event):	00:46:41
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:55:52 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:56:56 AM

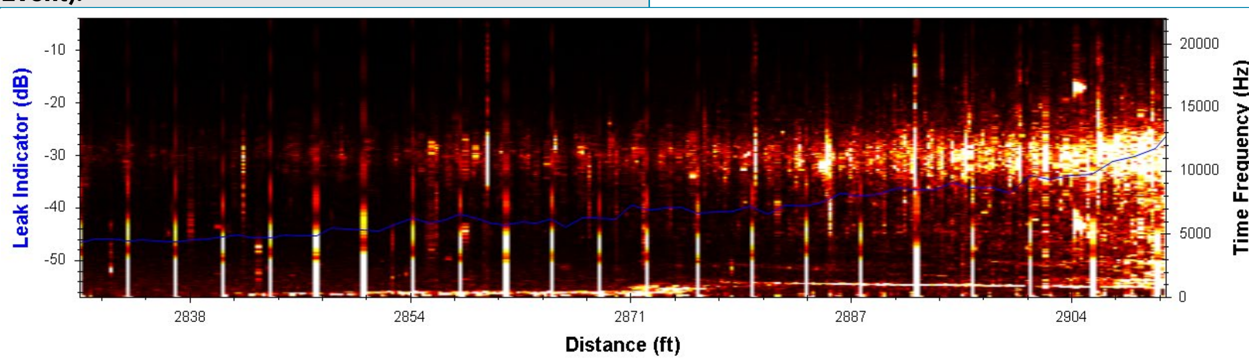


Figure A.9: Acoustic Intensity of Event

Site of Interest #5 - Gas Pocket #3 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	201 feet upstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:46:41
Time Since Insertion (End of Event):	00:46:53
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:56:56 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:57:08 AM

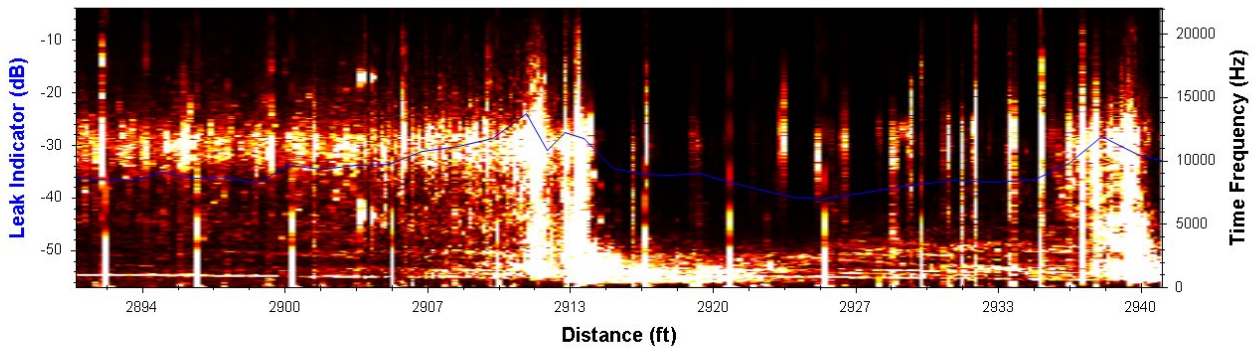


Figure A.10: Acoustic Intensity of Event

Site of Interest #6 - Gas Pocket #4 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	182 feet upstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:46:56
Time Since Insertion (End of Event):	00:47:10
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:57:11 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:57:25 AM

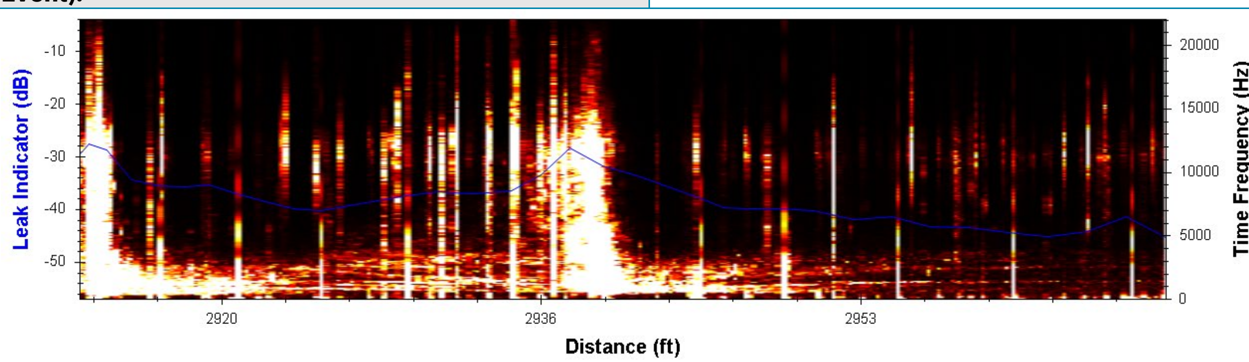


Figure A.11: Acoustic Intensity of Event

Site of Interest #7 - Gas Pocket #5 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	489 feet downstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:54:27
Time Since Insertion (End of Event):	00:54:34
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	11:04:42 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	11:04:49 AM

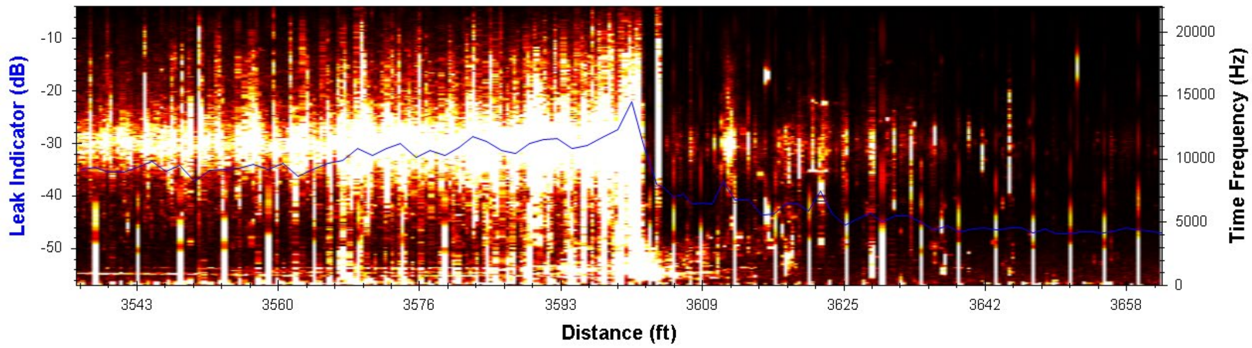


Figure A.12: Acoustic Intensity of Event

Site of Interest #8 - Gas Pocket #6 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	3 feet upstream of Exposed Pipe (TL #6)
Time Since Insertion (Start of Event):	01:06:10
Time Since Insertion (End of Event):	01:06:19
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	11:16:25 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	11:16:34 AM

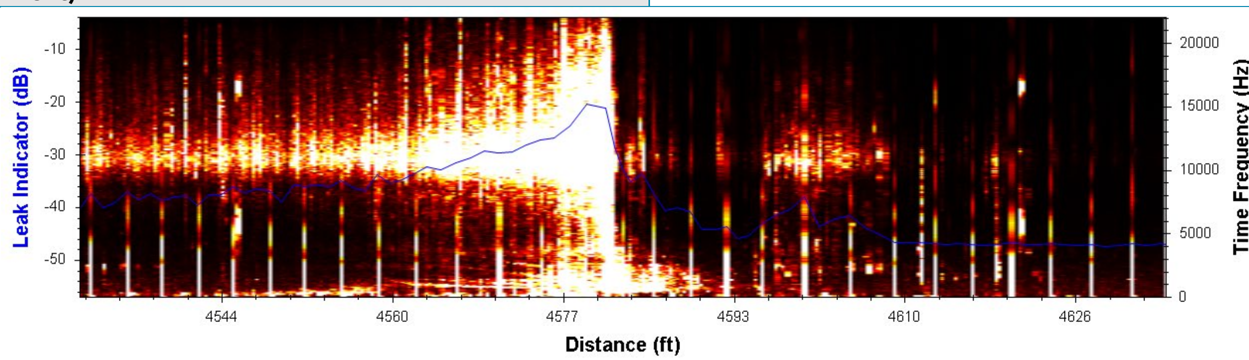


Figure A.13: Acoustic Intensity of Event

Site of Interest #9 - Gas Pocket #7 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	103 feet upstream of Manhole - Exposed Pipe (TL #8)
Time Since Insertion (Start of Event):	01:35:10
Time Since Insertion (End of Event):	01:35:35
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	11:45:25 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	11:45:50 AM

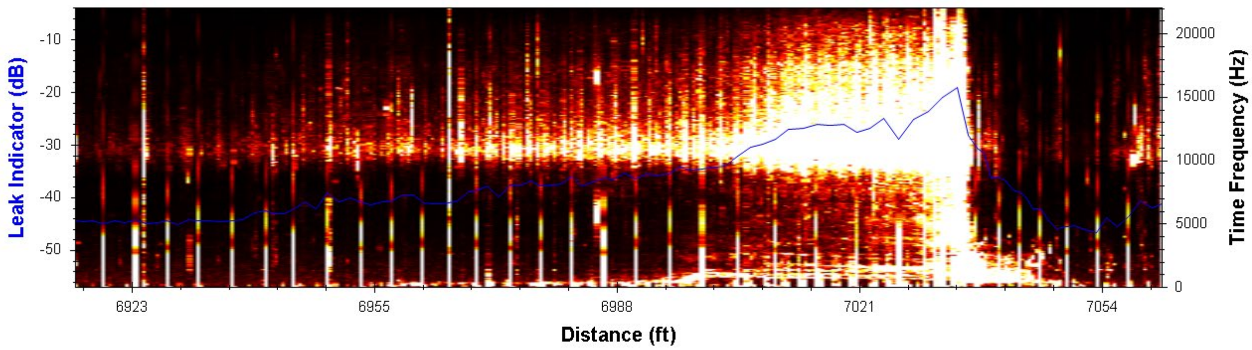


Figure A.14: Acoustic Intensity of Event

Site of Interest #10 - Acoustic Anomaly #1 (24-Inch)	
Distance to Nearest Tracking Feature:	118 feet downstream of Manhole – Exposed Pipe (TL #9)
Confidence in Location:	Medium
Time Since Insertion:	01:46:15
Time of SmartBall Tool Pass (GMT-8:00):	11:56:30 AM

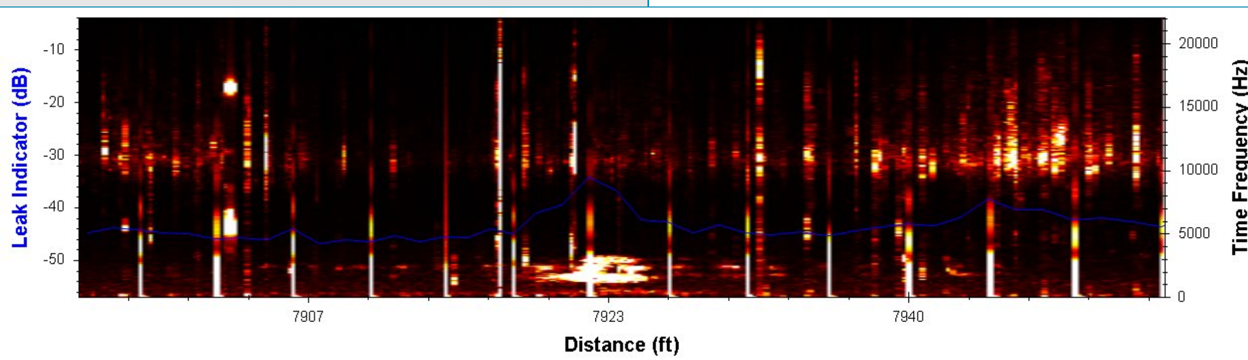


Figure A.15: Acoustic Intensity of Event

Site of Interest #11 - Gas Pocket #8 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	310 feet upstream of Meter Vault – Exposed Pipe (TL#11)
Time Since Insertion (Start of Event):	01:53:56
Time Since Insertion (End of Event):	01:54:06
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	12:04:11 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	12:04:21 PM

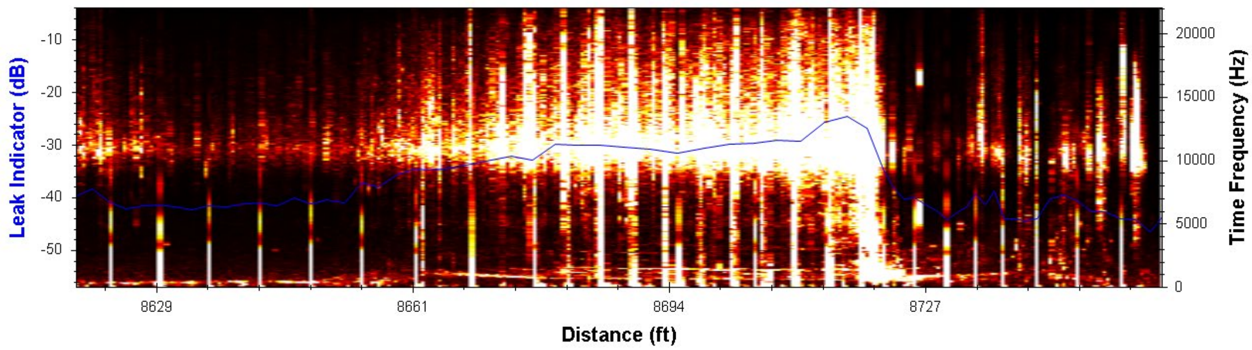


Figure A.16: Acoustic Intensity of Event

Site of Interest #12 – Gas Slug #1 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	250 feet upstream of Meter Vault – Exposed Pipe (TL #11)
Time Since Insertion (Start of Event):	01:54:33
Time Since Insertion (End of Event):	01:56:38
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	12:04:48 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	12:06:53 PM

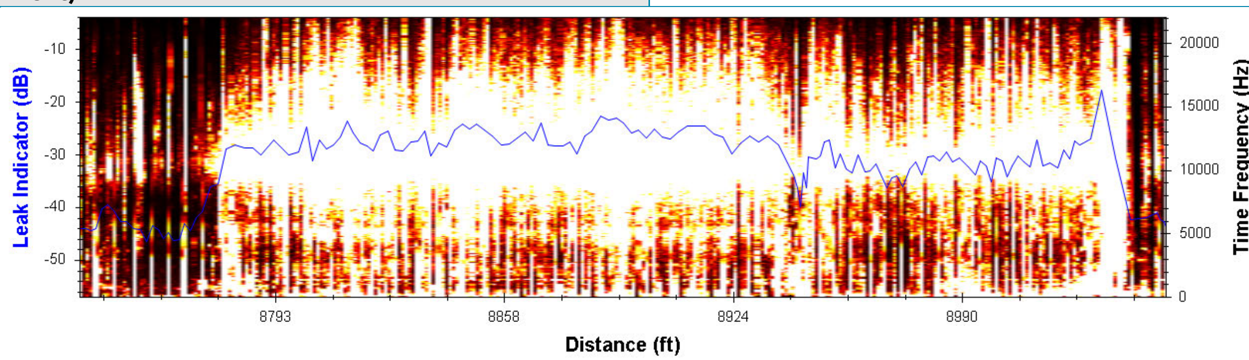


Figure A.17: Acoustic Intensity of Event

Site of Interest #13 - Gas Pocket #9 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	1 foot downstream of Meter Vault – Exposed Pipe (TL#11)
Time Since Insertion (Start of Event):	01:56:38
Time Since Insertion (End of Event):	01:56:46
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	12:06:53 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	12:07:01 PM

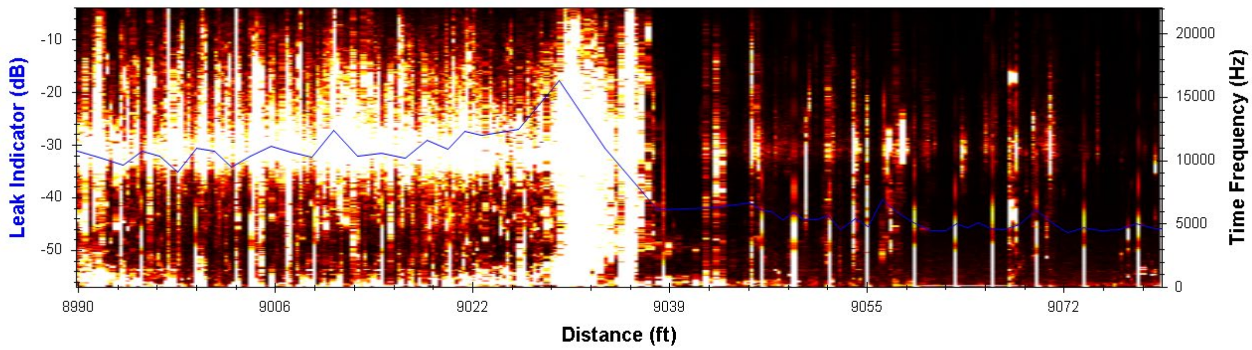


Figure A.18: Acoustic Intensity of Event

APPENDIX B

SmartBall® Tracking

Table B.1: SmartBall Receiver Tracking Locations (18-Inch Asbestos Concrete Pipe)

Tracking Location Number	Distance from Insertion [feet]	Passage Time [hh:mm:ss]	Location Description	GPS Coordinates
TL #1	0	1:21:21 PM	10-inch Gate Valve (Insertion)	34.422670, -119.852101
TL #2	31	Tracking Not Acquired	Vault	34.422699, -119.852198
TL #3	276	1:44:09 PM	Manhole – Exposed Pipe	34.423327, -119.851911
TL #4	7,095	2:36:19 PM	Manhole – Exposed Pipe	34.419845, -119.835720
TL #5	7,767	2:41:18 PM	Manhole – Exposed Pipe	34.421291, -119.835076
TL #6	9,007	2:50:30 PM	Meter Vault – Exposed Pipe	34.422700, -119.832614
TL #7	9,094	2:51:47 PM	Weir Well inside Wastewater Treatment Plant (Extraction)	34.422734, -119.832340

Table B.2: SmartBall Receiver Tracking Locations (24-Inch Ductile Iron Pipe)

Tracking Location Number	Distance from Insertion [feet]	Passage Time [hh:mm:ss]	Location Description	GPS Coordinates
TL #1	0	10:10:14 AM	10-inch Gate Valve (Insertion)	34.422677, -119.852096
TL #2	27	10:12:44 AM	Vault	34.422703, -119.852180
TL #3	250	10:23:21 AM	Manhole – Exposed Pipe	34.423275, -119.851910
TL #4	902	10:31:34 AM	Exposed Pipe	34.424956, -119.851207
TL #5	3,111	10:58:49 AM	Exposed Pipe	34.425806, -119.845018
TL #6	4,579	11:16:27 AM	Exposed Pipe	34.423041, -119.841537
TL #7	5,284	11:24:56 AM	Exposed Pipe	34.421745, -119.839799
TL #8	7,110	11:46:40 AM	Manhole – Exposed Pipe	34.419825, -119.835711

Tracking Location Number	Distance from Insertion [feet]	Passage Time [hh:mm:ss]	Location Description	GPS Coordinates
TL #9	7,805	11:55:07 AM	Manhole – Exposed Pipe	34.421315, -119.835062
TL #10	8,637	Tracking Not Acquired	Excavation – Exposed Pipe	34.422624, -119.833856
TL #11	9,023	12:06:53 PM	Meter Vault – Exposed Pipe	34.422692, -119.832603
TL #12	9,107	12:07:52 PM	Weir Well inside Wastewater Treatment Plant (Extraction)	34.422734, -119.832340

Table B.2: SmartBall Receiver Tracking Locations (24-Inch Ductile Iron Pipe)

Figure B.1 and B.2 show data collected by the TLs, indicating the relative position of the SmartBall tool to each tracking location. Data obtained from each TL is represented by a single color.

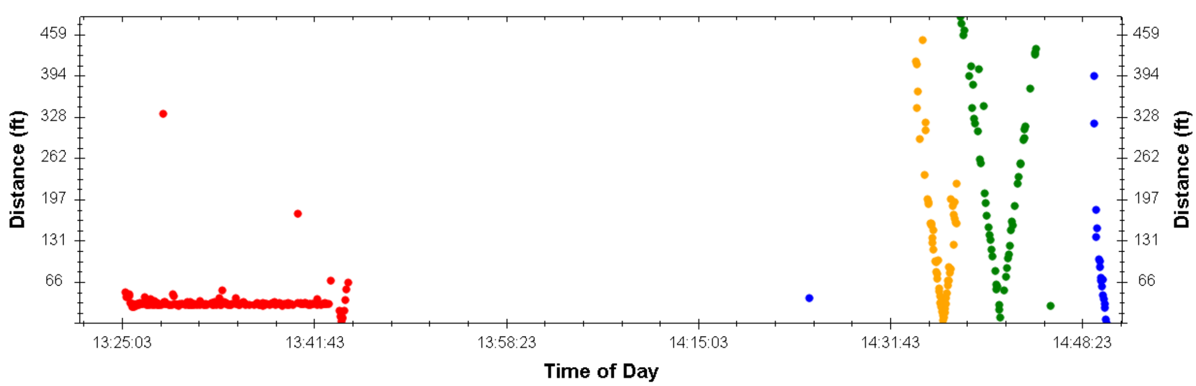


Figure B.1: Tracking Location Positional Data for the 18-Inch Asbestos Concrete Pipe Force Main

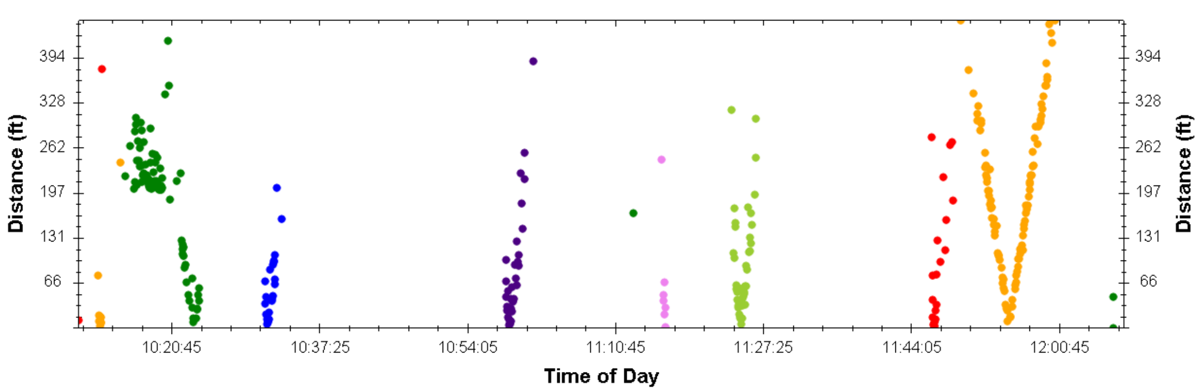


Figure B.2: Tracking Location Positional Data for the 24-Inch Ductile Iron Pipe Force Main

Figure B.3: Aerial View of 18-Inch Asbestos Concrete Pipe with Tracking Locations

Figure B.4: Aerial View of 24-Inch Ductile Iron Pipe with Tracking Locations

Each tracking location for 18-Inch Asbestos Concrete Pipe is further detailed in the tables below.

TL #1		
Distance from Insertion:	0 feet	
Location Description:	10-inch Gate Valve (Insertion)	
Passage Time [hh:mm:ss]:	1:21:21 PM	
Latitude, Longitude:	34.422670, -119.852101	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #2		
Distance from Insertion:	31 feet	
Location Description:	Vault	
Passage Time [hh:mm:ss]:	Tracking Not Acquired	
Latitude, Longitude:	34.422699, -119.852198	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #3		
Distance from Insertion:	276 feet	
Location Description:	Manhole – Exposed Pipe	
Passage Time [hh:mm:ss]:	1:44:09 PM	
Latitude, Longitude:	34.423327, -119.851911	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

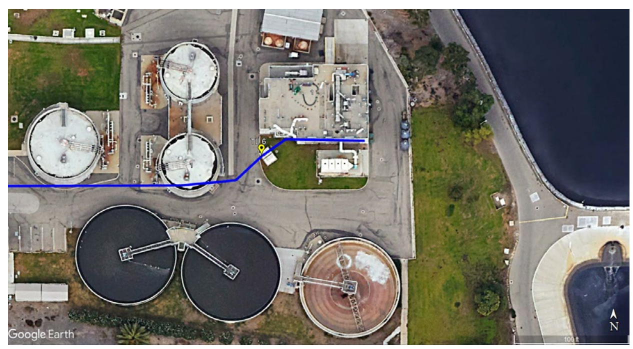
TL #4		
Distance from Insertion:	7,095 feet	
Location Description:	Manhole – Exposed Pipe	
Passage Time [hh:mm:ss]:	2:36:19 PM	
Latitude, Longitude:	34.419845, -119.835720	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

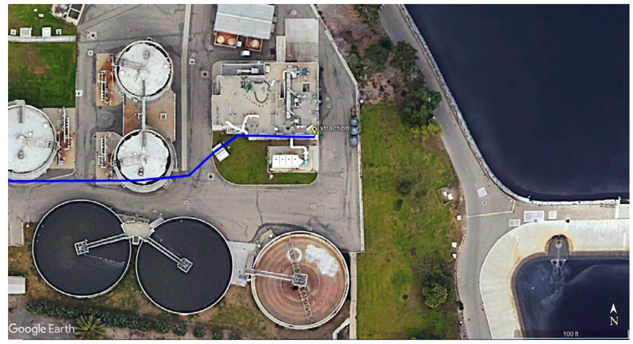
TL #5	
Distance from Insertion:	7,767 feet
Location Description:	Manhole – Exposed Pipe
Passage Time [hh:mm:ss]:	2:41:18 PM
Latitude, Longitude:	34.421291, -119.835076

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #6	
Distance from Insertion:	9,007 feet
Location Description:	Meter Vault – Exposed Pipe
Passage Time [hh:mm:ss]:	2:50:30 PM
Latitude, Longitude:	34.422700, -119.832614



*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

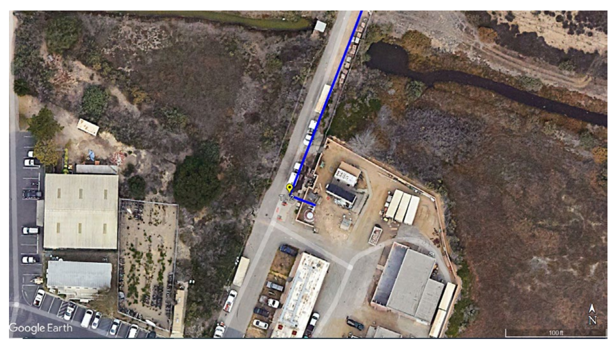
<table>
<tr><th colspan="3">TL #7</th></tr>
<tr><td>Distance from Insertion:</td><td>9,094 feet</td><td rowspan="4">
</td></tr>
<tr><td>Location Description:</td><td>Weir Well inside Wastewater Treatment Plant (Extraction)</td></tr>
<tr><td>Passage Time [hh:mm:ss]:</td><td>2:51:47 PM</td></tr>
<tr><td>Latitude, Longitude:</td><td>34.422734, -119.832340</td></tr>
</table>

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

Each tracking location for 24-Inch Ductile Iron Pipe Force Main is further detailed in the tables below.

TL #1		
Distance from Insertion:	0 feet	
Location Description:	10-inch Gate Valve (Insertion)	
Passage Time [hh:mm:ss]:	10:10:14 AM	
Latitude, Longitude:	34.422677, -119.852096	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #2		
Distance from Insertion:	27 feet	
Location Description:	Vault	
Passage Time [hh:mm:ss]:	10:12:44 AM	
Latitude, Longitude:	34.422703, -119.852180	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

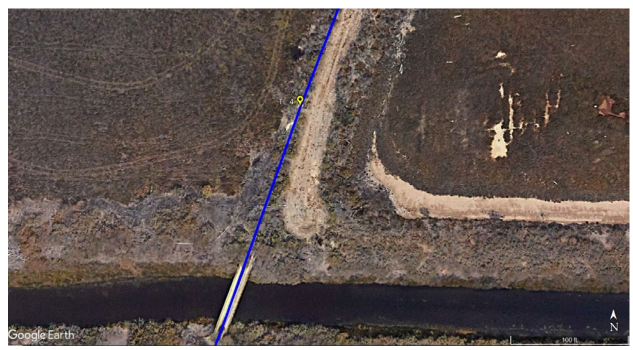
TL #3

Distance from Insertion:	250 feet
Location Description:	Manhole – Exposed Pipe
Passage Time [hh:mm:ss]:	10:23:21 AM
Latitude, Longitude:	34.423275, -119.851910

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #4

Distance from Insertion:	902 feet
Location Description:	Exposed Pipe
Passage Time [hh:mm:ss]:	10:31:34 AM
Latitude, Longitude:	34.424956, -119.851207



*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #5

Distance from Insertion:	3,111 feet
Location Description:	Exposed Pipe
Passage Time [hh:mm:ss]:	10:58:49 AM
Latitude, Longitude:	34.425806, -119.845018

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #6

Distance from Insertion:	4,579 feet	
Location Description:	Exposed Pipe	
Passage Time [hh:mm:ss]:	11:16:27 AM	
Latitude, Longitude:	34.423041, -119.841537	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #7

Distance from Insertion:	5,284 feet	
Location Description:	Exposed Pipe	
Passage Time [hh:mm:ss]:	11:24:56 AM	
Latitude, Longitude:	34.421745, -119.839799	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #8

Distance from Insertion:	7,110 feet	
Location Description:	Manhole – Exposed Pipe	
Passage Time [hh:mm:ss]:	11:46:40 AM	
Latitude, Longitude:	34.419825, -119.835711	

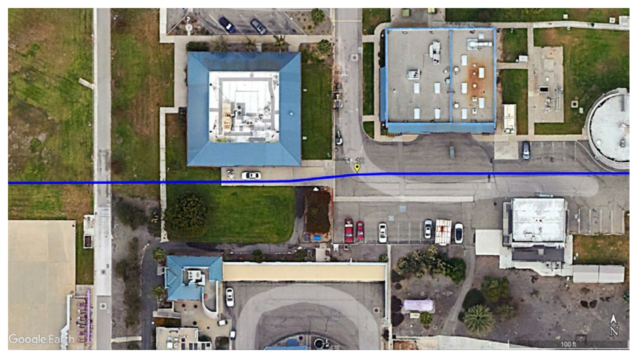
*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #9

Distance from Insertion:	7,805 feet	
Location Description:	Manhole – Exposed Pipe	
Passage Time [hh:mm:ss]:	11:55:07 AM	
Latitude, Longitude:	34.421315, -119.835062	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

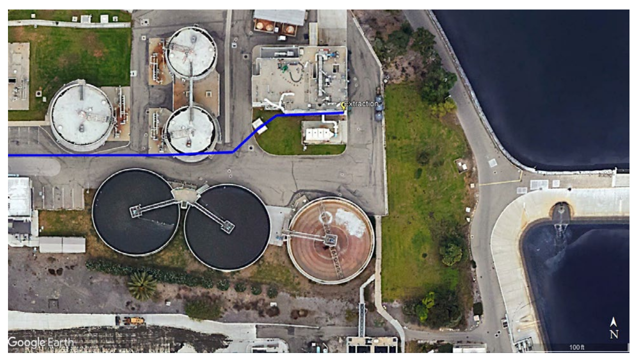
TL #10

Distance from Insertion:	8,637 feet	
Location Description:	Excavation – Exposed Pipe	
Passage Time [hh:mm:ss]:	12:06:53 PM	
Latitude, Longitude:	34.422624, -119.833856	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #11		
Distance from Insertion:	9,023 feet	
Location Description:	Meter Vault – Exposed Pipe	
Passage Time [hh:mm:ss]:	12:06:53 PM	
Latitude, Longitude:	34.422692, -119.832603	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #12		
Distance from Insertion:	9,107 feet	
Location Description:	Weir Well inside Wastewater Treatment Plant (Extraction)	
Passage Time [hh:mm:ss]:	12:07:52 PM	
Latitude, Longitude:	34.422734, -119.832340	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

APPENDIX C

SmartBall® Methodology

C.1 Overview

The SmartBall inspection platform is a free-swimming acoustic-based non-destructive inline inspection technology that detects acoustic activity associated with leaks and pockets of trapped air and utilizes the latest accelerometer and gyroscope technologies combined with advanced location algorithms to map pressurized pipelines. The SmartBall tool is comprised of a water-tight aluminum alloy core containing a power source, electronic components, and instrumentation that includes an acoustic sensor, tri-axial accelerometer, tri-axial magnetometer, GPS synchronized ultrasonic transmitter, strain gauge, and temperature sensor. A protective outer foam shell encapsulates the aluminum core and provides a larger surface area by which the device is propelled by the hydraulic flow of the fluid in the pipeline. The foam shell also reduces the ambient noise from the rolling action, resulting in a silent background. The SmartBall tool is deployed into the live flow of a pipeline, traverses the pipeline while recording data, and is captured and extracted at a point downstream. During the inspection, the location of the SmartBall is tracked at known points along the alignment to correlate inspection data with specific locations.

Figure C.1: Synchronizing a SmartBall Core with a SmartBall Tracking Device

C.2 Identifying Leaks and Air or Gas Pockets

Inline leak detection technology is inherently more sensitive than external methods and correlators because it brings the acoustic sensor within one pipe diameter of the leak. Acoustic leak detection functions by detecting the acoustic signature generated by the sudden drop in pressure of water exiting the pipeline at the site of a leak. SmartBall technology requires a minimum pressure differential between internal and external pipeline conditions of 15 psi (1 bar) for acoustic leak detection. On pipelines with known leaks the SmartBall technology requires operating pressure higher than failed pressure tests.

For pipelines in high water tables or river crossings, the resultant hydrostatic head acting against the exterior of the pipe wall must be taken into consideration. Additional factors affecting acoustic leak detection include scenarios such as tunnels, slip lining, and encasements. In these situations, the acoustic signature generated by a leak may not occur directly at the leak site inside the pipeline. Instead, it could manifest at the point where the fluid exits the tunnel, slip lining, or encasement if the 'leak path' becomes pressurized between the pipe wall and these structures. Furthermore, the audible sound of a leak and the effectiveness of acoustic detection can vary depending on the leak's volume and shape.

Understanding how pipelines leak can be a valuable skill when heading out to locate a leak point on a pipeline. By understanding the cause of leaks, one can limit the amount of excavating required to locate a given leak.

Cast/Ductile Iron Pipe

Cast and Ductile iron pipes mostly consist of bell and spigot type connections. Many leaks found on this type of pipeline will be located at a joint which can be caused by improper gasket installation or soil shift. In addition, to joint leaks cast and ductile iron pipes can also leak from cracks and/or through hole penetrations in the pipe barrel. The cause for these defects can be wide ranging. These types of defects will not immediately affect the pipeline itself but should be viewed as more serious than a joint leak as the structural integrity of the given pipe section has already been compromised. Barrel leaks should be addressed as soon as possible, and Pure will generally be able to identify whether a leak is on the joint or barrel of a pipe section for these types of pipes.

Steel Pipe

Steel pipelines are typically welded together to form a long continuous pipe with few gasket joints. Leaks on this type of pipeline can occur at joints or along the barrel both by way of cracking and through hole penetrations.

Plastic and Other Pipe Materials

Typical plastic pipe types include Polyvinyl Chloride (PVC) and High-density polyethylene (HDPE). Some other pipe types may include Glass Reinforced Pipe (GRP) that act and fail in similar ways to plastic pipes.

Generally speaking, leaks on these types of pipes will occur at the joints between two pipe sections. Usually this can be attributed to improper installation of the joint gasket or ground shifting leading to misalignment at the joint. A leak normally will not be located on the barrel of a plastic pipe as a simple crack or through hole penetration would likely cause the line to completely fail rather than just leak.

Knowing that more leaks occur at joints, one can focus efforts on joints of the line, rather than digging linearly upstream or downstream when trying to locate a leak.

Concrete/Prestressed Pipe

Concrete Pressure pipe is always constructed from bell and spigot type pipe sections. Like other bell and spigot style pipe, these pipe types will generally leak from faulty or misaligned joints. Other forms of failure such as cracking or through hole penetration have been the cause of leaks, but they are less common.

On some classes of concrete pressure pipe, Pure will be able to identify if a leak is on the joint or the barrel of a pipe section. If a leak were located in the barrel of a concrete pressure pipe, its verification would be critical, as it is most likely a form of severe structural degradation.

C.2.1 Acoustic Events Representing Leaks

A leak inside a pressurized pipeline produces a specific acoustic signal. This acoustic signal is created when the pressurized water inside the pipeline escapes into the lower pressure environment outside the pipe. While the SmartBall tool traverses the pipeline, it continuously records all acoustic data in the pipeline, which is evaluated later to identify acoustic activity that may be associated with leaks along the pipeline. As the SmartBall tool rolls along the bottom of the pipeline, it will always pass within one (1) pipe diameter of a leak or pocket of trapped air or gas.

As the SmartBall tool approaches a leak, the acoustic signal detected by the SmartBall technology will increase. The acoustic signal will increase as the tool approaches the leak, peak at the point at which the SmartBall tool passes the point of the leak, and then diminish as the SmartBall tool continues away from the leak. This phenomenon is clearly evident in Figure C.2.

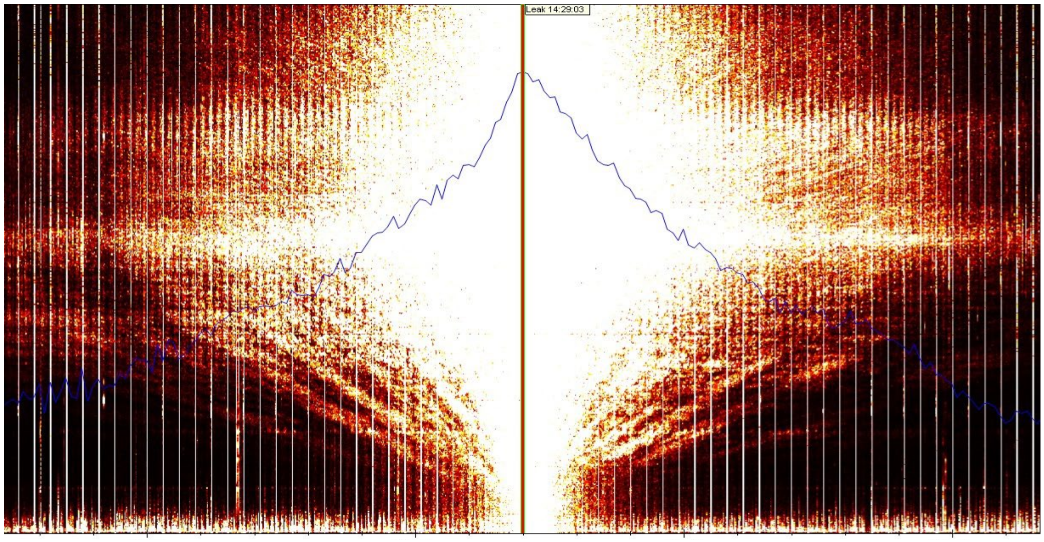


Figure C.2: Detected Leak, as shown in the SmartBall Analysis Software

In addition to detecting potential leaks and pockets of trapped air or gas, acoustic events are further evaluated and classified as being small, medium, or large based of the acoustic profile frequencies of each leak.

The characteristics typical of a true leak as detected by the SmartBall technology include:

- The range of frequencies present increases as the tool approaches the leak
- The frequencies that appear first, grow in intensity as the SmartBall tool approaches the leak
- The frequencies that appear to indicate a leak are consistent as the SmartBall tool approaches the leak

C.2.2 Acoustic Events Representing Air or Gas Pockets

Pockets of trapped air or gas inside a pipeline generate a distinct acoustic signal that is detectable using the SmartBall technology. Air or gas pockets in pressure pipes are typically detected at high points in the pipeline and are often the result of malfunctioning air release valves (ARVs) or a lack of ARVs. The acoustic signal is created by the liquid turbulence at the air/water interface. In full, pressurized pipes, this turbulence is not present.

Pockets of trapped air or gas inside a pipeline have distinct acoustic signatures that are readily identified by the SmartBall analysis software and trained technicians. Pure classifies trapped air inside a pipeline into three (3) categories:

1. **Entrained Air:**

This classification of trapped air or gas is characterized by small, moving bubbles of air or gas within the pipeline as illustrated in Figure C.3. Entrained air is not typically static in a pipeline and frequently migrates with the flow. These moving pockets of air or gas are generated in three (3) ways: (1) They can be introduced at a pumping station as a result of air becoming entrained in the water or by inefficiencies within the pump station. (2) They can be created at the tail of a hydraulic jump at the end of a fully developed air or gas pocket where small pockets of air or gas diffuse into the liquid phase and are carried downstream with the flow. (3) Finally, entrained air may be created by the biochemical processes inherent in wastewater force mains.

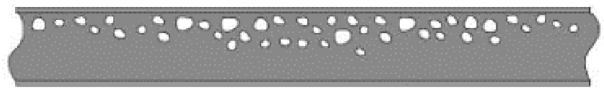


Figure C.3: Entrained Air[1]

2. **Slug or Developing Air or Gas Pockets:**

This classification can be characterized as small pockets of trapped air or gas that often develop from an amalgamation of entrained air as illustrated in Figure C.4. Slugs can also be introduced via ARVs. Slugs can be either static or migratory. If they are detected at a localized high point, they are likely static; if not, they are likely migrating towards a high point.

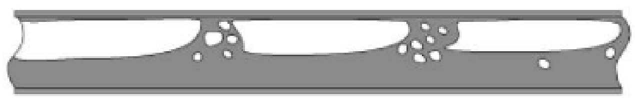


Figure C.4: Slugs[2]

3. **Fully Developed Air or Gas Pockets:**

Fully developed air or gas pockets are usually located at localized high points along a pipeline. These develop as a result of slugs that accumulate at a high point, and then extend into the downward slope of the pipe. A fully developed air or gas pocket typically has a hydraulic jump prior to the re-submergence of the pipe, creating an area of turbulent flow and air or gas dissolution into the liquid phase. Due to the turbulent nature of the hydraulic jump and frequent wet/dry cycles at these locations from changes in flow condition, these areas are at a higher risk of failure than other portions of the air or gas pocket.

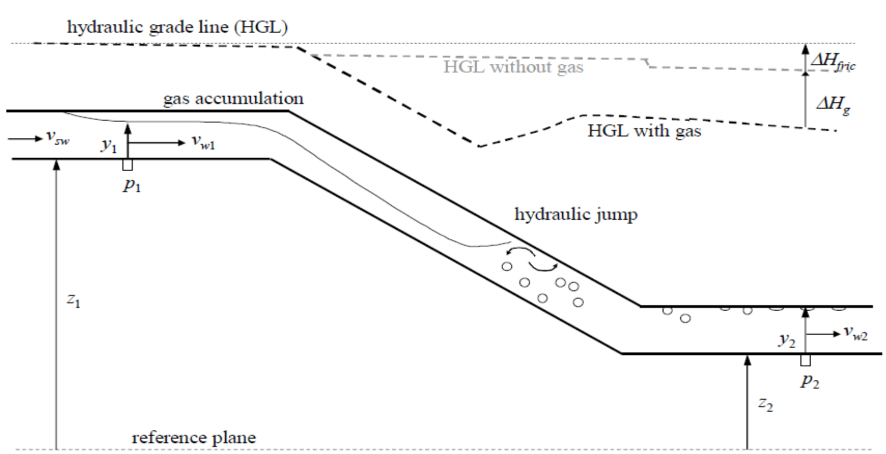


Figure C.5: Diagram of a Fully Developed Air or Gas Pocket[3]

1 Pothof, Ivo, *Co-current Air-Water Flow in Downward Sloping Pipes* (I.W.M. Pothof, 2011), 9.
2 Pothof, *Air-Water Flow*, 9.
3 Pothof, *Air-Water Flow*, ii.

An example of the acoustic signature generated by a pocket of trapped air or gas is shown in Figure C.6.

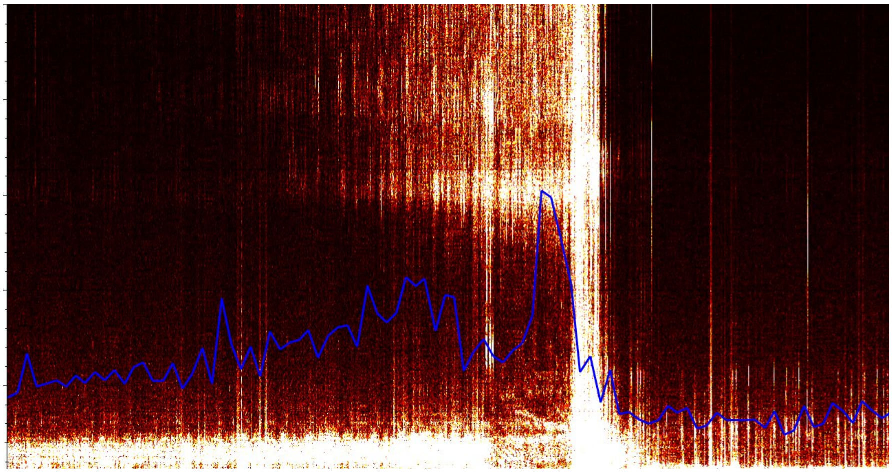


Figure C.6: Detected Air or Gas Pocket, as shown in the SmartBall Analysis Software

C.3 SmartBall Tracking

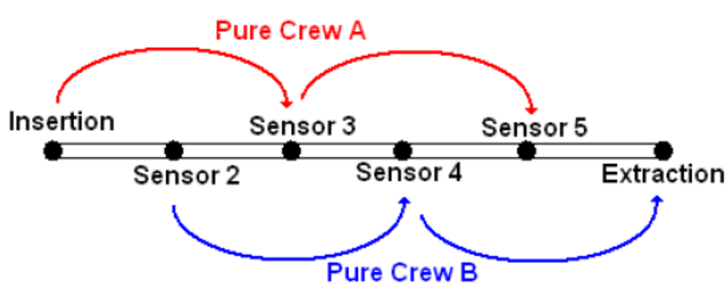
C.3.1 Tracking

SmartBall Receivers (SBR) and Remote Tracking Tools (RTT) are tracking devices that are used to track the position of the SmartBall tool as it traverses the pipeline. SBR and RTT tracking devices comprise a GPS receiver and a processing computer or unit. Both the SmartBall tool and the SBR/RTT are synchronized to standard GPS time.

Consumable Surface mounted sensors (SMS) are mounted to the prepared pipeline surface at planned locations and are connected to an SBR/RTT via coaxial cable. The SBR/RTT and SMS combination detect ultrasonic pulses emitted from the SmartBall tool. The SBR/RTT determines the time taken for the pulse to travel from the SmartBall tool to the SBR/RTT and calculates the location of the SmartBall tool at any given time. Figure C.7 shows an SMS, which is typically mounted to the pipeline itself or pipeline appurtenance.

Figure C.7: SMS Adhered to a Flange

Teams would typically leapfrog during tracking of the SmartBall tool as shown below. The number of tracking teams depends on the project complexity, flow velocity and duration.



Typical leap frog during inspection

This locational data is paralleled with the data extracted from the SmartBall tool. This combination is then used to identify the locations of leaks and pockets of trapped air or gas.

C.3.2 Correlation to Pipeline Information

An important part of the data analysis process is correlating data to the physical pipe in which it was collected. As the SmartBall tool does not have an odometer, distances are derived from correlating drawings and/or GIS information provided by the pipeline owner with GPS data gathered by tracking devices and at tracking locations, and motion sensor data onboard the tool.

Location accuracy is dependent on quality of provided information and collected data. Pipeline drawings and/or GIS information forms the foundation that is further refined using GPS data. Between these known locations, distances are derived assuming constant end-over-end rolling motion between features with tracking devices to determine the location of the tool as it travels through a pipeline. Additional sensor data utilized for locating include a magnetometer to identify pipe joints and features along the pipeline, and a strain gauge to identify elevation changes. Factors negatively impacting location accuracy are shown in the table below:

Data used in correlating locations	Factors negatively impacting location accuracy
Drawings	Missing or no drawings at all Unreliable/ Outdated drawings Inaccurate drawings Non legible drawings Delivery of drawings late in the project process
GIS information	No GIS information at all Inaccurate GIS information Delivery of GIS late in the project process
Rolling motion	Fast flow velocities Vertical deflections Debris inside the line Biofilm growth on pipe wall (Slippage) Outlets that are not closed Bottom outlets Change / stop of flow rate during inspection
Tracking locations	Small pipe diameters Flexible pipe material (Plastic) Bends in between tracking locations Large tracking spacing Large sensor mounting offsets

An example of data correlation from a sample pipeline is illustrated in Figure C.8.

Figure C.8: Data Correlation - Example from Another Pipeline

C.4 Advantages and Limitations of the SmartBall Technology

The SmartBall technology acquires high quality acoustic data that is evaluated to identify leaks and pockets of trapped air or gas. While other leak detection techniques such as noise loggers and correlators may identify a single leak or air or gas pocket between each sensor, they cannot accurately locate the limits of an event nor identify multiple events. The SmartBall tool travels directly past each acoustic event of interest and thus significant advantages are recognized:

- Medium and Large Diameter Pipes

  SmartBall technology has successfully inspected and detected leaks on a wide range of medium and large diameter pipelines 12 inch to 96 inch in diameter (300 millimeters to 2400 millimeters). Many conventional leak detection technologies (e.g., correlators) have limitations that prevent their use on medium and large diameter pipes.

- Pipe Material:

  The SmartBall tool's leak detection ability is not affected by pipe material. Because the tool passes by the point at which the acoustic event is being created, the pipe wall is not relied on to transmit the acoustic event through the line to a sensor located far away from the actual event of interest. This greatly increases the SmartBall tool's sensitivity and ability to distinguish between separate acoustic events.

- Sensitivity:

  The sensitivity of all leak detection technologies is a function of several variables and as a result, no absolute thresholds can be established. However, the acoustic sensor inside the SmartBall tool always passes within one (1) pipe diameter of an acoustic event; therefore, it can be used to identify very small leaks due to the proximity of the SmartBall tool to the leak. It should be noted that the SmartBall technology cannot differentiate between a true leak, a simulated leak, and the potential noise of a pressure reducing valve. As such, acoustic events corresponding to features on a main should be investigated further in the field.

- Length of Survey:

  SmartBall technology has the ability to record acoustic data for over 18 hours. Depending on flow rates, the tool can inspect long pipelines during a single deployment. The longest single recording within a water pipeline with a single deployment had the SmartBall tool recorded acoustic data for a length of pipeline exceeding 48 kilometers.

All non-destructive testing technologies have unique capabilities and limitations that affect the accuracy and efficacy of the technology. The SmartBall tool has the following limitations:

- Minimum Pressure:

The acoustic activity associated with a leak is derived from the pressure differential across the pipe wall. With little to no pressure differential, the SmartBall tool will not detect leakage as there will be no associated acoustic activity. Pure recommends a minimum pressure differential of 15 psi (1.03 Bar) for leak detection inspections; however, under ideal conditions leaks have been detected in pipelines with pressures as low as 5 psi (0.34 Bar). There is no minimum pressure recommendation for the detection of areas of trapped air or gas.

- Ambient Noise:

  The SmartBall technology detects and reports events that have acoustic characteristics similar to leaks on pressurized pipelines. However, other forms of ambient noise may be identified during the data analysis. For medium and large leaks, there is very little that can match these acoustic characteristics; therefore, these events are reported with a high degree of certainty. For small leaks, there may be other forms of ambient noise with similar acoustic signatures, making these signals more difficult to evaluate. Pure has invested significant resources into characterizing acoustic events and consequently asserts that leaks described in this report are leaks, unless otherwise noted. However, unknown pressure reducing valves, cracked valves in close proximity to the subject pipeline, interconnected pipelines that have not been completely isolated, and leaks in pipelines immediately adjacent to the subject pipeline can contain a similar acoustic signature and could be reported as leaks. Cars, pumps, boat traffic, and other forms of common ambient noise will not be reported as leaks as they generate different acoustic signatures.

- Reported Locations:

  The event locations in this report are based on project experience and the limitations of the technologies used to calculate location. There are also several other factors that could decrease the accuracy of locating leaks and air or gas pockets. Accuracy rankings for each event are included in each event overview.

C.5 Overview of a SmartBall Inspection

Figure C.9 shows an overview of a typical SmartBall inspection.

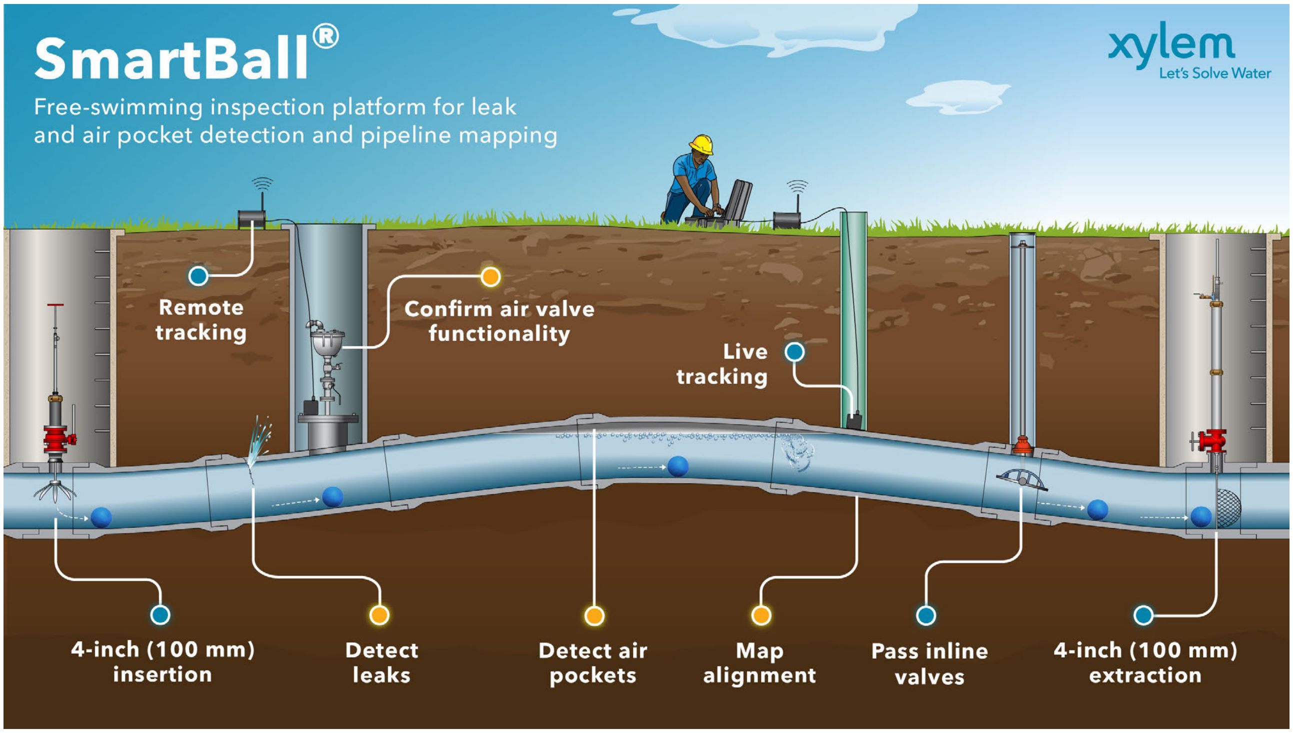
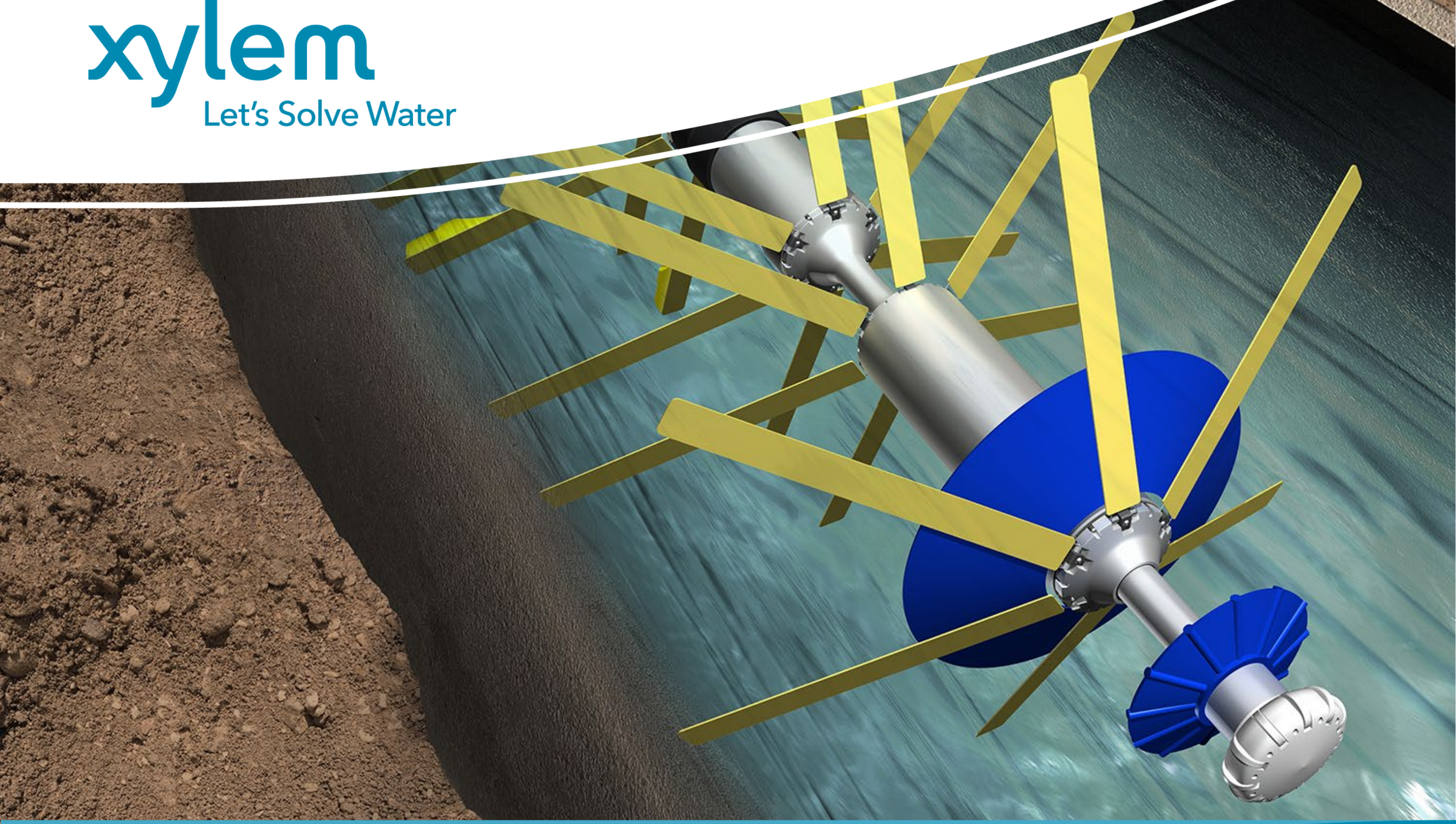


Figure C.9: Overview of a SmartBall Inspection

Appendix B - PipeDiver Electromagnetic Inspection Report – Xylem



PipeDiver® Electromagnetic Inspection Report

24-inch Ductile Iron Pipeline

MNS Engineers Inc and Goleta West Sanitary District

Version 1.0 – May 2025
(Final)

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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:

May 6, 2025

Brian Hext — Date
Project Manager

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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:

May 5, 2025

Carley Williamson — Date
Editorial Reviewer

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May 6, 2025

Daniel DeFever, PE — 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:

May 5, 2025

Bryon Boyd — Date
Contractual Reviewer

Confidentiality Clause

TABLE OF CONTENTS

Appendices

Executive Summary

On December 11, 2024, and February 5, 2025, Pure Technologies, a Xylem brand (Pure Technologies), conducted an electromagnetic inspection of the ductile iron pipe (DIP) in the 24-inch Ductile Iron Pipeline. The evaluation was performed using Pure Technologies' proprietary PipeDiver® platform, a non-destructive electromagnetic inspection technology. The purpose of the inspection was to locate and identify pipes with indications of corrosion induced pipe wall thinning or "wall loss". The inspection covered a cumulative distance of 1.64 miles and spanned a total of 493 fully inspected pipes and 2 partially inspected pipes between Goleta West Sanitary District Yard and the Wastewater Treatment Plant Headworks. The electromagnetic inspection scope is presented in Table ES.1.

Table ES.1: Scope of the Electromagnetic Inspection		
Pipeline	**Start Station**	**End Station**
24-inch Ductile Iron Pipeline	N/A	~85+71

'N/A' is reported as the start station due to unavailability of pipe laying schedules and plan and profile drawings.
'~' Station number approximated from the plan and profile drawings and electromagnetic data.

Pure Technologies' evaluation of the 24-inch Ductile Iron Pipeline concluded that of the 493 fully inspected pipes and 2 partially inspected pipes:

- One (1) electromagnetic anomaly characteristic of wall loss was detected.
  - The area of wall loss was 20 square inches.
  - The wall loss anomaly has been quantified with an estimated depth of 60 percent of an assumed 0.38-inch nominal pipe wall thickness.

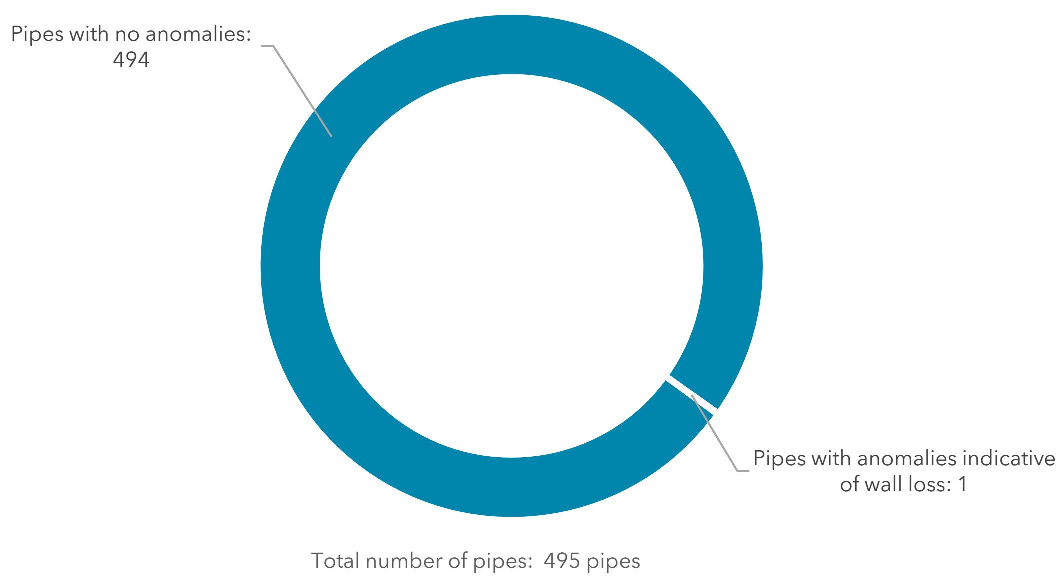

Figure ES.1: Electromagnetic Inspection Results

1. Project Background and Scope

1.1. Project Scope

In December 2024 and February 2025, Pure Technologies conducted an electromagnetic inspection of the DIP in the 24-inch Ductile Iron Pipeline using the PipeDiver inspection platform.

The purpose of the electromagnetic inspection was to locate and identify pipes with indications of wall loss. Corrosion or thinning of the pipe's wall is the primary cause of failure in metallic pipelines. Because the only structural component is the pipe wall itself, any loss in cross-sectional area due to corrosion has an immediate impact on the overall strength of the pipe. Structural and finite element analyses provide information regarding the structural capacity of a distressed pipe under its current loading conditions. With an electromagnetic baseline and a detailed structural analysis, the significance of identified wall loss anomalies may be understood. A full condition assessment will be completed following this report.

The inspected portion of the 24-inch Ductile Iron Pipeline is composed of 24-inch DIP. The 24-inch Ductile Iron Pipeline is owned and operated by the Goleta West Sanitary District.

1.2. Description of the PipeDiver Platform

PipeDiver is a free-swimming platform that uses electromagnetics to identify localized areas of pipe wall loss in metallic pipes. The tool creates an electromagnetic field that interacts with the pipe wall as it moves through the pipeline. Where pipe wall loss exists, the electromagnetic field is changed. This field data is recorded by the detectors and stored onboard the tool. Post-inspection, analysts identify, quantify, and locate areas of pipe wall loss.

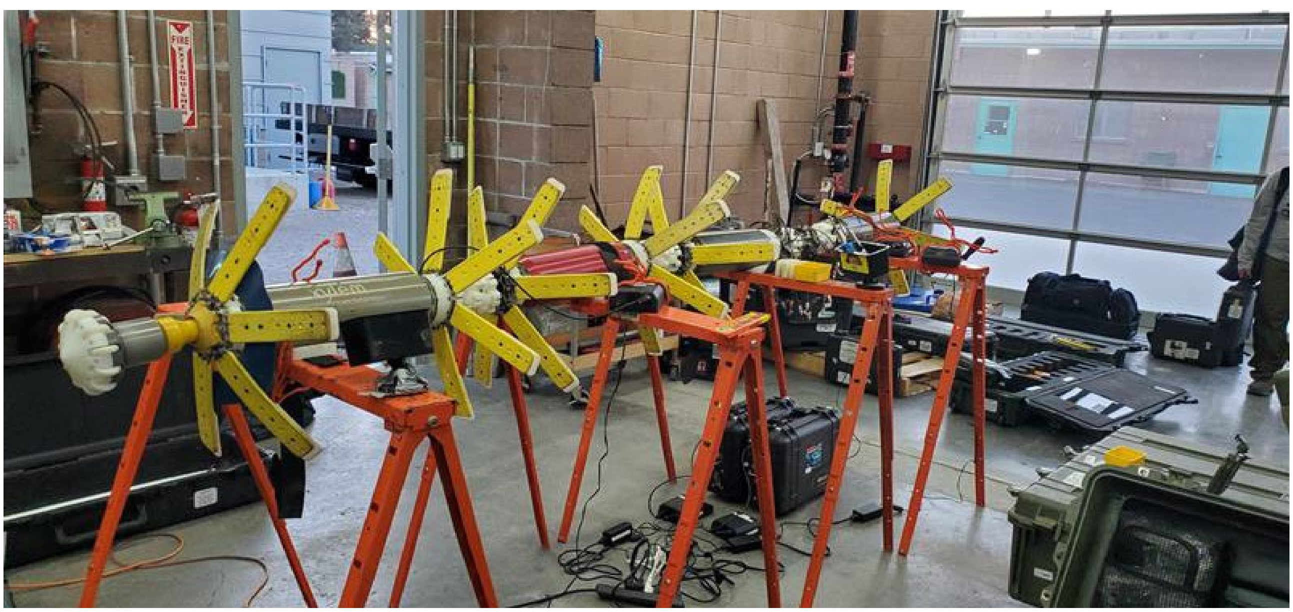

Figure 1.1: PipeDiver Inspection Platform

The tool is made up of several modules containing the electronics, computers, and batteries required for generating and collecting electromagnetic inspection data (Figure 1.1). The exciter is located in the body of the tool while the detectors are positioned circumferentially at the tips of the petals so they are as close as possible to the pipe wall. Electromagnetic inspections evaluate the electromagnetic signature of the pipe wall to identify anomalies that are produced by variations in the pipe thickness due to wall loss or manufacturing defects. Various characteristics associated with an electromagnetic anomaly (length, magnitude, signal shift, etc.) are evaluated. If calibration information is available with pipe design specifications similar to the pipe being inspected, then quantification of the size and depth of pipe wall loss anomalies can be provided (refer to Section 2.3 for more details on calibration).

1.3. PipeDiver Inspection Details

The PipeDiver tool was inserted into the pipeline via a 24-inch elbow located inside of the Goleta West Sanitary District Yard. After the tool was inserted and the access Tee was reassembled, the downstream isolation valves were opened. As the PipeDiver traveled through the pipeline, field crews tracked the tool from above ground at regular intervals using tracking units. The tracking units detected a signal emitted from the PipeDiver tool and calculated the distance of the tool from the tracking location.

The PipeDiver tool was originally planned to be extracted from the pipeline using a bar screen at the Wastewater Treatment Plant headworks. However, the PipeDiver got stuck ~100 meters from the proposed extraction. Multiple attempts were then made to manipulate the flow, however, these attempts were unsuccessful in dislodging the tool. A crew then excavated the location where the tool was located. After draining the pipe, the flange was removed and the tool was extracted.

Pure Technologies then remobilized to complete the second run of the inspection. This insertion was successful, and the tool was retrieved from the bar screen at the Wastewater Treatment Plant headworks.

Figure 1.2: PipeDiver Inspection Platform Being Pulled from Pipeline

2. Inspection Results

2.1. Electromagnetic Inspection Results

Electromagnetic data was collected on December 11, 2024, and February 5, 2025, for the 24-inch Ductile Iron Pipeline using the PipeDiver electromagnetic inspection platform. The inspected section spanned an overall distance of 1.64 miles and a total of 493 fully inspected pipes and 2 partially pipes. Pure Technologies' inspection schedule is presented in Table 2.1.

Table 2.1: Inspection Summary

Date	Pipeline	Pipe Material	Start Station	End Station	Distance
December 11, 2024 and February 5, 2025	24-inch Ductile Iron Pipeline	DIP	N/A	~85+71	**1.64 miles**

'N/A' is reported as the start station due to unavailability of pipe laying schedules and plan and profile drawings.
'~' Station number approximated from plan and profile drawings and electromagnetic data.

2.1.1. Pipes with Pipe Wall Anomalies

Of the 493 fully inspected pipes and 2 partially inspected pipes, one (1) pipe has electromagnetic anomalies consistent with pipe wall loss with an estimated 60 percent of an assumed 0.38-inch nominal pipe wall thickness, with an estimated area of 20 square inches. Table 2.2 details the pipe wall anomaly.

- 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 Anomaly Longitudinal Position is measured from the upstream station joint of the pipe to the center of the anomaly and is rounded to the nearest 0.5 feet.
- The Anomaly Circumferential Position is looking towards the downstream station joint and is rounded to the nearest 5 degrees. The 12 o'clock position is 0 degrees. Refer to Figure 2.2 for the radial layout of circumferential degrees and clock position.
- The Anomaly Area is based on the longitudinal length and the number of sensors that detected the anomaly. The anomaly is assumed to be square and is rounded to the nearest square inch.
- The Estimated Depth of Wall Loss is the average estimated percentage of relative pipe wall thickness across the anomaly area based on Pure Technologies' calibration testing performed at other sites and is rounded to the nearest 5 percent.

Wall loss anomalies identified in the electromagnetic data are quantified by calculating the overall volumetric loss of the metallic pipe wall. To better visualize the volumetric loss, the anomaly is reported as an estimated square area and percentage of relative loss of wall thickness across the anomaly area. Anomalies with a large area and shallow depth of wall loss will have similar

characteristics in the electromagnetic data as anomalies with a smaller area and deeper depth of wall loss.

The estimated size of wall loss anomalies is dependent on the proximity of the exciter and detector coils located on the PipeDiver inspection platform to the pipe wall. Calculations of the area and the depth of pipe wall anomaly is based on calibration testing at other sites, which assumes that the PipeDiver inspection platform was centered in the pipeline during the inspection.

A visual representation of the electromagnetic data of the pipe identified to have pipe wall loss is detailed in Section 2.1.2.

Table 2.2: Pipes with Anomalies Consistent with Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Anomaly Longitudinal Position (feet from Upstream Station)	Anomaly Circumferential Position (degrees - looking toward Downstream Station)	Anomaly Area (square inches)	Estimated Depth of Pipe Wall Loss (% of nominal thickness)
10105	16+27	18	10.5	100	20	60

The electromagnetic data signal is sensitive not only to physical differences in pipe properties, but it is also sensitive to any magnetic differences in the metallic components of the pipe. Variations of a pipe's magnetic properties results in variations in the electromagnetic data, which can impact the detection capabilities and accuracy in the estimations of the pipe wall loss anomaly. In some cases, metallic pipe design standards account for some of these manufactured dimensional or material property tolerances. For instance, according to American Water Works Association's (AWWA) C150 Design Standard, ductile iron pipe may be manufactured with a certain wall thickness tolerance, varying from 0.05 to 0.09 inches depending on diameter, which may vary from pipe to pipe or along the length of one individual pipe.

Several pipes in the collected data were affected by noise and changes in pipeline flow. As a result, large signal variations are observed in the data, affecting the overall data quality. The affected pipes are listed in the Pipe List (Appendix B) and the results for these pipes are reported with less certainty.

2.1.2. Electromagnetic Pipe Diagrams

To visualize the results, two-dimensional rollout graphs were created to illustrate the recorded electromagnetic data of the pipe identified with pipe wall loss defect.

Each figure below is laid out as if the pipes are split down the length of the crown and rolled out flat. The X-axis represents the distance, in feet, from the upstream station joint of the pipe. The Y-axis denotes the circumferential position of a pipe with reference to the clock position, where 12 o'clock represents the crown of the pipe and 6 o'clock represents the invert of the pipe. Figure 2.2 shows the radial layout of circumferential degrees and clock position when looking toward downstream joint.

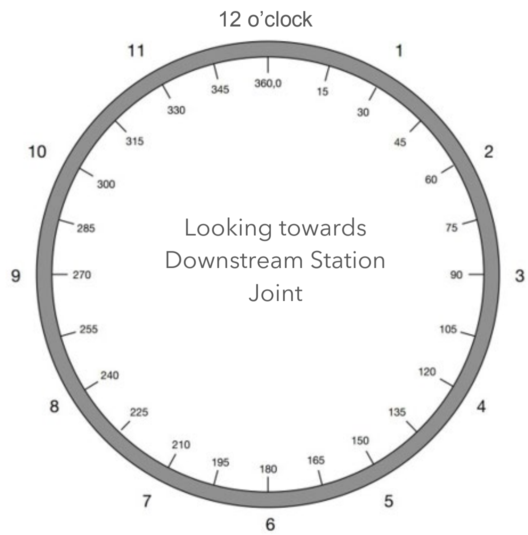

Figure 2.2: Radial Layout of Circumferential Degrees and Clock Position

The rollout graphs for the identified pipe wall anomalies in the 24-inch Ductile Iron Pipeline are presented in Figure 2.3. The colors in these figures are meant for reference only to indicate the longitudinal and circumferential location of the anomalies on the pipes and cannot be used to infer pipe depth. The red color represents the location of the identified pipe wall loss defects.

Pure Reference Number 10105

Pipe rollout graph:

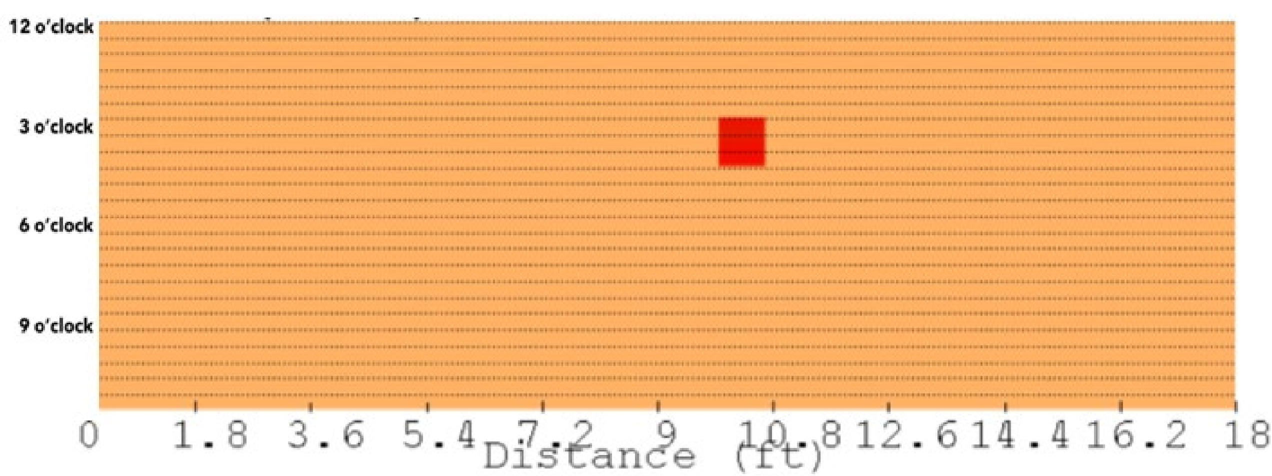

Figure 2.3: Pipes with Wall Loss Anomalies

2.2. Locating Pipes with Defects

An important part of the data analysis process is correlating the PipeDiver data to the physical pipe in which it was collected. Because the tool is free-swimming and does not have an odometer, data is collected in the time-domain and distances are derived through correlating identifiable features in the data to known locations on the pipeline. Examples of features that can be identified in the electromagnetic data and used as correlation points are inline valves, bends or outlets as well as tracking points. An example of data correlation from another pipeline is illustrated in Figure 2.4. Between these known locations, distances are derived assuming that the tool is travelling at constant velocity and that the distance between the locations is correct.

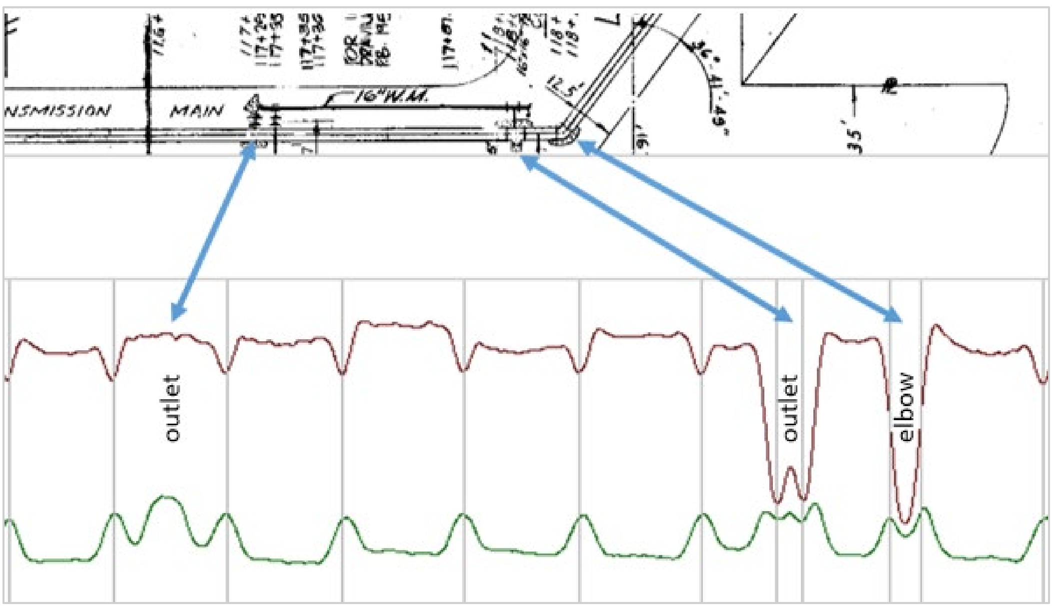

Figure 2.4: Data Correlation Example from Another Pipeline

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 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 is available to assist with any excavations or investigation. Please contact Pure Technologies for assistance. The Pipe List can be found in Appendix B.

2.3. Quantification of Defects through Calibration

Effective quantification of defects identified in electromagnetic data requires knowledge of how the electromagnetic signal behaves without pipe damage (baseline condition) and the ability to compare that baseline condition to the data signal received from the pipe when it is damaged. Because the data signal is sensitive to pipeline properties (e.g. pipe wall thickness, material, class, pipe diameter, etc.), two (2) pipes with the same diameter, but with different classes, will exhibit different baseline signals. Additionally, these pipes will produce signals that respond differently to wall loss.

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., material, diameter, wall thickness, 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 systematically varying the size of the wall loss defects and recording the response. The results from the calibration testing are incorporated into Pure Technologies' analysis software. At this point, an experienced data analyst can measure an anomaly signal and compare it to the calibration information to quantify the size and depth of the wall loss defects.

While the calibration process was not performed on pipes from the 24-inch Ductile Iron Pipeline, wall anomalies that were identified are based on calibration testing on metallic pipes at other sites. As such, the minimum size of a wall loss anomaly detectable by Pure Technologies' electromagnetic tool for the 24-inch Ductile Iron Pipeline is estimated to have 30 percent wall loss and longitudinal length of 3 inches.

If a wall loss anomaly is smaller than the minimum size stated above, detection may be possible only when the sensor is close to the anomaly (i.e., sensor passes directly under the anomaly).

However, as the nominal thickness of the pipe wall for pipes in the 24-inch Ductile Iron Pipeline is not available, the estimated depth of wall loss cannot be quantified.

If the wall thickness is provided and relevant calibration information is available, or field validations are performed on any pipes from the 24-inch Ductile Iron Pipeline at a future date, the results can be applied to the data from this inspection and the depth of pipe wall loss anomalies can be calculated.

For more details regarding the calibration process, electromagnetics capabilities, limitations, and functions, refer to Appendix A.

2.4. Confidence Codes in Pipe List

The PipeDiver inspection platform's capability to detect and quantify pipe wall loss anomalies is impacted by pipeline flow velocity, gas pockets in the pipeline, the availability of calibration information, and availability of as-built specifications. If inspection conditions are not optimal, then the results may be reported with less certainty.

The analysts' confidence in the identification and quantification of pipe wall loss anomalies is reported on a pipe-by pipe basis using "confidence codes" in the Pipe List in Appendix B.

2.4.1. Confidence Codes for Detection of Pipe Wall Loss

The speed at which the inspection tool is traveling through the pipeline impacts the electromagnetic data quality. The minimum size of a pipe wall loss anomaly detectable by Pure Technologies' electromagnetic tool is expected when the optimal flow velocity of 1.0 foot/second is achieved for each inspection run. When the optimal flow velocity is not achieved for one (1) or more inspection runs, the minimum size of pipe wall loss anomaly detectable by the Pure Technologies' electromagnetic tool may be larger than expected. A confidence ***color*** code is used in the Pipe List to represent how the inspection's pipeline flow affected data analysis.

2.4.2. Confidence Codes for Quantification of Pipe Wall Loss

The availability of calibration information and pipe specifications of the inspected pipeline affect the analysts' ability to accurately quantify pipe wall loss. A confidence ***number*** code may be assigned to pipes with identified pipe wall loss in the Pipe List based on the availability of calibration information and pipe specifications.

3. Conclusions

Based on the PipeDiver inspection carried out on December 11, 2024, and February 5, 2025, Pure Technologies concluded that:

- One (1) electromagnetic anomaly characteristic of wall loss was detected across a total of 493 fully inspected pipes and 2 partially inspected pipes.
    - Area of wall loss was 20 square inches.
    - Wall loss anomaly has been quantified with an estimated depth of 60 percent of an assumed nominal pipe wall thickness.

APPENDIX A

Electromagnetic Inspection Technology

A1 Electromagnetic Inspection Technology

A1.1 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.

Electromagnetics are used to generate an electric current in the pipe wall. A signal generator outputs a low frequency alternating electric current into a coil of wire, known as an exciter coil, positioned at the center or near the surface of the pipe. The magnetic field generated by this coil extends through the liner and into the pipe wall. As the coil travels along the length of the pipe, the field also moves, creating a localized magnetic field that generates eddy currents in the pipe wall.

When the pipe wall is uniform, the current will flow uniformly through the pipe wall; however, if a defect exists, a distortion in the current is formed. As the magnetic field passes over the section of pipe wall loss, currents are generated that form opposing magnetic field lines. These disruptions in the uniform magnetic field are recorded by the inspection tool for further analysis. The analysis and interpretation of the response of the magnetic field allows for estimates of the size and depth of the pipe wall loss, as well as its approximate location along the length of the pipe.

With pipe wall loss, the detection capabilities are heavily dependent on the proximity of the detector sensor to the pipe wall and to the defect. When the detector lift-off is greater than 2 inches or 50 millimetres, the signal of the wall loss anomaly is minimized and can potentially be masked by the noise in the data. Therefore, a constant tool speed is required to ensure that the noise is kept at a minimum.

A1.2 Analysis Considerations

Electromagnetic inspections detect electromagnetic anomalies, or differences, in the expected induced field of a metallic pipeline. Anomalies that are consistent with pipe wall loss 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 pipe wall loss detection depends on several 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 pipe wall loss anomalies 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 pipe wall thickness and composition. 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 are used to identify and quantify regions with pipe wall loss. Discrepancies between 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 pipe wall loss, in some cases, the signals are similar and an appurtenance could be misinterpreted as pipe wall loss 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 an area with pipe wall loss and could also cause anomalies that may be misinterpreted as pipe wall loss.

Discontinuities or variations such as abnormal welding in liner construction. These discontinuities can mask actual damage or mimic damage where none exists.

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; however, this interference is rare.

Motion. Turbulence, excessive debris/build up, and passing through bends or valves all produce distortion which can affect the quantification of pipe wall loss 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.

Thickness of Pipe Wall. For the current electromagnetic system, if the thickness of pipe wall is greater than 0.5 inches or 13 millimetres, or the diameter of pipe is greater than 36 inches or 914 millimetres, accuracy of detection will decrease. Even within the optimal pipe size and configuration, the resolution and precision of measurement is affected by pipe material's permeability. This factor can be obtained through proper calibration. Pure Technologies maintains a database for steel, ductile iron, and cast iron pipes that aids the estimation. However, if no calibration is applicable for a given inspected pipeline, the detected anomalies can only be ranked to show comparative severity level.

Feature Pipes. The electromagnetic technology can detect pipe wall loss 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.

Longitudinal Anomaly Position. The signal of a pipe wall loss anomaly varies along the length of a given pipe. Pipe wall loss anomalies close to the middle of a pipe are easier to detect and measure than anomalies near the joint. The increased presence of metal at the joint causes a distinct signal response which may affect the signal of the anomalies. The minimum size of anomalies required for the signal to be detectable and quantifiable near the joint depends on the pipe type, joint configuration, and proximity of anomaly to the joint. As a result, pipe wall loss estimates located close to the middle of a pipe will be provided with greater confidence than near the joints.

Circumferential Anomaly Position. The position of an individual anomaly can be accurately determined in data within 0.5 feet or 0.1 metres longitudinally, and within 15 degrees circumferentially. However, sometimes due to vehicle tilting or rotation, circumferential positioning could be off by one (1) or two (2) detectors. If there are multiple anomalies too close together that they begin to merge into a single signal, only the center of signal will be used for estimating the position. This estimation could cause a discrepancy in the determination of the anomaly position of up to 30 degrees.

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 anomalies 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 anomaly. 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 anomalies. In the case where both end effects and anomalies exist, quantification is more challenging.

Background Signal Variations. The electromagnetic data signal is sensitive not only to physical differences in pipe properties, but it is also sensitive to any magnetic differences in the metallic 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 exactly the same physically, if the steel for the pipe wall comes 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 anomalies are quantified by measuring the anomaly signal relative to a background signal, any variations between background signals can affect the accuracy of the measurement and ultimately the estimates of the pipe wall loss anomaly. For instance, according to American Water Works Association's

(AWWA) C150 Design Standard, ductile iron pipe may be manufactured with a certain wall thickness tolerance, varying from 0.05 to 0.09 inches depending on diameter, which may vary from pipe to pipe or along the length of one individual pipe. All these factors will result in variations in the background signals.

Number of Pipe Wall Loss Anomalies. Results are predicted with greater accuracy for pipes containing single anomaly regions than for pipes containing multiple anomaly regions. As the number of anomaly regions per pipe increases, or as these regions become closer together, the complexity of the interpretation increases. In some cases, anomaly regions can interact with each other from an electromagnetic standpoint to create signals of varying 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 pipe wall loss in a pipe section based on all the information available and assuming that the signal changes are caused by discontinuity in pipe wall material.

Calibration of Pipe Wall. The calibration of pipe wall involves forming pipe wall defects of various sizes and arrangements while using a variety of instrument configurations to conduct the scans. Detection and quantification of pipe wall loss can then be determined based on calibration results. Depending on the clarity of data, small defects could be masked due to excessive noise. The diagram shown in Figure A1.1 depicts the various simulated defects that would be created on site during a typical calibration.

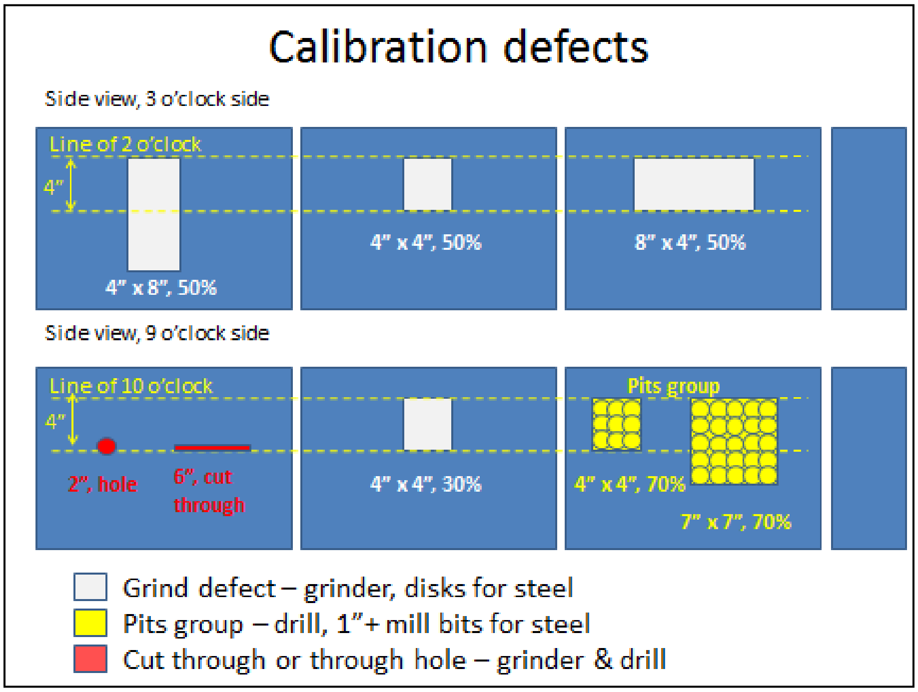

Figure A1.1: Sample of Defects Performed in a Pipe Wall Calibration

Variations in pipe properties do not affect the ability of the electromagnetic inspection equipment to locate pipe wall loss anomalies, but the variations will affect the accuracy in quantifying anomalies.

APPENDIX B

Pipe List

MNS Engineers Inc. & GWSD
24-inch Ductile Iron Pipeline

Electromagnetic Inspection Results
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Cylinder Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Downstream Station	Cylinder Anomaly Longitudinal Position (feet from Low Station)	Cylinder Anomaly Circumferential Position (degrees - looking toward Low Station with pipe crown at 0 degrees)	Calculated Area of Cylinder Wall Loss (square inches)	Estimated Depth of Cylinder Wall Loss	Confidence Code	Comments
Towards 24-inch Elbow at GWSD Yard (Insertion)									
10001	N/A	14	N/A					S; I	Partially inspected ~14ft of unknown pipe length. Pipe length reported with less certainty due to pipeline flow.
10002	N/A	18	N/A					S; I	Pipe length reported with less certainty due to pipeline flow.
10003	N/A	14	N/A					C; S; I	Pipe length reported with less certainty due to pipeline flow.
10004	N/A	14	N/A					C; S; I	90° Elbow. Pipe length reported with less certainty due to pipeline flow.
10005	0+00	13	0+06					C; S; I	Pipe length reported with less certainty due to pipeline flow.
10006	0+06	17	0+23					C; S; I	Valve Vault. 24" x 24" x 18" TEE. Pipe length reported with less certainty due to pipeline flow.
10007	0+23	18	0+41					C; S; I	Suspected 14" OL. Pipe reported with less certainty due to pipeline flow.
10008	0+41	18	0+59					I	Pipe length reported with less certainty due to pipeline flow.
10009	0+59	18	0+77					I	Pipe length reported with less certainty due to pipeline flow.
10010	0+77	18	0+95					I	Pipe length reported with less certainty due to pipeline flow.
10011	0+95	18	1+13					I	Pipe length reported with less certainty due to pipeline flow.
10012	1+13	18	1+31					I	Pipe length reported with less certainty due to pipeline flow.
10013	1+31	18	1+49					I	Pipe length reported with less certainty due to pipeline flow.
10014	1+49	18	1+67					I	Pipe length reported with less certainty due to pipeline flow.
10015	1+67	18	1+85					I	Pipe length reported with less certainty due to pipeline flow.
10016	1+85	18	2+03					I	Pipe length reported with less certainty due to pipeline flow.
10017	2+03	18	2+21					I	Pipe length reported with less certainty due to pipeline flow.
10018	2+21	18	2+38					I	Pipe length reported with less certainty due to pipeline flow.
10019	2+38	18	2+56					I	Pipe length reported with less certainty due to pipeline flow.
10020	2+56	16	2+72					I	Pipe length reported with less certainty due to pipeline flow.
10021	2+66	5	2+71					I	Pipe length reported with less certainty due to pipeline flow.
10022	2+72	17	2+89					C; S; I	Pipe length reported with less certainty due to pipeline flow.
10023	2+71	18	2+89					C; S; I	Pipe length reported with less certainty due to tool pause.
10024	2+89	18	3+07					I	
10025	3+07	18	3+25					I	
10026	3+25	18	3+43					I	
10027	3+43	18	3+61					I	
10028	3+61	18	3+79					I	
10029	3+79	18	3+97					I	
10030	3+97	18	4+15					I	
10031	4+15	18	4+33					I	
10032	4+33	18	4+51					I	
10033	4+51	18	4+69					I	
10034	4+69	18	4+87					I	
10035	4+87	18	5+05					I	
10036	5+05	18	5+23					I	
10037	5+23	18	5+41					I	
10038	5+41	18	5+59					I	
10039	5+59	18	5+77					I	
10040	5+77	18	5+95					I	
10041	5+95	18	6+13					I	
10042	6+13	18	6+31					I	
10043	6+31	4	6+35					I	23° Elbow.
10044	6+35	5	6+40					I	Pipe length reported with less certainty due to elbow.
10045	6+40	5	6+45					I	Pipe length reported with less certainty due to elbow.
10046	6+45	14	6+59					I	Pipe length reported with less certainty due to elbow.
10047	6+59	4	6+63					I	23° Elbow.
10048	6+63	18	6+80					I	
10049	6+80	13	6+93					I	Elbow.
10050	6+93	7	7+00					I	
10051	7+00	18	7+18					I	
10052	7+18	18	7+36					I	
10053	7+36	18	7+54					I	
10054	7+54	18	7+72					I	Pipe length reported with less certainty due to elbow.
10055	7+72	4	7+76					I	Elbow.
10056	7+76	18	7+93					I	Pipe length reported with less certainty due to elbow.
10057	7+93	5	7+98					I	Elbow.
10058	7+98	18	8+16					I	
10059	8+16	18	8+34					I	
10060	8+34	18	8+52					I	
10061	8+52	18	8+70					I	
10062	8+70	18	8+88					I	
10063	8+88	18	9+06					I	
10064	9+06	18	9+23					I	
10065	9+23	18	9+41					I	
10066	9+41	18	9+59					I	
10067	9+59	18	9+77					I	
10068	9+77	18	9+95					I	
10069	9+95	18	10+13					I	
10070	10+13	18	10+31					I	
10071	10+31	18	10+48					I	
10072	10+48	18	10+66					I	
10073	10+66	18	10+84					I	
10074	10+84	18	11+02					I	
10075	11+02	18	11+20					I	
10076	11+20	18	11+38					I	
10077	11+38	18	11+55					I	
10078	11+55	18	11+73					I	
10079	11+73	18	11+91					I	
10080	11+91	18	12+09					I	
10081	12+09	18	12+27					I	
10082	12+27	18	12+45					I	
10083	12+45	18	12+63					I	
10084	12+63	18	12+80					I	
10085	12+80	18	12+98					I	
10086	12+98	18	13+16					I	
10087	13+16	18	13+34					I	Pipe length reported with less certainty due to pipeline flow.
10088	13+34	8	13+42					I	67° Elbow.
10089	13+42	18	13+60					I	
10090	13+60	18	13+78					I	
10091	13+78	18	13+95					I	
10092	13+95	18	14+13					I	
10093	14+13	18	14+31					I	
10094	14+31	18	14+49					I	
10095	14+49	18	14+67					I	
10096	14+67	18	14+84					I	
10097	14+84	18	15+02					I	
10098	15+02	18	15+20					I	
10099	15+20	18	15+38					I	
10100	15+38	18	15+56					I	
10101	15+56	18	15+73					I	
10102	15+73	18	15+91					I	
10103	15+91	18	16+09					I	
10104	16+09	18	16+27					I	
10105	16+27	18	16+45	10.5	100	20	60%	I;1	Localized anomaly indicative of wall loss.
10106	16+45	18	16+62					I	
10107	16+62	18	16+80					I	
10108	16+80	18	16+98					I	
10109	16+98	18	17+16					I	
10110	17+16	18	17+34					I	
10111	17+34	18	17+51					I	
10112	17+51	18	17+69					I	
10113	17+69	18	17+87					I	
10114	17+87	18	18+05					I	
10115	18+05	18	18+23					I	
10116	18+23	18	18+40					I	
10117	18+40	18	18+58					I	
10118	18+58	18	18+76					I	
10119	18+76	18	18+94					I	
10120	18+94	18	19+12					I	

MNS Engineers Inc. & GWSD
24-inch Ductile Iron Pipeline

Electromagnetic Inspection Results
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Cylinder Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Downstream Station	Cylinder Anomaly Longitudinal Position (feet from Low Station)	Cylinder Anomaly Circumferential Position (degrees - looking toward Low Station with pipe crown at 0 degrees)	Calculated Area of Cylinder Wall Loss (square inches)	Estimated Depth of Cylinder Wall Loss	Confidence Code	Comments
10121	19+12	18	19+29					I	
10122	19+29	18	19+47					I	
10123	19+47	18	19+65					I	
10124	19+65	18	19+83					I	
10125	19+83	18	20+01					I	
10126	20+01	18	20+18					I	
10127	20+18	18	20+36					I	
10128	20+36	18	20+54					I	
10129	20+54	18	20+72					I	
10130	20+72	18	20+90					I	
10131	20+90	18	21+08					I	
10132	21+08	18	21+25					I	
10133	21+25	18	21+43					I	
10134	21+43	18	21+61					I	
10135	21+61	18	21+79					I	
10136	21+79	18	21+97					I	
10137	21+97	18	22+14					I	
10138	22+14	18	22+32					I	
10139	22+32	18	22+50					I	
10140	22+50	18	22+68					I	
10141	22+68	18	22+86					I	
10142	22+86	18	23+03					I	
10143	23+03	18	23+21					I	
10144	23+21	18	23+39					I	
10145	23+39	18	23+57					I	
10146	23+57	18	23+75					I	
10147	23+75	18	23+92					I	
10148	23+92	18	24+10					I	
10149	24+10	18	24+28					I	
10150	24+28	18	24+46					I	
10151	24+46	18	24+64					I	
10152	24+64	18	24+81					I	
10153	24+81	18	24+99					I	
10154	24+99	18	25+17					I	
10155	25+17	18	25+35					I	
10156	25+35	18	25+53					I	
10157	25+53	18	25+70					I	
10158	25+70	18	25+88					I	
10159	25+88	18	26+06					I	
10160	26+06	18	26+24					I	
10161	26+24	18	26+42					I	
10162	26+42	18	26+59					I	
10163	26+59	18	26+77					I	
10164	26+77	18	26+95					I	
10165	26+95	18	27+13					I	
10166	27+13	18	27+31					I	
10167	27+31	18	27+49					I	
10168	27+49	18	27+66					I	
10169	27+66	18	27+84					I	
10170	27+84	18	28+02					I	
10171	28+02	18	28+20					I	
10172	28+20	18	28+38					I	
10173	28+38	18	28+55					I	
10174	28+55	13	28+68					I	
10175	28+68	7	28+75					I	45° Elbow.
10176	28+75	18	28+93					I	Pipe reported with less certainty due to tool movement.
10177	28+93	18	29+11					I	
10178	29+11	18	29+29					I	
10179	29+29	18	29+47					I	
10180	29+47	18	29+65					I	
10181	29+65	18	29+83					I	
10182	29+83	18	30+01					I	
10183	30+01	18	30+19					I	
10184	30+19	18	30+37					I	
10185	30+37	18	30+55					I	
10186	30+55	18	30+73					I	
10187	30+73	18	30+91					I	
10188	30+91	18	31+09					I	
10189	31+09	18	31+27					I	
10190	31+27	18	31+45					I	
10191	31+45	18	31+63					I	
10192	31+63	18	31+81					I	
10193	31+81	18	31+99					I	
10194	31+99	18	32+17					I	
10195	32+17	18	32+35					I	
10196	32+35	18	32+53					I	
10197	32+53	18	32+71					I	
10198	32+71	18	32+89					I	
10199	32+89	18	33+07					I	
10200	33+07	18	33+25					I	
10201	33+25	18	33+43					I	
10202	33+43	18	33+61					I	
10203	33+61	18	33+79					I	
10204	33+79	18	33+97					I	
10205	33+97	18	34+15					I	
10206	34+15	18	34+33					I	
10207	34+33	18	34+51					I	
10208	34+51	18	34+69					I	
10209	34+69	18	34+87					I	
10210	34+87	18	35+05					I	
10211	35+05	18	35+23					I	
10212	35+23	18	35+41					I	
10213	35+41	18	35+59					I	
10214	35+59	18	35+77					I	
10215	35+77	18	35+95					I	
10216	35+95	18	36+13					I	
10217	36+13	18	36+31					I	
10218	36+31	18	36+49					I	
10219	36+49	18	36+67					I	
10220	36+67	18	36+85					I	
10221	36+85	18	37+03					I	
10222	37+03	18	37+21					I	
10223	37+21	18	37+39					I	
10224	37+39	18	37+57					I	
10225	37+57	18	37+75					I	
10226	37+75	18	37+93					I	
10227	37+93	18	38+11					I	
10228	38+11	18	38+29					I	
10229	38+29	18	38+47					I	
10230	38+47	18	38+65					I	
10231	38+65	18	38+83					I	
10232	38+83	18	39+01					I	
10233	39+01	18	39+19					I	
10234	39+19	18	39+37					I	
10235	39+37	18	39+55					I	
10236	39+55	18	39+73					I	
10237	39+73	18	39+91					I	
10238	39+91	18	40+09					I	
10239	40+09	18	40+27					I	
10240	40+27	18	40+45					I	
10241	40+45	18	40+63					I	

MNS Engineers Inc. & GWSD
24-inch Ductile Iron Pipeline

Electromagnetic Inspection Results
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Cylinder Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Downstream Station	Cylinder Anomaly Longitudinal Position (feet from Low Station)	Cylinder Anomaly Circumferential Position (degrees - looking toward Low Station with pipe crown at 0 degrees)	Calculated Area of Cylinder Wall Loss (square inches)	Estimated Depth of Cylinder Wall Loss	Confidence Code	Comments
10242	40+63	7	40+70					I	27° Elbow.
10243	40+70	18	40+88					I	
10244	40+88	18	41+06					I	
10245	41+06	18	41+24					I	
10246	41+24	18	41+42					I	
10247	41+42	18	41+60					I	
10248	41+60	15	41+75					I	Analysis Equation: 41+75BK = 42+29AH.
10249	42+29	5	42+34					I	20° Elbow.
10250	42+34	12	42+46					I	
10251	42+46	18	42+64					I	
10252	42+64	18	42+82					I	
10253	42+82	18	43+00					I	
10254	43+00	18	43+18					I	
10255	43+18	18	43+35					I	
10256	43+35	18	43+53					I	
10257	43+53	18	43+71					I	
10258	43+71	18	43+89					I	
10259	43+89	18	44+07					I	
10260	44+07	18	44+25					I	
10261	44+25	18	44+42					I	
10262	44+42	18	44+60					I	
10263	44+60	18	44+78					I	
10264	44+78	18	44+96					I	
10265	44+96	18	45+14					I	
10266	45+14	18	45+31					I	
10267	45+31	18	45+49					I	
10268	45+49	18	45+67					I	
10269	45+67	18	45+85					I	
10270	45+85	18	46+03					I	
10271	46+03	18	46+21					I	
10272	46+21	18	46+38					I	
10273	46+38	18	46+56					I	
10274	46+56	18	46+74					I	
10275	46+74	18	46+92					I	
10276	46+92	18	47+10					I	
10277	47+10	18	47+27					I	
10278	47+27	18	47+45					I	
10279	47+45	18	47+63					I	
10280	47+63	18	47+81					I	
10281	47+81	18	47+99					I	
10282	47+99	18	48+17					I	
10283	48+17	18	48+34					I	
10284	48+34	18	48+52					I	
10285	48+52	18	48+70					I	
10286	48+70	18	48+88					I	
10287	48+88	18	49+06					I	
10288	49+06	18	49+23					I	
10289	49+23	18	49+41					I	
10290	49+41	18	49+59					I	
10291	49+59	18	49+77					I	
10292	49+77	18	49+95					I	
10293	49+95	18	50+13					I	
10294	50+13	18	50+30					I	
10295	50+30	18	50+48					I	
10296	50+48	18	50+66					I	
10297	50+66	18	50+84					I	
10298	50+84	18	51+02					I	
10299	51+02	18	51+20					I	
10300	51+20	18	51+37					I	
10301	51+37	18	51+55					I	
10302	51+55	18	51+73					I	
10303	51+73	18	51+91					I	
10304	51+91	18	52+09					I	
10305	52+09	18	52+26					I	
10306	52+26	18	52+44					I	
10307	52+44	18	52+62					I	
10308	52+62	18	52+80					I	
10309	52+80	18	52+98					I	
10310	52+98	18	53+16					I	
10311	53+16	18	53+33					I	
10312	53+33	18	53+51					I	
10313	53+51	18	53+69					I	
10314	53+69	18	53+87					I	
10315	53+87	18	54+05					I	
10316	54+05	18	54+22					I	
10317	54+22	18	54+40					I	
10318	54+40	18	54+58					I	
10319	54+58	18	54+76					I	
10320	54+76	18	54+94					I	
10321	54+94	18	55+12					I	
10322	55+12	18	55+29					I	
10323	55+29	18	55+47					I	
10324	55+47	18	55+65					I	
10325	55+65	18	55+83					I	
10326	55+83	18	56+01					I	
10327	56+01	18	56+19					I	
10328	56+19	18	56+36					I	
10329	56+36	18	56+54					I	
10330	56+54	18	56+72					I	
10331	56+72	18	56+90					I	
10332	56+90	18	57+08					I	
10333	57+08	18	57+25					I	
10334	57+25	18	57+43					I	
10335	57+43	18	57+61					I	
10336	57+61	18	57+79					I	
10337	57+79	18	57+97					I	
10338	57+97	18	58+15					I	
10339	58+15	18	58+32					I	
10340	58+32	18	58+50					I	
10341	58+50	18	58+68					I	
10342	58+68	18	58+86					I	
10343	58+86	18	59+04					I	
10344	59+04	18	59+21					I	
10345	59+21	18	59+39					I	
10346	59+39	18	59+57					I	
10347	59+57	18	59+75					I	
10348	59+75	18	59+93					I	
10349	59+93	18	60+11					I	
10350	60+11	18	60+28					I	
10351	60+28	18	60+46					I	
10352	60+46	18	60+64					I	
10353	60+64	13	60+77					I	
10354	60+77	7	60+84					I	11° Elbow.
10355	60+84	18	61+02					I	
10356	61+02	18	61+19					I	
10357	61+19	18	61+37					I	
10358	61+37	18	61+55					I	
10359	61+55	18	61+73					I	
10360	61+73	18	61+91					I	
10361	61+91	18	62+09					I	
10362	62+09	18	62+26					I	

MNS Engineers Inc. & GWSD
24-inch Ductile Iron Pipeline

Electromagnetic Inspection Results
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Cylinder Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Downstream Station	Cylinder Anomaly Longitudinal Position (feet from Low Station)	Cylinder Anomaly Circumferential Position (degrees - looking toward Low Station with pipe crown at 0 degrees)	Calculated Area of Cylinder Wall Loss (square inches)	Estimated Depth of Cylinder Wall Loss	Confidence Code	Comments
10363	62+26	18	62+44					I	
10364	62+44	18	62+62					I	
10365	62+62	8	62+70					C; S; I	89° Elbow.
10366	62+70	15	62+85					C; S; I	Pipe reported with less certainty due to electromagnetic noise.
10367	62+85	18	63+03					I	
10368	63+03	18	63+21					I	
10369	63+21	18	63+39					I	
10370	63+39	18	63+57					I	
10371	63+57	18	63+75					I	
10372	63+75	18	63+94					I	
10373	63+94	18	64+12					I	
10374	64+12	18	64+30					I	
10375	64+30	18	64+48					I	
10376	64+48	18	64+66					I	
10377	64+66	18	64+84					I	
10378	64+84	18	65+02					I	
10379	65+02	18	65+20					I	
10380	65+20	18	65+38					I	
10381	65+38	18	65+56					I	
10382	65+56	18	65+74					I	
10383	65+74	18	65+92					I	
10384	65+92	18	66+10					I	
10385	66+10	18	66+28					I	
10386	66+28	18	66+47					I	
10387	66+47	18	66+65					I	
10388	66+65	18	66+83					I	
10389	66+83	18	67+01					I	
10390	67+01	18	67+19					I	
10391	67+19	18	67+37					I	
10392	67+37	18	67+55					I	
10393	67+55	18	67+73					I	
10394	67+73	18	67+91					I	
10395	67+91	18	68+09					I	
10396	68+09	18	68+27					I	
10397	68+27	18	68+45					I	
10398	68+45	18	68+63					I	
10399	68+63	18	68+81					I	
10400	68+81	18	69+00					I	
10401	69+00	18	69+18					I	
10402	69+18	18	69+36					I	
10403	69+36	18	69+54					I	
10404	69+54	18	69+72					I	
10405	69+72	18	69+90					I	
10406	69+90	18	70+08					I	
10407	70+08	18	70+26					I	
10408	70+26	18	70+44					I	
10409	70+44	18	70+62					I	
10410	70+62	18	70+80					C; S; I	Pipe reported with less certainty due to electromagnetic noise.
10411	70+80	18	70+98					I	
10412	70+98	18	71+16					I	
10413	71+16	18	71+34					I	
10414	71+34	18	71+53					I	
10415	71+53	18	71+71					I	
10416	71+71	18	71+89					I	
10417	71+89	18	72+07					I	
10418	72+07	18	72+25					I	
10419	72+25	18	72+43					I	
10420	72+43	18	72+61					I	
10421	72+61	7	72+68					I	Pipe reported with less certainty due to tool movement.
10422	72+68	13	72+81					C; S; I	75° Elbow.
10423	72+81	18	72+99					I	
10424	72+99	18	73+17					I	
10425	73+17	18	73+35					I	
10426	73+35	18	73+53					I	
10427	73+53	18	73+71					I	
10428	73+71	18	73+89					I	
10429	73+89	18	74+07					I	
10430	74+07	18	74+25					I	
10431	74+25	18	74+43					I	
10432	74+43	18	74+61					I	
10433	74+61	18	74+79					I	
10434	74+79	18	74+97					I	
10435	74+97	18	75+15					I	
10436	75+15	18	75+33					I	
10437	75+33	18	75+51					I	
10438	75+51	18	75+69					I	
10439	75+69	18	75+87					I	
10440	75+87	18	76+04					I	
10441	76+04	18	76+22					I	
10442	76+22	18	76+40					I	
10443	76+40	18	76+58					I	
10444	76+58	18	76+76					I	
10445	76+76	18	76+94					I	
10446	76+94	18	77+12					I	
10447	77+12	18	77+30					I	
10448	77+30	18	77+48					I	
10449	77+48	18	77+66					C; S; I	Pipe reported with less certainty due to electromagnetic noise.
10450	77+66	18	77+84					I	
10451	77+84	18	78+02					I	
10452	78+02	18	78+20					I	
10453	78+20	18	78+38					I	
10454	78+38	18	78+56					I	
10455	78+56	18	78+74					I	
10456	78+74	18	78+92					I	
10457	78+92	18	79+10					I	
10458	79+10	18	79+28					I	
10459	79+28	18	79+46					I	
10460	79+46	18	79+64					I	
10461	79+64	18	79+82					I	
10462	79+82	18	80+00					I	
10463	80+00	18	80+18					I	
10464	80+18	18	80+36					I	
10465	80+36	18	80+54					I	
10466	80+54	18	80+72					I	
10467	80+72	18	80+90					I	
10468	80+90	18	81+08					I	
10469	81+08	18	81+26					I	
10470	81+26	18	81+44					I	
10471	81+44	18	81+62					I	
10472	81+62	18	81+80					I	
10473	81+80	18	81+98					I	
10474	81+98	14	82+12					I	Pipe reported with less certainty due to electromagnetic noise.
10475	82+12	13	82+25					C; S; I	90° Elbow. Equation: 82+19BK = 82+18AH.
10476	82+25	12	82+37					I	
10477	82+37	18	82+55					I	
10478	82+55	18	82+73					I	
10479	82+73	18	82+91					I	
10480	82+91	18	83+09					I	
10481	83+09	18	83+27					I	
10482	83+27	18	83+45					I	
10483	83+45	18	83+63					I	

MNS Engineers Inc. & GWSD
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Electromagnetic Inspection Results
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Cylinder Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Downstream Station	Cylinder Anomaly Longitudinal Position (feet from Low Station)	Cylinder Anomaly Circumferential Position (degrees - looking toward Low Station with pipe crown at 0 degrees)	Calculated Area of Cylinder Wall Loss (square inches)	Estimated Depth of Cylinder Wall Loss	Confidence Code	Comments
10484	83+63	18	83+81					I	
10485	83+81	18	83+99					I	
10486	83+99	18	84+17					I	
10487	84+17	18	84+35					I	
10488	84+35	18	84+53					I	
10489	84+53	18	84+71					I	
10490	84+71	18	84+89					I	
10491	84+89	18	85+07					I	
10492	85+07	18	85+25					I	
10493	85+25	18	85+43					I	
10494	85+43	18	85+61					I	
10495	85+61	10	85+71					I	Partially inspected ~10ft of unknown pipe length.
Towards Wastewater Treatment Plant Headworks (Extraction)									

OL Outlet.

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

Pipe laying schedules were not available. Pipe lengths and station numbers were approximated from the electromagnetic data and plan and profile drawings.

No drawings were available for PRN 10001 to 10006. Station numbers are 'N/A' in this section.

Flow is assumed to be in the direction from GWSD Yard to the Wastewater Treatment Plant Headworks.

Confidence Codes	
Detection of Pipe Wall Loss	
Colour Coded Detection Confidence	This code correlates to the analysts ability to **identify** pipe wall loss
(red)	Low or no probability of defect detection. Both inspection runs have a flow velocity >2 ft/s. SP is too short to detect pipe wall loss.
(yellow)	Minimum detection limit for anomalies may be larger than expected. One or both inspection runs have a flow velocity >1ft/s.
(green)	Defect detection expected at tool's optimal size and depth. Both inspection runs have a flow velocity ≤1ft/s.
Letter Code: Detection Qualifiers	This code correlates to the amount of noise observed on one or both inspection runs which affects analysts ability to **identify** pipe wall loss
No letter	Uniform signal quality along the pipe
C	Potential loss of signal along crown
S	Potential loss of signal along springline
I	Potential loss of signal along Invert
Quantification of Pipe Wall Loss	
Number Code: Quantification Confidence	This code correlates to the availability of calibration pipes and inspected pipe specifications which affects analysts ability to accurately **quantify** pipe wall loss
No number	All supporting information available: full quantification
1	Virtual calibration or assumed spec information: Full quantification with elevated uncertainty
2	Unknown pipe specification:Partial quantification
3	Unknown pipe material: Anomaly identification

Appendix C - Condition Assessment Report – Xylem

xylem
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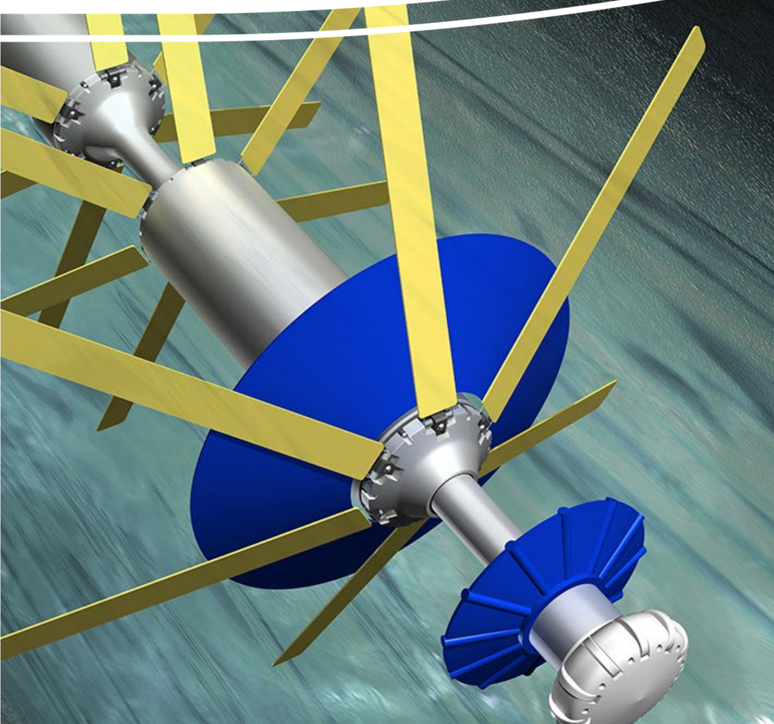

Condition Assessment Report

24-inch Ductile Iron Pipeline

MNS Engineers Inc and Goleta West Sanitary District

Version 1.0 – May 2025
(Final)

pure TECHNOLOGIES
a xylem brand

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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:

May 23, 2025

Brian Hext | Date
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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:

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Josh Greenberg | Date
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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:

May 23, 2025

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Contractual Reviewer

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Appendices

Executive Summary

Pure Technologies, a Xylem brand (Pure Technologies), conducted a condition assessment of the ductile iron pipe (DIP) in the 24-inch Ductile Iron Pipeline for the Goleta West Sanitary District (GWSD). The evaluation was performed using Pure Technologies' proprietary PipeDiver® electromagnetic platform, SmartBall® leak and gas pocket detection technology, and a structural evaluation. Additionally, a leak and gas pocket inspection was completed on the parallel 18-inch asbestos concrete pipe. The inspection scopes are presented in Table ES.1.

Table ES.1: Scope of the Inspections			
Pipeline	**Inspection Technology**	**Start Location**	**End Location**
24-inch Ductile Iron Pipeline	PipeDiver	24-inch Blind Flange at GWSD Yard	Wastewater Treatment Plant Headworks
	SmartBall		Weir Well inside Wastewater Treatment Plant t
18-inch Asbestos Pipeline	SmartBall		

The purpose of the SmartBall inspections was to locate and identify any leaks or gas pockets within the inspected portion of the pipelines. Overall, there were no acoustic events resembling leaks, 10 total static gas pockets, 5 total gas slugs, and 2 entrained air events detected between the two pipelines. Section 2 provides more detail on these results including the location of the static gas pockets.

The purpose of the PipeDiver inspection was to locate and identify pipes with indications of corrosion induced pipe wall thinning or "wall loss" on the 24-inch DIP. The inspection spanned a total of 493 fully inspected pipes and 2 partially inspected pipes between Goleta West Sanitary District Yard and the Wastewater Treatment Plant Headworks. Pure Technologies concluded that of the 493 fully inspected pipes and 2 partially inspected pipes:

- One (1) electromagnetic anomaly characteristic of wall loss was detected.
  - The area of wall loss was 20 square inches.
  - The wall loss anomaly has been quantified with an estimated depth of 60 percent of a conservatively assumed 0.38-inch nominal pipe wall thickness.

To provide context as to whether the distressed pipe listed above is of structural concern, a structural evaluation was completed on the 24-inch DIP. This evaluation included an American Water Works Association (AWWA) C150 design check on the inspected portion of the 24-inch DIP pipeline as well as Finite Element Analysis (FEA) on the specific distress identified in the distressed pipe to determine the Yield Limit. The results of this evaluation are presented in Section 4.

A list of conclusions from the inspections and analyses listed above as well as associated short- and long-term recommendations can be found in Section 5.

1. Project Background and Scope

1.1. Project Scope

In December 2024 and February 2025, Pure Technologies conducted an electromagnetic and leak and gas pocket inspection of the DIP in the 24-inch Ductile Iron Pipeline. The inspected portion of the 24-inch Ductile Iron Pipeline is owned and operated by the Goleta West Sanitary District (GWSD.

The purpose of the inspections was to locate and identify pipes with indications of wall loss, leaks, and gas pockets. Corrosion or thinning of the pipe's wall is the primary cause of failure in metallic pipelines. Because the only structural component is the pipe wall itself, any loss in cross-sectional area due to corrosion has an immediate impact on the overall strength of the pipe. Structural and finite element analyses, completed as part of this scope, provide information regarding the structural capacity of a distressed pipe under its current loading conditions. With an electromagnetic baseline and a detailed structural analysis, the significance of identified wall loss anomalies may be understood and put into context. These inspections and analyses are outlined in the following sections.

For further information on the PipeDiver tool and SmartBall tool along with inspection details, see the full reports as Appendix 1 and Appendix 2.

1.2. Ductile Iron Pipe

1.2.1. DIP Design and Manufacturing

Commercial introduction of DIP occurred in the mid-1950s and became the material of choice of cast iron for ferrous pressure pipe by the early 1970s. Ductile iron is produced by adding specified amounts of magnesium, cerium, or sodium alloy to the molten iron with low phosphorus and low sulfur content. The magnesium alloy changes the microstructure by causingthe elemental carbon to form spheroidal or nodular graphitic shapes contrasting with the flake form found in spun-cast iron. This consistent microstructure of spheroidal graphite when combined with an annealing process increases both the strength of the iron and its ductility. Therefore, the wall thickness of DIP is significantly less than its predecessor while providing the same structural capacity.

The design of pressurized DIP is controlled by ANSI/AWWA C150/A21.50. The net thickness required is determined from three considerations, limiting stress in the pipe wall due to internal pressure (working and surge), and separately external load (soil and traffic), and finally limiting the horizontal deflection of the pipe. The latter is primarily intended to prevent cracking of a cement mortar lining. For internal pressure, the hoop tensile stress is limited to 50% of the minimum yield strength (42 ksi), and for external load the bending stress is limited to either 50% of the design bending stress (48 ksi) or 66.7% of the minimum yield strength.

One of the challenges in assessing DIP is determining if the pipe has undergone any loss of wall due to internal or external corrosion. The reason for this difficulty relates to the manufacturing process and the casting thickness tolerances established in AWWA C151. Table 1.1 lists the casting thickness tolerance for the various diameters.

Table 1.1: DIP Casting Tolerance

Diameter of Range, inches	Casting Tolerance, inches
3-8	0.05
10-12	0.06
14-42	0.07
48	0.08
54-64	0.09

DIP manufacturers do not publish or release information on their actual manufacturing tolerances. However, Pure Technologies has observed through multiple condition assessment projects for DIP that most of the variance is apparent along the length of the barrel rather than around the circumference. This is related to the casting process where the molten iron is fed into a spinning mold and centrifugal force is used to distribute the iron around the circumference. There is no maximum thickness tolerance in AWWA C151. It is therefore reasonable to expect to see a similar thickness distribution on the plus side of the nominal.

As such, the 24-inch DIP for this project could have a manufacturing thickness variance of up to 0.07-inches below and above the nominal thickness. This wide variance makes it very difficult to carryout insitu wall thickness (or stiffness) measurements and produce conclusive evidence that wall loss has occurred without visual confirmation. Measured thicknesses would have to be in excess of this manufacturing tolerance to conclusively determine that wall loss has occurred. Therefore, unless significant wall loss is observed through initial condition assessment activities, the data should be used as a baseline and compared to future inspection results to develop a higher confidence in management and rehabilitation/replacement strategies. A typical DIP cross section can be seen in Figure 1.1.

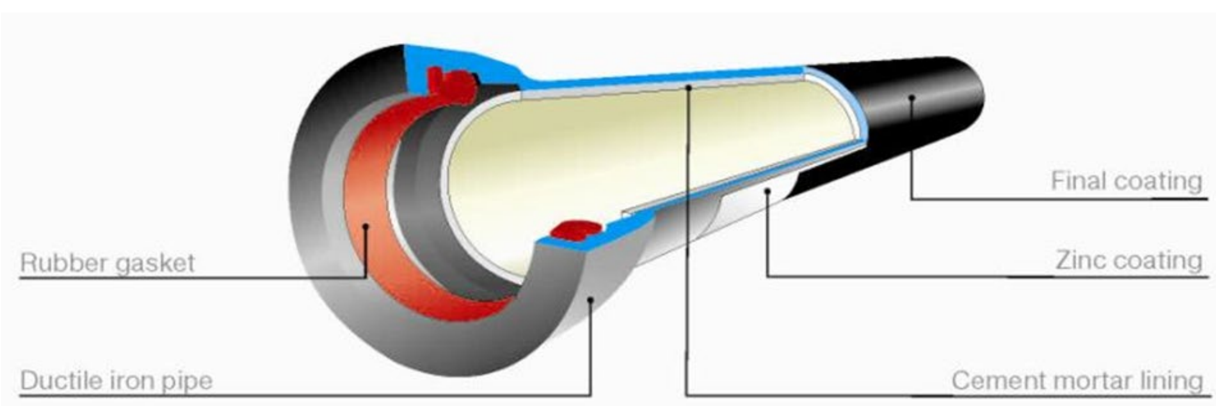

Figure 1.1: Cross Section of a DIP

1.2.2. DIP Failure Modes

The primary causes of failure of DIP are related to external and/or internal corrosion. DIP in water service with a cement mortar lining has not generally experienced many problems associated with internal corrosion. Only if the lining is damaged during handling and installation, or later as a result of 3rd party damage (impact on outer surface) would one expect to see any internal corrosion in a water pipe. The external corrosion rate is typically several orders of magnitude higher than any internal corrosion rate, even on a bare pipe, so external corrosion is the primary failure mechanism for DIP in a water application. This is not the case when DIP is used in a force main application. Based on a survey conducted as part of a Water Environment Research Foundation's Inspection Guidelines for Wastewater Force Mains, internal corrosion is the primary cause of failure for force mains (see Figure 1.2).

Naturally, there can also be contributing factors such as manufacturing, design, operational and installation defects that could lead to a premature failure in DIP. It is difficult to inspect and assess against many of these other "hidden" defects, other than monitoringthe pressures in the pipeline to confirm that working pressures and occasional surges do not exceed the design limits for the class used.

1.2.2.1. Internal Corrosion

Internal corrosion is the primary source of failure for DIP force mains; therefore, surveys to identify areas with the highest probability for corrosion are critical. Gas pockets in force mains are of significant concern as concentrations of hydrogen sulfide gas within wastewater may be released from solution into the atmosphere and subsequently converted to sulfuric acid by bacteria in the slime layer on the pipe wall that may cause corrosion and eventual breakdown of the pipe's exposed surface. Figure 1.2 provides an example of hydrogen sulfide corrosion of a DIP. As part of Pure Technologies database of force main condition assessment, Pure Technologies has found that over 70% of gas pockets as detected by inline acoustic methods are not located at expected high points. Section 2.4 provides supporting evidence to this for both the 18-inch Asbestos pipeline and 24-inch DIP.

1.2.2.2. External Corrosion

DIP, like most metals, wants to revert back to a lower energy state, typically an oxide of the metal. This thermodynamic process is called corrosion and for DIP at ambient temperatures in an aqueous environment (i.e., the electrolyte) is electrochemical in nature. Underground corrosion of unprotected ferrous pipes is often the result of differential corrosion cells, where the oxidation and reduction reactions are physically separated, but can occur at the same site. For differential corrosion there must be an anode (oxidation reaction), cathode (reduction reaction), a metallic path electrically connecting the anode and cathode (i.e., the pipe itself) and the cells must be immersed in an electrically conductive electrolyte, which is the moist soil normally.

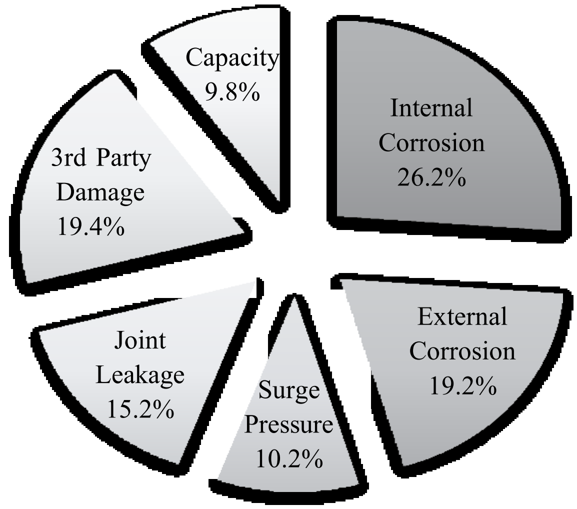

Figure 1.2: Internal Corrosion of DIP (left) and Dip Failure Modes (right)

2. Leak and Gas Pocket Inspection Results

2.1. Overview

Pure Technologies performed two (2) SmartBall® inspections of the 18-Inch Asbestos Concrete Pipe (ACP) pipeline and 24-Inch DIP pipeline, both owned by Goleta West Sanitary District (GWSD), on December 10, 2024. The scope of the SmartBall inspection included leak detection and gas pocket detection. The SmartBall inspection details and results are presented in Table 2.1 while the full report including inspection details can be found in Appendix 1.

Table 2.1: SmartBall Inspection Details and Results

Pipeline Name	18-Inch Asbestos Concrete Pipe	24-Inch Ductile Iron Pipe
Pipe Material:	ACP	DIP
Diameter of Pipe:	18 inches	24 inches
Product:	Wastewater	Wastewater
Inspection Start Location:	24-inch Blind Flange at GWSD Yard (Insertion/TL #1)	24-inch Blind Flange at GWSD Yard (Insertion/TL #1)
Inspection End Location:	Weir Well inside Wastewater Treatment Plant (Extraction/TL#7)	Weir Well inside Wastewater Treatment Plant (Extraction/TL#12)
Total Length Inspected:	9,094 feet	9,107 feet
Duration of the Inspection:	1 hour, 30 minutes	1 hour, 57 minutes
Average SmartBall Velocity:	1.7 feet/second	1.3 feet/second
Total Number of Leaks:	0	0
Total Number of Acoustic Anomalies:	0	1
Total Number of Static Air Pocket/Trapped Gas Events:	1	9
Total Number of Gas Slugs:	4	1
Total Number of Entrained Air Events:	0	2

2.2. Results

The data collected by the SmartBall inspection tool was internally peer reviewed to verify that all acoustic events were detected and accurately classified. There were no acoustic events resembling leaks detected during the inspection.

2.2.1. Acoustic Anomaly

Table 2.2 provides a detailed summary of the acoustic anomaly detected by the SmartBall tool.

Table 2.2: Summary of Acoustic Anomalies (24-Inch Ductile Iron Pipe)					
Acoustic Anomaly Number	**Time of Tool Pass**	**Nearest Tracking Feature**	**Distance from Nearest Tracking Feature**	**Comments**	**Confidence in Location**
Acoustic Anomaly #1	11:56:30 AM	Manhole – Exposed Pipe	118 feet downstream of Manhole – Exposed Pipe (TL #9)	Acoustic signal suspected external to pipeline, potentially from nearby roadway or airport. No anomaly was detected during the 18-inch ACP in this area.	High

Confidence in Location

- *High – Acoustic event is within tracking data, OR a nearby feature is visible in* <u>*both*</u> *the data and field and rolling motion of the inspection tool is consistent.*
- *Medium – Acoustic event is outside the tracking data and* <u>*either*</u> *the rolling motion of inspection tool is consistent or a nearby feature is visible in* <u>*both*</u> *the data and field.*
- *Low – Acoustic event is outside of tracking data and rolling motion of the tool is inconsistent OR discrepancies in pipeline alignment between SmartBall data and client supplied information.*

2.2.2. Air Events

Table 2.3 and Table 2.4 provides a detailed summary of the gas pocket and migratory acoustic events detected during the inspection by the SmartBall technology. It is important to note that the presence and capacity of events detected during the inspection may change under varying operating conditions.

Table 2.3: Summary of Air Events (18-Inch Asbestos Concrete Pipe)						
Gas Pocket, Gas Slug, Entrained Air	**Length [feet]**	**Distance from Insertion (Start of Pocket) [feet]**	**Distance from Insertion (End of Pocket) [feet]**	**Nearest Tracking Feature**	**Distance from Nearest Tracking Feature**	**Confidence in Location**
Gas Slug #1	~41	42	83	10-inch Gate Valve (Insertion)	41 feet downstream of 10-inch Gate Valve (Insertion/TL #1)	Medium
Gas Slug #2	~9	118	127	10-inch Gate Valve (Insertion)	118 feet downstream of 10-inch Gate Valve (Insertion/TL #1)	Medium
Gas Pocket #1	~18	127	145	10-inch Gate Valve (Insertion)	127 feet downstream of 10-inch Gate Valve (Insertion/TL #1)	Medium
Gas Slug #3	~40	155	195	Manhole – Exposed Pipe	121 feet upstream of Manhole – Exposed Pipe (TL #3)	Medium
Gas Slug #4	28	8,996	9,024	Meter Vault – Exposed Pipe	11 feet upstream of Meter Vault – Exposed Pipe (TL #6)	Medium

Table 2.4: Summary of Air Events (24-Inch Ductile Iron Pipe)						
Gas Pocket, Gas Slug, Entrained Air	**Length [feet]**	**Distance from Insertion (Start of Pocket) [feet]**	**Distance from Insertion (End of Pocket) [feet]**	**Nearest Tracking Feature**	**Distance from Nearest Tracking Feature**	**Confidence in Location**
Gas Pocket #1	~50	717	767	Exposed Pipe	185 feet upstream of Exposed Pipe (TL#4)	Medium
Gas Pocket #2	~13	2,544	2,556	Exposed Pipe	567 feet upstream of Exposed Pipe (TL#5)	Medium
Entrained Air #1	~10	2,620	2,630	Exposed Pipe	491 feet upstream of Exposed Pipe (TL#5)	Medium
Entrained Air #2	~81	2,828	2,909	Exposed Pipe	282 feet upstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #3	~15	2,909	2,925	Exposed Pipe	201 feet upstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #4	~22	2,929	2,951	Exposed Pipe	182 feet upstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #5	~7	3,600	3,607	Exposed Pipe	489 feet downstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #6	~11	4,576	4,587	Exposed Pipe	3 feet upstream of Exposed Pipe (TL #6)	Medium
Gas Pocket #7	~38	7,008	7,045	Manhole - Exposed Pipe	103 feet upstream of Manhole - Exposed Pipe (TL #8)	Medium
Gas Pocket #8	~17	8,714	8,731	Meter Vault – Exposed Pipe	310 feet upstream of Meter Vault – Exposed Pipe (TL #11)	Medium
Gas Slug #1	~250	8,773	9,024	Meter Vault – Exposed Pipe	250 feet upstream of Meter Vault – Exposed Pipe (TL #11)	Medium
Gas Pocket #9	~23	9,024	9,048	Meter Vault – Exposed Pipe	1 foot downstream of Meter Vault – Exposed Pipe (TL #11)	Medium

Confidence in Location

- *High – Acoustic event is within tracking data, OR a nearby feature is visible in both the data and field and rolling motion of the inspection tool is consistent.*
- *Medium – Acoustic event is outside the tracking data and either the rolling motion of inspection tool is consistent or a nearby feature is visible in both the data and field.*
- *Low – Acoustic event is outside of tracking data and rolling motion of the tool is inconsistent OR discrepancies in pipeline alignment between SmartBall data and client supplied information.*

2.3. Aerial View of Events

Figure 2.1 and Figure 2.2 show an aerial overview of the inspection results.

Figure 2.1: Aerial View of 18-Inch Asbestos Concrete Pipe with Location of Results

Figure 2.2: Aerial View of 24-Inch Ductile Iron Pipe with Location of Results

2.4. Gas Pocket Locations

Static gas pockets can contribute to the formation of Hydrogen Sulfide gas (H_2S), which is the number one cause of failure in wastewater pipelines. As part of the condition assessment, Pure Technologies reviewed the locations of static gas pockets in both pipelines compared to the plan and profile drawings to determine if any air release valves (ARV) are present or may not be functioning properly. Recommendations based on the analysis below can be found in Section 5.2.

2.4.1. 24-inch Ductile Iron Pipe Pipeline

For the 24-inch DIP pipeline, nine (9) gas pockets were detected at various locations. To translate the gas pocket locations to the plan and profile drawings, Pure Technologies used a combination of the SmartBall results in Table 2.4 and the stationing used in the drawings. Since the PipeDiver and SmartBall were inserted ~90-feet before leaving the Valve Vault (Station 0+00), Pure Technologies took the footage locations in Table 2.4 and subtracted 90-feet to come up with a station number on the plan and profile drawings.

For example, Gas Pocket #1 was 717-feet until 767-feet from insertion of the SmartBall. Subtracting 90-feet from 717-feet, the Gas Pocket is estimated to be 627-feet from the exit of the Valve Vault (Station 0+00), meaning the gas pocket would translate to Station 6+27 to 6+77.

Note that this method is approximate, and station locations can vary. A GIS deliverable with these aerial locations has been provided upon submittal of the SmartBall report. The results of the comparisons are summarized in Table 2.5.

Table 2.5: Summary of Gas Pockets (24-Inch Ductile Iron Pipe)

Gas Pocket	Length [feet]	Distance from Insertion [feet]	Approximate Calculated Stationing	Description of Location
Gas Pocket #1	~50	717	6+27 to 6+77	Located at steeper positive slope (S=0.433); Drawings indicate an ARV at STA 6+80; Ensure ARV is functioning correctly
Gas Pocket #2	~13	2,544	24+54 to 24+67	Drawings indicate an ARV was removed and plugged at ~Station 24+20
Gas Pocket #3	~15	2,909	28+19 to 28+34	Zero slope (S=0); No obvious features
Gas Pocket #4	~22	2,929	28+39 to 28+61	Zero slope (S=0); No obvious features
Gas Pocket #5	~7	3,600	35+10 to 35+17	Zero slope (S=0); No obvious features
Gas Pocket #6	~11	4,576	44+86 to 44+97	Drawings indicate an ARV at Station 45+10; Ensure ARV is functioning correctly
Gas Pocket #7	~38	7,008	69+18 to 69+56	Slight positive slope (S=+0.00176); No obvious features
Gas Pocket #8	~17	8,714	86+24 to 86+41	Drawings conclude at STA 86+02; Ensure ARV at STA 84+43 is functioning correctly
Gas Pocket #9	~23	9,024	89+34 to 89+57	Drawings conclude at STA 86+02; Ensure ARV at STA 84+43 is functioning correctly

2.4.2. 18-inch Asbestos Pipeline

For the 18-inch Asbestos pipeline, one (1) gas pocket was detected. To translate the gas pocket location to the plan and profile drawings, Pure Technologies used a combination of the SmartBall results in Table 2.3 and the stationing used in the drawings. Based on the drawings, Station 0+00 appears to be right after the 90-degree bend, meaning the SmartBall was inserted ~31-feet before Station 0+00. Therefore, 31-feet has been subtracted from the distance from insertion column in Table 2.6 to get an estimated station number. The results of the comparisons are summarized in Table 2.6.

As with Section 2.4.1, note that this method is approximate, and station locations can vary. A GIS deliverable with these aerial locations has been provided upon submittal of the SmartBall report.

Table 2.6: Summary of Gas Pocket (18-Inch Asbestos Pipe)

Gas Pocket	Length [feet]	Distance from Insertion [feet]	Approximate Calculated Stationing	Description of Location
Gas Pocket #1	~18	127	1+09 to 1+27	Slight positive slope (+0.59%); Closest ARV at Station 2+93 is ~166 feet away

3. Electromagnetic Inspection Results

3.1. Electromagnetic Inspection Results

Electromagnetic data was collected on December 11, 2024, and February 5, 2025, for the 24-inch Ductile Iron Pipeline using the PipeDiver electromagnetic inspection platform. The inspected section spanned an overall distance of 1.64 miles and a total of 493 fully inspected pipes and 2 partial pipes. Pure Technologies' inspection schedule is presented in Table 3.1. The full PipeDiver report including inspection details can be found in Appendix 2.

Table 3.1: Inspection Summary

Date	Pipeline	Pipe Material	Start Station	End Station	Distance
December 11, 2024 and February 5, 2025	24-inch Ductile Iron Pipeline	DIP	N/A	~85+71	**1.64 miles**

'N/A' is reported as the start station due to unavailability of pipe laying schedules and plan and profile drawings.
'~' Station number approximated from plan and profile drawings and electromagnetic data.

3.1.1. Pipes with Pipe Wall Anomalies

Of the 493 fully inspected pipes and 2 partially inspected pipes, one (1) pipe has electromagnetic anomalies consistent with pipe wall loss with an estimated 60 percent of an assumed 0.38-inch nominal pipe wall thickness, with an estimated area of 20 square inches. Table 3.2 details the pipe wall anomaly.

- 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 Anomaly Longitudinal Position is measured from the upstream station joint of the pipe to the center of the anomaly and is rounded to the nearest 0.5 feet.
- The Anomaly Circumferential Position is looking towards the downstream station joint and is rounded to the nearest 5 degrees. The 12 o'clock position is 0 degrees. Refer to Figure 2.2 for the radial layout of circumferential degrees and clock position.
- The Anomaly Area is based on the longitudinal length and the number of sensors that detected the anomaly. The anomaly is assumed to be square and is rounded to the nearest square inch.
- The Estimated Depth of Wall Loss is the average estimated percentage of relative pipe wall thickness across the anomaly area based on Pure Technologies' calibration testing performed at other sites and is rounded to the nearest 5 percent.

Wall loss anomalies identified in the electromagnetic data are quantified by calculating the overall volumetric loss of the metallic pipe wall. To better visualize the volumetric loss, the anomaly is reported as an estimated square area and percentage of relative loss of wall thickness across the anomaly area. Anomalies with a large area and shallow depth of wall loss will have similar

characteristics in the electromagnetic data as anomalies with a smaller area and deeper depth of wall loss.

The estimated size of wall loss anomalies is dependent on the proximity of the exciter and detector coils located on the PipeDiver inspection platform to the pipe wall. Calculations of the area and the depth of pipe wall anomaly is based on calibration testing at other sites, which assumes that the PipeDiver inspection platform was centered in the pipeline during the inspection. A visual representation of the electromagnetic data of the pipe identified to have pipe wall loss is detailed in Section 3.1.2.

Table 3.2: Pipes with Anomalies Consistent with Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Anomaly Longitudinal Position (feet from Upstream Station)	Anomaly Circumferential Position (degrees - looking toward Downstream Station)	Anomaly Area (square inches)	Estimated Depth of Pipe Wall Loss (% of nominal thickness)
10105	16+27	18	10.5	100	20	60

The electromagnetic data signal is sensitive not only to physical differences in pipe properties, but it is also sensitive to any magnetic differences in the metallic components of the pipe. Variations of a pipe's magnetic properties results in variations in the electromagnetic data, which can impact the detection capabilities and accuracy in the estimations of the pipe wall loss anomaly. In some cases, metallic pipe design standards account for some of these manufactured dimensional or material property tolerances. For instance, according to American Water Works Association's (AWWA) C150 Design Standard, ductile iron pipe may be manufactured with a certain wall thickness tolerance, varying from 0.05 to 0.09 inches depending on diameter, which may vary from pipe to pipe or along the length of one individual pipe.

Several pipes in the collected data were affected by noise and changes in pipeline flow. As a result, large signal variations are observed in the data, affecting the overall data quality. The affected pipes are listed in the Pipe List (Appendix B of Appendix 2) and the results for these pipes are reported with less certainty.

3.1.2. Electromagnetic Pipe Diagrams

To visualize the results, two-dimensional rollout graphs were created to illustrate the recorded electromagnetic data of the pipe identified with pipe wall loss defect.

Each figure below is laid out as if the pipes are split down the length of the crown and rolled out flat. The X-axis represents the distance, in feet, from the upstream station joint of the pipe. The Y-axis denotes the circumferential position of a pipe with reference to the clock position, where 12 o'clock represents the crown of the pipe and 6 o'clock represents the invert of the pipe. Figure 3.2 shows the radial layout of circumferential degrees and clock position when looking toward downstream joint.

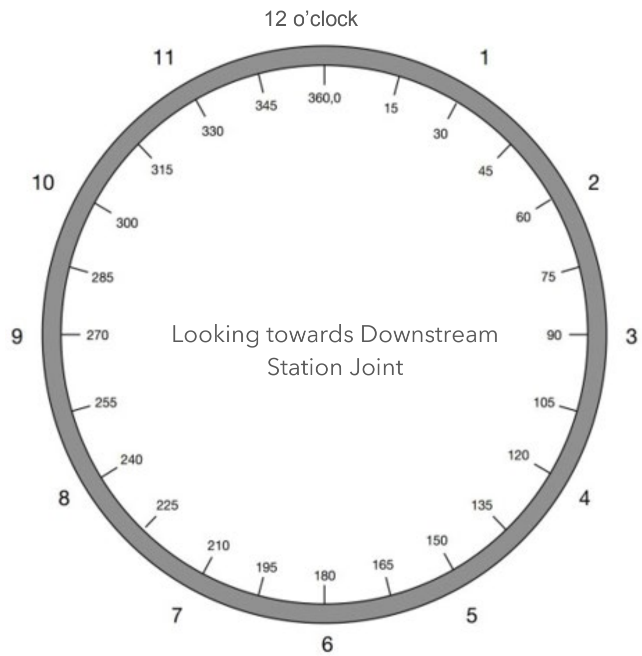

Figure 3.2: Radial Layout of Circumferential Degrees and Clock Position

The rollout graphs for the identified pipe wall anomaly in the 24-inch Ductile Iron Pipeline is presented in Figure 3.3. The colors in this figure are meant for reference only to indicate the longitudinal and circumferential location of the anomaly on the pipe and cannot be used to infer pipe depth. The red color represents the location of the identified pipe wall loss defect.

Pure Reference Number 10105

Pipe rollout graph:

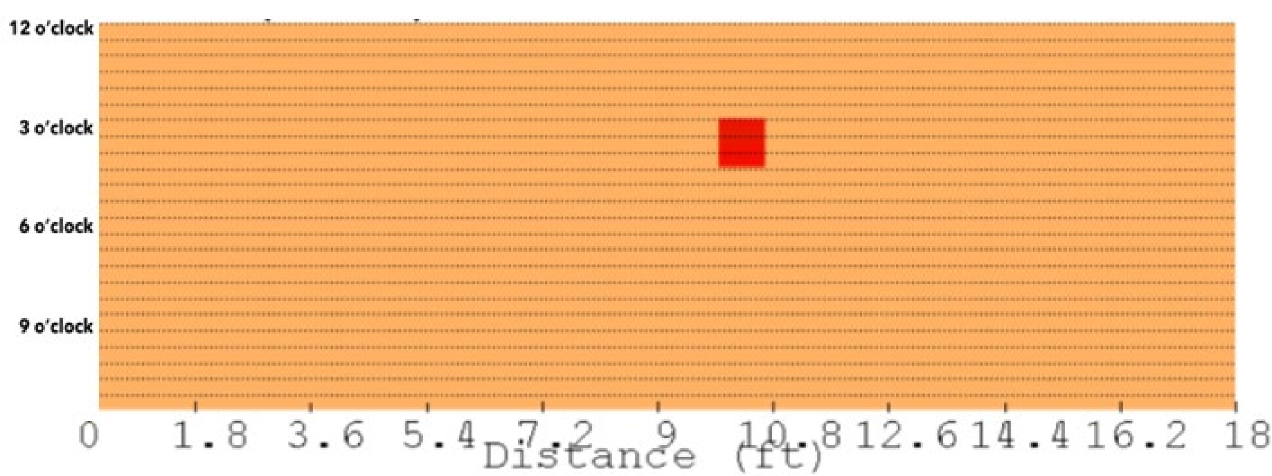

Figure 3.3: Pipes with Wall Loss Anomaly

3.2. Locating Pipes with Defects

An important part of the data analysis process is correlating the PipeDiver data to the physical pipe in which it was collected. Because the tool is free-swimming and does not have an odometer, data is collected in the time-domain and distances are derived through correlating identifiable features in the data to known locations on the pipeline. Examples of features that can be identified in the electromagnetic data and used as correlation points are inline valves, bends or outlets as well as tracking points. An example of data correlation from another pipeline is illustrated in Figure 3.4. Between these known locations, distances are derived assuming that the tool is travelling at constant velocity and that the distance between the locations is correct.

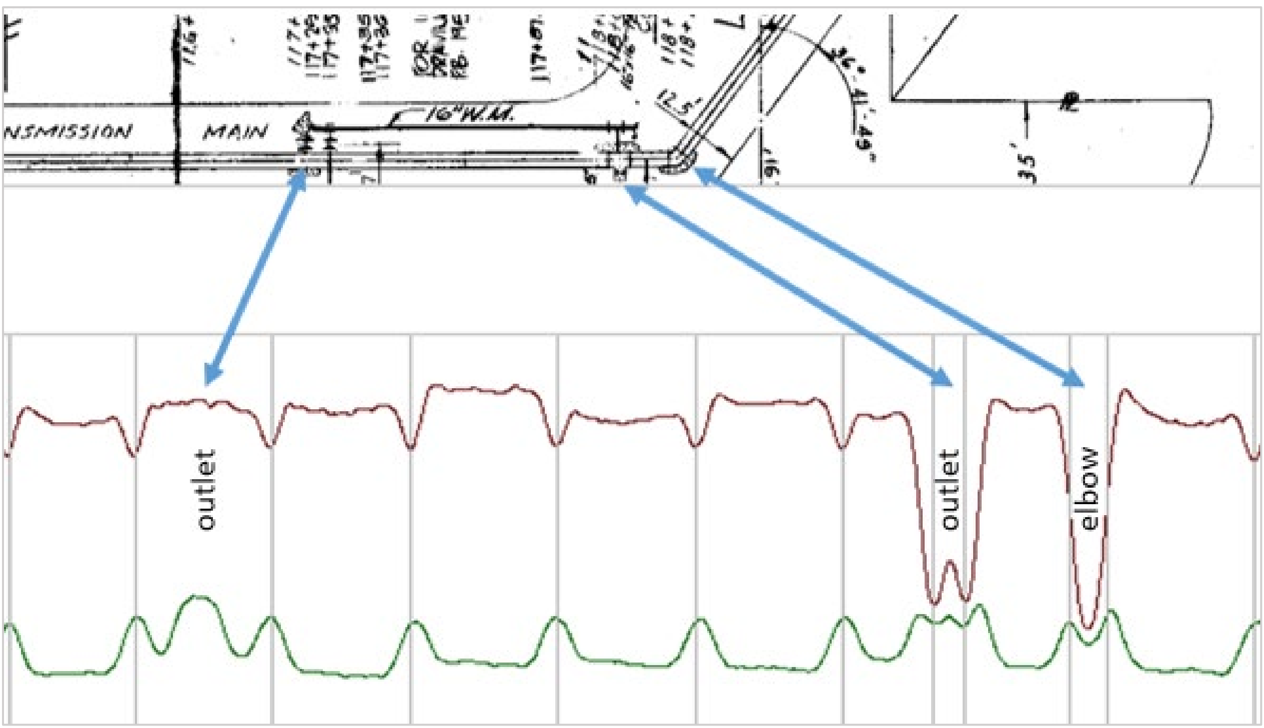

Figure 3.4: Data Correlation Example from Another Pipeline

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 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 is available to assist with any excavations or investigation. Please contact Pure Technologies for assistance. The Pipe List can be found in Appendix 2.

3.3. Quantification of Defects through Calibration

Effective quantification of defects identified in electromagnetic data requires knowledge of how the electromagnetic signal behaves without pipe damage (baseline condition) and the ability to compare that baseline condition to the data signal received from the pipe when it is damaged. Because the data signal is sensitive to pipeline properties (e.g. pipe wall thickness, material, class, pipe diameter, etc.), two (2) pipes with the same diameter, but with different classes, will exhibit different baseline signals. Additionally, these pipes will produce signals that respond differently to wall loss.

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., material, diameter, wall thickness, 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 systematically varying the size of the wall loss defects and recording the response. The results from the calibration testing are incorporated into Pure Technologies' analysis software. At this point, an experienced data analyst can measure an anomaly signal and compare it to the calibration information to quantify the size and depth of the wall loss defects.

While the calibration process was not performed on pipes from the 24-inch Ductile Iron Pipeline, wall anomalies that were identified are based on calibration testing on metallic pipes at other sites. As such, the minimum size of a wall loss anomaly detectable by Pure Technologies' electromagnetic tool for the 24-inch Ductile Iron Pipeline is estimated to have 30 percent wall loss and longitudinal length of 3 inches.

If a wall loss anomaly is smaller than the minimum size stated above, detection may be possible only when the sensor is close to the anomaly (i.e., sensor passes directly under the anomaly).

However, as the nominal thickness of the pipe wall for pipes in the 24-inch Ductile Iron Pipeline is not available, the estimated depth of wall loss has been quantified with elevated uncertainty.

If the wall thickness is provided and relevant calibration information is available, or field validations are performed on any pipes from the 24-inch Ductile Iron Pipeline at a future date, the results can be applied to the data from this inspection and the depth of the pipe wall loss anomaly may be revised.

For more details regarding the calibration process, electromagnetics capabilities, limitations, and functions, refer to Appendix 2.

3.4. Confidence Codes in Pipe List

The PipeDiver inspection platform's capability to detect and quantify pipe wall loss anomalies is impacted by pipeline flow velocity, gas pockets in the pipeline, the availability of calibration information, and availability of as-built specifications. If inspection conditions are not optimal, then the results may be reported with less certainty.

The analysts' confidence in the identification and quantification of pipe wall loss anomalies is reported on a pipe-by pipe basis using "confidence codes" in the Pipe List in Appendix B in Appendix 2.

3.4.1. Confidence Codes for Detection of Pipe Wall Loss

The speed at which the inspection tool is traveling through the pipeline impacts the electromagnetic data quality. The minimum size of a pipe wall loss anomaly detectable by Pure Technologies' electromagnetic tool is expected when the optimal flow velocity of 1.0 foot/second is achieved for each inspection run. When the optimal flow velocity is not achieved for one (1) or more inspection runs, the minimum size of pipe wall loss anomaly detectable by the Pure Technologies' electromagnetic tool may be larger than expected. A confidence ***color*** code is used in the Pipe List to represent how the pipeline flow during the inspection affected data analysis.

3.4.2. Confidence Codes for Quantification of Pipe Wall Loss

The availability of calibration information and pipe specifications of the inspected pipeline affect the analysts' ability to accurately quantify pipe wall loss. A confidence ***number*** code may be assigned to pipes with identified pipe wall loss in the Pipe List based on the availability of calibration information and pipe specifications.

4. Structural Evaluation

The primary purpose of the structural analysis performed is to provide the minimum required thickness for the DIP to withstand the internal and external loads based on the AWWA C150 Standard as well as provide context to the remaining structural capacity of the pipe with distress.

4.1. Design Specifications

No detailed drawings of the pipe design were available for the 24-inch DIP. Therefore, Pure Technologies used the installation year of 1978 from the plan and profile drawings to assume the design properties for the calculations (Table 4.1). This was done by first digitizing the plan and profile drawings to determine earth cover along the pipeline, then using operating pressures provided by GWSD to assume the most conservative pipe design based on the AWWA C150 – 1976 standard. Within that standard Pure Technologies used the thinnest pipe class available for 24-inch DIP based on all parameters, Class 50, translating to a 0.38-inch wall thickness.

Another important input for the structural evaluation is the actual maximum operating pressures of the pipeline as well as pipeline flow. GWSD provided Pure Technologies with a maximum operating pressure of 25 psi (with all pumps running) and a volumetric flow of 5.8 million gallons per day (mgd) for the pipeline, which was utilized in the calculations to determine the resulting minimum wall thickness.

Table 4.1: Constants Used for Structural Analysis

Parameters	Value
Inside Diameter of the Pipe (inch)	24
Assumed Pipe Class	50
Assumed Design Thickness (inch)	0.38
Pipe Effective Length (inch)	36
Yield Strength (psi)	42,000
Volumetric Flow (cfs)	9
Design Bending Stress (psi)	48,000
Gamma of the Soil (pcf)	120
Weight of Fluid (pcf)	87.4
Gravity (ft/s^2)	32.2
Young's Modulus (ksi)	24,000
Bulk Modulus (ksi)	300
Max. Allowable Deflection (%)	3
Manning Coeff	0.011
Initial Pressure into the Pipeline (psi) Taken from GWSD correspondence	25

4.2. AWWA C150 Design Check

Pure Technologies performed a design check of the pipeline to determine the necessary wall thickness for current loading conditions. Often loading conditions change between the design of the pipe and the current day demands. Pure Technologies utilizes the DIP design standard, AWWA C150 *Thickness Design of Ductile-Iron Pipe* (AWWA C150) as well as AWWA C151 *American National Standard for Ductile-Iron, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids* (AWWA C151), the contemporary DIP manufacturing guideline. Prior to 1991, DIP was classified based on thickness class rather than by today's standard of pressure class. Thickness class designations include Classes 50 through 56 and generally as the thickness class increases, so does the minimum wall thickness and associated pressure/loading capacity.

Using the equations presented in the current design standard for DIP, Pure Technologies calculated the minimum pipe wall thickness required to withstand both internal pressure and external loading along the length of the pipeline. Since internal pressure and external load act in opposite directions, they are analyzed as separate loading conditions with the higher required thickness governing.

Since the only structural component of a DIP is the ductile iron itself, any loss of cross-sectional area due to corrosion has an immediate impact on the overall strength of the pipe. Calculating the required thickness and comparing that to the measured thicknesses for each pipe can show which pipes have an available factor of safety should corrosion wall loss occur, and which pipes are more likely to fail should any damage to the ductile iron take place. Checking the minimum required thickness per the design criteria gives a first level of understanding the current conditions and the significance of any damage found.

4.2.1. Design Check Results

Using the AWWA C150 standard, the conservative assumption for the nominal wall thickness for the DIP was Class 50, or 0.38-inches. Using the equations in the AWWA C150, the minimum required thickness, including a +/- 0.07-inch service allowance, for each pipe was calculated.

Based on the AWWA C150 design and loading conditions, the nominal wall thickness of 0.38-inches is not adequate over the entire length of the inspected pipeline. The results are graphically shown in Figure 4.1 where the nominal (assumed) thickness is shown in as a blue line and there is one (1) point in which the red line exceeds the assumed wall thickness. This point is where the most extreme earth loading condition exists on the pipeline where there is 13.34-feet of earth cover at Station 85+00.

According to the 1976 AWWA C150 standard, Class 50 pipe has a maximum depth of cover of 31-feet with 'Type 5' laying conditions and a maximum depth of cover of 8-feet with 'Type 1' laying conditions. For this analysis, the pipeline was assumed to have 'Type 2' laying conditions, or a maximum depth of cover of 12-feet. It is likely this pipe was installed with a greater than a 'Type 2' laying condition.

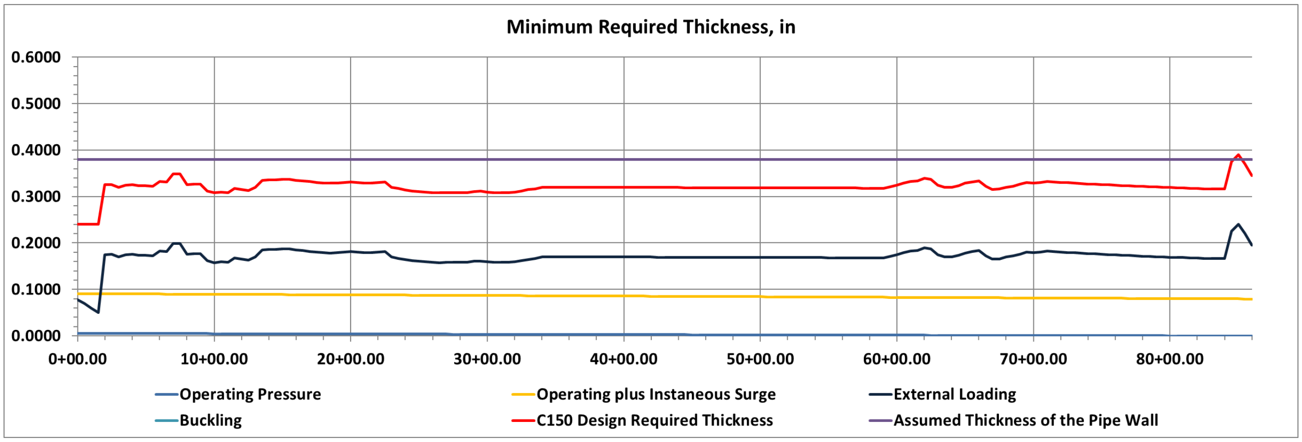

Figure 4.1: AWWA C150 Structural Design Check

Using the design check to assess the severity of the defects is a very conservative way to evaluate their significance. The impact of the significance in this case assumes that the wall loss applies to the entire circumference of the pipe. To more accurately determine the structural impact of a defect, an FEA model was developed and is presented in Section 4.3.

4.3. Finite Element Analysis

To develop actionable information from data generated during the non-destructive field testing, Pure Technologies has developed a condition-based pipeline management model based on structural evaluation of DIP. This model incorporates data from the operation of the pipeline, drawings, depth of cover, and industry design specifications. The results of this model are presented in a pipeline condition curve that allows for both the localized and systemic condition evaluation of the pipeline. This curve represents the Yield Limit of the ductile iron force main along its length, which identifies the specific wall thickness required to remain in the elastic zone.

The establishment of minimum wall thickness for the DIP is performed using a design check in accordance with ANSI/AWWA C150/A21.50, which provides guidance for the minimum wall thickness based on several operational factors including operating and surge pressure, pipe embedment type, depth of cover, and live load conditions. Along with depth of cover, pressure is one of the primary data inputs when conducting a structural evaluation of DIP. When pipe wall degradation is combined with the operational pressure or surge pressure, the likelihood of failure can be significantly increased.

During the FEA, the corrosion model was subjected to internal pressure, pipe and fluid weights, and external loads while varying both the longitudinal length of the corrosion defect areas and the amount of wall loss. Figure 4.2 shows an example of the 3D mesh used for the corrosion model. Corrosion was around the 100-degree position (looking towards downstream joint) at 10.5-feet from the upstream station.

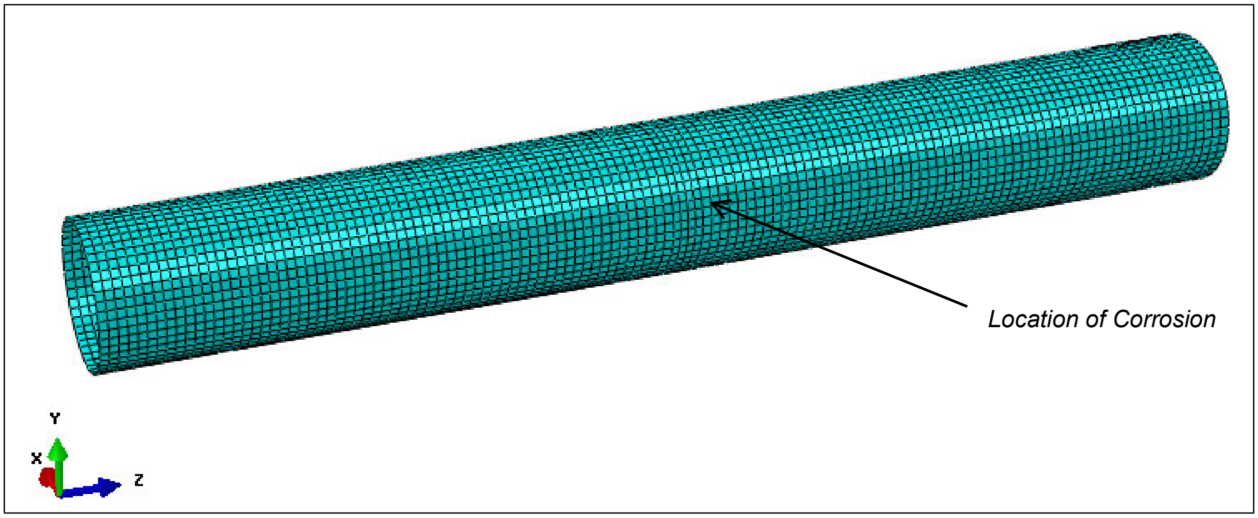

Figure 4.2: 3D Mesh of DIP Model

4.3.1. FEA Results

A finite element model was created using the design properties found in Table 4.1. This model subjects the distressed pipes to internal and external loading to achieve a curve that will determine the pipe design's Yield Limits based on pressure, earth/live loading, and pipe wall defect depth and dimension. The Yield Limit identifies the specific wall thickness required to maintain an un-deformed state, the elastic zone. This parameter is used to determine the risk of failure for wall loss defects on the pipeline. Any wall thickness measurements less than this limit should be considered for rehabilitation or replacement.

A FEA curve is applicable for defects with an earth cover range of +/- two (2) feet. The plan and profile drawings were used to determine the earth cover for the identified distressed pipe, Pure Reference Number 10105 at 4.25-feet. The FEA curve used the specific distress information provided in Table 4.2 to create the pipe performance curve.

Table 4.2: Pipes with Anomalies Consistent with Wall Loss						
Pure Reference Number	Upstream Station	Pipe Length (feet)	Anomaly Longitudinal Position (feet from Upstream Station)	Anomaly Circumferential Position (degrees - looking toward Downstream Station)	Anomaly Area (square inches)	Estimated Depth of Pipe Wall Loss (% of nominal thickness)
10105	16+27	18	10.5	100	20	60

Figure 4.2 presents the results of the FEA on Pure Reference Number 10105; the pressures and defect lengths can be evaluated on the graph to determine respective Yield. Note that the defect area is assumed to be a circle, meaning the length of the corroded area is the diameter of that circle. Therefore, 20 square inches would be a ~5-inch corroded area.

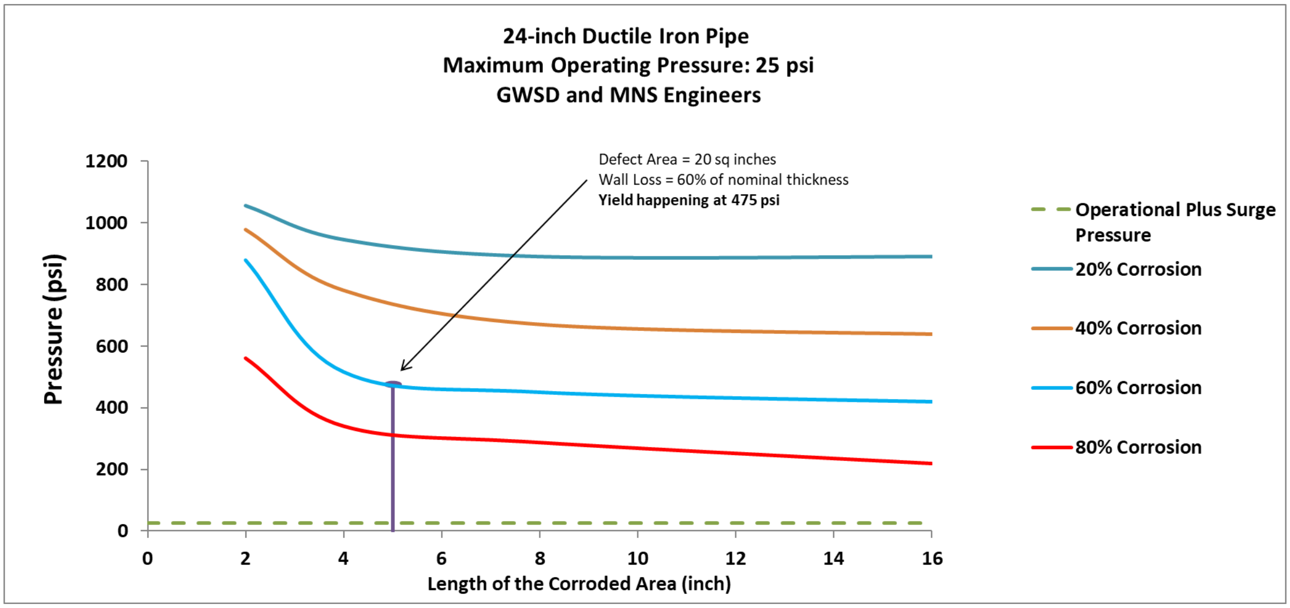

Figure 4.2: Finite Element Analysis Results for Pure Reference Number 10105

When evaluated at 25 psi, the yielding of the pipe could occur in several scenarios. The first being if the pipe experiences pressures of 475 psi and the second being if the length of the corroded area continues to grow greater than 16 inches. Finally, a combination of both can occur.

Although the defect area and percent wall loss on the FEA are below the yield, note that Section 3.3 presents that wall loss defects are quantified by calculating the overall volumetric loss of the metallic pipe wall. Anomalies with a large area and shallow depth of wall loss will have similar characteristics in the electromagnetic data as anomalies with a smaller area and deeper depth of wall loss. Therefore, although 60-percent corrosion and 20 square-inches is Pure Technologies best volumetric estimation, the corrosion percentages and area may be higher or lower than this estimation. With electromagnetic technologies, Pure Technologies only reports anomalies as an estimated square area and percentage of relative loss of wall thickness across the anomaly area to better visualize/translate the volumetric loss. With ultrasonic technologies, these dimensions are better distinguished.

With this knowledge, Pure Technologies ultimately recommends an external investigation and repair or replacement consideration of this pipe given the uncertainty of the pipe specifications, the volumetric assumption, and that the pipe appears to be in an area where excavation is possible with relatively low earth cover.

5. Conclusions and Recommendations

5.1. Conclusions

Based on analysis of the data recorded during the SmartBall inspections of the 18-inch ACP and 24-inch DIP, Pure Technologies concludes the following:

- There were no acoustic events resembling leaks detected during the inspections.
- There was one (1) acoustic anomaly identified on the 24-inch DIP. Based on the acoustic signal, this anomaly is suspected to be external to the pipeline, potentially from the nearby roadway or airport. No anomaly was detected during the 18-inch ACP inspection in this area.
- Several gas pockets, gas slugs, and entrained air events were detected throughout both pipelines. While the presence and capacity of entrained air and gas slugs detected during the inspection may change under varying operating conditions, note that these events and static gas pockets can contribute to the formation of Hydrogen Sulfide gas (H_2S), which is the number one cause of failure in wastewater pipelines.

  Section 2.4 outlines the approximate static gas pocket locations including correlation to the plan and profile drawings. In general, it is recommended that the locations of the static gas pockets be reviewed to determine their source, and all air release valves are checked to ensure proper functionality.

Based on the PipeDiver inspection carried out on December 11, 2024, and February 5, 2025, Pure Technologies concluded that:

- One (1) electromagnetic anomaly characteristic of wall loss was detected across a total of 493 fully inspected pipes and 2 partially inspected pipes.
  - The area of wall loss was 20 square inches.
  - The wall loss anomaly has been quantified with an estimated depth of 60 percent of an assumed 0.38-inch nominal pipe wall thickness.
  - There were no associated gas pockets or leaks at this location during the SmartBall inspection.

Based on the AWWA C150 design check completed, a minimum required thickness of 0.39-inches is required at Station 85+00 for the 13.34-feet of earth cover, however, 0.38-inches is adequate across the rest of the 24-inch DIP pipeline. For this analysis, the pipeline was assumed to have 'Type 2 (Flat bottom trench; Backfill lightly consolidated to centerline of pipe)' laying conditions translating to a maximum depth of cover of 12-feet. However, this pipe likely has more compact laying conditions meaning it can handle at least 17-feet, depending on the laying conditions present.

Based on the FEA pipe performance curve made for Pure Reference Number 10105, the Yield Limit is not reached based on the loading conditions listed in Table 4.1. However, Pure Technologies recommends an external investigation and repair or replacement of this pipe given the uncertainty of the pipe specifications, the volumetric assumption (see Section 3.1.1), and that the pipe appears to be in an area where excavation is possible with relatively low earth cover.

5.2. Recommendations

Based on the synthesis of all inspections and analyses, Pure Technologies provides the following recommendations for consideration:

- Pure Technologies recommends investigating the wall loss defect on Pure Reference Number 10105 by external excavation and wall thickness testing. Upon investigation, GWSD and MNS Engineers Inc. should be prepared to repair this pipe section to mitigate the risk of failure. If repaired, Pure Technologies recommends installing an anode to the exposed pipe during the repair.
    - Since the PipeDiver technology reports volumetric wall loss, which is presented as an estimated area and average wall loss depth, it is generally recommended to validate critical defects to determine its exact size and depth, as well as identify if the wall loss is internal or external and determine if a repair is needed to mitigate the risk of failure.
    - It is also recommended to consider performing soil corrosivity at the location of Pure Reference Number 10105 and anywhere along the pipeline where the opportunity is presented to further evaluate potential causes of wall loss.
- Pure Technologies recommends ensuring all ARV's on both pipelines are working properly. Prioritization should be placed on the ARV at Station 6+80, Station 45+10, and 84+43 in the 24-inch DIP as these ARV's contain static gas pockets within close proximity as listed in Table 2.5.
- Static gas pockets can contribute to the formation of Hydrogen Sulfide gas (H_2S), which is the number one cause of failure in wastewater pipelines. Due to the majority of static gas pockets not being near ARV's and therefore are at localized high spots not indicated on the drawings, Pure Technologies recommends hydrogen sulfide monitoring in order to fully understand if any existing or future gas pockets are of concern to the pipeline.
    - If H_2S is present and at high concentrations, further action can be recommended including potential installation of new ARV's and potential additional excavations at gas pocket locations to look for internal wall loss.
- Assuming Pure Reference Number 10105 and H_2S concerns are addressed, Pure Technologies recommends the 18-inch ACP and 24-inch DIP both be reinspected and reassessed within seven (7) to ten (10) years of the 2024 inspection date. With a set reinspection date, any future deterioration or leaks can be monitored and addressed accordingly.

6. References

- American Water Works Association (AWWA), C150 *Thickness Design of Ductile-Iron Pipe* (AWWA C150), New York, NY.
- American Water Works Association (AWWA), C151 American National Standard for Ductile-Iron, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids (AWWA C151), New York, NY.
- Molnar, K. M., Finno, R. J., Rossow, E. C. (2004). Analysis of effects of deep braced excavations on adjacent buried utilities, Available at http://www.iti.northwestern.edu/publications (accessed 10 October 2005).

APPENDIX 1

SmartBall® Inspection Report

xylem
Let's Solve Water

SmartBall® Inspection Report

18-Inch Asbestos Concrete & 24-Inch Ductile Iron Pipe

MNS Engineers, Inc. and Goleta West Sanitary District

Version 2.0 – February 2025
(final)

pure TECHNOLOGIES
a xylem brand

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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:

February 20, 2025

Brian Hext — 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:

February 20, 2025

Carley Williamson — 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:

February 20, 2025

Daniel DeFever, PE — 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:

February 20, 2025

Bryon Boyd — Date

Contractual 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 MNS Engineers, Inc. and Goleta West Sanitary District and its engineering consultants and is not to be distributed to third parties without the express written consent of Pure Technologies, a Xylem brand.

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Executive Summary

MNS Engineers, Inc. (MNS Engineers) retained the services of Pure Technologies, a Xylem brand (Pure Technologies), to perform two (2) SmartBall® inspections of the 18-Inch Asbestos Concrete Pipe (ACP) line and 24-Inch Ductile Iron Pipe (DIP) line, both owned by Goleta West Sanitary District (GWSD), on December 10, 2024. The scope of the SmartBall inspection included leak detection and gas pocket detection. The SmartBall inspection details and results are presented in Table ES.1.

Table ES.1: SmartBall Inspection Details and Results		
Pipeline Name	18-Inch Asbestos Concrete Pipe	24-Inch Ductile Iron Pipe
Pipe Material:	ACP	DIP
Diameter of Pipe:	18 inches	24 inches
Product:	Wastewater	Wastewater
Inspection Start Location:	24-inch Blind Flange at GWSD Yard (Insertion/TL #1)	24-inch Blind Flange at GWSD Yard (Insertion/TL #1)
Inspection End Location:	Weir Well inside Wastewater Treatment Plant (Extraction/TL#7)	Weir Well inside Wastewater Treatment Plant (Extraction/TL#12)
Total Length Inspected:	9,094 feet	9,107 feet
Duration of the Inspection:	1 hour, 30 minutes	1 hour, 57 minutes
Average SmartBall Velocity:	1.7 feet/second	1.3 feet/second
Total Number of Leaks:	0	0
Total Number of Acoustic Anomalies:	0	1
Total Number of Static Air Pocket/Trapped Gas Events:	1	9
Total Number of Gas Slugs:	4	1
Total Number of Entrained Air Events:	0	2

A summary of results from the SmartBall inspection are presented in Table ES.2 and Table ES.3.

Table ES.2: Summary of Air Events (18-Inch Asbestos Concrete Pipe)			
Acoustic Event Number	**Length [feet]**	**Distance from Insertion (Start of Event) [feet]**	**Distance from Insertion (End of Event) [feet]**
Gas Slug #1	~41	42	83
Gas Slug #2	~9	118	127
Gas Pocket #1	~18	127	145
Gas Slug #3	~40	155	195
Gas Slug #4	28	8,996	9,024

Table ES.3: Summary of Air Events (24-Inch Ductile Iron Pipe)			
Acoustic Event Number	**Length [feet]**	**Distance from Insertion (Start of Event) [feet]**	**Distance from Insertion (End of Event) [feet]**
Gas Pocket #1	~50	717	767
Gas Pocket #2	~13	2,544	2,556
Entrained Air #1	~10	2,620	2,630
Entrained Air #2	~81	2,828	2,909
Gas Pocket #3	~15	2,909	2,925
Gas Pocket #4	~22	2,929	2,951
Gas Pocket #5	~7	3,600	3,607
Gas Pocket #6	~11	4,576	4,587
Gas Pocket #7	~38	7,008	7,045
Gas Pocket #8	~17	8,714	8,731
Gas Slug #1	~250	8,773	9,024
Gas Pocket #9	~23	9,024	9,048

Details and properties of the acoustic events identified in this report can be found in Section 4 and Appendix C.

1. Project Background

The approximate pipeline locations are shown in Figure 1.1 and Figure 1.2. Flow proceeds from Insertion to Extraction. The upstream direction is defined as being toward Insertion, while the downstream direction is defined as being toward Extraction.

Figure 1.1: Aerial View of 18-Inch Asbestos Concrete Pipe

Figure 1.2: Aerial View of 24-Inch Ductile Iron Pipe

2. SmartBall Inspection Details

2.1. Insertion

The SmartBall tool was inserted into the pipelines at a 24-inch Blind Flange at the Goleta West Sanitary District (GWSD) Yard. Figure 2.1 shows the tool being placed into the pipeline for the first inspection. Once placed in the pipe, the flange was then closed and a pump was utilized to propel the tool past the H crossover valve vault.

Figure 2.1: SmartBall Tool Being Placed into 24-inch Blind Flange at GWSD Yard

2.2. Extraction

The SmartBall tool was extracted at the Weir Well inside the Wastewater Treatment Plant. The extraction was completed using a net as seen in Figure 2.2. While the retrieval of the tool for the first run of the SmartBall went to plan, the first attempt to retrieve the tool for the second run with the custom net and a fish net failed. It was then decided to backflow to move the tool back out of the well and reset net and retry. This also failed and it was determined the following day to pump down the well with an external pump and the SmartBall tool was then retrieved.

Figure 2.2: SmartBall Extraction Net Being Placed into Position

2.3. Tracking

Pure Technologies' proprietary tracking devices were used to track the SmartBall inspection tool during the inspections. The tracking devices were connected to sensors attached to the pipeline at Tracking Locations (TL) listed in Table 2.1 and Table 2.2.

Table 2.1: SmartBall Receiver Tracking Locations (18-Inch Asbestos Concrete Pipe)

Tracking Location Number	Distance from Insertion [feet]	Passage Time [hh:mm:ss]	Location Description	GPS Coordinates
TL #1	0	1:21:21 PM	10-inch Gate Valve (Insertion)	34.422670, -119.852101
TL #2	31	Tracking Not Acquired	Vault	34.422699, -119.852198
TL #3	276	1:44:09 PM	Manhole – Exposed Pipe	34.423327, -119.851911
TL #4	7,095	2:36:19 PM	Manhole – Exposed Pipe	34.419845, -119.835720
TL #5	7,767	2:41:18 PM	Manhole – Exposed Pipe	34.421291, -119.835076
TL #6	9,007	2:50:30 PM	Meter Vault – Exposed Pipe	34.422700, -119.832614
TL #7	9,094	2:51:47 PM	Weir Well inside Wastewater Treatment Plant (Extraction)	34.422734, -119.832340

Table 2.2: SmartBall Receiver Tracking Locations (24-Inch Ductile Iron Pipe)

Tracking Location Number	Distance from Insertion [feet]	Passage Time [hh:mm:ss]	Location Description	GPS Coordinates
TL #1	0	10:10:14 AM	10-inch Gate Valve (Insertion)	34.422677, -119.852096
TL #2	27	10:12:44 AM	Vault	34.422703, -119.852180
TL #3	250	10:23:21 AM	Manhole – Exposed Pipe	34.423275, -119.851910
TL #4	902	10:31:34 AM	Exposed Pipe	34.424956, -119.851207
TL #5	3,111	10:58:49 AM	Exposed Pipe	34.425806, -119.845018
TL #6	4,579	11:16:27 AM	Exposed Pipe	34.423041, -119.841537
TL #7	5,284	11:24:56 AM	Exposed Pipe	34.421745, -119.839799
TL #8	7,110	11:46:40 AM	Manhole – Exposed Pipe	34.419825, -119.835711
TL #9	7,805	11:55:07 AM	Manhole – Exposed Pipe	34.421315, -119.835062
TL #10	8,637	Tracking Not Acquired	Excavation – Exposed Pipe	34.422624, -119.833856
TL #11	9,023	12:06:53 PM	Meter Vault – Exposed Pipe	34.422692, -119.832603
TL #12	9,107	12:07:52 PM	Weir Well inside Wastewater Treatment Plant (Extraction)	34.422734, -119.832340

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 MNS Engineers. The Tracking Locations are further detailed in Appendix B.

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 2.3 and 2.4. The slope of the black line indicates the instantaneous velocity of the SmartBall inspection tool.

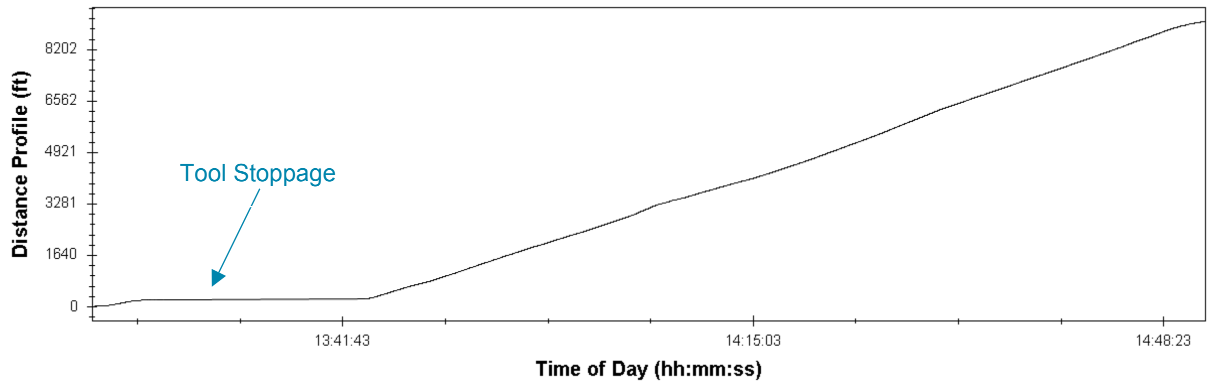


Figure 2.3: Distance traveled by SmartBall tool versus Time of Day during the 18-Inch ACP

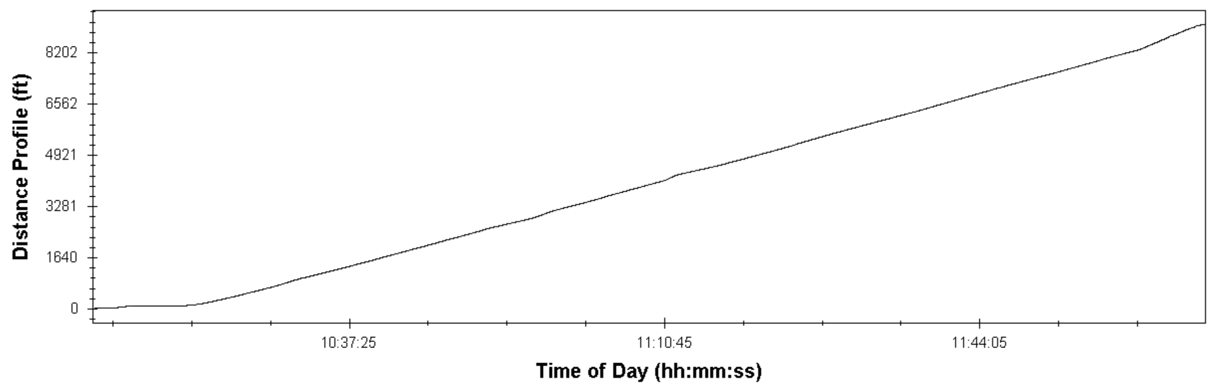


Figure 2.4: Distance traveled by SmartBall tool versus Time of Day during the 24-Inch Ductile Iron Pipe

3. Summary of Acoustic Events

3.1. Acoustic Data Results

The data collected by the SmartBall inspection tool was internally peer reviewed to verify that all acoustic events were detected and accurately classified. There were no acoustic events resembling leaks detected during the inspection.

3.1.1. Acoustic Anomaly

Table 3.1 provides a detailed summary of each acoustic anomaly detected by the SmartBall.

Table 3.1: Summary of Acoustic Anomalies (24-Inch Ductile Iron Pipe)

Acoustic Anomaly Number	Time of Tool Pass	Nearest Tracking Feature	Distance from Nearest Tracking Feature	Comments	Confidence in Location
Acoustic Anomaly #1	11:56:30 AM	Manhole – Exposed Pipe	118 feet downstream of Manhole – Exposed Pipe (TL #9)	Acoustic signal suspected external to pipeline, potentially from nearby roadway or airport. No anomaly was detected during the 18-inch ACP in this area.	High

Confidence in Location

- *High – Acoustic event is within tracking data, OR a nearby feature is visible in both the data and field and rolling motion of the inspection tool is consistent.*
- *Medium – Acoustic event is outside the tracking data and either the rolling motion of inspection tool is consistent or a nearby feature is visible in both the data and field.*
- *Low – Acoustic event is outside of tracking data and rolling motion of the tool is inconsistent OR discrepancies in pipeline alignment between SmartBall data and client supplied information.*

3.1.2. Air Events

Table 3.2 and Table 3.3 provides a detailed summary of the gas pocket and migratory acoustic events detected during the inspection by the SmartBall technology. It is important to note that the presence and capacity of events detected during the inspection may change under varying operating conditions.

Table 3.2: Summary of Air Events (18-Inch Asbestos Concrete Pipe)

Gas Pocket, Gas Slug, Entrained Air	Length [feet]	Distance from Insertion (Start of Pocket) [feet]	Distance from Insertion (End of Pocket) [feet]	Nearest Tracking Feature	Distance from Nearest Tracking Feature	Confidence in Location
Gas Slug #1	~41	42	83	10-inch Gate Valve (Insertion)	41 feet downstream of 10-inch Gate Valve (Insertion/TL #1)	Medium
Gas Slug #2	~9	118	127	10-inch Gate Valve (Insertion)	118 feet downstream of 10-inch Gate Valve (Insertion/TL #1)	Medium
Gas Pocket #1	~18	127	145	10-inch Gate Valve (Insertion)	127 feet downstream of 10-inch Gate Valve (Insertion/TL #1)	Medium
Gas Slug #3	~40	155	195	Manhole – Exposed Pipe	121 feet upstream of Manhole – Exposed Pipe (TL #3)	Medium
Gas Slug #4	28	8,996	9,024	Meter Vault – Exposed Pipe	11 feet upstream of Meter Vault – Exposed Pipe (TL #6)	Medium

Table 3.3: Summary of Air Events (24-Inch Ductile Iron Pipe)

Gas Pocket, Gas Slug, Entrained Air	Length [feet]	Distance from Insertion (Start of Pocket) [feet]	Distance from Insertion (End of Pocket) [feet]	Nearest Tracking Feature	Distance from Nearest Tracking Feature	Confidence in Location
Gas Pocket #1	~50	717	767	Exposed Pipe	185 feet upstream of Exposed Pipe (TL#4)	Medium
Gas Pocket #2	~13	2,544	2,556	Exposed Pipe	567 feet upstream of Exposed Pipe (TL#5)	Medium
Entrained Air #1	~10	2,620	2,630	Exposed Pipe	491 feet upstream of Exposed Pipe (TL#5)	Medium
Entrained Air #2	~81	2,828	2,909	Exposed Pipe	282 feet upstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #3	~15	2,909	2,925	Exposed Pipe	201 feet upstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #4	~22	2,929	2,951	Exposed Pipe	182 feet upstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #5	~7	3,600	3,607	Exposed Pipe	489 feet downstream of Exposed Pipe (TL#5)	Medium
Gas Pocket #6	~11	4,576	4,587	Exposed Pipe	3 feet upstream of Exposed Pipe (TL #6)	Medium
Gas Pocket #7	~38	7,008	7,045	Manhole - Exposed Pipe	103 feet upstream of Manhole - Exposed Pipe (TL #8)	Medium

Table 3.3: Summary of Air Events (24-Inch Ductile Iron Pipe)						
Gas Pocket, Gas Slug, Entrained Air	**Length [feet]**	**Distance from Insertion (Start of Pocket) [feet]**	**Distance from Insertion (End of Pocket) [feet]**	**Nearest Tracking Feature**	**Distance from Nearest Tracking Feature**	**Confidence in Location**
Gas Pocket #8	~17	8,714	8,731	Meter Vault – Exposed Pipe	310 feet upstream of Meter Vault – Exposed Pipe (TL #11)	Medium
Gas Slug #1	~250	8,773	9,024	Meter Vault – Exposed Pipe	250 feet upstream of Meter Vault – Exposed Pipe (TL #11)	Medium
Gas Pocket #9	~23	9,024	9,048	Meter Vault – Exposed Pipe	1 foot downstream of Meter Vault – Exposed Pipe (TL #11)	Medium

<u>*Confidence in Location*</u>

- *High – Acoustic event is within tracking data, OR a nearby feature is visible in <u>both</u> the data and field and rolling motion of the inspection tool is consistent.*
- *Medium – Acoustic event is outside the tracking data and <u>either</u> the rolling motion of inspection tool is consistent or a nearby feature is visible in <u>both</u> the data and field.*
- *Low – Acoustic event is outside of tracking data and rolling motion of the tool is inconsistent OR discrepancies in pipeline alignment between SmartBall data and client supplied information.*

3.2. Aerial View of Events

Figure 3.1 and Figure 3.2 show an aerial overview of the inspection results.

Figure 3.1: Aerial View of 18-Inch Asbestos Concrete Pipe with Location of Results

Figure 3.2: Aerial View of 24-Inch Ductile Iron Pipe with Location of Results

4. Conclusions

Based on analysis of the data recorded during the SmartBall inspections, Pure Technologies concludes the following:

- There were no acoustic events resembling leaks detected during the inspections.
- There was one (1) acoustic anomaly identified on the 24-inch DIP. Based on the acoustic signal, this anomaly is suspected to be external to the pipeline, potentially from the nearby roadway or airport. No anomaly was detected during the 18-inch ACP inspection in this area.
- Several gas pockets, gas slugs, and entrained air events were detected throughout both pipelines. While the presence and capacity of entrained air and gas slugs detected during the inspection may change under varying operating conditions, note that these events and static gas pockets can contribute to the formation of Hydrogen Sulfide gas (H_2S), which is the number one cause of failure in Force Mains. It is recommended that the locations of the static gas pockets be reviewed, and all associated air release valves are checked to ensure proper functionality.
    - See Appendix C, Section C.2.2 for more details on acoustic events representing entrained air, gas slugs, and fully developed air pockets.

APPENDIX A

Acoustic Event Details

Details of acoustic events of interest detected during the SmartBall inspection 18-Inch Asbestos Concrete Pipe are provided below.

Site of Interest #1 – Gas Slug #1 (18-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	41 feet downstream of 10-inch Gate Valve (Insertion/TL #1)
Time Since Insertion (Start of Event):	00:01:35
Time Since Insertion (End of Event):	00:02:15
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	01:22:57 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	01:23:36 PM

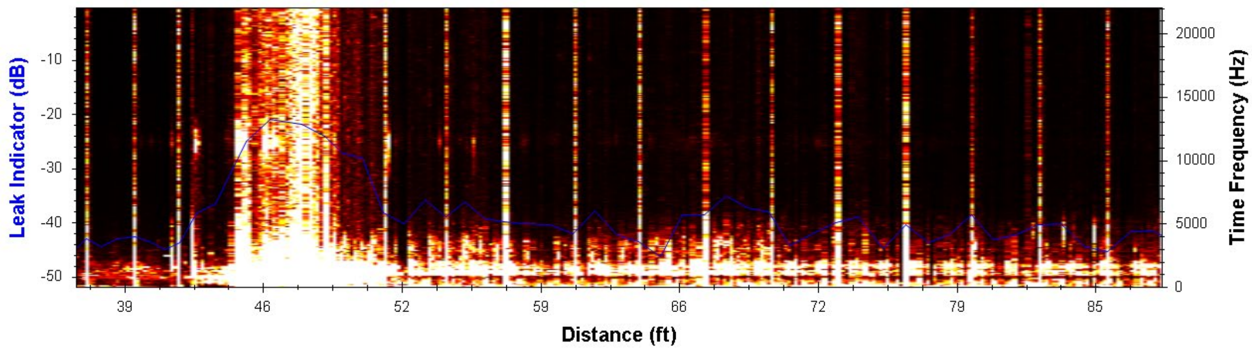


Figure A.1: Acoustic Intensity of Event

Site of Interest #2 – Gas Slug #2 (18-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	118 feet downstream of 10-inch Gate Valve (Insertion/TL #1)
Time Since Insertion (Start of Event):	00:02:48
Time Since Insertion (End of Event):	00:02:56
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	01:24:09 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	01:24:17 PM

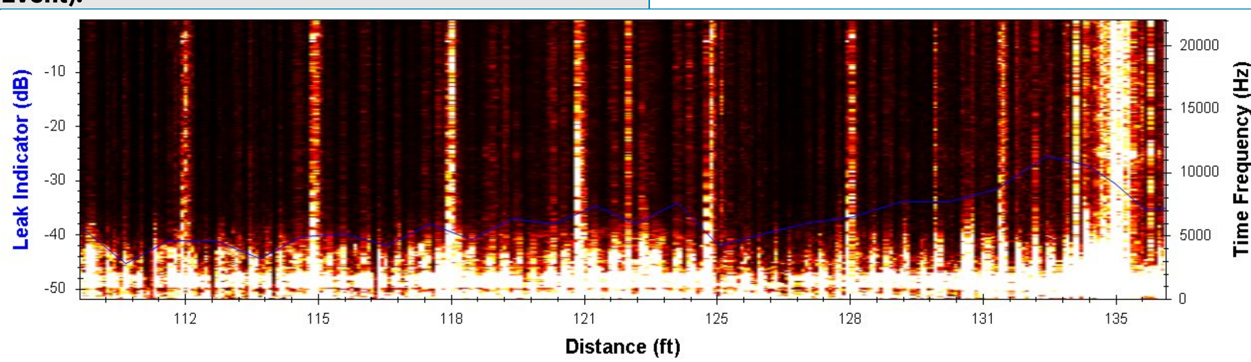


Figure A.2: Acoustic Intensity of Event

Site of Interest #3 - Gas Pocket #1 (18-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	127 feet downstream of 10-inch Gate Valve (Insertion/TL #1)
Time Since Insertion (Start of Event):	00:02:56
Time Since Insertion (End of Event):	00:03:14
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	01:24:18 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	01:24:35 PM

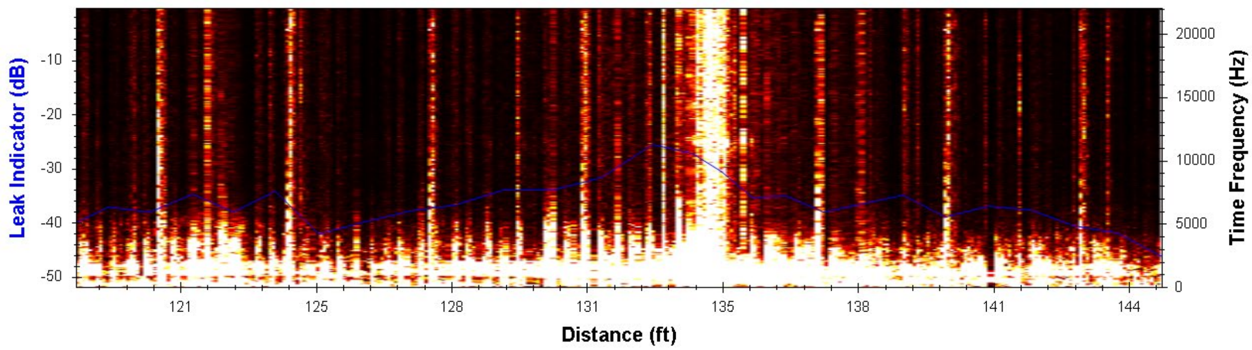


Figure A.3: Acoustic Intensity of Event

Site of Interest #4 – Gas Slug #3 (18-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	121 feet upstream of Manhole – Exposed Pipe (TL #3)
Time Since Insertion (Start of Event):	00:03:27
Time Since Insertion (End of Event):	00:05:18
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	01:24:48 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	01:26:39 PM

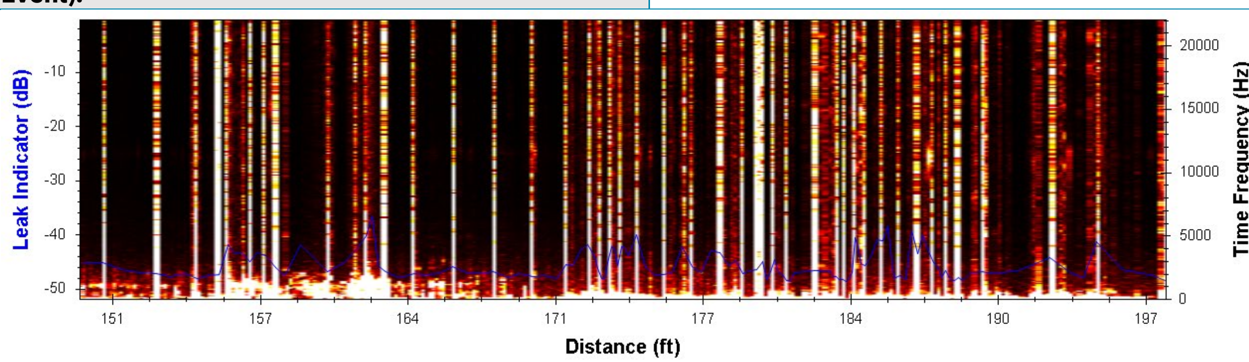


Figure A.4: Acoustic Intensity of Event

Site of Interest #5 – Gas Slug #4 (18-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	11 feet upstream of Meter Vault – Exposed Pipe (TL#6)
Time Since Insertion (Start of Event):	01:29:02
Time Since Insertion (End of Event):	01:29:24
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	02:50:24 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	02:50:45 PM

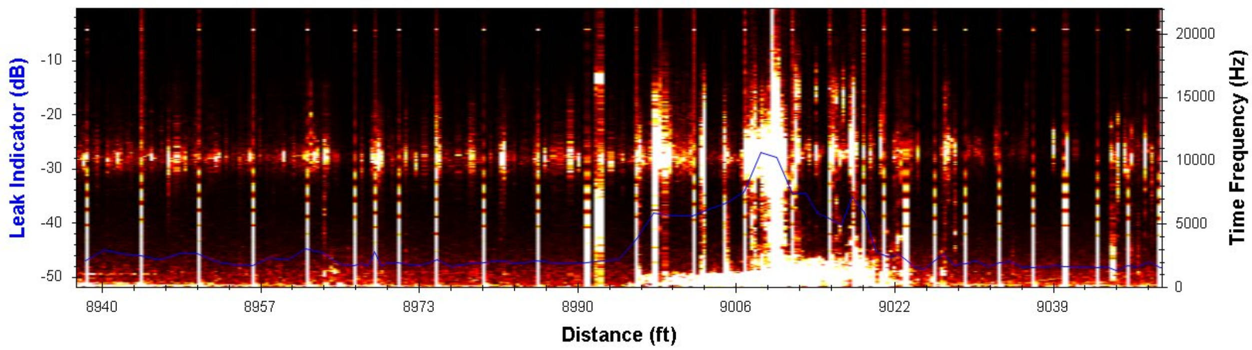


Figure A.5: Acoustic Intensity of Event

Details of acoustic events of interest detected during the SmartBall inspection 24-Inch Ductile Iron Pipe are provided below.

Site of Interest #1 - Gas Pocket #1 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	185 feet upstream of Exposed Pipe (TL#4)
Time Since Insertion (Start of Event):	00:19:22
Time Since Insertion (End of Event):	00:19:56
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:29:37 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:30:11 AM

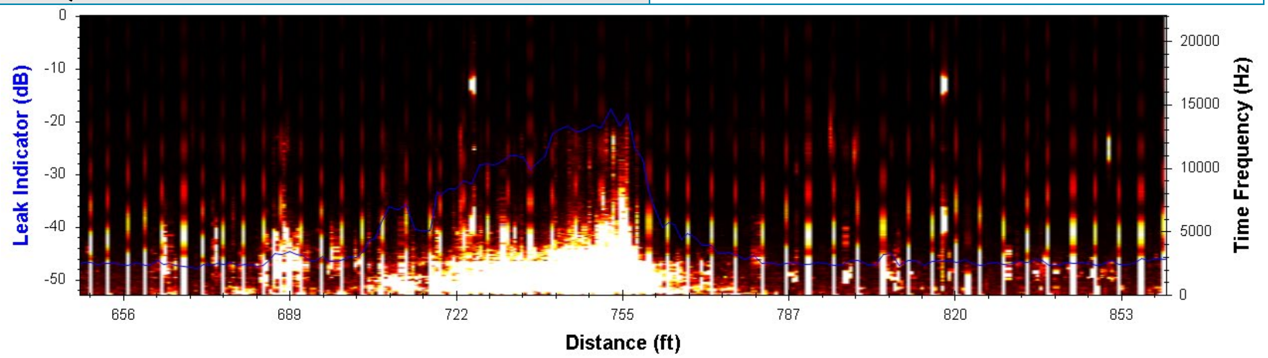


Figure A.6: Acoustic Intensity of Event

Site of Interest #2 - Gas Pocket #2 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	567 feet upstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:41:39
Time Since Insertion (End of Event):	00:41:48
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:51:54 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:52:03 AM

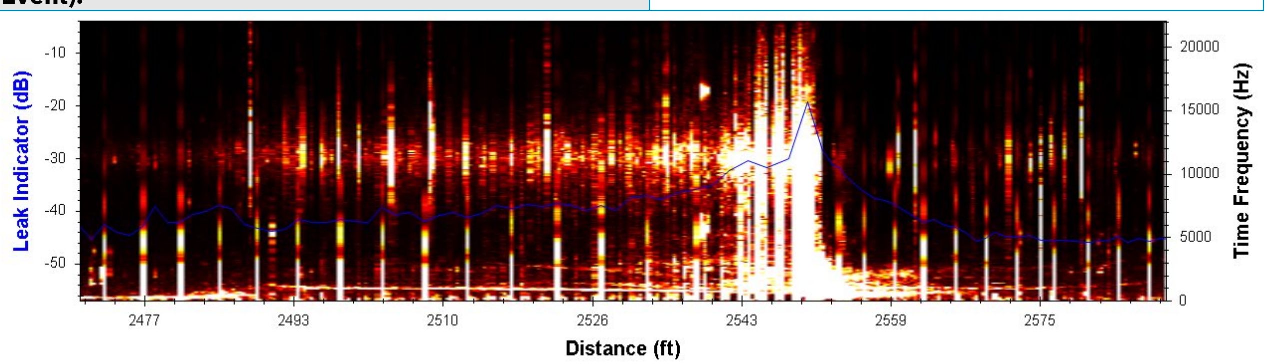


Figure A.7: Acoustic Intensity of Event

Site of Interest #3 - Entrained Air #1 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	491 feet upstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:42:40
Time Since Insertion (End of Event):	00:42:49
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:52:55 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:53:04 AM

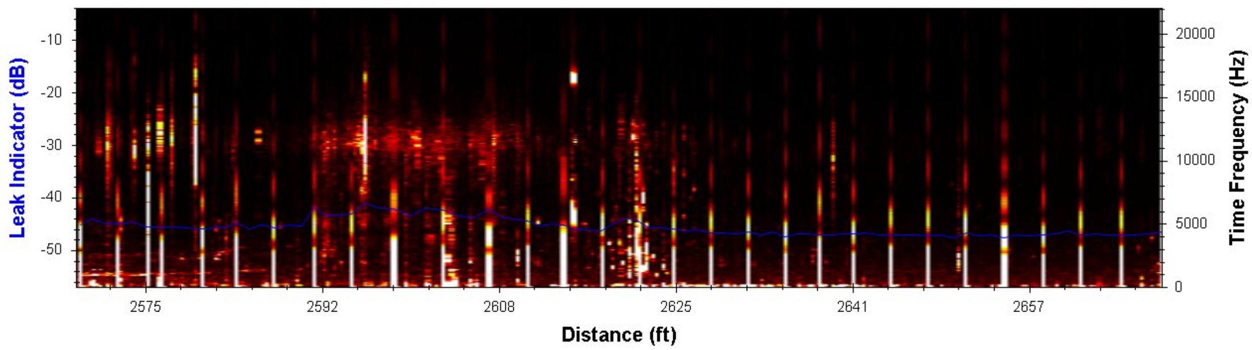


Figure A.8: Acoustic Intensity of Event

Site of Interest #4 - Entrained Air #2 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	282 feet upstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:45:37
Time Since Insertion (End of Event):	00:46:41
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:55:52 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:56:56 AM

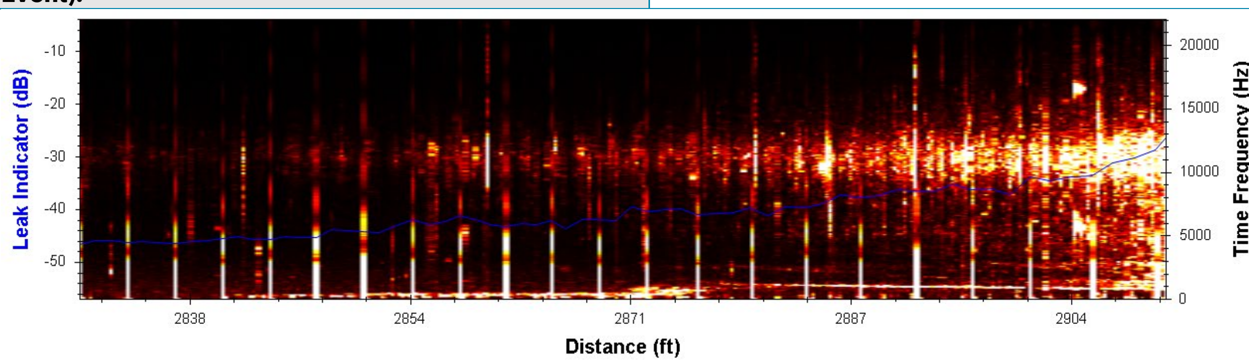


Figure A.9: Acoustic Intensity of Event

Site of Interest #5 - Gas Pocket #3 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	201 feet upstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:46:41
Time Since Insertion (End of Event):	00:46:53
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:56:56 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:57:08 AM

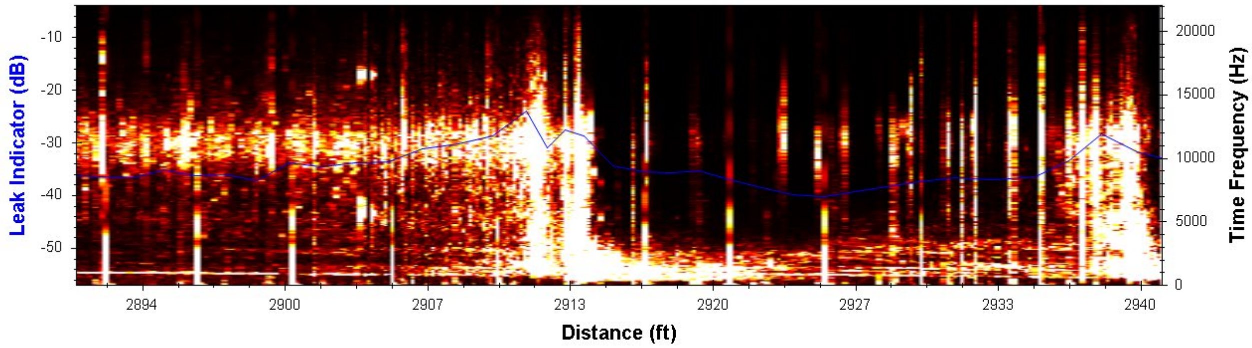


Figure A.10: Acoustic Intensity of Event

Site of Interest #6 - Gas Pocket #4 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	182 feet upstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:46:56
Time Since Insertion (End of Event):	00:47:10
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	10:57:11 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	10:57:25 AM

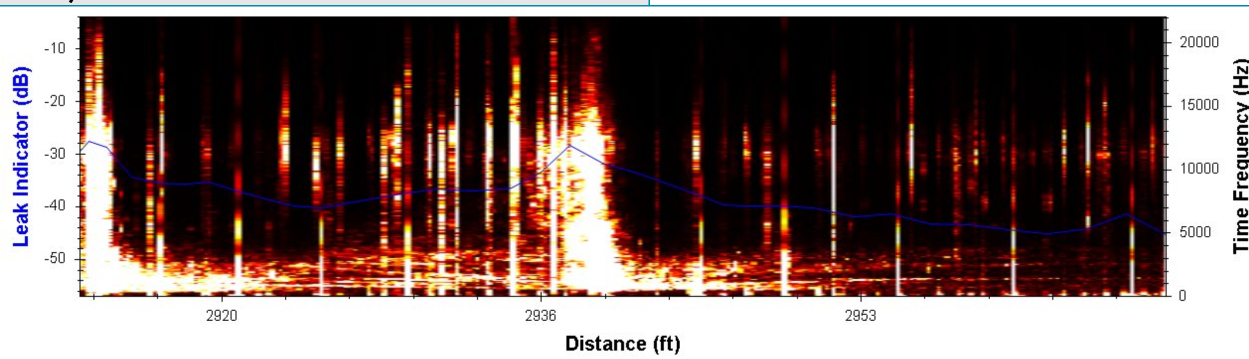


Figure A.11: Acoustic Intensity of Event

Site of Interest #7 - Gas Pocket #5 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	489 feet downstream of Exposed Pipe (TL#5)
Time Since Insertion (Start of Event):	00:54:27
Time Since Insertion (End of Event):	00:54:34
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	11:04:42 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	11:04:49 AM

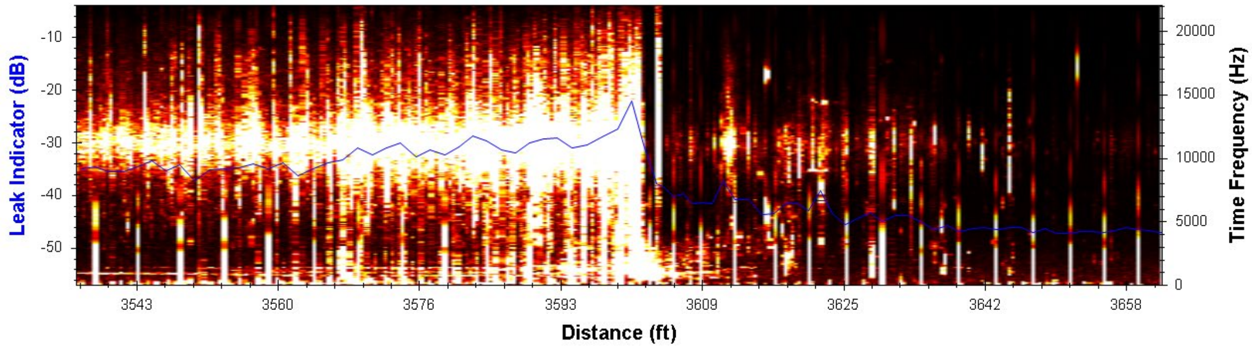


Figure A.12: Acoustic Intensity of Event

Site of Interest #8 - Gas Pocket #6 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	3 feet upstream of Exposed Pipe (TL #6)
Time Since Insertion (Start of Event):	01:06:10
Time Since Insertion (End of Event):	01:06:19
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	11:16:25 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	11:16:34 AM

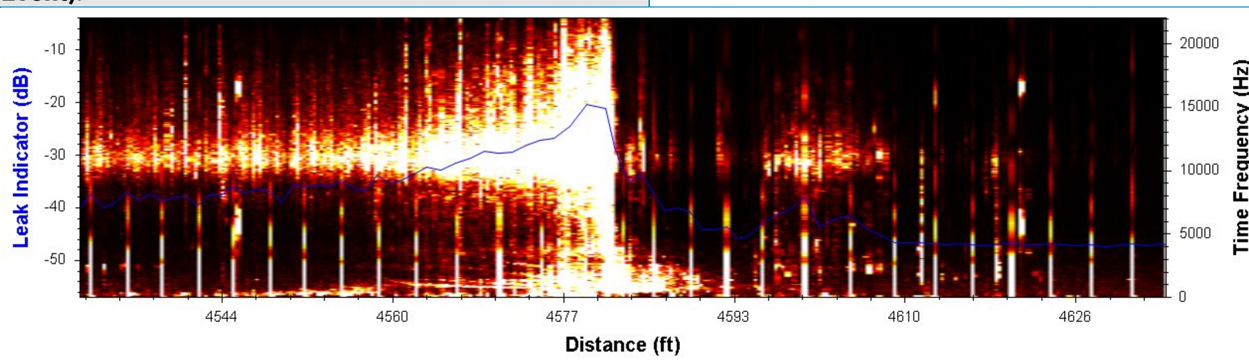


Figure A.13: Acoustic Intensity of Event

Site of Interest #9 - Gas Pocket #7 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	103 feet upstream of Manhole - Exposed Pipe (TL #8)
Time Since Insertion (Start of Event):	01:35:10
Time Since Insertion (End of Event):	01:35:35
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	11:45:25 AM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	11:45:50 AM

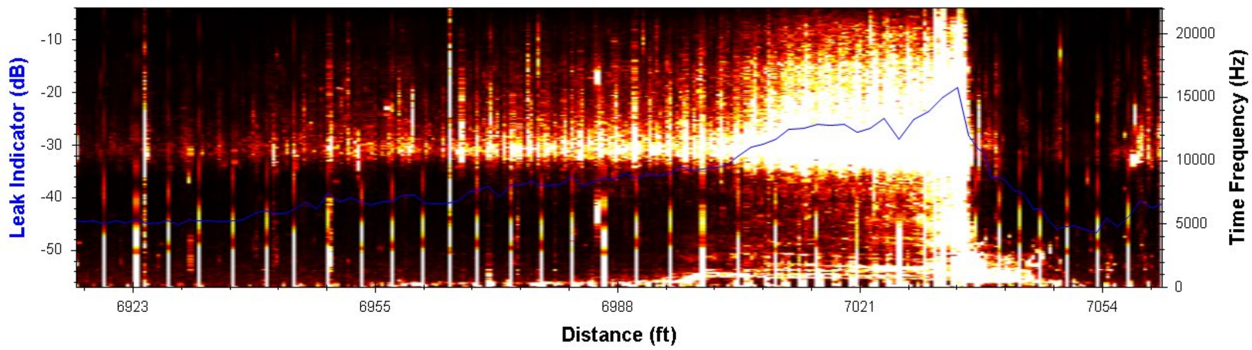


Figure A.14: Acoustic Intensity of Event

Site of Interest #10 - Acoustic Anomaly #1 (24-Inch)	
Distance to Nearest Tracking Feature:	118 feet downstream of Manhole – Exposed Pipe (TL #9)
Confidence in Location:	Medium
Time Since Insertion:	01:46:15
Time of SmartBall Tool Pass (GMT-8:00):	11:56:30 AM

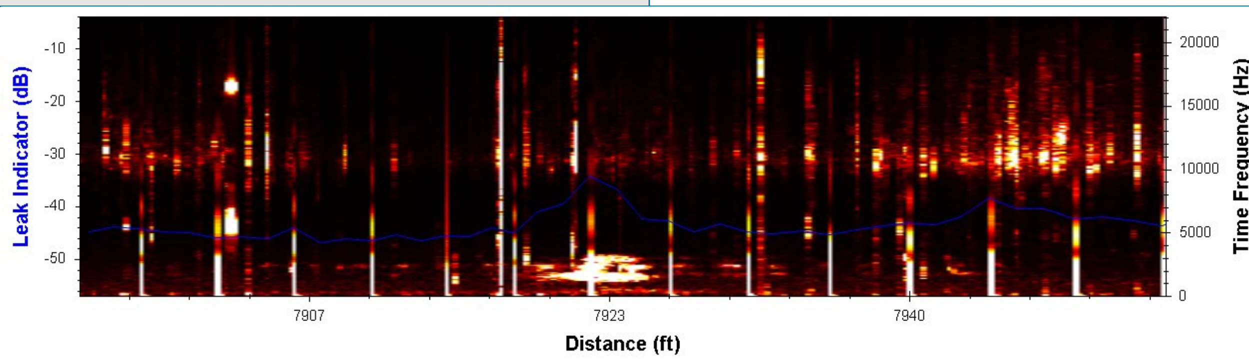


Figure A.15: Acoustic Intensity of Event

Site of Interest #11 - Gas Pocket #8 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	310 feet upstream of Meter Vault – Exposed Pipe (TL#11)
Time Since Insertion (Start of Event):	01:53:56
Time Since Insertion (End of Event):	01:54:06
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	12:04:11 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	12:04:21 PM

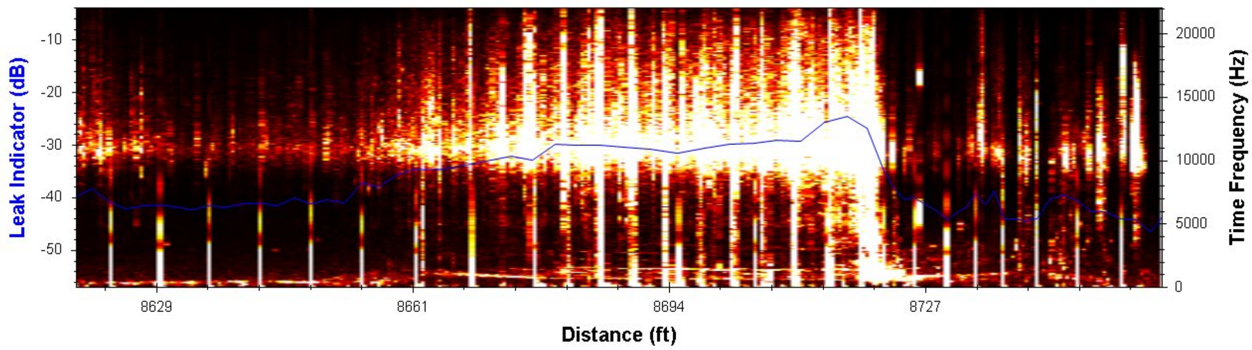


Figure A.16: Acoustic Intensity of Event

Site of Interest #12 – Gas Slug #1 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	250 feet upstream of Meter Vault – Exposed Pipe (TL #11)
Time Since Insertion (Start of Event):	01:54:33
Time Since Insertion (End of Event):	01:56:38
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	12:04:48 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	12:06:53 PM

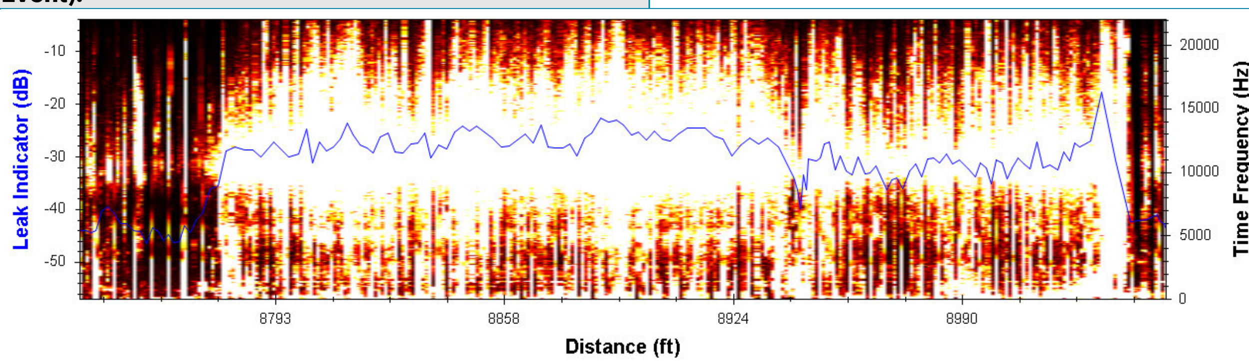


Figure A.17: Acoustic Intensity of Event

Site of Interest #13 - Gas Pocket #9 (24-Inch)	
Confidence in Location:	Medium
Distance to Nearest Tracking Feature (Start of Event):	1 foot downstream of Meter Vault – Exposed Pipe (TL#11)
Time Since Insertion (Start of Event):	01:56:38
Time Since Insertion (End of Event):	01:56:46
Time of SmartBall Tool Pass (GMT-8:00) (Start of Event)	12:06:53 PM
Time of SmartBall Tool Pass (GMT-8:00) (End of Event):	12:07:01 PM

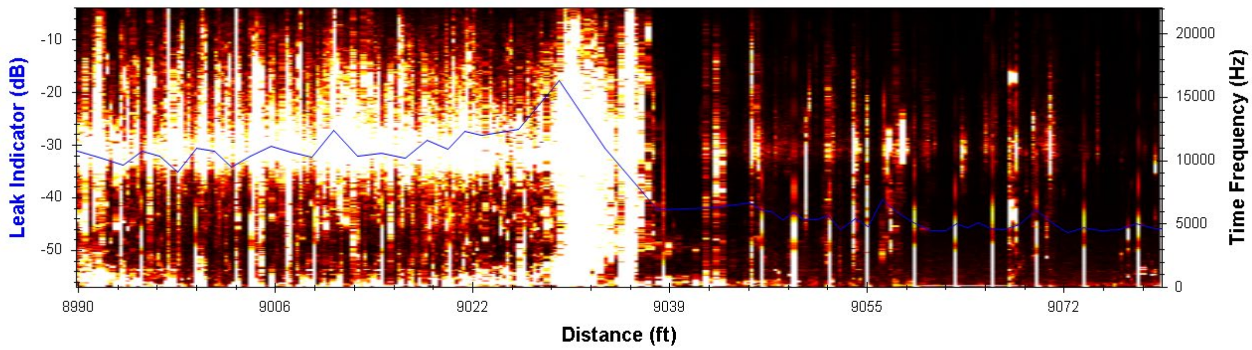


Figure A.18: Acoustic Intensity of Event

APPENDIX B

SmartBall® Tracking

Table B.1: SmartBall Receiver Tracking Locations (18-Inch Asbestos Concrete Pipe)				
Tracking Location Number	**Distance from Insertion [feet]**	**Passage Time [hh:mm:ss]**	**Location Description**	**GPS Coordinates**
TL #1	0	1:21:21 PM	10-inch Gate Valve (Insertion)	34.422670, -119.852101
TL #2	31	Tracking Not Acquired	Vault	34.422699, -119.852198
TL #3	276	1:44:09 PM	Manhole - Exposed Pipe	34.423327, -119.851911
TL #4	7,095	2:36:19 PM	Manhole - Exposed Pipe	34.419845, -119.835720
TL #5	7,767	2:41:18 PM	Manhole - Exposed Pipe	34.421291, -119.835076
TL #6	9,007	2:50:30 PM	Meter Vault - Exposed Pipe	34.422700, -119.832614
TL #7	9,094	2:51:47 PM	Weir Well inside Wastewater Treatment Plant (Extraction)	34.422734, -119.832340

Table B.2: SmartBall Receiver Tracking Locations (24-Inch Ductile Iron Pipe)				
Tracking Location Number	**Distance from Insertion [feet]**	**Passage Time [hh:mm:ss]**	**Location Description**	**GPS Coordinates**
TL #1	0	10:10:14 AM	10-inch Gate Valve (Insertion)	34.422677, -119.852096
TL #2	27	10:12:44 AM	Vault	34.422703, -119.852180
TL #3	250	10:23:21 AM	Manhole - Exposed Pipe	34.423275, -119.851910
TL #4	902	10:31:34 AM	Exposed Pipe	34.424956, -119.851207
TL #5	3,111	10:58:49 AM	Exposed Pipe	34.425806, -119.845018
TL #6	4,579	11:16:27 AM	Exposed Pipe	34.423041, -119.841537
TL #7	5,284	11:24:56 AM	Exposed Pipe	34.421745, -119.839799
TL #8	7,110	11:46:40 AM	Manhole - Exposed Pipe	34.419825, -119.835711

Table B.2: SmartBall Receiver Tracking Locations (24-Inch Ductile Iron Pipe)

Tracking Location Number	Distance from Insertion [feet]	Passage Time [hh:mm:ss]	Location Description	GPS Coordinates
TL #9	7,805	11:55:07 AM	Manhole – Exposed Pipe	34.421315, -119.835062
TL #10	8,637	Tracking Not Acquired	Excavation – Exposed Pipe	34.422624, -119.833856
TL #11	9,023	12:06:53 PM	Meter Vault – Exposed Pipe	34.422692, -119.832603
TL #12	9,107	12:07:52 PM	Weir Well inside Wastewater Treatment Plant (Extraction)	34.422734, -119.832340

Figure B.1 and B.2 show data collected by the TLs, indicating the relative position of the SmartBall tool to each tracking location. Data obtained from each TL is represented by a single color.

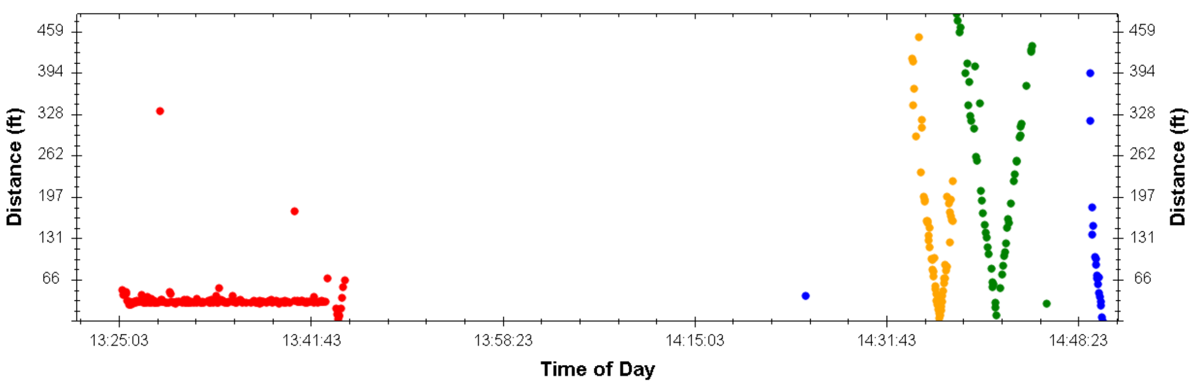


Figure B.1: Tracking Location Positional Data for the 18-Inch Asbestos Concrete Pipe Force Main

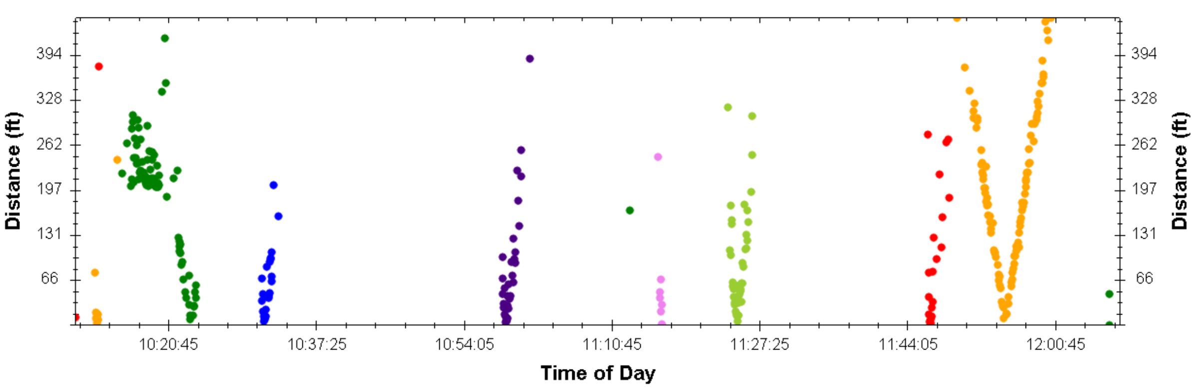


Figure B.2: Tracking Location Positional Data for the 24-Inch Ductile Iron Pipe Force Main

Figure B.3: Aerial View of 18-Inch Asbestos Concrete Pipe with Tracking Locations

Figure B.4: Aerial View of 24-Inch Ductile Iron Pipe with Tracking Locations

Each tracking location for 18-Inch Asbestos Concrete Pipe is further detailed in the tables below.

TL #1		
Distance from Insertion:	0 feet	
Location Description:	10-inch Gate Valve (Insertion)	
Passage Time [hh:mm:ss]:	1:21:21 PM	
Latitude, Longitude:	34.422670, -119.852101	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #2		
Distance from Insertion:	31 feet	
Location Description:	Vault	
Passage Time [hh:mm:ss]:	Tracking Not Acquired	
Latitude, Longitude:	34.422699, -119.852198	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #3		
Distance from Insertion:	276 feet	
Location Description:	Manhole – Exposed Pipe	
Passage Time [hh:mm:ss]:	1:44:09 PM	
Latitude, Longitude:	34.423327, -119.851911	

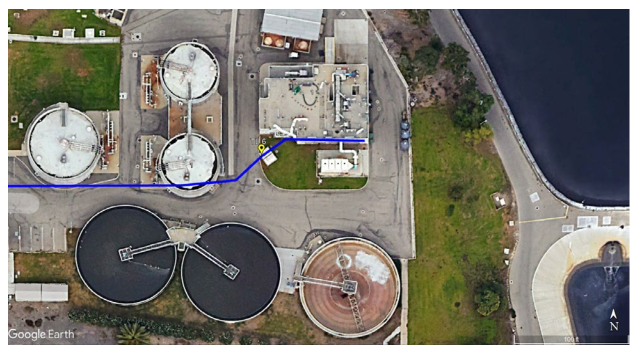
*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #4		
Distance from Insertion:	7,095 feet	
Location Description:	Manhole – Exposed Pipe	
Passage Time [hh:mm:ss]:	2:36:19 PM	
Latitude, Longitude:	34.419845, -119.835720	

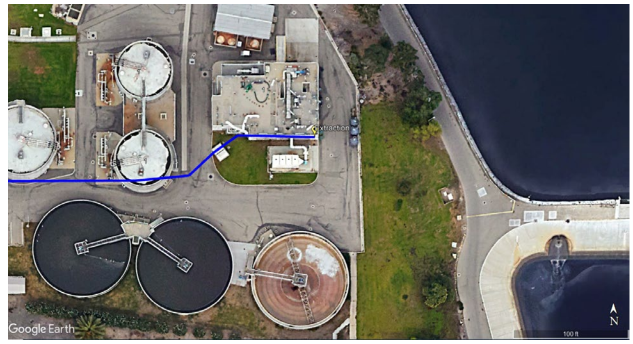
*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #5		
Distance from Insertion:	7,767 feet	
Location Description:	Manhole – Exposed Pipe	
Passage Time [hh:mm:ss]:	2:41:18 PM	
Latitude, Longitude:	34.421291, -119.835076	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #6		
Distance from Insertion:	9,007 feet	
Location Description:	Meter Vault – Exposed Pipe	
Passage Time [hh:mm:ss]:	2:50:30 PM	
Latitude, Longitude:	34.422700, -119.832614	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

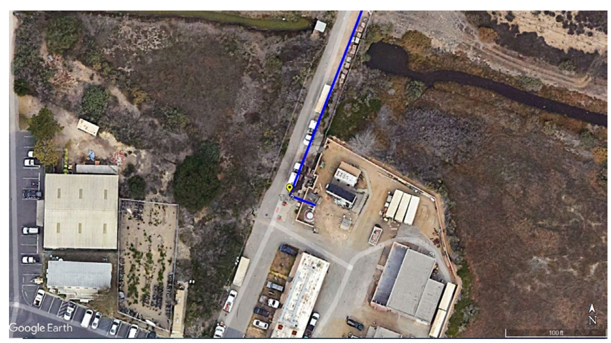
TL #7		
Distance from Insertion:	9,094 feet	
Location Description:	Weir Well inside Wastewater Treatment Plant (Extraction)	
Passage Time [hh:mm:ss]:	2:51:47 PM	
Latitude, Longitude:	34.422734, -119.832340	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

Each tracking location for 24-Inch Ductile Iron Pipe Force Main is further detailed in the tables below.

TL #1		
Distance from Insertion:	0 feet	
Location Description:	10-inch Gate Valve (Insertion)	
Passage Time [hh:mm:ss]:	10:10:14 AM	
Latitude, Longitude:	34.422677, -119.852096	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

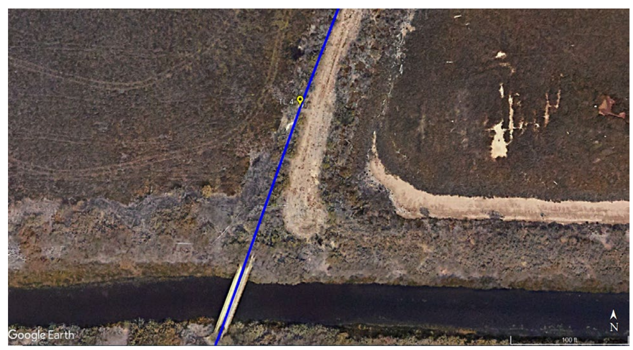
TL #2		
Distance from Insertion:	27 feet	
Location Description:	Vault	
Passage Time [hh:mm:ss]:	10:12:44 AM	
Latitude, Longitude:	34.422703, -119.852180	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #3	
Distance from Insertion:	250 feet
Location Description:	Manhole – Exposed Pipe
Passage Time [hh:mm:ss]:	10:23:21 AM
Latitude, Longitude:	34.423275, -119.851910

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #4	
Distance from Insertion:	902 feet
Location Description:	Exposed Pipe
Passage Time [hh:mm:ss]:	10:31:34 AM
Latitude, Longitude:	34.424956, -119.851207



*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #5	
Distance from Insertion:	3,111 feet
Location Description:	Exposed Pipe
Passage Time [hh:mm:ss]:	10:58:49 AM
Latitude, Longitude:	34.425806, -119.845018

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #6		
Distance from Insertion:	4,579 feet	
Location Description:	Exposed Pipe	
Passage Time [hh:mm:ss]:	11:16:27 AM	
Latitude, Longitude:	34.423041, -119.841537	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #7		
Distance from Insertion:	5,284 feet	
Location Description:	Exposed Pipe	
Passage Time [hh:mm:ss]:	11:24:56 AM	
Latitude, Longitude:	34.421745, -119.839799	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #8		
Distance from Insertion:	7,110 feet	
Location Description:	Manhole – Exposed Pipe	
Passage Time [hh:mm:ss]:	11:46:40 AM	
Latitude, Longitude:	34.419825, -119.835711	

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

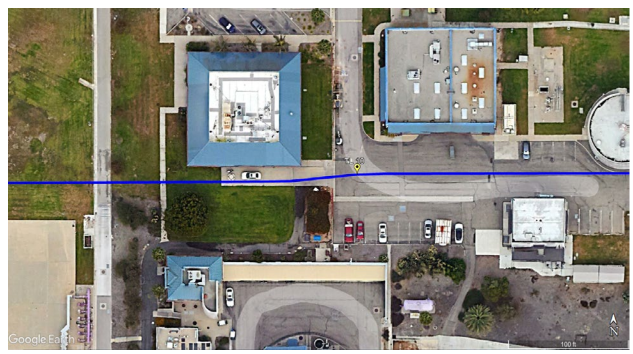
TL #9

Distance from Insertion:	7,805 feet
Location Description:	Manhole – Exposed Pipe
Passage Time [hh:mm:ss]:	11:55:07 AM
Latitude, Longitude:	34.421315, -119.835062

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #10

Distance from Insertion:	8,637 feet
Location Description:	Excavation – Exposed Pipe
Passage Time [hh:mm:ss]:	12:06:53 PM
Latitude, Longitude:	34.422624, -119.833856



*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

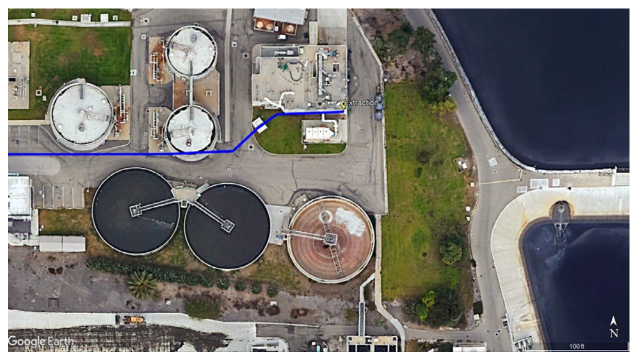
TL #11

Distance from Insertion:	9,023 feet
Location Description:	Meter Vault – Exposed Pipe
Passage Time [hh:mm:ss]:	12:06:53 PM
Latitude, Longitude:	34.422692, -119.832603

*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

TL #12

Distance from Insertion:	9,107 feet
Location Description:	Weir Well inside Wastewater Treatment Plant (Extraction)
Passage Time [hh:mm:ss]:	12:07:52 PM
Latitude, Longitude:	34.422734, -119.832340



*Distance in the table above are based on drawings and/or GIS information provided to Pure Technologies by MNS Engineers Inc

APPENDIX C

SmartBall® Methodology

C.1 Overview

The SmartBall inspection platform is a free-swimming acoustic-based non-destructive inline inspection technology that detects acoustic activity associated with leaks and pockets of trapped air and utilizes the latest accelerometer and gyroscope technologies combined with advanced location algorithms to map pressurized pipelines. The SmartBall tool is comprised of a water-tight aluminum alloy core containing a power source, electronic components, and instrumentation that includes an acoustic sensor, tri-axial accelerometer, tri-axial magnetometer, GPS synchronized ultrasonic transmitter, strain gauge, and temperature sensor. A protective outer foam shell encapsulates the aluminum core and provides a larger surface area by which the device is propelled by the hydraulic flow of the fluid in the pipeline. The foam shell also reduces the ambient noise from the rolling action, resulting in a silent background. The SmartBall tool is deployed into the live flow of a pipeline, traverses the pipeline while recording data, and is captured and extracted at a point downstream. During the inspection, the location of the SmartBall is tracked at known points along the alignment to correlate inspection data with specific locations.

Figure C.1: Synchronizing a SmartBall Core with a SmartBall Tracking Device

C.2 Identifying Leaks and Air or Gas Pockets

Inline leak detection technology is inherently more sensitive than external methods and correlators because it brings the acoustic sensor within one pipe diameter of the leak. Acoustic leak detection functions by detecting the acoustic signature generated by the sudden drop in pressure of water exiting the pipeline at the site of a leak. SmartBall technology requires a minimum pressure differential between internal and external pipeline conditions of 15 psi (1 bar) for acoustic leak detection. On pipelines with known leaks the SmartBall technology requires operating pressure higher than failed pressure tests.

For pipelines in high water tables or river crossings, the resultant hydrostatic head acting against the exterior of the pipe wall must be taken into consideration. Additional factors affecting acoustic leak detection include scenarios such as tunnels, slip lining, and encasements. In these situations, the acoustic signature generated by a leak may not occur directly at the leak site inside the pipeline. Instead, it could manifest at the point where the fluid exits the tunnel, slip lining, or encasement if the 'leak path' becomes pressurized between the pipe wall and these structures. Furthermore, the audible sound of a leak and the effectiveness of acoustic detection can vary depending on the leak's volume and shape.

Understanding how pipelines leak can be a valuable skill when heading out to locate a leak point on a pipeline. By understanding the cause of leaks, one can limit the amount of excavating required to locate a given leak.

Cast/Ductile Iron Pipe

Cast and Ductile iron pipes mostly consist of bell and spigot type connections. Many leaks found on this type of pipeline will be located at a joint which can be caused by improper gasket installation or soil shift. In addition, to joint leaks cast and ductile iron pipes can also leak from cracks and/or through hole penetrations in the pipe barrel. The cause for these defects can be wide ranging. These types of defects will not immediately affect the pipeline itself but should be viewed as more serious than a joint leak as the structural integrity of the given pipe section has already been compromised. Barrel leaks should be addressed as soon as possible, and Pure will generally be able to identify whether a leak is on the joint or barrel of a pipe section for these types of pipes.

Steel Pipe

Steel pipelines are typically welded together to form a long continuous pipe with few gasket joints. Leaks on this type of pipeline can occur at joints or along the barrel both by way of cracking and through hole penetrations.

Plastic and Other Pipe Materials

Typical plastic pipe types include Polyvinyl Chloride (PVC) and High-density polyethylene (HDPE). Some other pipe types may include Glass Reinforced Pipe (GRP) that act and fail in similar ways to plastic pipes.

Generally speaking, leaks on these types of pipes will occur at the joints between two pipe sections. Usually this can be attributed to improper installation of the joint gasket or ground shifting leading to misalignment at the joint. A leak normally will not be located on the barrel of a plastic pipe as a simple crack or through hole penetration would likely cause the line to completely fail rather than just leak.

Knowing that more leaks occur at joints, one can focus efforts on joints of the line, rather than digging linearly upstream or downstream when trying to locate a leak.

Concrete/Prestressed Pipe

Concrete Pressure pipe is always constructed from bell and spigot type pipe sections. Like other bell and spigot style pipe, these pipe types will generally leak from faulty or misaligned joints. Other forms of failure such as cracking or through hole penetration have been the cause of leaks, but they are less common.

On some classes of concrete pressure pipe, Pure will be able to identify if a leak is on the joint or the barrel of a pipe section. If a leak were located in the barrel of a concrete pressure pipe, its verification would be critical, as it is most likely a form of severe structural degradation.

C.2.1 Acoustic Events Representing Leaks

A leak inside a pressurized pipeline produces a specific acoustic signal. This acoustic signal is created when the pressurized water inside the pipeline escapes into the lower pressure environment outside the pipe. While the SmartBall tool traverses the pipeline, it continuously records all acoustic data in the pipeline, which is evaluated later to identify acoustic activity that may be associated with leaks along the pipeline. As the SmartBall tool rolls along the bottom of the pipeline, it will always pass within one (1) pipe diameter of a leak or pocket of trapped air or gas.

As the SmartBall tool approaches a leak, the acoustic signal detected by the SmartBall technology will increase. The acoustic signal will increase as the tool approaches the leak, peak at the point at which the SmartBall tool passes the point of the leak, and then diminish as the SmartBall tool continues away from the leak. This phenomenon is clearly evident in Figure C.2.

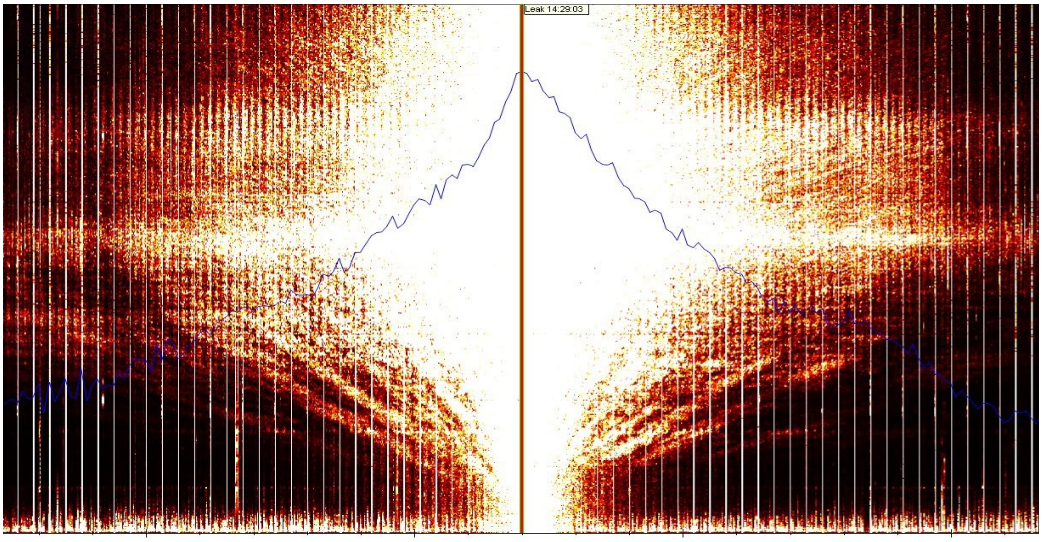


Figure C.2: Detected Leak, as shown in the SmartBall Analysis Software

In addition to detecting potential leaks and pockets of trapped air or gas, acoustic events are further evaluated and classified as being small, medium, or large based of the acoustic profile frequencies of each leak.

The characteristics typical of a true leak as detected by the SmartBall technology include:

- The range of frequencies present increases as the tool approaches the leak
- The frequencies that appear first, grow in intensity as the SmartBall tool approaches the leak
- The frequencies that appear to indicate a leak are consistent as the SmartBall tool approaches the leak

C.2.2 Acoustic Events Representing Air or Gas Pockets

Pockets of trapped air or gas inside a pipeline generate a distinct acoustic signal that is detectable using the SmartBall technology. Air or gas pockets in pressure pipes are typically detected at high points in the pipeline and are often the result of malfunctioning air release valves (ARVs) or a lack of ARVs. The acoustic signal is created by the liquid turbulence at the air/water interface. In full, pressurized pipes, this turbulence is not present.

Pockets of trapped air or gas inside a pipeline have distinct acoustic signatures that are readily identified by the SmartBall analysis software and trained technicians. Pure classifies trapped air inside a pipeline into three (3) categories:

1. **Entrained Air:**

This classification of trapped air or gas is characterized by small, moving bubbles of air or gas within the pipeline as illustrated in Figure C.3. Entrained air is not typically static in a pipeline and frequently migrates with the flow. These moving pockets of air or gas are generated in three (3) ways: (1) They can be introduced at a pumping station as a result of air becoming entrained in the water or by inefficiencies within the pump station. (2) They can be created at the tail of a hydraulic jump at the end of a fully developed air or gas pocket where small pockets of air or gas diffuse into the liquid phase and are carried downstream with the flow. (3) Finally, entrained air may be created by the biochemical processes inherent in wastewater force mains.

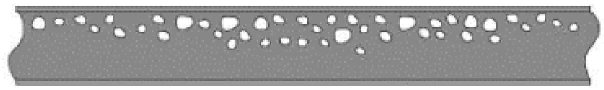


Figure C.3: Entrained Air[1]

2. **Slug or Developing Air or Gas Pockets:**

This classification can be characterized as small pockets of trapped air or gas that often develop from an amalgamation of entrained air as illustrated in Figure C.4. Slugs can also be introduced via ARVs. Slugs can be either static or migratory. If they are detected at a localized high point, they are likely static; if not, they are likely migrating towards a high point.

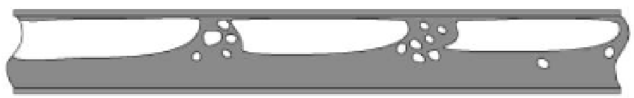


Figure C.4: Slugs[2]

3. **Fully Developed Air or Gas Pockets:**

Fully developed air or gas pockets are usually located at localized high points along a pipeline. These develop as a result of slugs that accumulate at a high point, and then extend into the downward slope of the pipe. A fully developed air or gas pocket typically has a hydraulic jump prior to the re-submergence of the pipe, creating an area of turbulent flow and air or gas dissolution into the liquid phase. Due to the turbulent nature of the hydraulic jump and frequent wet/dry cycles at these locations from changes in flow condition, these areas are at a higher risk of failure than other portions of the air or gas pocket.

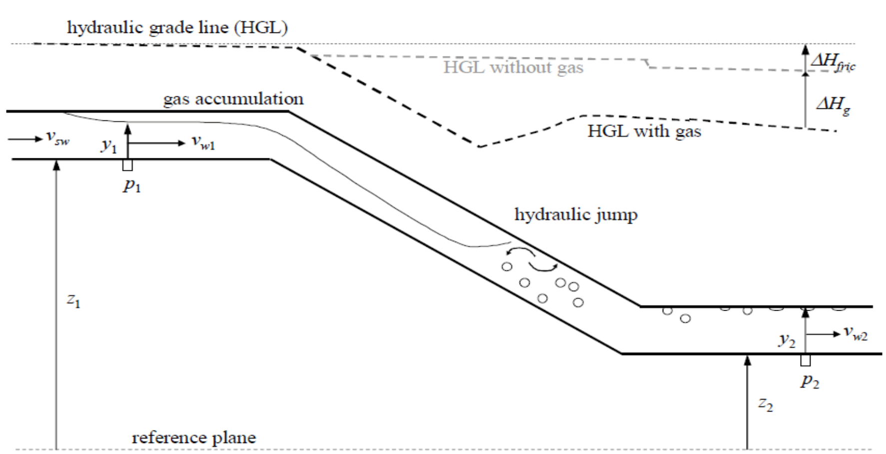


Figure C.5: Diagram of a Fully Developed Air or Gas Pocket[3]

[1] Pothof, Ivo, *Co-current Air-Water Flow in Downward Sloping Pipes* (I.W.M. Pothof, 2011), 9.
[2] Pothof, *Air-Water Flow*, 9.
[3] Pothof, *Air-Water Flow*, ii.

An example of the acoustic signature generated by a pocket of trapped air or gas is shown in Figure C.6.

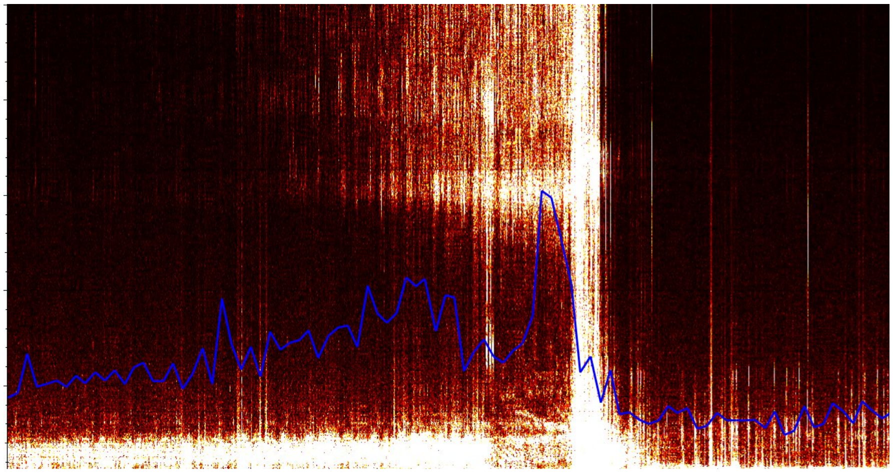


Figure C.6: Detected Air or Gas Pocket, as shown in the SmartBall Analysis Software

C.3 SmartBall Tracking

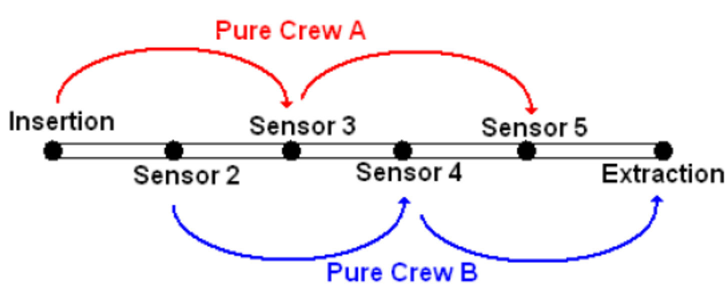
C.3.1 Tracking

SmartBall Receivers (SBR) and Remote Tracking Tools (RTT) are tracking devices that are used to track the position of the SmartBall tool as it traverses the pipeline. SBR and RTT tracking devices comprise a GPS receiver and a processing computer or unit. Both the SmartBall tool and the SBR/RTT are synchronized to standard GPS time.

Consumable Surface mounted sensors (SMS) are mounted to the prepared pipeline surface at planned locations and are connected to an SBR/RTT via coaxial cable. The SBR/RTT and SMS combination detect ultrasonic pulses emitted from the SmartBall tool. The SBR/RTT determines the time taken for the pulse to travel from the SmartBall tool to the SBR/RTT and calculates the location of the SmartBall tool at any given time. Figure C.7 shows an SMS, which is typically mounted to the pipeline itself or pipeline appurtenance.

Figure C.7: SMS Adhered to a Flange

Teams would typically leapfrog during tracking of the SmartBall tool as shown below. The number of tracking teams depends on the project complexity, flow velocity and duration.



Typical leap frog during inspection

This locational data is paralleled with the data extracted from the SmartBall tool. This combination is then used to identify the locations of leaks and pockets of trapped air or gas.

C.3.2 Correlation to Pipeline Information

An important part of the data analysis process is correlating data to the physical pipe in which it was collected. As the SmartBall tool does not have an odometer, distances are derived from correlating drawings and/or GIS information provided by the pipeline owner with GPS data gathered by tracking devices and at tracking locations, and motion sensor data onboard the tool.

Location accuracy is dependent on quality of provided information and collected data. Pipeline drawings and/or GIS information forms the foundation that is further refined using GPS data. Between these known locations, distances are derived assuming constant end-over-end rolling motion between features with tracking devices to determine the location of the tool as it travels through a pipeline. Additional sensor data utilized for locating include a magnetometer to identify pipe joints and features along the pipeline, and a strain gauge to identify elevation changes. Factors negatively impacting location accuracy are shown in the table below:

Data used in correlating locations	Factors negatively impacting location accuracy
Drawings	Missing or no drawings at all Unreliable/ Outdated drawings Inaccurate drawings Non legible drawings Delivery of drawings late in the project process
GIS information	No GIS information at all Inaccurate GIS information Delivery of GIS late in the project process
Rolling motion	Fast flow velocities Vertical deflections Debris inside the line Biofilm growth on pipe wall (Slippage) Outlets that are not closed Bottom outlets Change / stop of flow rate during inspection
Tracking locations	Small pipe diameters Flexible pipe material (Plastic) Bends in between tracking locations Large tracking spacing Large sensor mounting offsets

An example of data correlation from a sample pipeline is illustrated in Figure C.8.

Figure C.8: Data Correlation - Example from Another Pipeline

C.4 Advantages and Limitations of the SmartBall Technology

The SmartBall technology acquires high quality acoustic data that is evaluated to identify leaks and pockets of trapped air or gas. While other leak detection techniques such as noise loggers and correlators may identify a single leak or air or gas pocket between each sensor, they cannot accurately locate the limits of an event nor identify multiple events. The SmartBall tool travels directly past each acoustic event of interest and thus significant advantages are recognized:

- Medium and Large Diameter Pipes

  SmartBall technology has successfully inspected and detected leaks on a wide range of medium and large diameter pipelines 12 inch to 96 inch in diameter (300 millimeters to 2400 millimeters). Many conventional leak detection technologies (e.g., correlators) have limitations that prevent their use on medium and large diameter pipes.

- Pipe Material:

  The SmartBall tool's leak detection ability is not affected by pipe material. Because the tool passes by the point at which the acoustic event is being created, the pipe wall is not relied on to transmit the acoustic event through the line to a sensor located far away from the actual event of interest. This greatly increases the SmartBall tool's sensitivity and ability to distinguish between separate acoustic events.

- Sensitivity:

  The sensitivity of all leak detection technologies is a function of several variables and as a result, no absolute thresholds can be established. However, the acoustic sensor inside the SmartBall tool always passes within one (1) pipe diameter of an acoustic event; therefore, it can be used to identify very small leaks due to the proximity of the SmartBall tool to the leak. It should be noted that the SmartBall technology cannot differentiate between a true leak, a simulated leak, and the potential noise of a pressure reducing valve. As such, acoustic events corresponding to features on a main should be investigated further in the field.

- Length of Survey:

  SmartBall technology has the ability to record acoustic data for over 18 hours. Depending on flow rates, the tool can inspect long pipelines during a single deployment. The longest single recording within a water pipeline with a single deployment had the SmartBall tool recorded acoustic data for a length of pipeline exceeding 48 kilometers.

All non-destructive testing technologies have unique capabilities and limitations that affect the accuracy and efficacy of the technology. The SmartBall tool has the following limitations:

- Minimum Pressure:

The acoustic activity associated with a leak is derived from the pressure differential across the pipe wall. With little to no pressure differential, the SmartBall tool will not detect leakage as there will be no associated acoustic activity. Pure recommends a minimum pressure differential of 15 psi (1.03 Bar) for leak detection inspections; however, under ideal conditions leaks have been detected in pipelines with pressures as low as 5 psi (0.34 Bar). There is no minimum pressure recommendation for the detection of areas of trapped air or gas.

- Ambient Noise:

  The SmartBall technology detects and reports events that have acoustic characteristics similar to leaks on pressurized pipelines. However, other forms of ambient noise may be identified during the data analysis. For medium and large leaks, there is very little that can match these acoustic characteristics; therefore, these events are reported with a high degree of certainty. For small leaks, there may be other forms of ambient noise with similar acoustic signatures, making these signals more difficult to evaluate. Pure has invested significant resources into characterizing acoustic events and consequently asserts that leaks described in this report are leaks, unless otherwise noted. However, unknown pressure reducing valves, cracked valves in close proximity to the subject pipeline, interconnected pipelines that have not been completely isolated, and leaks in pipelines immediately adjacent to the subject pipeline can contain a similar acoustic signature and could be reported as leaks. Cars, pumps, boat traffic, and other forms of common ambient noise will not be reported as leaks as they generate different acoustic signatures.

- Reported Locations:

  The event locations in this report are based on project experience and the limitations of the technologies used to calculate location. There are also several other factors that could decrease the accuracy of locating leaks and air or gas pockets. Accuracy rankings for each event are included in each event overview.

C.5 Overview of a SmartBall Inspection

Figure C.9 shows an overview of a typical SmartBall inspection.

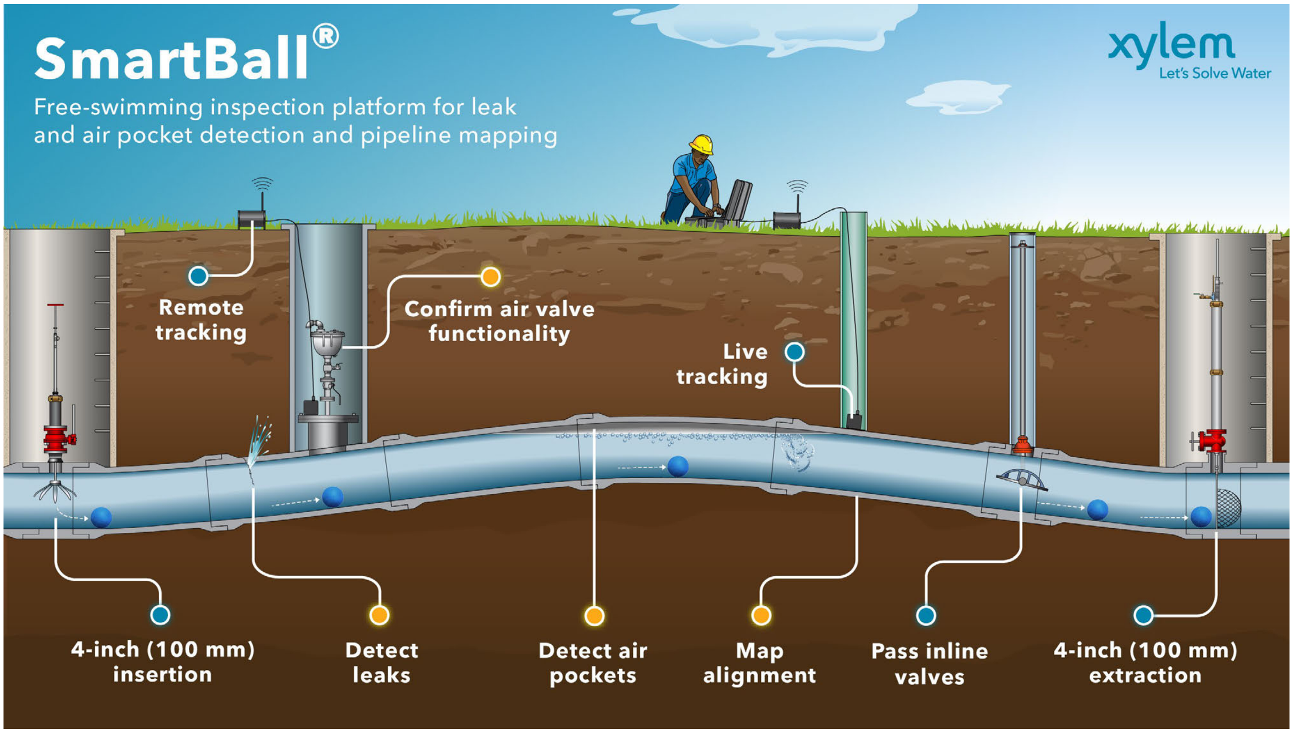
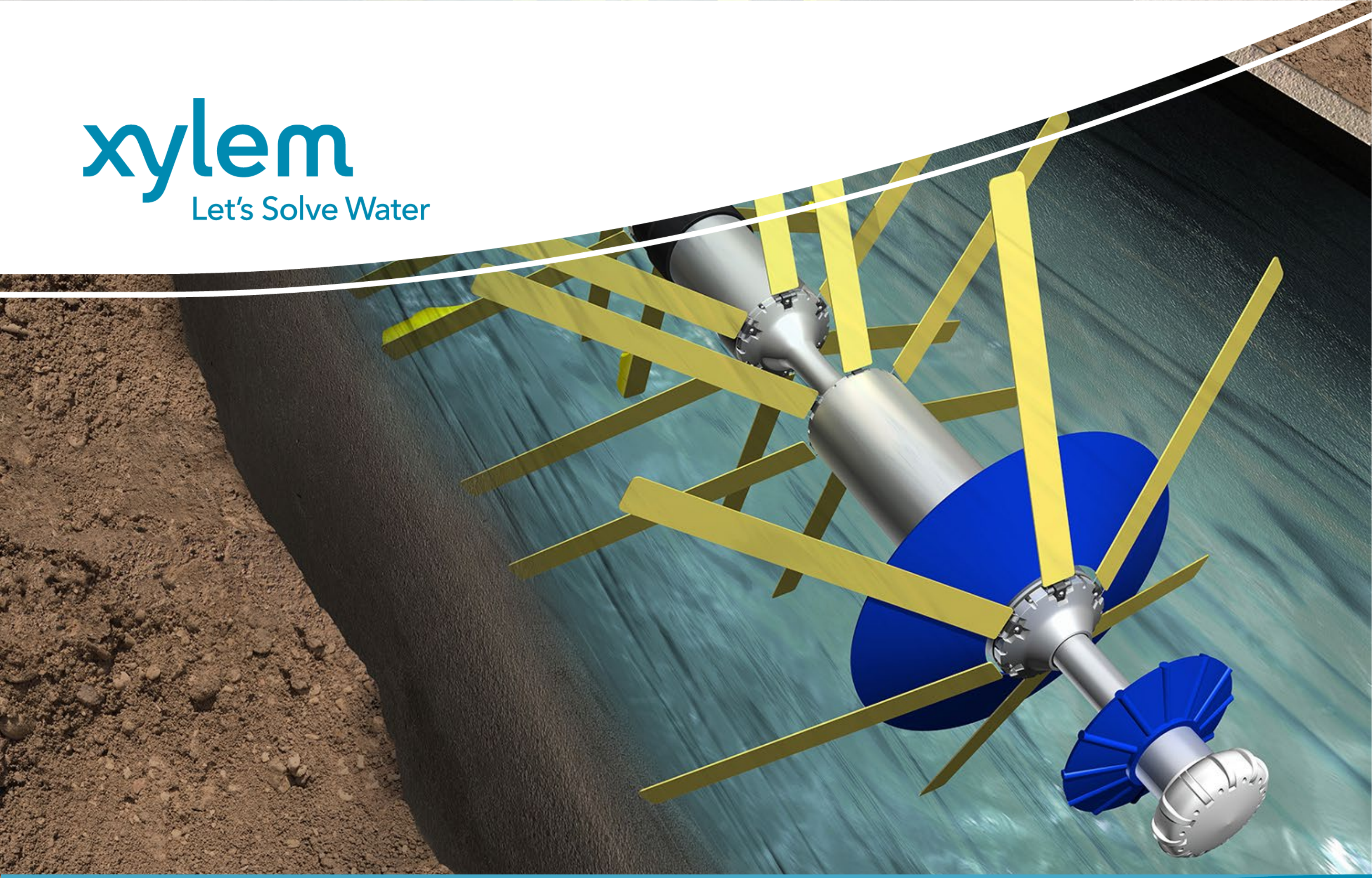


Figure C.9: Overview of a SmartBall Inspection

APPENDIX 2

PipeDiver® Electromagnetic Inspection Report

xylem
Let's Solve Water



PipeDiver® Electromagnetic Inspection Report

24-inch Ductile Iron Pipeline

MNS Engineers Inc and Goleta West Sanitary District

Version 1.0 – May 2025
(Final)

pure TECHNOLOGIES
a xylem brand

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

May 6, 2025

Brian Hext — Date
Project Manager

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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:

May 5, 2025

Carley Williamson — Date
Editorial Reviewer

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May 6, 2025

Daniel DeFever, PE — 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:

May 5, 2025

Bryon Boyd — Date
Contractual Reviewer

Confidentiality Clause

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Executive Summary

On December 11, 2024, and February 5, 2025, Pure Technologies, a Xylem brand (Pure Technologies), conducted an electromagnetic inspection of the ductile iron pipe (DIP) in the 24-inch Ductile Iron Pipeline. The evaluation was performed using Pure Technologies' proprietary PipeDiver® platform, a non-destructive electromagnetic inspection technology. The purpose of the inspection was to locate and identify pipes with indications of corrosion induced pipe wall thinning or "wall loss". The inspection covered a cumulative distance of 1.64 miles and spanned a total of 493 fully inspected pipes and 2 partially inspected pipes between Goleta West Sanitary District Yard and the Wastewater Treatment Plant Headworks. The electromagnetic inspection scope is presented in Table ES.1.

Table ES.1: Scope of the Electromagnetic Inspection

Pipeline	Start Station	End Station
24-inch Ductile Iron Pipeline	N/A	~85+71

'N/A' is reported as the start station due to unavailability of pipe laying schedules and plan and profile drawings.
'~' Station number approximated from the plan and profile drawings and electromagnetic data.

Pure Technologies' evaluation of the 24-inch Ductile Iron Pipeline concluded that of the 493 fully inspected pipes and 2 partially inspected pipes:

- One (1) electromagnetic anomaly characteristic of wall loss was detected.
    - The area of wall loss was 20 square inches.
    - The wall loss anomaly has been quantified with an estimated depth of 60 percent of an assumed 0.38-inch nominal pipe wall thickness.

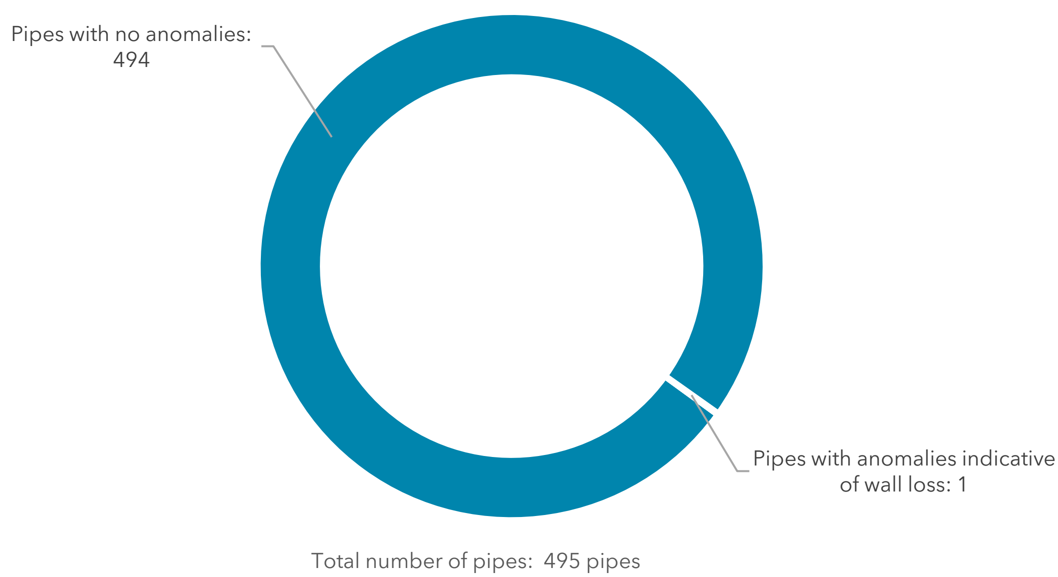

Figure ES.1: Electromagnetic Inspection Results

1. Project Background and Scope

1.1. Project Scope

In December 2024 and February 2025, Pure Technologies conducted an electromagnetic inspection of the DIP in the 24-inch Ductile Iron Pipeline using the PipeDiver inspection platform.

The purpose of the electromagnetic inspection was to locate and identify pipes with indications of wall loss. Corrosion or thinning of the pipe's wall is the primary cause of failure in metallic pipelines. Because the only structural component is the pipe wall itself, any loss in cross-sectional area due to corrosion has an immediate impact on the overall strength of the pipe. Structural and finite element analyses provide information regarding the structural capacity of a distressed pipe under its current loading conditions. With an electromagnetic baseline and a detailed structural analysis, the significance of identified wall loss anomalies may be understood. A full condition assessment will be completed following this report.

The inspected portion of the 24-inch Ductile Iron Pipeline is composed of 24-inch DIP. The 24-inch Ductile Iron Pipeline is owned and operated by the Goleta West Sanitary District.

1.2. Description of the PipeDiver Platform

PipeDiver is a free-swimming platform that uses electromagnetics to identify localized areas of pipe wall loss in metallic pipes. The tool creates an electromagnetic field that interacts with the pipe wall as it moves through the pipeline. Where pipe wall loss exists, the electromagnetic field is changed. This field data is recorded by the detectors and stored onboard the tool. Post-inspection, analysts identify, quantify, and locate areas of pipe wall loss.

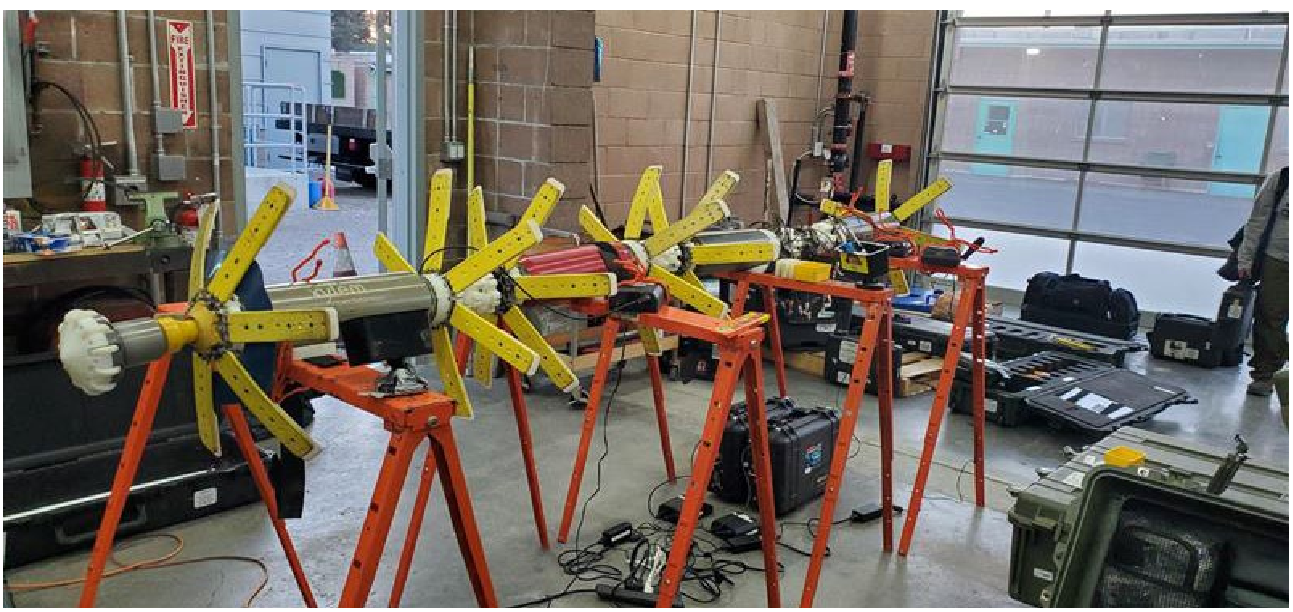

Figure 1.1: PipeDiver Inspection Platform

The tool is made up of several modules containing the electronics, computers, and batteries required for generating and collecting electromagnetic inspection data (Figure 1.1). The exciter is located in the body of the tool while the detectors are positioned circumferentially at the tips of the petals so they are as close as possible to the pipe wall. Electromagnetic inspections evaluate the electromagnetic signature of the pipe wall to identify anomalies that are produced by variations in the pipe thickness due to wall loss or manufacturing defects. Various characteristics associated with an electromagnetic anomaly (length, magnitude, signal shift, etc.) are evaluated. If calibration information is available with pipe design specifications similar to the pipe being inspected, then quantification of the size and depth of pipe wall loss anomalies can be provided (refer to Section 2.3 for more details on calibration).

1.3. PipeDiver Inspection Details

The PipeDiver tool was inserted into the pipeline via a 24-inch elbow located inside of the Goleta West Sanitary District Yard. After the tool was inserted and the access Tee was reassembled, the downstream isolation valves were opened. As the PipeDiver traveled through the pipeline, field crews tracked the tool from above ground at regular intervals using tracking units. The tracking units detected a signal emitted from the PipeDiver tool and calculated the distance of the tool from the tracking location.

The PipeDiver tool was originally planned to be extracted from the pipeline using a bar screen at the Wastewater Treatment Plant headworks. However, the PipeDiver got stuck ~100 meters from the proposed extraction. Multiple attempts were then made to manipulate the flow, however, these attempts were unsuccessful in dislodging the tool. A crew then excavated the location where the tool was located. After draining the pipe, the flange was removed and the tool was extracted.

Pure Technologies then remobilized to complete the second run of the inspection. This insertion was successful, and the tool was retrieved from the bar screen at the Wastewater Treatment Plant headworks.

Figure 1.2: PipeDiver Inspection Platform Being Pulled from Pipeline

2. Inspection Results

2.1. Electromagnetic Inspection Results

Electromagnetic data was collected on December 11, 2024, and February 5, 2025, for the 24-inch Ductile Iron Pipeline using the PipeDiver electromagnetic inspection platform. The inspected section spanned an overall distance of 1.64 miles and a total of 493 fully inspected pipes and 2 partially pipes. Pure Technologies' inspection schedule is presented in Table 2.1.

Table 2.1: Inspection Summary

Date	Pipeline	Pipe Material	Start Station	End Station	Distance
December 11, 2024 and February 5, 2025	24-inch Ductile Iron Pipeline	DIP	N/A	~85+71	**1.64 miles**

'N/A' is reported as the start station due to unavailability of pipe laying schedules and plan and profile drawings.
'~' Station number approximated from plan and profile drawings and electromagnetic data.

2.1.1. Pipes with Pipe Wall Anomalies

Of the 493 fully inspected pipes and 2 partially inspected pipes, one (1) pipe has electromagnetic anomalies consistent with pipe wall loss with an estimated 60 percent of an assumed 0.38-inch nominal pipe wall thickness, with an estimated area of 20 square inches. Table 2.2 details the pipe wall anomaly.

- 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 Anomaly Longitudinal Position is measured from the upstream station joint of the pipe to the center of the anomaly and is rounded to the nearest 0.5 feet.
- The Anomaly Circumferential Position is looking towards the downstream station joint and is rounded to the nearest 5 degrees. The 12 o'clock position is 0 degrees. Refer to Figure 2.2 for the radial layout of circumferential degrees and clock position.
- The Anomaly Area is based on the longitudinal length and the number of sensors that detected the anomaly. The anomaly is assumed to be square and is rounded to the nearest square inch.
- The Estimated Depth of Wall Loss is the average estimated percentage of relative pipe wall thickness across the anomaly area based on Pure Technologies' calibration testing performed at other sites and is rounded to the nearest 5 percent.

Wall loss anomalies identified in the electromagnetic data are quantified by calculating the overall volumetric loss of the metallic pipe wall. To better visualize the volumetric loss, the anomaly is reported as an estimated square area and percentage of relative loss of wall thickness across the anomaly area. Anomalies with a large area and shallow depth of wall loss will have similar

characteristics in the electromagnetic data as anomalies with a smaller area and deeper depth of wall loss.

The estimated size of wall loss anomalies is dependent on the proximity of the exciter and detector coils located on the PipeDiver inspection platform to the pipe wall. Calculations of the area and the depth of pipe wall anomaly is based on calibration testing at other sites, which assumes that the PipeDiver inspection platform was centered in the pipeline during the inspection.

A visual representation of the electromagnetic data of the pipe identified to have pipe wall loss is detailed in Section 2.1.2.

Table 2.2: Pipes with Anomalies Consistent with Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Anomaly Longitudinal Position (feet from Upstream Station)	Anomaly Circumferential Position (degrees - looking toward Downstream Station)	Anomaly Area (square inches)	Estimated Depth of Pipe Wall Loss (% of nominal thickness)
10105	16+27	18	10.5	100	20	60

The electromagnetic data signal is sensitive not only to physical differences in pipe properties, but it is also sensitive to any magnetic differences in the metallic components of the pipe. Variations of a pipe's magnetic properties results in variations in the electromagnetic data, which can impact the detection capabilities and accuracy in the estimations of the pipe wall loss anomaly. In some cases, metallic pipe design standards account for some of these manufactured dimensional or material property tolerances. For instance, according to American Water Works Association's (AWWA) C150 Design Standard, ductile iron pipe may be manufactured with a certain wall thickness tolerance, varying from 0.05 to 0.09 inches depending on diameter, which may vary from pipe to pipe or along the length of one individual pipe.

Several pipes in the collected data were affected by noise and changes in pipeline flow. As a result, large signal variations are observed in the data, affecting the overall data quality. The affected pipes are listed in the Pipe List (Appendix B) and the results for these pipes are reported with less certainty.

2.1.2. Electromagnetic Pipe Diagrams

To visualize the results, two-dimensional rollout graphs were created to illustrate the recorded electromagnetic data of the pipe identified with pipe wall loss defect.

Each figure below is laid out as if the pipes are split down the length of the crown and rolled out flat. The X-axis represents the distance, in feet, from the upstream station joint of the pipe. The Y-axis denotes the circumferential position of a pipe with reference to the clock position, where 12 o'clock represents the crown of the pipe and 6 o'clock represents the invert of the pipe. Figure 2.2 shows the radial layout of circumferential degrees and clock position when looking toward downstream joint.

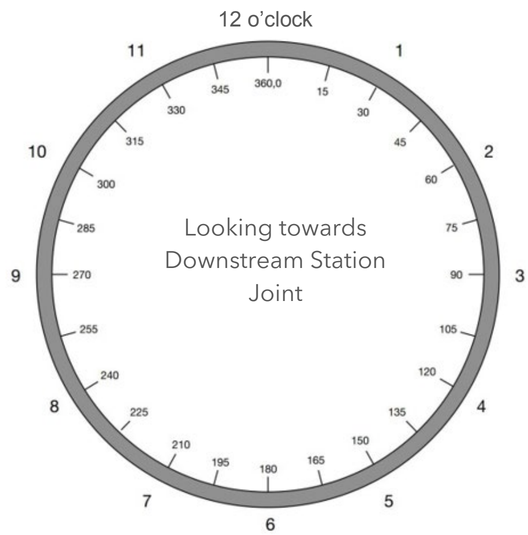

Figure 2.2: Radial Layout of Circumferential Degrees and Clock Position

The rollout graphs for the identified pipe wall anomalies in the 24-inch Ductile Iron Pipeline are presented in Figure 2.3. The colors in these figures are meant for reference only to indicate the longitudinal and circumferential location of the anomalies on the pipes and cannot be used to infer pipe depth. The red color represents the location of the identified pipe wall loss defects.

Pure Reference Number 10105

Pipe rollout graph:

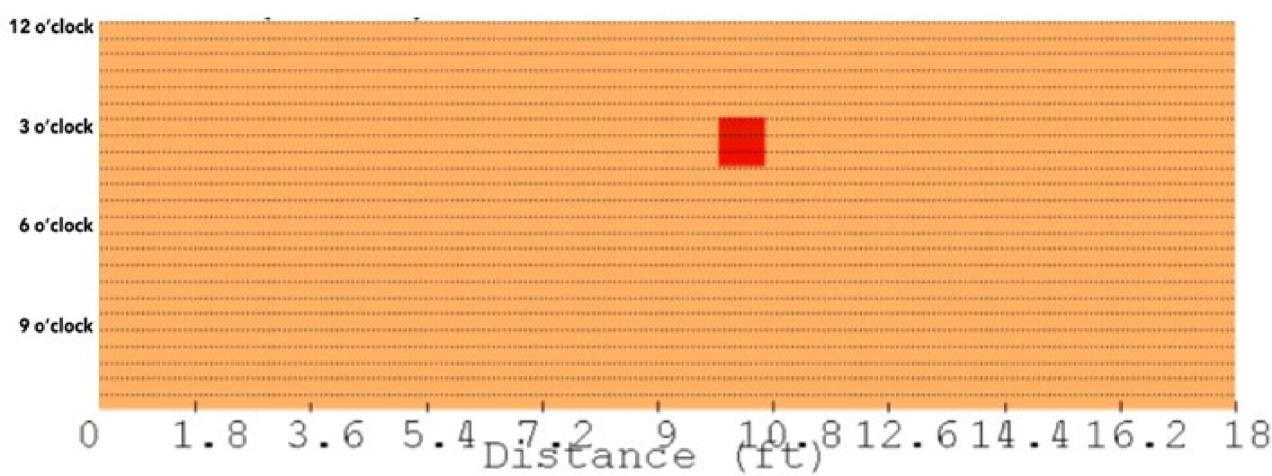

Figure 2.3: Pipes with Wall Loss Anomalies

2.2. Locating Pipes with Defects

An important part of the data analysis process is correlating the PipeDiver data to the physical pipe in which it was collected. Because the tool is free-swimming and does not have an odometer, data is collected in the time-domain and distances are derived through correlating identifiable features in the data to known locations on the pipeline. Examples of features that can be identified in the electromagnetic data and used as correlation points are inline valves, bends or outlets as well as tracking points. An example of data correlation from another pipeline is illustrated in Figure 2.4. Between these known locations, distances are derived assuming that the tool is travelling at constant velocity and that the distance between the locations is correct.

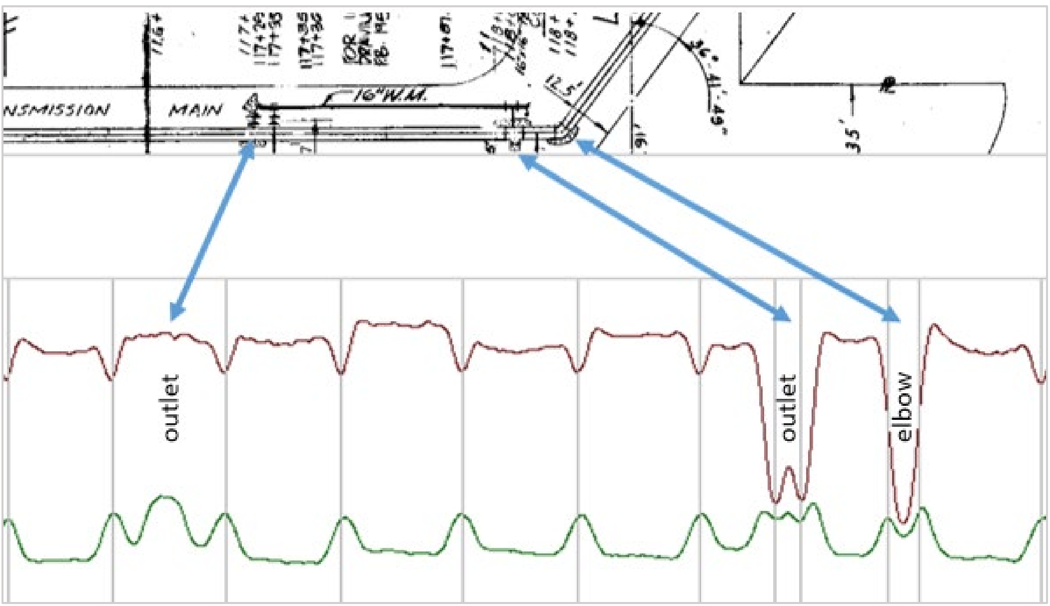

Figure 2.4: Data Correlation Example from Another Pipeline

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 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 is available to assist with any excavations or investigation. Please contact Pure Technologies for assistance. The Pipe List can be found in Appendix B.

2.3. Quantification of Defects through Calibration

Effective quantification of defects identified in electromagnetic data requires knowledge of how the electromagnetic signal behaves without pipe damage (baseline condition) and the ability to compare that baseline condition to the data signal received from the pipe when it is damaged. Because the data signal is sensitive to pipeline properties (e.g. pipe wall thickness, material, class, pipe diameter, etc.), two (2) pipes with the same diameter, but with different classes, will exhibit different baseline signals. Additionally, these pipes will produce signals that respond differently to wall loss.

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., material, diameter, wall thickness, 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 systematically varying the size of the wall loss defects and recording the response. The results from the calibration testing are incorporated into Pure Technologies' analysis software. At this point, an experienced data analyst can measure an anomaly signal and compare it to the calibration information to quantify the size and depth of the wall loss defects.

While the calibration process was not performed on pipes from the 24-inch Ductile Iron Pipeline, wall anomalies that were identified are based on calibration testing on metallic pipes at other sites. As such, the minimum size of a wall loss anomaly detectable by Pure Technologies' electromagnetic tool for the 24-inch Ductile Iron Pipeline is estimated to have 30 percent wall loss and longitudinal length of 3 inches.

If a wall loss anomaly is smaller than the minimum size stated above, detection may be possible only when the sensor is close to the anomaly (i.e., sensor passes directly under the anomaly).

However, as the nominal thickness of the pipe wall for pipes in the 24-inch Ductile Iron Pipeline is not available, the estimated depth of wall loss cannot be quantified.

If the wall thickness is provided and relevant calibration information is available, or field validations are performed on any pipes from the 24-inch Ductile Iron Pipeline at a future date, the results can be applied to the data from this inspection and the depth of pipe wall loss anomalies can be calculated.

For more details regarding the calibration process, electromagnetics capabilities, limitations, and functions, refer to Appendix A.

2.4. Confidence Codes in Pipe List

The PipeDiver inspection platform's capability to detect and quantify pipe wall loss anomalies is impacted by pipeline flow velocity, gas pockets in the pipeline, the availability of calibration information, and availability of as-built specifications. If inspection conditions are not optimal, then the results may be reported with less certainty.

The analysts' confidence in the identification and quantification of pipe wall loss anomalies is reported on a pipe-by pipe basis using "confidence codes" in the Pipe List in Appendix B.

2.4.1. Confidence Codes for Detection of Pipe Wall Loss

The speed at which the inspection tool is traveling through the pipeline impacts the electromagnetic data quality. The minimum size of a pipe wall loss anomaly detectable by Pure Technologies' electromagnetic tool is expected when the optimal flow velocity of 1.0 foot/second is achieved for each inspection run. When the optimal flow velocity is not achieved for one (1) or more inspection runs, the minimum size of pipe wall loss anomaly detectable by the Pure Technologies' electromagnetic tool may be larger than expected. A confidence ***color*** code is used in the Pipe List to represent how the inspection's pipeline flow affected data analysis.

2.4.2. Confidence Codes for Quantification of Pipe Wall Loss

The availability of calibration information and pipe specifications of the inspected pipeline affect the analysts' ability to accurately quantify pipe wall loss. A confidence ***number*** code may be assigned to pipes with identified pipe wall loss in the Pipe List based on the availability of calibration information and pipe specifications.

3. Conclusions

Based on the PipeDiver inspection carried out on December 11, 2024, and February 5, 2025, Pure Technologies concluded that:

- One (1) electromagnetic anomaly characteristic of wall loss was detected across a total of 493 fully inspected pipes and 2 partially inspected pipes.
    - Area of wall loss was 20 square inches.
    - Wall loss anomaly has been quantified with an estimated depth of 60 percent of an assumed nominal pipe wall thickness.

APPENDIX A

Electromagnetic Inspection Technology

A1 Electromagnetic Inspection Technology

A1.1 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.

Electromagnetics are used to generate an electric current in the pipe wall. A signal generator outputs a low frequency alternating electric current into a coil of wire, known as an exciter coil, positioned at the center or near the surface of the pipe. The magnetic field generated by this coil extends through the liner and into the pipe wall. As the coil travels along the length of the pipe, the field also moves, creating a localized magnetic field that generates eddy currents in the pipe wall.

When the pipe wall is uniform, the current will flow uniformly through the pipe wall; however, if a defect exists, a distortion in the current is formed. As the magnetic field passes over the section of pipe wall loss, currents are generated that form opposing magnetic field lines. These disruptions in the uniform magnetic field are recorded by the inspection tool for further analysis. The analysis and interpretation of the response of the magnetic field allows for estimates of the size and depth of the pipe wall loss, as well as its approximate location along the length of the pipe.

With pipe wall loss, the detection capabilities are heavily dependent on the proximity of the detector sensor to the pipe wall and to the defect. When the detector lift-off is greater than 2 inches or 50 millimetres, the signal of the wall loss anomaly is minimized and can potentially be masked by the noise in the data. Therefore, a constant tool speed is required to ensure that the noise is kept at a minimum.

A1.2 Analysis Considerations

Electromagnetic inspections detect electromagnetic anomalies, or differences, in the expected induced field of a metallic pipeline. Anomalies that are consistent with pipe wall loss 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 pipe wall loss detection depends on several 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 pipe wall loss anomalies 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 pipe wall thickness and composition. 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 are used to identify and quantify regions with pipe wall loss. Discrepancies between 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 pipe wall loss, in some cases, the signals are similar and an appurtenance could be misinterpreted as pipe wall loss 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 an area with pipe wall loss and could also cause anomalies that may be misinterpreted as pipe wall loss.

Discontinuities or variations such as abnormal welding in liner construction. These discontinuities can mask actual damage or mimic damage where none exists.

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; however, this interference is rare.

Motion. Turbulence, excessive debris/build up, and passing through bends or valves all produce distortion which can affect the quantification of pipe wall loss 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.

Thickness of Pipe Wall. For the current electromagnetic system, if the thickness of pipe wall is greater than 0.5 inches or 13 millimetres, or the diameter of pipe is greater than 36 inches or 914 millimetres, accuracy of detection will decrease. Even within the optimal pipe size and configuration, the resolution and precision of measurement is affected by pipe material's permeability. This factor can be obtained through proper calibration. Pure Technologies maintains a database for steel, ductile iron, and cast iron pipes that aids the estimation. However, if no calibration is applicable for a given inspected pipeline, the detected anomalies can only be ranked to show comparative severity level.

Feature Pipes. The electromagnetic technology can detect pipe wall loss 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.

Longitudinal Anomaly Position. The signal of a pipe wall loss anomaly varies along the length of a given pipe. Pipe wall loss anomalies close to the middle of a pipe are easier to detect and measure than anomalies near the joint. The increased presence of metal at the joint causes a distinct signal response which may affect the signal of the anomalies. The minimum size of anomalies required for the signal to be detectable and quantifiable near the joint depends on the pipe type, joint configuration, and proximity of anomaly to the joint. As a result, pipe wall loss estimates located close to the middle of a pipe will be provided with greater confidence than near the joints.

Circumferential Anomaly Position. The position of an individual anomaly can be accurately determined in data within 0.5 feet or 0.1 metres longitudinally, and within 15 degrees circumferentially. However, sometimes due to vehicle tilting or rotation, circumferential positioning could be off by one (1) or two (2) detectors. If there are multiple anomalies too close together that they begin to merge into a single signal, only the center of signal will be used for estimating the position. This estimation could cause a discrepancy in the determination of the anomaly position of up to 30 degrees.

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 anomalies 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 anomaly. 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 anomalies. In the case where both end effects and anomalies exist, quantification is more challenging.

Background Signal Variations. The electromagnetic data signal is sensitive not only to physical differences in pipe properties, but it is also sensitive to any magnetic differences in the metallic 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 exactly the same physically, if the steel for the pipe wall comes 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 anomalies are quantified by measuring the anomaly signal relative to a background signal, any variations between background signals can affect the accuracy of the measurement and ultimately the estimates of the pipe wall loss anomaly. For instance, according to American Water Works Association's

(AWWA) C150 Design Standard, ductile iron pipe may be manufactured with a certain wall thickness tolerance, varying from 0.05 to 0.09 inches depending on diameter, which may vary from pipe to pipe or along the length of one individual pipe. All these factors will result in variations in the background signals.

Number of Pipe Wall Loss Anomalies. Results are predicted with greater accuracy for pipes containing single anomaly regions than for pipes containing multiple anomaly regions. As the number of anomaly regions per pipe increases, or as these regions become closer together, the complexity of the interpretation increases. In some cases, anomaly regions can interact with each other from an electromagnetic standpoint to create signals of varying 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 pipe wall loss in a pipe section based on all the information available and assuming that the signal changes are caused by discontinuity in pipe wall material.

Calibration of Pipe Wall. The calibration of pipe wall involves forming pipe wall defects of various sizes and arrangements while using a variety of instrument configurations to conduct the scans. Detection and quantification of pipe wall loss can then be determined based on calibration results. Depending on the clarity of data, small defects could be masked due to excessive noise. The diagram shown in Figure A1.1 depicts the various simulated defects that would be created on site during a typical calibration.

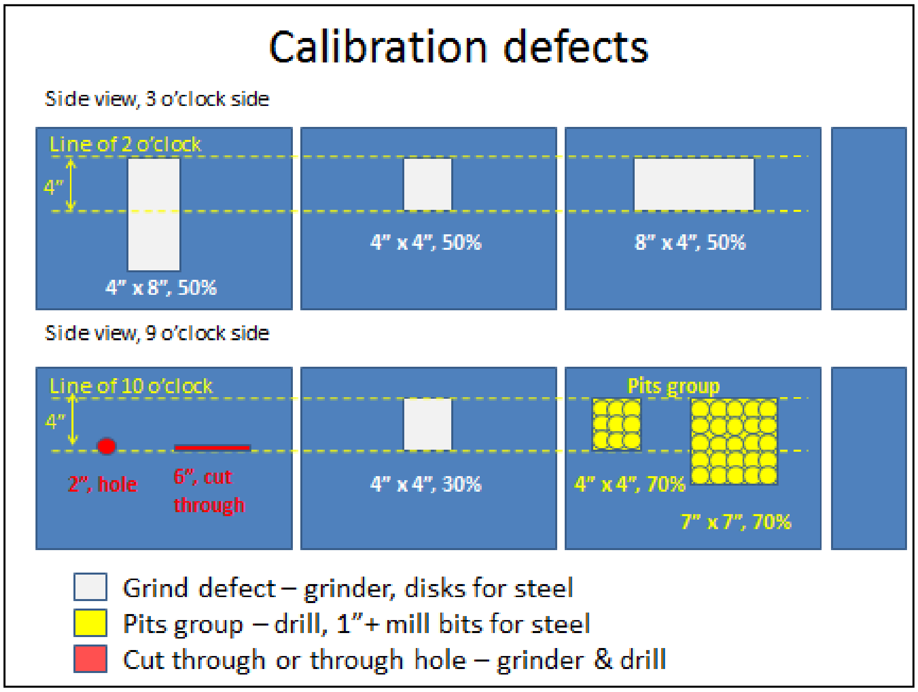

Figure A1.1: Sample of Defects Performed in a Pipe Wall Calibration

Variations in pipe properties do not affect the ability of the electromagnetic inspection equipment to locate pipe wall loss anomalies, but the variations will affect the accuracy in quantifying anomalies.

APPENDIX B

Pipe List

MNS Engineers Inc. & GWSD
24-inch Ductile Iron Pipeline

Electromagnetic Inspection Results
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Cylinder Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Downstream Station	Cylinder Anomaly Longitudinal Position (feet from Low Station)	Cylinder Anomaly Circumferential Position (degrees - looking toward Low Station with pipe crown at 0 degrees)	Calculated Area of Cylinder Wall Loss (square inches)	Estimated Depth of Cylinder Wall Loss	Confidence Code	Comments
Towards 24-inch Elbow at GWSD Yard (Insertion)									
10001	N/A	14	N/A					S; I	Partially inspected ~14ft of unknown pipe length. Pipe length reported with less certainty due to pipeline flow.
10002	N/A	18	N/A					S; I	Pipe length reported with less certainty due to pipeline flow.
10003	N/A	14	N/A					C; S; I	Pipe length reported with less certainty due to pipeline flow.
10004	N/A	14	N/A					C; S; I	90° Elbow. Pipe length reported with less certainty due to pipeline flow.
10005	0+00	13	0+06					C; S; I	Pipe length reported with less certainty due to pipeline flow.
10006	0+06	17	0+23					C; S; I	Valve Vault. 24" x 24" x 18" TEE. Pipe length reported with less certainty due to pipeline flow.
10007	0+23	18	0+41					C; S; I	Suspected 14" OL. Pipe reported with less certainty due to pipeline flow.
10008	0+41	18	0+59					I	Pipe length reported with less certainty due to pipeline flow.
10009	0+59	18	0+77					I	Pipe length reported with less certainty due to pipeline flow.
10010	0+77	18	0+95					I	Pipe length reported with less certainty due to pipeline flow.
10011	0+95	18	1+13					I	Pipe length reported with less certainty due to pipeline flow.
10012	1+13	18	1+31					I	Pipe length reported with less certainty due to pipeline flow.
10013	1+31	18	1+49					I	Pipe length reported with less certainty due to pipeline flow.
10014	1+49	18	1+67					I	Pipe length reported with less certainty due to pipeline flow.
10015	1+67	18	1+85					I	Pipe length reported with less certainty due to pipeline flow.
10016	1+85	18	2+03					I	Pipe length reported with less certainty due to pipeline flow.
10017	2+03	18	2+21					I	Pipe length reported with less certainty due to pipeline flow.
10018	2+21	18	2+38					I	Pipe length reported with less certainty due to pipeline flow.
10019	2+38	18	2+56					I	Pipe length reported with less certainty due to pipeline flow.
10020	2+56	16	2+72					I	Pipe length reported with less certainty due to pipeline flow.
10021	2+66	5	2+71					I	Pipe length reported with less certainty due to pipeline flow.
10022	2+72	17	2+89					C; S; I	Pipe length reported with less certainty due to pipeline flow.
10023	2+71	18	2+89					C; S; I	Pipe length reported with less certainty due to tool pause.
10024	2+89	18	3+07					I	
10025	3+07	18	3+25					I	
10026	3+25	18	3+43					I	
10027	3+43	18	3+61					I	
10028	3+61	18	3+79					I	
10029	3+79	18	3+97					I	
10030	3+97	18	4+15					I	
10031	4+15	18	4+33					I	
10032	4+33	18	4+51					I	
10033	4+51	18	4+69					I	
10034	4+69	18	4+87					I	
10035	4+87	18	5+05					I	
10036	5+05	18	5+23					I	
10037	5+23	18	5+41					I	
10038	5+41	18	5+59					I	
10039	5+59	18	5+77					I	
10040	5+77	18	5+95					I	
10041	5+95	18	6+13					I	
10042	6+13	18	6+31					I	
10043	6+31	4	6+35					I	23° Elbow.
10044	6+35	5	6+40					I	Pipe length reported with less certainty due to elbow.
10045	6+40	5	6+45					I	Pipe length reported with less certainty due to elbow.
10046	6+45	14	6+59					I	Pipe length reported with less certainty due to elbow.
10047	6+59	4	6+63					I	23° Elbow.
10048	6+63	18	6+80					I	
10049	6+80	13	6+93					I	Elbow.
10050	6+93	7	7+00					I	
10051	7+00	18	7+18					I	
10052	7+18	18	7+36					I	
10053	7+36	18	7+54					I	
10054	7+54	18	7+72					I	Pipe length reported with less certainty due to elbow.
10055	7+72	4	7+76					I	Elbow.
10056	7+76	18	7+93					I	Pipe length reported with less certainty due to elbow.
10057	7+93	5	7+98					I	Elbow.
10058	7+98	18	8+16					I	
10059	8+16	18	8+34					I	
10060	8+34	18	8+52					I	
10061	8+52	18	8+70					I	
10062	8+70	18	8+88					I	
10063	8+88	18	9+06					I	
10064	9+06	18	9+23					I	
10065	9+23	18	9+41					I	
10066	9+41	18	9+59					I	
10067	9+59	18	9+77					I	
10068	9+77	18	9+95					I	
10069	9+95	18	10+13					I	
10070	10+13	18	10+31					I	
10071	10+31	18	10+48					I	
10072	10+48	18	10+66					I	
10073	10+66	18	10+84					I	
10074	10+84	18	11+02					I	
10075	11+02	18	11+20					I	
10076	11+20	18	11+38					I	
10077	11+38	18	11+55					I	
10078	11+55	18	11+73					I	
10079	11+73	18	11+91					I	
10080	11+91	18	12+09					I	
10081	12+09	18	12+27					I	
10082	12+27	18	12+45					I	
10083	12+45	18	12+63					I	
10084	12+63	18	12+80					I	
10085	12+80	18	12+98					I	
10086	12+98	18	13+16					I	
10087	13+16	18	13+34					I	Pipe length reported with less certainty due to pipeline flow.
10088	13+34	8	13+42					I	67° Elbow.
10089	13+42	18	13+60					I	
10090	13+60	18	13+78					I	
10091	13+78	18	13+95					I	
10092	13+95	18	14+13					I	
10093	14+13	18	14+31					I	
10094	14+31	18	14+49					I	
10095	14+49	18	14+67					I	
10096	14+67	18	14+84					I	
10097	14+84	18	15+02					I	
10098	15+02	18	15+20					I	
10099	15+20	18	15+38					I	
10100	15+38	18	15+56					I	
10101	15+56	18	15+73					I	
10102	15+73	18	15+91					I	
10103	15+91	18	16+09					I	
10104	16+09	18	16+27					I	
10105	16+27	18	16+45	10.5	100	20	60%	I;1	Localized anomaly indicative of wall loss.
10106	16+45	18	16+62					I	
10107	16+62	18	16+80					I	
10108	16+80	18	16+98					I	
10109	16+98	18	17+16					I	
10110	17+16	18	17+34					I	
10111	17+34	18	17+51					I	
10112	17+51	18	17+69					I	
10113	17+69	18	17+87					I	
10114	17+87	18	18+05					I	
10115	18+05	18	18+23					I	
10116	18+23	18	18+40					I	
10117	18+40	18	18+58					I	
10118	18+58	18	18+76					I	
10119	18+76	18	18+94					I	
10120	18+94	18	19+12					I	

MNS Engineers Inc. & GWSD
24-inch Ductile Iron Pipeline

Electromagnetic Inspection Results
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Cylinder Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Downstream Station	Cylinder Anomaly Longitudinal Position (feet from Low Station)	Cylinder Anomaly Circumferential Position (degrees - looking toward Low Station with pipe crown at 0 degrees)	Calculated Area of Cylinder Wall Loss (square inches)	Estimated Depth of Cylinder Wall Loss	Confidence Code	Comments
10121	19+12	18	19+29					I	
10122	19+29	18	19+47					I	
10123	19+47	18	19+65					I	
10124	19+65	18	19+83					I	
10125	19+83	18	20+01					I	
10126	20+01	18	20+18					I	
10127	20+18	18	20+36					I	
10128	20+36	18	20+54					I	
10129	20+54	18	20+72					I	
10130	20+72	18	20+90					I	
10131	20+90	18	21+08					I	
10132	21+08	18	21+25					I	
10133	21+25	18	21+43					I	
10134	21+43	18	21+61					I	
10135	21+61	18	21+79					I	
10136	21+79	18	21+97					I	
10137	21+97	18	22+14					I	
10138	22+14	18	22+32					I	
10139	22+32	18	22+50					I	
10140	22+50	18	22+68					I	
10141	22+68	18	22+86					I	
10142	22+86	18	23+03					I	
10143	23+03	18	23+21					I	
10144	23+21	18	23+39					I	
10145	23+39	18	23+57					I	
10146	23+57	18	23+75					I	
10147	23+75	18	23+92					I	
10148	23+92	18	24+10					I	
10149	24+10	18	24+28					I	
10150	24+28	18	24+46					I	
10151	24+46	18	24+64					I	
10152	24+64	18	24+81					I	
10153	24+81	18	24+99					I	
10154	24+99	18	25+17					I	
10155	25+17	18	25+35					I	
10156	25+35	18	25+53					I	
10157	25+53	18	25+70					I	
10158	25+70	18	25+88					I	
10159	25+88	18	26+06					I	
10160	26+06	18	26+24					I	
10161	26+24	18	26+42					I	
10162	26+42	18	26+59					I	
10163	26+59	18	26+77					I	
10164	26+77	18	26+95					I	
10165	26+95	18	27+13					I	
10166	27+13	18	27+31					I	
10167	27+31	18	27+49					I	
10168	27+49	18	27+66					I	
10169	27+66	18	27+84					I	
10170	27+84	18	28+02					I	
10171	28+02	18	28+20					I	
10172	28+20	18	28+38					I	
10173	28+38	18	28+55					I	
10174	28+55	13	28+68					I	
10175	28+68	7	28+75					I	45° Elbow.
10176	28+75	18	28+93					I	Pipe reported with less certainty due to tool movement.
10177	28+93	18	29+11					I	
10178	29+11	18	29+29					I	
10179	29+29	18	29+47					I	
10180	29+47	18	29+65					I	
10181	29+65	18	29+83					I	
10182	29+83	18	30+01					I	
10183	30+01	18	30+19					I	
10184	30+19	18	30+37					I	
10185	30+37	18	30+55					I	
10186	30+55	18	30+73					I	
10187	30+73	18	30+91					I	
10188	30+91	18	31+09					I	
10189	31+09	18	31+27					I	
10190	31+27	18	31+45					I	
10191	31+45	18	31+63					I	
10192	31+63	18	31+81					I	
10193	31+81	18	31+99					I	
10194	31+99	18	32+17					I	
10195	32+17	18	32+35					I	
10196	32+35	18	32+53					I	
10197	32+53	18	32+71					I	
10198	32+71	18	32+89					I	
10199	32+89	18	33+07					I	
10200	33+07	18	33+25					I	
10201	33+25	18	33+43					I	
10202	33+43	18	33+61					I	
10203	33+61	18	33+79					I	
10204	33+79	18	33+97					I	
10205	33+97	18	34+15					I	
10206	34+15	18	34+33					I	
10207	34+33	18	34+51					I	
10208	34+51	18	34+69					I	
10209	34+69	18	34+87					I	
10210	34+87	18	35+05					I	
10211	35+05	18	35+23					I	
10212	35+23	18	35+41					I	
10213	35+41	18	35+59					I	
10214	35+59	18	35+77					I	
10215	35+77	18	35+95					I	
10216	35+95	18	36+13					I	
10217	36+13	18	36+31					I	
10218	36+31	18	36+49					I	
10219	36+49	18	36+67					I	
10220	36+67	18	36+85					I	
10221	36+85	18	37+03					I	
10222	37+03	18	37+21					I	
10223	37+21	18	37+39					I	
10224	37+39	18	37+57					I	
10225	37+57	18	37+75					I	
10226	37+75	18	37+93					I	
10227	37+93	18	38+11					I	
10228	38+11	18	38+29					I	
10229	38+29	18	38+47					I	
10230	38+47	18	38+65					I	
10231	38+65	18	38+83					I	
10232	38+83	18	39+01					I	
10233	39+01	18	39+19					I	
10234	39+19	18	39+37					I	
10235	39+37	18	39+55					I	
10236	39+55	18	39+73					I	
10237	39+73	18	39+91					I	
10238	39+91	18	40+09					I	
10239	40+09	18	40+27					I	
10240	40+27	18	40+45					I	
10241	40+45	18	40+63					I	

MNS Engineers Inc. & GWSD
24-inch Ductile Iron Pipeline

Electromagnetic Inspection Results
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Cylinder Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Downstream Station	Cylinder Anomaly Longitudinal Position (feet from Low Station)	Cylinder Anomaly Circumferential Position (degrees - looking toward Low Station with pipe crown at 0 degrees)	Calculated Area of Cylinder Wall Loss (square inches)	Estimated Depth of Cylinder Wall Loss	Confidence Code	Comments
10242	40+63	7	40+70					I	27° Elbow.
10243	40+70	18	40+88					I	
10244	40+88	18	41+06					I	
10245	41+06	18	41+24					I	
10246	41+24	18	41+42					I	
10247	41+42	18	41+60					I	
10248	41+60	15	41+75					I	Analysis Equation: 41+75BK = 42+29AH.
10249	42+29	5	42+34					I	20° Elbow.
10250	42+34	12	42+46					I	
10251	42+46	18	42+64					I	
10252	42+64	18	42+82					I	
10253	42+82	18	43+00					I	
10254	43+00	18	43+18					I	
10255	43+18	18	43+35					I	
10256	43+35	18	43+53					I	
10257	43+53	18	43+71					I	
10258	43+71	18	43+89					I	
10259	43+89	18	44+07					I	
10260	44+07	18	44+25					I	
10261	44+25	18	44+42					I	
10262	44+42	18	44+60					I	
10263	44+60	18	44+78					I	
10264	44+78	18	44+96					I	
10265	44+96	18	45+14					I	
10266	45+14	18	45+31					I	
10267	45+31	18	45+49					I	
10268	45+49	18	45+67					I	
10269	45+67	18	45+85					I	
10270	45+85	18	46+03					I	
10271	46+03	18	46+21					I	
10272	46+21	18	46+38					I	
10273	46+38	18	46+56					I	
10274	46+56	18	46+74					I	
10275	46+74	18	46+92					I	
10276	46+92	18	47+10					I	
10277	47+10	18	47+27					I	
10278	47+27	18	47+45					I	
10279	47+45	18	47+63					I	
10280	47+63	18	47+81					I	
10281	47+81	18	47+99					I	
10282	47+99	18	48+17					I	
10283	48+17	18	48+34					I	
10284	48+34	18	48+52					I	
10285	48+52	18	48+70					I	
10286	48+70	18	48+88					I	
10287	48+88	18	49+06					I	
10288	49+06	18	49+23					I	
10289	49+23	18	49+41					I	
10290	49+41	18	49+59					I	
10291	49+59	18	49+77					I	
10292	49+77	18	49+95					I	
10293	49+95	18	50+13					I	
10294	50+13	18	50+30					I	
10295	50+30	18	50+48					I	
10296	50+48	18	50+66					I	
10297	50+66	18	50+84					I	
10298	50+84	18	51+02					I	
10299	51+02	18	51+20					I	
10300	51+20	18	51+37					I	
10301	51+37	18	51+55					I	
10302	51+55	18	51+73					I	
10303	51+73	18	51+91					I	
10304	51+91	18	52+09					I	
10305	52+09	18	52+26					I	
10306	52+26	18	52+44					I	
10307	52+44	18	52+62					I	
10308	52+62	18	52+80					I	
10309	52+80	18	52+98					I	
10310	52+98	18	53+16					I	
10311	53+16	18	53+33					I	
10312	53+33	18	53+51					I	
10313	53+51	18	53+69					I	
10314	53+69	18	53+87					I	
10315	53+87	18	54+05					I	
10316	54+05	18	54+22					I	
10317	54+22	18	54+40					I	
10318	54+40	18	54+58					I	
10319	54+58	18	54+76					I	
10320	54+76	18	54+94					I	
10321	54+94	18	55+12					I	
10322	55+12	18	55+29					I	
10323	55+29	18	55+47					I	
10324	55+47	18	55+65					I	
10325	55+65	18	55+83					I	
10326	55+83	18	56+01					I	
10327	56+01	18	56+19					I	
10328	56+19	18	56+36					I	
10329	56+36	18	56+54					I	
10330	56+54	18	56+72					I	
10331	56+72	18	56+90					I	
10332	56+90	18	57+08					I	
10333	57+08	18	57+25					I	
10334	57+25	18	57+43					I	
10335	57+43	18	57+61					I	
10336	57+61	18	57+79					I	
10337	57+79	18	57+97					I	
10338	57+97	18	58+15					I	
10339	58+15	18	58+32					I	
10340	58+32	18	58+50					I	
10341	58+50	18	58+68					I	
10342	58+68	18	58+86					I	
10343	58+86	18	59+04					I	
10344	59+04	18	59+21					I	
10345	59+21	18	59+39					I	
10346	59+39	18	59+57					I	
10347	59+57	18	59+75					I	
10348	59+75	18	59+93					I	
10349	59+93	18	60+11					I	
10350	60+11	18	60+28					I	
10351	60+28	18	60+46					I	
10352	60+46	18	60+64					I	
10353	60+64	13	60+77					I	
10354	60+77	7	60+84					I	11° Elbow.
10355	60+84	18	61+02					I	
10356	61+02	18	61+19					I	
10357	61+19	18	61+37					I	
10358	61+37	18	61+55					I	
10359	61+55	18	61+73					I	
10360	61+73	18	61+91					I	
10361	61+91	18	62+09					I	
10362	62+09	18	62+26					I	

MNS Engineers Inc. & GWSD
24-inch Ductile Iron Pipeline

Electromagnetic Inspection Results
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Cylinder Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Downstream Station	Cylinder Anomaly Longitudinal Position (feet from Low Station)	Cylinder Anomaly Circumferential Position (degrees - looking toward Low Station with pipe crown at 0 degrees)	Calculated Area of Cylinder Wall Loss (square inches)	Estimated Depth of Cylinder Wall Loss	Confidence Code	Comments
10363	62+26	18	62+44					I	
10364	62+44	18	62+62					I	
10365	62+62	8	62+70					C; S; I	89° Elbow.
10366	62+70	15	62+85					C; S; I	Pipe reported with less certainty due to electromagnetic noise.
10367	62+85	18	63+03					I	
10368	63+03	18	63+21					I	
10369	63+21	18	63+39					I	
10370	63+39	18	63+57					I	
10371	63+57	18	63+75					I	
10372	63+75	18	63+94					I	
10373	63+94	18	64+12					I	
10374	64+12	18	64+30					I	
10375	64+30	18	64+48					I	
10376	64+48	18	64+66					I	
10377	64+66	18	64+84					I	
10378	64+84	18	65+02					I	
10379	65+02	18	65+20					I	
10380	65+20	18	65+38					I	
10381	65+38	18	65+56					I	
10382	65+56	18	65+74					I	
10383	65+74	18	65+92					I	
10384	65+92	18	66+10					I	
10385	66+10	18	66+28					I	
10386	66+28	18	66+47					I	
10387	66+47	18	66+65					I	
10388	66+65	18	66+83					I	
10389	66+83	18	67+01					I	
10390	67+01	18	67+19					I	
10391	67+19	18	67+37					I	
10392	67+37	18	67+55					I	
10393	67+55	18	67+73					I	
10394	67+73	18	67+91					I	
10395	67+91	18	68+09					I	
10396	68+09	18	68+27					I	
10397	68+27	18	68+45					I	
10398	68+45	18	68+63					I	
10399	68+63	18	68+81					I	
10400	68+81	18	69+00					I	
10401	69+00	18	69+18					I	
10402	69+18	18	69+36					I	
10403	69+36	18	69+54					I	
10404	69+54	18	69+72					I	
10405	69+72	18	69+90					I	
10406	69+90	18	70+08					I	
10407	70+08	18	70+26					I	
10408	70+26	18	70+44					I	
10409	70+44	18	70+62					I	
10410	70+62	18	70+80					C; S; I	Pipe reported with less certainty due to electromagnetic noise.
10411	70+80	18	70+98					I	
10412	70+98	18	71+16					I	
10413	71+16	18	71+34					I	
10414	71+34	18	71+53					I	
10415	71+53	18	71+71					I	
10416	71+71	18	71+89					I	
10417	71+89	18	72+07					I	
10418	72+07	18	72+25					I	
10419	72+25	18	72+43					I	
10420	72+43	18	72+61					I	
10421	72+61	7	72+68					I	Pipe reported with less certainty due to tool movement.
10422	72+68	13	72+81					C; S; I	75° Elbow.
10423	72+81	18	72+99					I	
10424	72+99	18	73+17					I	
10425	73+17	18	73+35					I	
10426	73+35	18	73+53					I	
10427	73+53	18	73+71					I	
10428	73+71	18	73+89					I	
10429	73+89	18	74+07					I	
10430	74+07	18	74+25					I	
10431	74+25	18	74+43					I	
10432	74+43	18	74+61					I	
10433	74+61	18	74+79					I	
10434	74+79	18	74+97					I	
10435	74+97	18	75+15					I	
10436	75+15	18	75+33					I	
10437	75+33	18	75+51					I	
10438	75+51	18	75+69					I	
10439	75+69	18	75+87					I	
10440	75+87	18	76+04					I	
10441	76+04	18	76+22					I	
10442	76+22	18	76+40					I	
10443	76+40	18	76+58					I	
10444	76+58	18	76+76					I	
10445	76+76	18	76+94					I	
10446	76+94	18	77+12					I	
10447	77+12	18	77+30					I	
10448	77+30	18	77+48					I	
10449	77+48	18	77+66					C; S; I	Pipe reported with less certainty due to electromagnetic noise.
10450	77+66	18	77+84					I	
10451	77+84	18	78+02					I	
10452	78+02	18	78+20					I	
10453	78+20	18	78+38					I	
10454	78+38	18	78+56					I	
10455	78+56	18	78+74					I	
10456	78+74	18	78+92					I	
10457	78+92	18	79+10					I	
10458	79+10	18	79+28					I	
10459	79+28	18	79+46					I	
10460	79+46	18	79+64					I	
10461	79+64	18	79+82					I	
10462	79+82	18	80+00					I	
10463	80+00	18	80+18					I	
10464	80+18	18	80+36					I	
10465	80+36	18	80+54					I	
10466	80+54	18	80+72					I	
10467	80+72	18	80+90					I	
10468	80+90	18	81+08					I	
10469	81+08	18	81+26					I	
10470	81+26	18	81+44					I	
10471	81+44	18	81+62					I	
10472	81+62	18	81+80					I	
10473	81+80	18	81+98					I	
10474	81+98	14	82+12					I	Pipe reported with less certainty due to electromagnetic noise.
10475	82+12	13	82+25					C; S; I	90° Elbow. Equation: 82+19BK = 82+18AH.
10476	82+25	12	82+37					I	
10477	82+37	18	82+55					I	
10478	82+55	18	82+73					I	
10479	82+73	18	82+91					I	
10480	82+91	18	83+09					I	
10481	83+09	18	83+27					I	
10482	83+27	18	83+45					I	
10483	83+45	18	83+63					I	

MNS Engineers Inc. & GWSD
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Electromagnetic Inspection Results
Pipe Sections that Exhibit Electromagnetic Anomalies Consistent with Cylinder Wall Loss

Pure Reference Number	Upstream Station	Pipe Length (feet)	Downstream Station	Cylinder Anomaly Longitudinal Position (feet from Low Station)	Cylinder Anomaly Circumferential Position (degrees - looking toward Low Station with pipe crown at 0 degrees)	Calculated Area of Cylinder Wall Loss (square inches)	Estimated Depth of Cylinder Wall Loss	Confidence Code	Comments
10484	83+63	18	83+81					I	
10485	83+81	18	83+99					I	
10486	83+99	18	84+17					I	
10487	84+17	18	84+35					I	
10488	84+35	18	84+53					I	
10489	84+53	18	84+71					I	
10490	84+71	18	84+89					I	
10491	84+89	18	85+07					I	
10492	85+07	18	85+25					I	
10493	85+25	18	85+43					I	
10494	85+43	18	85+61					I	
10495	85+61	10	85+71					I	Partially inspected ~10ft of unknown pipe length.
Towards Wastewater Treatment Plant Headworks (Extraction)									

OL Outlet.

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

Pipe laying schedules were not available. Pipe lengths and station numbers were approximated from the electromagnetic data and plan and profile drawings.

No drawings were available for PRN 10001 to 10006. Station numbers are 'N/A' in this section.

Flow is assumed to be in the direction from GWSD Yard to the Wastewater Treatment Plant Headworks.

Confidence Codes	
Detection of Pipe Wall Loss	
Colour Coded Detection Confidence	This code correlates to the analysts ability to **identify** pipe wall loss
(red)	Low or no probability of defect detection. Both inspection runs have a flow velocity >2 ft/s. SP is too short to detect pipe wall loss.
(yellow)	Minimum detection limit for anomalies may be larger than expected. One or both inspection runs have a flow velocity >1ft/s.
(green)	Defect detection expected at tool's optimal size and depth. Both inspection runs have a flow velocity ≤1ft/s.
Letter Code: Detection Qualifiers	This code correlates to the amount of noise observed on one or both inspection runs which affects analysts ability to **identify** pipe wall loss
No letter	Uniform signal quality along the pipe
C	Potential loss of signal along crown
S	Potential loss of signal along springline
I	Potential loss of signal along Invert
Quantification of Pipe Wall Loss	
Number Code: Quantification Confidence	This code correlates to the availability of calibration pipes and inspected pipe specifications which affects analysts ability to accurately **quantify** pipe wall loss
No number	All supporting information available: full quantification
1	Virtual calibration or assumed spec information: Full quantification with elevated uncertainty
2	Unknown pipe specification:Partial quantification
3	Unknown pipe material: Anomaly identification

Appendix D - Soil Corrosivity Report – HDR

Technical Memorandum

Date:	Wednesday, December 10, 2025
Project:	Goleta West Sanitary District – Force Main Corrosion Risk Evaluation
To:	Brian McCarthy, General Manager, Goleta West Sanitary District
From:	Dan Ellison, PE, Senior Condition Assessment Engineer, HDR with input from Bradley Stuart, PE, Project Manager / Corrosion Engineer, HDR
Subject:	Corrosion Risk Evaluation – Findings and Recommendations

This technical memorandum (TM) summarizes the results from several investigations regarding the corrosion risks associated with the Goleta West Sanitary District's (District) 47-year-old, 24-inch ductile iron force main. A failure of this force main on February 17, 2024, had raised concerns regarding its condition and long-term reliability.

An earlier study by HDR concluded that the February 2024 failure was caused by external corrosion, and that the corrosion was caused by a combination of severely corrosive soils and imperfect external corrosion protection. HDR's failure study was documented in a technical memorandum, dated May 16, 2024 (Attachment 1).

Following the February 2024 failure, the District engaged MNS Engineers to coordinate a condition evaluation of this force main (as well as the older asbestos cement force main). As part of that evaluation, Pure Technologies conducted advanced in-pipe electromagnetic (EM) scanning of the force main and an in-pipe acoustic leak and gas pocket inspection. A draft copy of Pure's report was shared with HDR. In addition, the pipeline was recently excavated in several locations, to confirm inspection findings, to make pipeline repairs, and to conduct additional examinations.

In September 2025, the District engaged HDR to perform additional evaluations of the corrosivity of the soils along the pipeline alignment. HDR's limited investigation included:

- in-situ testing of soil resistivity in two locations,
- laboratory testing of three soil samples taken from one excavation,
- observation and inspection of the pipeline within the excavation where the soil samples were taken
- a review of photos from another recent excavation by the District, and
- observations of pipeline remnants in the District's storage yard.

A detailed report of this investigation is found in Attachment 2.

Summary of Key Findings

The following is a summary of key findings from these investigations. More detailed information is provided later in this TM and in the attachments.

1. Corrosive soils. In the locations where the soil has been tested, it has been found to range from "corrosive" to "severely corrosive".

2. Significant external corrosion damage. Significant corrosion damage has been found in multiple locations along the pipeline. These include: the February 2024 failure, where electromagnetic scanning found significant wall loss, and a pipe joint that happened to be discovered. Less significant corrosion damage was found at two other recent excavations.

3. Ineffective external corrosion protection. The polyethylene encasement that surrounds the pipe has cracked at folds, may not be sealed at seams, and is counterproductive if wastewater leaks from a pipe joint. Wherever the encasement is not fully sealed, groundwater can enter the encasement. This corrosion protection would not be considered adequate by today's standards in such corrosive soils, especially where groundwater levels fluctuate.

4. Internal corrosion may also exist. Force mains commonly fail due to internal corrosion at high points, where H_2S gas accumulates. The record drawings show eight locations where air release valves were originally installed at high points, but subsequently removed. Additionally, Pure's acoustic inspection found other "gas pockets", "gas slugs" and "air entrainment". Crown corrosion has not been verified in these locations.

5. Undetected corrosion damage is very likely to exist elsewhere. Of the 8,600 feet of force main pipe, less than 200 feet have been inspected externally. While Pure's inspections covered the entire pipeline, their inspection tools have various limitations. Given that corrosion has been found wherever the pipe has been excavated, varying degrees of corrosion would be anticipated along the entire alignment.

6. Future failures are expected. Because undetected corrosion damage likely exists along the force main, future failures would be expected to occur at an accelerating rate. Another failure in the next 10 years should be anticipated.

7. The options for mitigating the risks have limitations. These options include:

    - Cathodic protection (CP) of the entire pipeline would be difficult, because the pipeline is not electrically continuous and access is difficult due to the environmentally sensitive habitat within the security-restricted airport.

    - Cathodic protection would also not protect from internal corrosion. If H_2S gas is corroding the crowns of the pipe in various locations, CP would not help.

    - Comparative metering. By metering the flows entering and leaving the pipeline, the District may be able to detect a pipe failure and take action that limits the damage. (This mitigation is already in effect.)

Recommendations

These recommendations follow from the findings:

1. Attach sacrificial anodes when performing pipe repairs and at other locations where opportunities exist. These anodes have been proven to be cost-effective, require no maintenance, and cannot damage the pipe.
2. Implement comparative metering. The District has already implemented this action. The SCADA system continuously compares pipeline inflows and outflows and immediately alerts operators when flows leaving the pump station exceed effluent entering the treatment plant.
3. Consider replacement or rehabilitation of the pipeline. Given the relatively high consequences of a failure (i.e., the environmentally sensitive area), and a significant likelihood of another failure in the next 10 years, risks are higher than preferred.

Detailed Description of Findings

The findings above are explained in greater detail below.

1. Corrosive soils. In the locations where the soil has been tested, it has been found to range from “corrosive” to “severely corrosive”.

   In-situ and laboratory testing performed for the February 2024 failure analysis study found “severely corrosive” soils at the failure site. Findings included very low resistivities and high chloride content.

   In-situ and laboratory testing performed in November 2025 at other locations along the pipeline found “corrosive” to “severely” corrosive resistivities, but no significant salt content.

   Details from these tests are found in Attachments 1 and 2.

2. Significant external corrosion damage has been found in multiple locations along the pipeline. These include:

   - The February 2024 failure near STA 62+00, where general corrosion of the pipe exterior had caused severe thinning of the pipe wall.

     Figure 1 shows the pipeline area where corrosion occurred. In the highlighted area, the pipe wall had thinned to 1/8 inches or less.

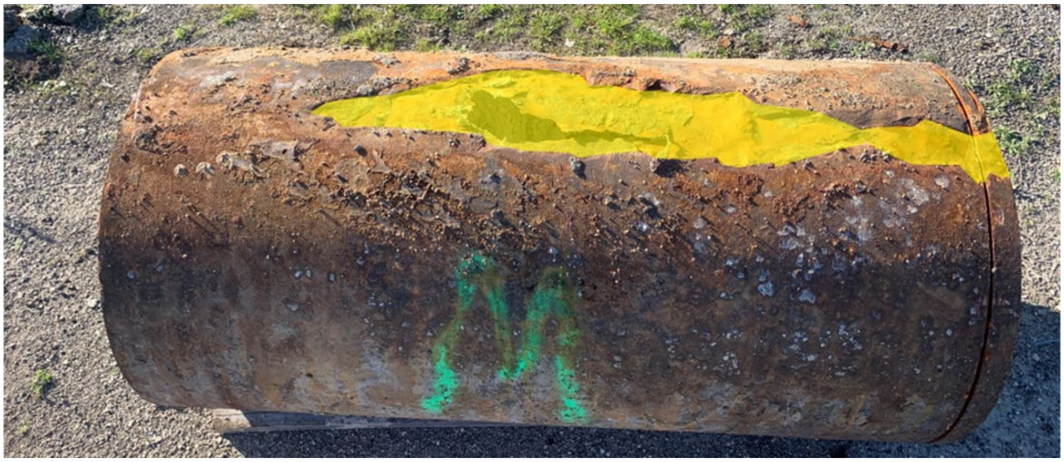

Figure 1: General corrosion found in 2024 failure (pipe has been rotated 180-deg)

- Pure's "Anomaly Area". Pure's EM inspection found an "Anomaly Area", which Pure considered indicative of significant pipe wall corrosion. When the location (identified in the report as near STA 16+27) was excavated, through-wall, external corrosion pitting was found. The internal mortar lining was visible from the exterior of the pipe, as seen in Figure 2.

  Due to the relatively low internal pressure of the force main, leakage was likely not occurring at this location. Competent cement mortar lining is capable of spanning over holes in the pipe wall several inches in diameter.

Figure 2: Corrosion through-hole at Pure's "Anomaly Area"

Significant external pitting corrosion was also observed in a large area of the pipe near this anomaly, as seen in Figure 3.


Figure 3: Corroded pipe in vicinity of Pure's "Anomaly Area"

- Pipe joint, near Pure's "Anomaly Area." During the excavation to repair the "Anomaly Area", additional external pitting corrosion was discovered at a nearby bell joint (Figure 4). In this case, through-wall corrosion had exposed the gasket of the pipe joint.


Figure 4: Through-hole at pipe joint

Very minor leakage was almost certainly occurring at this through-hole, as water in the annulus between the spigot and the bell should have escaped. This leakage likely contributed to additional external corrosion seen near the pipe joint, but because the hole was near the pipe invert, solids in the wastewater would have "caulked" the pipe opening, inhibiting leakage (Figure 5). "Seepage" may be a better description of what occurred, with the wastewater possibly contained within the PE encasement.

There is no evidence that the leakage from this hole contributed to the corrosion of the nearby "anomaly area".

Figure 5: Solids accumulation in pipe invert (now seen in 10 o'clock position)

- Excavation observed by HDR. On November 12, 2025, HDR observed the excavation of the pipe at STA 69+50, inspected the pipe exterior, and collected soil samples for laboratory analysis. Varying degrees of corrosion of the exterior was observed, with one corrosion pit measure at 0.2 inches. Some joint seepage may also have been present (Figure 6).

Figure 6: Corrosion near pipe bell at STA 69+50

- Excavation, east of Moffet Place. At an excavation performed on September 25, 2025, along the right-of-way east of Moffet Place, the District found significant corrosion of the pipe at a joint. From photos provided by the District, it appears that seepage from joint was likely causing corrosion of the pipe.

Figure 7: Corroded bell and spigot at excavation east of Moffet Place

3. Ineffective external corrosion protection. In each of the above cases, where external corrosion was found, polyethylene (PE) sheet encasement appeared to be present, but was not fully effective in stopping external corrosion. Reasons for the relative ineffectiveness of the PE encasement include:

- Leakage / seepage at pipe joints will introduce wastewater inside the PE encasement. Microbially induced corrosion can then occur, due to acid produced during wastewater decomposition. (This may have led to the general corrosion seen in Figure 1.)

- Cracking of the PE. Although the PE sheeting seems flexible, after decades the PE cracks at folds and creases, and these factures then admit water. Such fractured PE sheeting was commonly seen at the excavations described above.

  The brittle nature of the PE sheeting is quite apparent in Figure 6, where fragments of PE are lying in the earth below the pipe, while other fragments of the PE adhere to the pipe.

- Unsealed seams. Where the PE is lapped to other PE at seams, current standards call for it to be sealed with tape. Such taping was not generally observed in the excavations. Also, flat PE sheets may have been used rather than tubular PE sheets, which is the current standard. Flat sheets would have introduced another seam where water could enter.

  While tape is seen lying below the pipe in Figure 7, this is the only instance where sealing tape was discerned. It is not certain if the tape seen in the Figure came from the original construction, or from work related to the recent excavation.

  In the 2024 failure analysis report (Attachment 1) evidence of an untaped seam was seen along the invert of the pipe, where the failure occurred.

- PE damage. The PE can be punctured or torn if proper care is not exercised during construction handling and backfill. While sandy backfill material was observed in the pipe zone, several photos imply the PE may have been damaged, particularly near some of the pipe joints, where the PE may be stretched. Figure 6 and Figure 7 both show evidence that the PE had been torn or damaged.

PE pipe encasement is not intended to be leakproof, but is supposed to limit the amount of oxygen reaching the pipe surface. As noted in HDR's earlier failure analysis TM, the effectiveness of the polyethylene encasement depends greatly upon:

- The quality of the installation. Poorly taped seams, tears, and punctures lead to greater exposure of the pipe to fresh electrolyte.
- The corrosiveness of the soil. In very corrosive soils, even a small amount of electrolyte transfer can rapidly corrode the pipe.
- Wet-dry cycles. If the pipe is at a depth where groundwater submergence occurs periodically, greater volumes of electrolyte transfer into and out of the PE encasement.

All three of these factors are likely present for this pipeline. As noted in Attachment 2, if a metallic pipe were to be constructed here today, a more robust corrosion protection system would likely be specified, including a bonded coating and cathodic protection.

4. <u>Internal corrosion may also be occurring</u>. Metallic and concrete force mains commonly fail due to internal corrosion at high points and other locations along the pipeline where gas accumulates. Microbial decomposition of septic wastewater creates hydrogen sulfide (H_2S) gas. Where this gas accumulates, sulfuric acid (H_2SO_4) will form. The acid then corrodes the crown of the pipe. Standard cement mortar lining is ineffective in protecting pipes from such corrosion. Septic conditions that lead to this corrosion are very common in force mains, due to the aging of wastewater in lift station wet wells and the anerobic conditions within force mains themselves.

   There are multiple locations in this pipeline where H_2S may be present. The record drawings show eight high points where air release valves were originally installed (Figure 8). These air valves were intended to release the corrosive gas, but were reportedly removed years ago, likely due to maintenance issues. In addition to these known high points, Pure's acoustic inspection found additional locations where gas pockets, "gas slugs", and air entrainment may exist. To date, the District reports that crown corrosion has not been verified where gas pockets were detected by Pure.

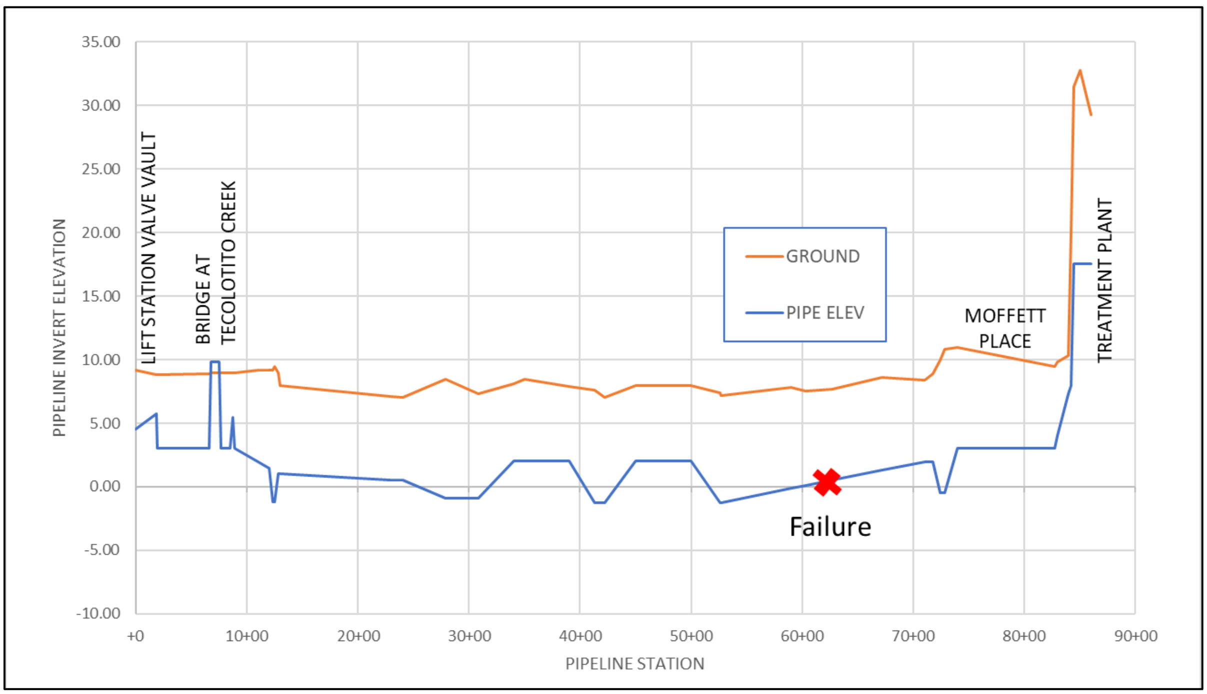

Figure 8: Force Main Profile – based on record drawings

In the excavation that HDR observed near STA 69+50, ultrasonic thickness measurements of the pipe crown did NOT detect crown corrosion, even though this was a location where Pure had reported a gas pocket. The record drawings at this location do not show a high point in the pipe profile, but these drawings were found to be inaccurate. They show the force main crossing under an abandoned 18-inch storm drain pipe. Instead, the force main was found to cross over the storm drain, which may indeed have created an undocumented high point in the force main.

5. Undetected corrosion damage is very likely to exist elsewhere. Of the 8600 feet of force main pipe, less than 200 feet have been inspected externally. While Pure's inspections covered the entire pipeline, their inspection methods have limitations:

   - It is not certain that force main pressures were sufficient for leak detection. The leak detection device, (i.e., "SmartBall") will generally only detect leaks at internal water pressures greater than 15 to 20 psi. At lower pressures, leaks produce insufficient noise to be discerned.

     During HDR's earlier failure investigation, the discharge pressure at the pump station was observed to read about 18 psi.[1] Pressures lower than this would exist in the pipeline, as the water flows uphill.

   - The electromagnetic scanning tool has "blind spots". The scanning process involves producing an electromagnetic field and then detecting changes to that electromagnetic field some distance away. When either the exciter or the detection devices passes a pipe joint, the EM field is disrupted. The joint is detected, but defects at or near the joint are obscured. The through-hole corrosion at the pipe bell (Figure 4), for instance, could not be detected.

   - This electromagnetic scanning tool is relatively imprecise. The tool used by Pure, the PipeDiver, was originally developed for inspecting Prestressed Concrete Cylinder Pipe, where broken prestressing wires produce a relatively large signal. When employing the tool in cylindrical metal pipes, Pure detects signal anomalies, which it then correlates through experience with various sizes of defects. In order to be detected, the defects need to be relatively large. Smaller defects will be missed.

     This PipeDiver tool has the advantage of being easier to deploy than more precise, remote-field technology EM tools that can detected small defects. Another tool, the "PipeDiver Ultra" offers similar flexibility coupled with very high precision, but would be completely ineffective through the areas where gas accumulates. (Water is needed to transmit the ultrasonic vibrations to and from the pipe wall.)

   Because this force main pipe operates at relatively low pressures and traverses around a marshy area, small leaks may go undetected. Such smaller leaks accelerate corrosion, eventually leading to larger failures.

6. Future failures are likely. Because undetected corrosion damage likely exists along the main, future failures would be expected. As the corrosion continues, the pipe becomes

[1] The record drawings indicate the force main rises from elevation 4.5 feet in a valve vault near the pump station to 19.5 feet where the pipeline enters the treatment plant. According to GWSD staff, the headworks of the treatment plant create additional back pressure. (The elevation of the pressure gauge at the lift station is 6 feet above the floor.)

weaker. Generally, the frequencies of corrosion-related failures increase exponentially. Thus, because the first failure occurred approximately 50 years after the pipeline was constructed, another failure might be expected about 5 years later. However, there is considerable uncertainty regarding these predictions. A failure within the next 10 years would be considered likely, but it also could be decades before the next significant event.

Because Pure did not find other anomalies, another failure is probably not imminent.

7. The options for mitigating the risks have limitations. Options include:

    - Cathodic protection of the entire pipeline would be difficult, because the pipeline is not electrically continuous. The pipeline was constructed with push-on, rubber gasketed joints which do not transmit an electric current. Either the joints would need to be bonded, or anodes would need to be attached to each segment of pipe.
    - Cathodic protection would also not protect from internal corrosion. If H_2S gas is corroding the crowns of the pipe in various locations, CP would not stop such corrosion.
    - Comparative metering. By metering flows entering and leaving the pipeline, the District may be able to detect a failure and take action that limits the damage, such as shutting down the lift station and diverting flows to the other force main. This mitigation would be relatively inexpensive[2]. This strategy might not detect smaller leaks, due precision limitations in flow meters.

Closure

HDR appreciates the opportunity to help the District evaluate this important pipeline.

Questions regarding this TM may be directed to Dan Ellison, 213.200.5152; dan.ellison@HDRinc.com.

Attachments:
Attachment 1 – 2024 Failure Analysis TM
Attachment 2 – Results of 2025 Soil Corrosivity Tests

[2] This measure may already have been implemented. During HDR's 2024 failure study, District staff indicated that a second meter was in the process of being installed.

Technical Memorandum

Date:	Thursday, May 16, 2024
Project:	Goleta West Sanitary District - Force Main Failure Investigation
To:	Brian McCarthy, General Manager, Goleta West Sanitary District
From:	Dan Ellison, PE, Project Manager, HDR Bradley Stuart, PE, Corrosion Engineer, HDR
Subject:	Findings of Force Main Failure Investigation

This technical memorandum (TM) examines factors that caused or contributed to the force main failure discovered on the morning of February 17, 2024, at Goleta West Sanitary District (GWSD). This TM is based on:

- An examination of remnants of the failed pipe at the GWSD storage yard
- Reviews of photos and record drawings provided by GWSD
- Interviews with GWSD staff regarding operations and activities leading up to discovery of the failure
- In-situ testing of soil corrosivity near the location of the failure
- Laboratory testing of samples of soil collected near the location of the failure

The primary cause of failure was confirmed to be external corrosion of the ~46-year-old ductile iron pipeline. The corrosion was caused by a combination of imperfect external corrosion protection and severely corrosive soils. An analysis of the force main system does not indicate that errors in design or operation were contributing causes of the failure.

Important factors likely limited the consequences of the failure: (1) a proactive leak investigation conducted by GWSD staff discovered the failure early, and (2) the availability of a functional standby force main allowed the continuation of wastewater pumping while repairs were undertaken.

System Description

The force main conveys wastewater from homes and businesses in the western Goleta valley and the community of Isla Vista to a nearby treatment plant operated by Goleta Sanitary District (GSD), a separate public agency. Record drawings indicate the 24-inch force main was constructed around 1978, making the force main approximately 46 years old.

The 24-inch force main was constructed in conjunction with a new lift station (PS2), intended to replace an older 18-inch asbestos cement (AC) force main and existing lift station (PS1). According to staff, these larger-capacity facilities were built in anticipation of greater development along the coast, extending from Isla Vista toward Gaviota. Because such development did not occur (and is no longer anticipated), the larger lift station (PS2) is not used. However, the newer pipeline became the primary force main, while the older pipeline (constructed in the early 1960s) was retained as a secondary backup. The two pipelines are interconnected at a valve vault which is about 150 feet downstream of the older lift station (PS1). The valve vault allows diversion of flows to either pipeline.

Although force mains by their nature are usually critical facilities (where failures have significant consequences), many lift stations do not have secondary (backup) force mains. The existence of a fully redundant force main limits wastewater spills when a pipeline failure occurs, and also facilitates inspection and maintenance of the force mains.

Figure 1: Force Main Alignment

Pipeline Alignment

Figure 1 shows the general alignment of the 24-inch force main, which originates at the valve vault about 150 feet from the PS1, and terminates 8,602 feet distant, at the headworks of the GSD Regional Wastewater Treatment Plant along Moffett Place. From the GWSD facility, a bridge carries the pipeline over Tecolotito Creek. The force main then follows an unpaved Santa Barbara Airport maintenance road across the airport property (near the Goleta Slough State Marine Conservation Area), before entering Moffett Place and continuing to the treatment plant.

Pipeline Profile

As shown in Figure 2, the profile of the pipeline is very flat. Between the PS1 lift station valve vault and Moffett Place, the pipeline invert varies between about -2 feet and +4 feet in elevation. At two storm channels, the pipeline rises a bit higher, to an elevation of +5 feet, and at the Tecolotito Creek bridge, it rises to +10 feet. As the pipeline enters the treatment plant, it rises higher, to about 18 feet in elevation.

The record drawings show 2-inch air release valves at each of the known high points along the pipeline. Notations on the scanned drawings indicate two additional valves may have also been added and subsequently removed. The proper functioning of these air release valves is important to the long-term integrity of the pipeline because they vent hydrogen sulfide gas, which otherwise would accumulate at the high points, oxidize to sulfuric acid, and corrode the pipe crown. Frequently, such air valves are not operational, because shutoff valves leading to the air valves are often closed (to minimize the release of odors), or the air valves are simply not maintained. Internal corrosion of force mains due to hydrogen sulfide accumulation is a very common cause of force main failures, although it was not a factor in this failure.

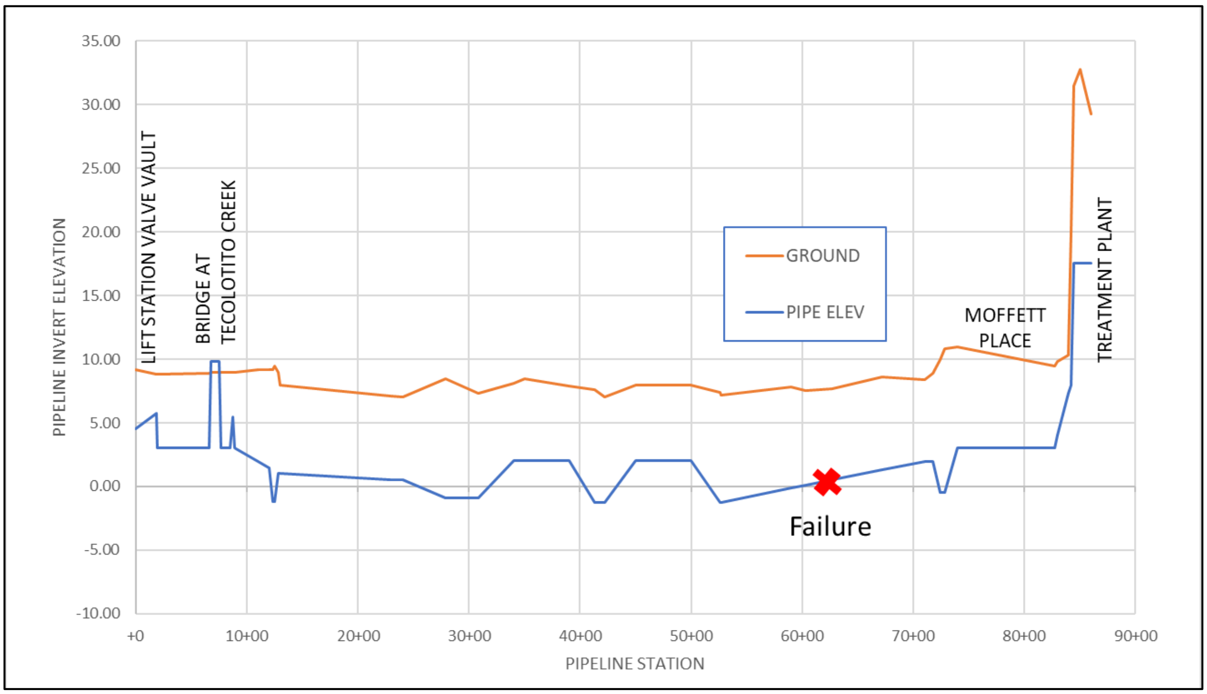

Figure 2: Force Main Profile – based on record drawings

Pressures

The static lift from the PS1 valve vault to the treatment plant is 14 feet. The dynamic head (based on a Hazen Williams Formula analysis) varies from about 0.2 feet to about 14 feet, as flows range from between about 0.7 mgd to 6.5 mgd[1]. At the Regional Wastewater Treatment Plant, the headworks facility generates additional back pressure, resulting in a pumping

[1] The reported capacity of the system, according to GWSD staff. (Note: mgd = million gallons per day)

discharge pressure (measured 6 feet above the lift station ground floor) of up to 30 psi, according to GWSD staff. (At the time of HDR's mid-afternoon site visit on April 30, 2024, the discharge pressure gauge read about 18 psi.)

Because the 24-inch pipeline was designed for greater flows than currently exist, flow velocities are less than typical, with maximum velocities of about 3 feet per second. Lower pipeline velocities mean lower energy costs for pumping and lower discharge pressures. However, lower flow velocities also mean longer travel times and greater potentials for septic sewage conditions, hydrogen sulfide gas, and accumulation of solids in the pipeline.

The two primary pumps at the operating lift station are controlled by variable frequency drives (VFDs), which allow the pump flows to vary with influent flows. The VFDs also moderate the transient surge pressures caused by normal pump starts and stops, and the VFDs reduce the frequency of pump starts and stops. A bladder-type, hydropneumatic tank near the valve vault provides additional protection for surge events.

Discharge surge pressures in the force main would be expected to be relatively minor, because:

- The pipeline velocities are low
- The pipeline is relatively flat and short
- The pumps are normally started and stopped using VFDs, and
- The surge-arrestor tank protects against unexpected shutdowns and is likely oversized, since it was designed for greater flows than currently exist

System Instrumentation
The following description of force main instrumentation is based on GWSD staff interviews:

- Force main flows are measured at flow meters at the GSD Regional Treatment Plant, with information conveyed by radio to GWSD by GSD. The meters measure flows from both the primary (24-inch) or the secondary (18-inch) force main.
- GWSD has constructed a vault for a new flow meter on the effluent side of GWSD lift station PS1, but the meter has not yet been delivered for installation. When this meter is available, GWSD plans to compare force main flows measured at the PS1 lift station and at the Regional Wastewater Treatment Plant, and signal an alarm through GWSD's SCADA system to alert staff when deviations indicate a possible leak in the operating force main. This system will operate continuously, alerting GWSD's on-call staff during non-working hours.
- Discharge pressures are measured at the lift station header pipe, with the instrument positioned approximately 6 feet above the ground-level floor.
- The GWSD SCADA system has the ability to monitor and control operations but does not currently preserve historical pressure or flow data. Upgrades to the SCADA system are on-going.

Events Preceding Pipeline Failure

The following narrative of events is based on interviews with GWSD staff.

According to GWSD staff, the force main failure was preceded by a leak repair that was initiated about 3 weeks earlier. The underground leak had been observed just outside the PS1 lift station in the original 18-inch AC force main that extends from the PS1 lift station to the valve vault. This underground leak was attributed to ground settlement in the area.

A bypass pumping system was set up, so PS1 and the pipeline could be isolated, and the underground leak could be repaired. The bypass system involved placing two temporary pumps at the PS1 lift station's influent manhole, with the discharge piping extending to a force main access vault, approximately 500 feet away. At the access vault, the discharge pipe was connected to an existing tee on the secondary 18-inch AC force main, rather than the primary 24-inch force main, in accordance with GWSD's standard bypass plan. With this bypass system in place, the PS1 lift station was shut down and the repair was undertaken.

The repair work was completed on the evening of Friday, February 16, with a major storm expected over the weekend. When the lift station was initially started, the discharge pressure reached 35 psi—an abnormal reading—at which point the PS1 lift station was automatically shut down. It was then determined that a closed valve at the Regional Wastewater Treatment Plant had caused the abnormal discharge pressure. The valve was opened and normal pumping resumed. Because the bypass pumping system had required surcharging in the upstream collection system, the first few hours of pumping was at greater-than-normal rates of flow, to clear the surcharge.

Per GWSD standard protocol, when changes are made to the force main operations, staff conducts an inspection of the alignment of the force main looking for leaks or anomalies. This inspection occurred early the following morning (Saturday, February 17). When the leak was discovered, immediate action was initiated to divert flows from the primary (24-inch) force main to the secondary (18-inch) force main.

Comment: Pipeline failures often occur shortly after a pipeline has been depressurized and repressurized. This is because flexing of a weak pipeline will trigger impending failures. In this case, it is possible that normal shutdown and startup strains were amplified by the inadvertent abnormal discharge pressure that occurred during initial startup. However, the force main failure was caused by advanced exterior corrosion of the pipe (as described below), not by lift station operations. In fact, the proactive leak investigation by GWSD staff on February 17 likely minimized the spill event. Had the failure occurred during normal, routine operations, it might have gone undetected for a longer period given the remote location on airport property.

HDR Observations

Pipe Material

HDR's examination of the pipe remnants confirms the material as ductile iron, matching the description provided by staff. The exterior surface texture is typical of annealed ductile iron pipe, and the pipe appears to have been coated with the industry-standard asphaltic seal coat.

According to the Ductile Iron Pipe Association, this seal coat serves mostly to give new pipe a uniform appearance and provides only minor corrosion protection.

The pipe wall thickness measures as slightly less 0.5 inches, indicating the pipe is either Pressure Class 350 (0.43 inches thick) or Thickness Class 52 or 53 (0.44 or 0.47 inches). As such, the pipe had an allowable pressure rating above 300 psi, much greater than its normal operating pressure. The thickness of the pipeline likely reflected external loading conditions and the design of the trench, and may have been conservative, with allowance for corrosion.

Ductile iron pipe is very commonly used for wastewater force mains. The iron provides high tensile strength, resisting the hoop tension created by the internal pipeline pressure. The ductile nature of the material means that failures tend to be leaks rather than large blowout fractures. Bell-and-spigot joints allow for easy pipeline construction, and the material is relatively rugged. The weakness of ductile iron pipe is its vulnerability to internal and external corrosion.

Internal corrosion protection

The pipe remnant at the GWSD yard was lined with 1/8-inch cement mortar. Mortar lining is generally preferred for water pipelines, except where hydrogen sulfide gas may accumulate, in which case it is quite susceptible to degradation. Because of risks associated with hydrogen sulfide corrosion, newer force mains are often lined with epoxy or other polymeric coatings, but these linings may not have been readily available when this pipeline was constructed.

The pipe remnant observed by HDR at the GWSD yard showed no signs of internal corrosion or lining degradation.

External corrosion protection

Photos taken of the failure show the pipe had been wrapped with polyethylene sheeting (Figure 3). This polyethylene "encasement" was (and still is) a standard, commonly used protection for ductile iron pipe installed in corrosive soils. The purpose of the polyethylene sheet wrapping is to prevent direct contact with soils and to limit the amount of electrolyte[2] that reaches the metal surface.

Because the polyethylene sheeting is not bonded to the pipe and is never completely leak free, water from the soil will leak into the polyethylene encasement and contact the metal. However, this small amount of water in the annulus between the polyethylene and the pipe wall will (in theory) become less corrosive as oxygen is depleted from the water and its pH is neutralized. To slow the transfer of water into and out of the encasement, tubular polyethylene sheets are now generally used, and all seams are to be sealed with tape, however when this pipe was constructed, tubular sheets may not have been available. When this pipeline was constructed, the standard for polyethylene encasement had only existed for about 5 years.

[2] Metal corrosion is an electrochemical reaction with the elements of a battery: anode, cathode, electrolyte, and electric current pathway. In this case, the electrolyte is water from the soil.

Figure 3: Photo of the 24-inch force main failure showing remnants of polyethylene wrapping

The effectiveness of the polyethylene encasement depends greatly upon:

- The quality of the installation. Poorly taped seams, tears, and punctures lead to greater exposure of the pipe to fresh electrolyte.
- The corrosiveness of the soil. In very corrosive soils, even a small amount of electrolyte transfer can rapidly corrode the pipe.
- Wet-dry cycles. If the pipe is at a depth where groundwater submergence occurs periodically, greater volumes of electrolyte transfer into and out of the encasement.

All three of these factors likely played a role in this failure.

Pipe Corrosion Observations

Pipe corrosion is often categorized as either "general corrosion" or "pitting corrosion" (Figure 4).The pipe remnant seen in GWSD photos and examined by HDR in the GWSD yard is somewhat unusual in that general corrosion has occurred over a large area, reducing the pipe wall to less than 1/8-inch in thickness. Pitting corrosion failures of polyethylene wrapped ductile iron pipes are more common. This is where small defects in the corrosion protection system produce "rust holes" through the pipe wall.

Figure 4: Highlighted areas show:

- Less common general corrosion of the GWSD Force Main (top photo) and
- More common pitting corrosion at another utility failure (bottom photo).

There are two likely explanations for the unusual general corrosion of the GWSD force main:

1. The polyethylene encasement had a significant breach, which exposed a large pipe area to corrosive soils.
2. The failure began as a small pipeline leak. Over time, the leaked wastewater (confined within the encasement), produced a large area of pipe deterioration aided by bacteria.

While both explanations could apply to this failure, evidence suggests that the first explanation was likely a predominant factor:

- Photos of the failure and the pipe remnant (Figure 5) suggest the polyethylene encasement did not consist of tubular sleeves but instead consisted of flat sheets, with a seam along the pipe axis, near where the failure occurred. The amount of corrosion damage suggests that this seam may have been damaged during the original construction, producing a significant breach in the encasement.

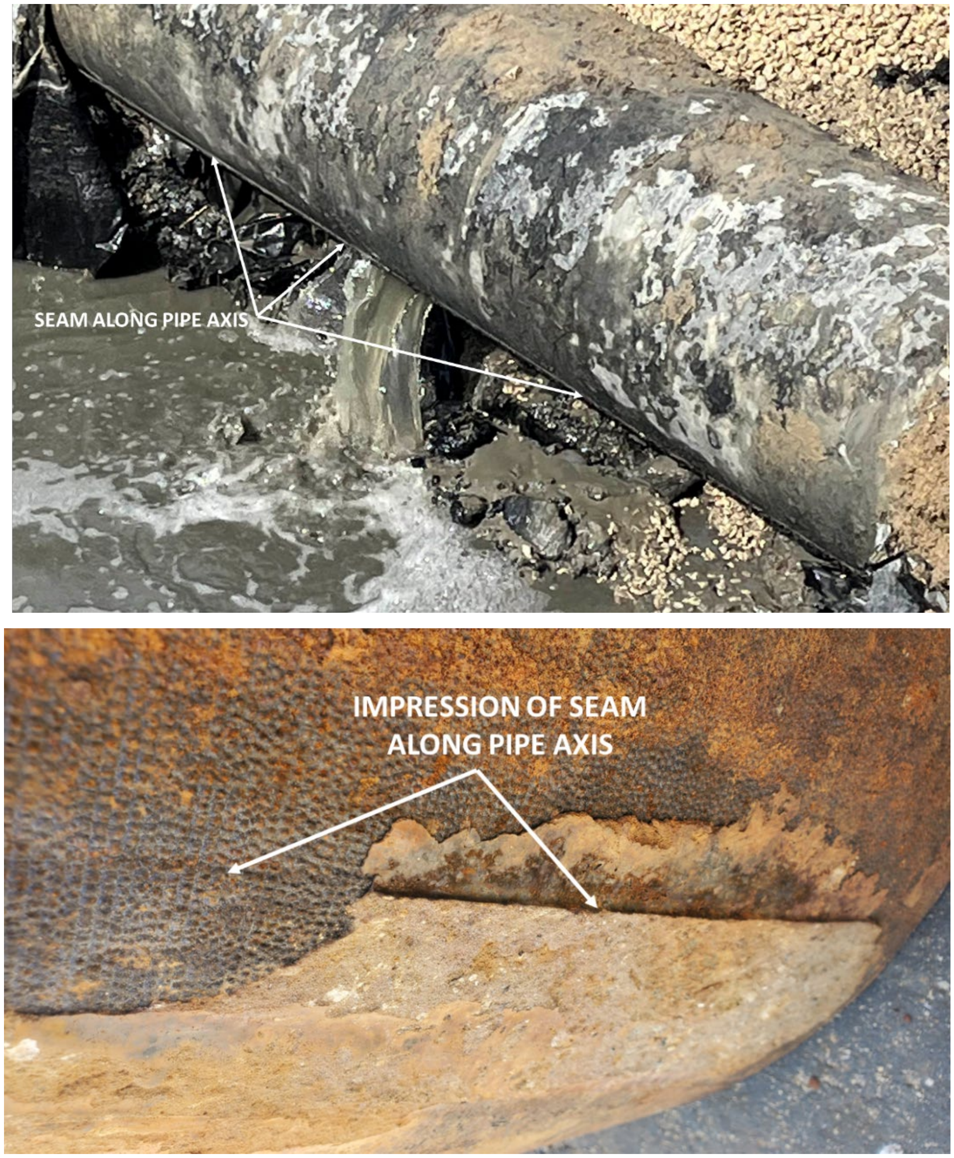

Figure 5: Photos suggesting a seam along the pipe axis, near the failure

- A layer of hard, well-adhered scale was found along the bottom of the pipe remnant. This scale appears to consist of calcified soil, aggregate, and corrosion products. Formation of this scale would require long-term, direct contact with the soil, suggesting a significant breach in the encasement existed.
- Nothing was observed that indicates leaked wastewater contributed to formation of the scale or to the general corrosion.

Figure 6: Encrusted scale with embedded aggregate

Soil Corrosivity Investigation

The soil corrosivity investigation included a visual examination of the pipe and soil corrosivity testing. The outcome of the failure investigation is as follows:

- The corrosion on the exterior of the piping was observed to be general corrosion.
- Field and laboratory testing indicated that the soil was severely corrosive towards ferrous metals such as ductile iron piping.

Details of the field and laboratory tests are found in Appendix A and Appendix B.

Corrosion Analysis Procedures

The following procedures were used for the soil corrosivity investigation.

VISUAL AND PHOTOGRAPHIC ASSESSMENT

The pipe was visually examined and photo documented. The external and internal surfaces of the pipe were inspected for corrosion, mechanical abrasion, metal loss, or other forms of damage that could cause or aid in the failure of the pipe.

FIELD SOIL RESISTIVITY TESTING

The electrical resistivity of the soil was measured in place at one location in two orientations using the Wenner Four Pin Method per ASTM G57. This procedure gives the average resistivity to a depth equal to the spacing between the pins. Approximate pin spacings of 2.5, 5, 7.5, 10, and 15 feet were used so that variations with depth could be evaluated. Strata resistivities were calculated from resistance data using the Barnes Procedure.

The location of the tests was close to the location of the failure but in soil that was not disturbed when the pipeline was repaired.

SOIL LABORATORY ANALYSIS

Two samples of soil were collected for laboratory analysis from a depth of approximately 7 to 11 feet. The locations of the samples were selected to be in undisturbed soil, near the location of the failure, at the same depth as the pipe.

The electrical resistivity of each sample was measured in a soil box per *ASTM International (ASTM)* G187 in their as-received condition and again after saturation with distilled water. Resistivities are near their lowest value when the soil is saturated. The pH of the saturated samples was measured per ASTM G51. A 5:1 water:soil extract from each sample was chemically analyzed for the major soluble salts commonly found in soil per ASTM D4327, ASTM D6919, and *American Water Works Association (AWWA*) Standard Method 2320-B.

Corrosion Analysis Findings

VISUAL AND PHOTOGRAPHIC ASSESSMENT

The failure section of ductile iron pipe was inspected at the district yard. The piping showed signs of significant corrosion. There were no signs of any mechanical damage on the piping.

Figure 7: Failure section of the pipe

The areas immediately adjacent to the break still had the asphaltic coating and stippling typical of ductile iron piping. The morphology of the corrosion suggests a breakdown of the asphaltic coating and annealing typical with that of ductile iron pipe. High chlorides contents in soils can facilitate the breakdown of both the coating and annealing.

FIELD SOIL RESISTIVITY TESTING

A major factor in determining soil corrosivity is electrical resistivity. The electrical resistivity of a soil is a measure of its resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. Corrosion currents, following Ohm's Law, are inversely proportional to soil resistivity. Lower electrical resistivities result from higher moisture and soluble salt contents and indicate corrosive soil. A correlation between electrical resistivity and corrosivity toward ferrous metals is shown in Table 1.[3]

Table 1: Soil Corrosivity Categories

Soil Resistivity (ohm-cm)	Corrosivity
Greater than 10,000	Mildly Corrosive
2,001 to 10,000	Moderately
1,001 to 2,000	Corrosive
0 to 1,000	Severely

Other soil characteristics that may influence corrosivity towards metals are pH, soluble salt content, soil types, aeration, anaerobic conditions, and site drainage.

The average and stratum resistivities measured in the field at pipe depth were in the severely corrosive categories. Average resistivities decreased with increasing depth. The full set of 4 pin data are found in Appendix A.

SOIL LABORATORY ANALYSIS

Electrical resistivities were in the severely corrosive category with as-received moisture. When saturated, the resistivities remained in the severely corrosive category. The as-received resistivities were at or near their saturated values.

Soil pH values varied from 7.8 to 8.2. This range is mildly to moderately alkaline.[4] These values do not particularly increase soil corrosivity.

The soluble salt content of the samples was very high. Chloride and sulfate salts were the predominant constituents. Chloride is particularly corrosive to ferrous metals, and in the higher concentrations measured in the soil samples, chloride can overcome the corrosion inhibiting effect of concrete on reinforcing steel. High concentrations of sulfate, as was measured in the soil samples, can react with components in concrete to cause degradation and reduced strength in a mechanism known as sulfate attack. Sulfate was in a range where sulfate resistant cement is recommended.

Nitrate was detected in low concentrations.

Tests were not made for sulfide and oxidation-reduction (redox) potential because these samples did not exhibit characteristics typically associated with anaerobic conditions.

The laboratory data are found in Appendix B.

[3] Romanoff, Melvin. Underground Corrosion, NBS Circular 579. Reprinted by NACE. Houston, TX, 1989, pp. 166–167.

[4] Romanoff, Melvin. Underground Corrosion, NBS Circular 579. Reprinted by NACE. Houston, TX, 1989, p. 8.

Conclusions

A combination of severely corrosive soils and imperfect external corrosion protection caused the failure of the force main pipe.

1. General corrosion of the pipeline occurred, with a large area of pipe wall reduced to less than 1/8-inch in thickness.
2. The general corrosion is likely due to a large breach in the polyethylene encasement, near where a seam in the encasement existed. External scaling of the pipe confirms long-term direct contact of the pipe with the soil.
3. Testing shows that soils are severely corrosive to ferrous materials:
   a. Soil resistivities measured in the field and in the laboratory were generally less than 500 ohm-cm, which is considered severely corrosive to metals.
   b. Chloride concentrations ranged from 1,500 to 2,000 mg / kg.
4. Failure of the weakened pipe was possibly triggered by the straining that occurred as the pipeline was depressurized and repressurized. An inadvertent elevated pressure may have amplified these strains. However, given the advanced corrosion, pipe failure was imminent, regardless.
5. The pipe material and its corrosion protection conformed to standard industry practices of the time when the pipeline was constructed, and nothing indicates that the pipeline was inadequately designed. In fact, the pressure rating of the pipeline is well in excess of any internal pressure from operations, including transient surge pressures.
6. The failure was likely detected sooner than otherwise would have occurred, due to the proactive leak detection performed by GWSD staff on the morning after the pipeline was placed back into service following a 3-week shutdown.
7. The availability of a secondary force main enabled a quick resumption of pumping operations, while repairs were undertaken.

*   *   *

HDR appreciates the opportunity to assist GWSD with this study. Questions regarding this report may be directed to Dan Ellison, 213.200.5152; dan.ellison@HDRinc.com.

<u>Attachments</u>:
Appendix A – Results of Soil Resistivity Field Tests
Appendix B – Results of Laboratory Tests

HDR

APPENDIX A

Table 1 - Soil Resistivity Field Tests

Goleta West Sanitary District
Failure Analysis
HDR # 10400114
24-Apr-24

LOCATION	DEPTH (feet)	MEASURED RESISTANCE (ohms)	AVERAGE RESISTIVITY TO DEPTH (ohm-cm)	STRATUM RESISTIVITY (ohm-cm)
				586
R1	2.5	1.2	586	
STA				317
	5.0	0.4	411	
				207
North South ish	7.5	0.2	309	
				3,433
Perpendicular with the c	10	0.2	400	
				120
	15	0.08	225	
				4,228
R2	2.5	8.5	4,228	
STA				960
	5.0	1.6	1,565	
				150
Parallel with ocean	7.5	0.3	378	
				212
	10	0.2	316	
				80
	15	0.05	159	

CORROSIVITY LEGEND (FERROUS METALS)			
Mildly	Moderately	Corrosive	Severely

431 West Baseline Road · Claremont, CA 91711
Phone: 909.626.0967

Table 2 - Laboratory Tests on Soil Samples

HDR, Claremont
Goleta West Sanitation District
Your #10400114, HDR Lab #24-0173LAB
7-May-24

Sample ID			53' South of pipe @ 7-11'	SW of pipe break close to creek @ 7-11'
Resistivity		**Units**		
as-received		ohm-cm	232	304
saturated		ohm-cm	216	300
pH			7.8	8.2
Electrical Conductivity		mS/cm	1.99	1.46
Chemical Analyses				
Cations				
calcium	Ca^{2+}	mg/kg	53	87
magnesium	Mg^{2+}	mg/kg	40	59
sodium	Na^{1+}	mg/kg	1,700	1,110
potassium	K^{1+}	mg/kg	195	120
ammonium	NH_4^{1+}	mg/kg	ND	ND
Anions				
carbonate	CO_3^{2-}	mg/kg	ND	ND
bicarbonate	HCO_3^{1-}	mg/kg	204	192
fluoride	F^{1-}	mg/kg	ND	ND
chloride	Cl^{1-}	mg/kg	2,020	1,480
sulfate	SO_4^{2-}	mg/kg	1,010	686
nitrate	NO_3^{1-}	mg/kg	ND	2.0
phosphate	PO_4^{3-}	mg/kg	ND	ND
Other Tests				
sulfide	S^{2-}	qual	na	na
Redox		mV	na	na

Resistivity per ASTM G187, pH per ASTM G51, Cations per ASTM D6919, Anions per ASTM D4327, and Alkalinity per APHA 2320-B.

Electrical conductivity in millisiemens/cm and chemical analyses were made on a 1:5 soil-to-water extract.

mg/kg = milligrams per kilogram (parts per million) of dry soil.

Redox = oxidation-reduction potential in millivolts

ND = not detected

na = not analyzed

GWSD Forcemain Soil Corrosivity Study

Goleta West Sanitary District

HDR #10445224,

Santa Barbara, CA

Contents

Technical Background

Soil Corrosivity

A major factor in determining soil corrosivity is electrical resistivity. The electrical resistivity of a soil is a measure of its resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. Corrosion currents, following Ohm's Law, are inversely proportional to soil resistivity. Lower electrical resistivities result from higher moisture and soluble salt contents and indicate corrosive soil. A correlation between electrical resistivity and corrosivity toward ferrous metals is shown in Table 1.[1]

Table 1. Soil Corrosivity Categories

Soil Resistivity (ohm-cm)	Corrosivity Category
Greater than 10,000	Mildly Corrosive
2,001 to 10,000	Moderately Corrosive
1,001 to 2,000	Corrosive
0 to 1,000	Severely Corrosive

Other soil characteristics that may influence corrosivity towards metals are pH, soluble salt content, soil types, aeration, anaerobic conditions, and site drainage.

Field Test Procedures

Two methods were used to evaluate the soil resistivity: Wenner Four-Pin resistivity testing, and soil sampling laboratory analysis. Wenner Four-Pin test locations were chosen at accessible locations that reflect the soil conditions of the pipes. Soil samples were taken from the excavations at pipe depth. The details of each technique are discussed herein.

Visual Assessment

The exterior surface of the piping was visually inspected to determine the overall physical condition. The condition of the pipe was visually examined and photo documented. The external and internal surface of the pipe was inspected for corrosion, mechanical abrasion, metal loss, or other forms of damage that could cause or aid in the deterioration of the pipe. The depth of areas of pitting and graphitization were measured using a W.R. Thorpe Pipe Pit Gauge.

Field Wenner Four-Pin Resistivity

The electrical resistivity of the soil was measured in place two times at two locations using the Wenner Four-Pin method in accordance with ASTM G57, *Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method*. This procedure gives the average resistivity to a depth equal to the spacing between the pins. Pin spacings of 2.5, 5, 7.5, 10, and 15 feet were used so that variations with depth could be evaluated. Wenner

[1] Romanoff, Melvin. Underground Corrosion, NBS Circular 579. Reprinted by NACE. Houston, TX, 1989, pp. 166–167.

Four-Pin test locations are marked with a red line in Figure 1. Locations for Wenner Four-Pin testing were determined based on areas where contact with soil was feasible. R1/R2 and R3/R4 were performed near approximately STA 71+00 and STA 78+00, respectively. Strata resistivities were calculated from resistance data using the Barnes Procedure. The Barnes Layer method predicts the resistivity of layers of earth based on the principle that each layer of earth is a resistor in parallel with the other layers of earth.

Figure 1. Wenner Four-Pin resistivity test locations

Soil Laboratory Analysis

The electrical resistivity of each sample was measured in a soil box per ASTM G187, *Measurement of Soil Resistivity Using the Two-Electrode Soil Box Method* in its as-received condition and again after saturation with distilled water. Resistivities are at about their lowest value when the soil is saturated. The pH of the saturated samples was measured per ASTM G51, *Measuring pH of Soil for Use in Corrosion Testing*. A 5:1 water:soil extract from each sample was chemically analyzed for the major soluble salts commonly found in soil per ASTM D4327, *Anions in Water by Suppressed Ion Chromatography*, ASTM D6919, *Determination of Dissolved Alkali and Alkaline Earth Cations and Ammonium in Water and Wastewater by Ion Chromatography*, and American Water Works Association (AWWA) Standard Method 2320-B, *Physical and Aggregate Properties of Water and Wastewater, Titration Method*. Soil samples were collected adjacent to the invert of the pipe. Figure 2 shows the approximate area where soil samples were taken from.

Figure 2. Approximate area of soil samples

Discussion

Visual Assessment

A visual inspection was conducted of the 24-inch force main in an excavation near STA 71+00 (Figure 3) and of a portion of the pipeline cut out near STA 78+00 (Figure 4). The nominal thickness of the pipe was measured to be 0.50 inches (Figure 5).

Figure 3. Overview of the 24-inch ductile iron pipe at STA 71+00

Figure 4. Overview of the replaced portion of 24-inch ductile iron pipe from near STA 78+00

Figure 5. Nominal thickness field measurements

The piping at STA 71+00 was found to have extensive corrosion at the invert of the pipe. Pitting from graphitization was found to be as deep as 0.150 inches (Figure 6). This wall loss is 30% of the nominal thickness of the pipe. Graphitization is the leaching of iron ions from the ferrous ductile iron substrate leaving behind carbon, as graphite. The leftover carbon does not provide any structural strength but remains in the same structure making it difficult to fully detect. As such, there is likely more pitting undetected by the extents of the visual inspection. The portion of piping removed near STA 78+00 was found to have through pitting near the bell and graphitization along the entire invert of the pipe.

Figure 6. 0.150 inch pit found at STA 71+00

Field Wenner Four-Pin Resistivity

The average and stratum resistivities measured in the field were in the mildly corrosive to moderately corrosive categories to a 7.5-foot depth. There was no correlation between average resistivity and depth of test (i.e. increasing or decreasing resistivity with depth). Table 2 summarizes the Wenner Four-Pin average resistivities to a 7.5-foot depth. The average resistivity across all measurements from zero (existing grade) to a depth of 7.5 feet was 14,816 ohm-cm. The full results of the Wenner Four-Pin testing are included in Table A1 in Appendix A.

Table 2. Soil corrosivity classification based on Wenner Four-Pin testing (average 0–7.5-foot depth)

Corrosivity category toward ferrous metals	Frequency	Percentage of measurements (%)
Severely Corrosive	1	25
Corrosive	3	75
Moderately Corrosive	0	0
Mildly Corrosive	0	0
Total	**4**	100

Soil Laboratory Analysis

Electrical resistivities were in the moderately corrosive category with as-received moisture. When saturated the electrical resistivities were in the severely corrosive and corrosive categories. Table 3 summarizes the results of laboratory resistivity testing.

Table 3. Soil corrosivity classification based on laboratory testing

Corrosivity category toward ferrous metals	Frequency	Percentage of measurements (%)
Severely Corrosive	2	66.6
Corrosive	1	33.3
Moderately Corrosive	0	0
Mildly Corrosive	0	0
Total	**3**	100

The laboratory resistivities were more corrosive than the Wenner Four-Pin resistivities.

Soil pH values varied from 6.9 to 7.3. This range is neutral.[2] These values do not particularly increase soil corrosivity.

The soluble salt content of the samples was moderate.

Chloride salts were not measured in high concentrations.

Sulfate salts were not measured in high enough concentrations to be considered corrosive.

Tests were not made for sulfide and oxidation-reduction (redox) potential because these samples did not exhibit characteristics typically associated with anaerobic conditions.

The laboratory analyses were performed under HDR laboratory number 25-0467. The full set of test results are presented in the attached Table A2 under Appendix A.

Conclusions

This soil for the 24-inch force main pipe is classified as severely corrosive to ferrous metals. If the pipeline were designed today cathodic protection would be recommended. Although cathodic protection can indefinitely mitigate corrosion, it is unable to reverse corrosion that has already occurred. Given the 47 years of service life for the piping, the soil tested in this study,

[2] Romanoff, Melvin. Underground Corrosion, NBS Circular 579. Reprinted by NACE. Houston, TX, 1989, p. 8.

and the past failures, the 24-inch FM has likely experienced extensive corrosion and cathodic protection would not be a viable remediation technique.

Recommendations

Corrosive and severely corrosive soils were identified from the field resistivity testing and laboratory test of samples collected at the excavations for the 24-inch ductile iron piping force main. GWSD should consider risk mitigation measures to prevent corrosion or breaks on the pipeline. Risk mitigation measures could include rehabilitation and/or replacement.

HDR

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Table A1 - Soil Resistivity Field Tests

Goleta West Sanitary District
Soil Corrosivity Analysis
HDR # 10445224
24-Sep-25

LOCATION	DEPTH (feet)	MEASURED RESISTANCE (ohms)	AVERAGE RESISTIVITY TO DEPTH (ohm-cm)	STRATUM RESISTIVITY (ohm-cm)
				80,000
R1	2.5	160.0	80,000	
STA				156,599
	5.0	105.9	105,900	
				23,031
V54 near manhole	7.5	32.1	48,150	
East west directional 4-				1,814
pin	10	3.3	6,520	
				405
	15	0.36	1,080	
				21,250
R2	2.5	42.5	21,250	
STA				8,225
	5.0	11.9	11,860	
				1,131
V54 near manhole	7.5	1.9	2,850	
				295
North south directional	10	0.5	900	
				675
	15	0.27	810	
				12,800
R3	2.5	25.6	12,800	
STA				2,878
	5.0	4.7	4,700	
Near treatment William				1,834
Moffett Place	7.5	2.1	3,090	
				1,071
North South Orientation	10	1.1	2,100	
				420
	15	0.30	900	

CORROSIVITY LEGEND (FERROUS METALS)			
Mildly	Moderately	Corrosive	Severely

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Table A1 - Soil Resistivity Field Tests

Goleta West Sanitary District
Soil Corrosivity Analysis
HDR # 10445224
24-Sep-25

LOCATION	DEPTH (feet)	MEASURED RESISTANCE (ohms)	AVERAGE RESISTIVITY TO DEPTH (ohm-cm)	STRATUM RESISTIVITY (ohm-cm)
				18,100
R4	2.5	36.2	18,100	
STA				8,622
	5.0	11.7	11,680	
				2,448
Near Treatment Plant	7.5	3.5	5,175	
				956
East West Orientation	10	1.2	2,460	
				1,736
	15	0.72	2,160	

CORROSIVITY LEGEND (FERROUS METALS)			
Mildly	Moderately	Corrosive	Severely

Table A2 - Laboratory Tests on Soil Samples

HDR, Claremont
GWSD FM Soil Corros Analysis
Your #10445224-03.01, HDR Lab #25-0467LAB
29-Nov-25

Sample ID			Sample B3 @ Pipe Depth	Sample B4 @ Pipe Depth	Sample B1 @ Pipe Depth
Resistivity		**Units**			
as-received		ohm-cm	10,000	7,600	4,400
saturated		ohm-cm	840	960	1,080
pH			7.3	7.2	6.9
Electrical Conductivity		mS/cm	0.43	0.42	0.25
Chemical Analyses					
Cations					
calcium	Ca^{2+}	mg/kg	133	129	53
magnesium	Mg^{2+}	mg/kg	53	47	15
sodium	Na^{1+}	mg/kg	190	194	182
potassium	K^{1+}	mg/kg	30	30	18
ammonium	NH_4^{1+}	mg/kg	ND	ND	ND
Anions					
carbonate	CO_3^{2-}	mg/kg	ND	ND	ND
bicarbonate	HCO_3^{1-}	mg/kg	232	189	162
fluoride	F^{1-}	mg/kg	5.0	5.0	4.0
chloride	Cl^{1-}	mg/kg	87	83	163
sulfate	SO_4^{2-}	mg/kg	772	759	215
nitrate	NO_3^{1-}	mg/kg	1.0	1.0	1.0
phosphate	PO_4^{3-}	mg/kg	6.0	6.0	4.0
Other Tests					
% moisture	H_2O	%	na	na	na
total acidity	H^{1+}	mmol/kg	na	na	na
sulfide	S^{2-}	qual	na	na	na
Redox		mV	na	na	na

Resistivity per ASTM G187, pH per ASTM G51, Cations per ASTM D6919, Anions per ASTM D4327, and Alkalinity per APHA 2320-B.

Electrical conductivity in millisiemens/cm and chemical analyses were made on a 1:5 soil-to-water extract.

mg/kg = milligrams per kilogram (parts per million) of dry soil.

Redox = oxidation-reduction potential in millivolts

ND = not detected

na = not analyzed

Appendix E - Environmental Constraints Memorandum - Rincon

Rincon Consultants, Inc.

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Santa Barbara, California 93101

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Revised August 1, 2023
Project No: 22-13229

Nick Panofsky, PE, Lead Engineer
MNS Engineers, Inc.
811 El Capitan Way, Suite 130
San Luis Obispo, California 93401
Via email: npanofsky@mnsengineers.com

Subject: Environmental Considerations and Permitting Constraints for the Goleta West Sanitary District Force Main Lining Project, Goleta, California

Dear Mr. Panofsky:

Rincon Consultants, Inc. (Rincon) is pleased to submit the following revised Environmental Considerations and Permitting Constraints Analysis for the Goleta West Sanitary District (District) Force Main Lining Project (project).

Project Understanding

Force Main Lining

An existing 18-inch wastewater asbestos concrete force main and a parallel 24-inch ductile iron force main traverse the Goleta Slough south of the Santa Barbara Municipal Airport. The project involves repairs to and lining of the existing 18-inch asbestos concrete force main, which will require several excavation pits along the alignment (Figure 1). In addition, an inspection program is proposed for the 24-inch ductile iron force main, which may require excavation at any point along the pipeline. No capacity increases are proposed. A portion of the existing pipeline crosses Tecolotito Creek via a pipe bridge and may require repairs. Based on input received from you on our January 12, 2023, kickoff call, it is our understanding that these repairs would not require operation of machinery within Tecolotito Creek.

Rincon's understanding of the proposed force main lining project was informed by the Draft Wastewater Force Mains Condition and Lining Assessment Technical Memo prepared by MNS (dated 1/20/2023), KMZ data showing the pipeline alignment and proposed excavation pit locations, and communications with MNS.

A preliminary review of the project alignment indicates that project-related ground disturbances at the eight proposed ingress and egress excavation pits are located within a developed roadway (Pits 1 through 3), undeveloped portions of the Goleta Slough adjacent to Santa Barbara Municipal Airport runways/taxiways (Pits 4 through 7), and along Moffett Place eastern road shoulder adjacent to the Goleta Sanitary District (Pit 8). The proposed pit dimensions are 9 feet long by 6 feet wide with a 12-inch clearance under the existing pipeline.

Pipe Bursting Option

Rincon originally submitted this memo in February 2023. In August 2023, Rincon revised this analysis to account for the following pipe bursting design option.

A pipe bursting methodology is under consideration for the 18-inch force main. The pipe bursting operation, if implemented, would likely occur after the previously described force main lining work is performed only on the 24-inch parallel main. Pipe bursting operations would occur in segments of approximately 400 feet at a time. Segments of 24-inch HDPE pipe would be fused together on grade to form continuous segments of pipe, 400 feet in length. These fused pipe segments would be laid directly on the ground, or on roller skids along and approximately parallel to the existing alignment. Heavy equipment, such as an excavator, would be required to move the pipe segments into position. A trailer-mounted fusing machine would be used to connect the pipe segments. For the pipe bursting operations, every 400 feet, a bursting pit would be required, with dimensions of approximately 35 feet long, 10 feet wide, and six to 12 feet deep, with depth dependent on the existing pipe depth. These pits could be constructed at any point along the existing force main, but could be shifted if specific conditions warrant, such as an unanticipated archaeological resource. Dewatering at each pit is likely, with discharge to a settling tank, then surface discharge to an existing storm drain, requiring an NPDES discharge permit. Shoring, consisting of trench boxes and vertically installed trench plates, would be needed to keep excavations open and provide a surface for the bursting equipment to pull against. A crane would be required to lift the pipe bursting equipment into each bursting pit, as well as a semi-driven trailer to move the bursting equipment between bursting pits.

Once materials and equipment are in place, the bursting operation would commence. The 400-foot-long segment of fused HDPE would be pulled through the existing pipe. A 28-inch diameter bursting head at the front of the pipe would break the existing pipe and provide an opening for the new pipe to be pulled into. A lubricant, such as bentonite slurry or a polymer lubricant, would be injected behind the bursting head to lubricate the pipe as it is pulled to reduce required pulling forces. Bursting pits would be coordinated with locations requiring excavation, such as at existing fittings, crossing utilities requiring protection, etc. Due to a combination of the increase in pipe size from the existing 18-inch pipe to the proposed 24-inch diameter pipe, there is a potential for uplift/surface lifting/rupture along the bursting alignment to occur.

Similar to the force main lining project, the pipe crossing Tecolotito Creek would be replaced by traditional methods, using a crane to lift pipe segments into place. Where the force main crosses Moffett Place, construction would be by traditional open trench methods.

As much equipment as feasible would be located within existing roads adjacent to the pipeline alignment, however, there would be significant disturbance in the vicinity of each bursting pit for equipment and materials.

The pipe bursting operation would add approximately 16 weeks of field work to the construction process, in addition to the field work required for the force main lining. We assume continuous monitoring would be required throughout this period.

Environmental Considerations and Constraints Analysis

Rincon conducted an environmental considerations and constraints analysis for the project consisting of a review of relevant background literature and a query of resource agency databases. The analysis focused on evaluating potential impacts to special status biological resources, cultural resources, or hazardous materials considerations which could result in constraints to project implementation. The methods, results, potential impacts, and recommendations for each environmental consideration and constraint are provided below by resource.

Biological Resources Constraints

Biological sensitivity is high near the project site as the Goleta Slough is a designated marine conservation area and environmentally sensitive habitat area (ESHA), comprised of freshwater wetlands and tidal marsh. This large expanse of open water and estuarine/wetland habitats supports a biologically important coastal ecosystem that provides functions such as floodwater storage capacity and the filtering of pollutants contained within stormwater runoff. The Goleta Slough contains breeding populations of listed species such as the state endangered Belding's savannah sparrow (*Passerculus sandwichensis beldingi*) and the federally endangered tidewater goby (*Eucyclogobius newberryi*), as well as other species of federal, state, and local concern.

Most of the project footprint occurs within Goleta Slough or within paved roadways or road shoulders. All vegetation communities and land cover types were interpreted from aerial imagery and were not confirmed in the field.

Special Status Species

Rincon conducted a biological literature review and preliminary desktop analysis of the project site. The analysis included a review of the following databases and literature sources to provide site context and physical characteristics, as well as identify potential special status species that may occur: the United States Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) system[1] and Critical Habitat Portal,[2] the California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB),[3] and the California Native Plant Society (CNPS) online Inventory of Rare Endangered Vascular Plants of California.[4] A 6-quadrangle search (i.e., United States Geological Survey [USGS] 7.5-minute quadrangles) was utilized for both the CNDDB and CNPS queries to establish a list of special status species with potential to occur within or adjacent to the project site. In addition, Rincon reviewed site-specific and project-vicinity programmatic biological studies, including the:

- City of Santa Barbara Local Coastal Plan/Coastal Land Use Plan (2019)
- City of Santa Barbara Coastal Plan – Airport and Goleta Slough (2003)
- Goleta Slough Ecosystem Management Plan (2015)

Based on review of CNDDB occurrences and aerial imagery during the desktop review, the following five special-status plant species and ten special-status wildlife species have moderate to high potential to occur within the project site:

- Coulter's goldfields (*Lasthenia glabrata* ssp. *Coulteri*) – California Rare Plant Rank 1B.1
- mesa horkelia (*Horkelia cuneata* var. *puberula*) – California Rare Plant Rank 1B.1

[1] USFWS. 2023. Information, Planning, and Conservation System (IPaC). https://ecos.fws.gov/ipac (accessed January 2023)
[2] USFWS. 2023. Critical Habitat Portal. https://ecos.fws.gov/ecp/report/table/critical-habitat.html (accessed January 2023)
[3] CDFW. 2023. California Natural Diversity Data Base, Rarefind V. 5.2.14 https://wildlife.ca.gov/Data/CNDDB/Maps-and-Data (accessed January 2023)
[4] CNPS. 2023. *Inventory of Rare and Endangered Plants* (online edition V9-01 1.0). http://www.rareplants.cnps.org/ (accessed January 2023)

- salt marsh bird's-beak (*Chloropyron maritimum* ssp. *Maritimum*) – Federal and State Endangered
- Santa Barbara honeysuckle (*Lonicera subspicata* var. *subspicata*) – California Rare Plant Rank 1B.2
- southern tarplant (*Centromadia parryi* ssp. *Australis*) – California Rare Plant Rank 1B.1
- American peregrine falcon (*Falco peregrinus*) – State Fully Protected
- Belding's savannah sparrow (*Passerculus sandwichensis beldingi*) – State Endangered
- California brown pelican (*Pelecanus occidentalis californicus*) – State Fully Protected
- Cooper's Hawk (*Accipiter cooperii*) – State Watch List
- Crotch's bumblebee (*Bombus crotchii*) – State Candidate
- light-footed Ridgway's rail (*Rallus obsoletus levipes*) – Federal and State Endangered
- steelhead – southern California Distinct Population Segment (DPS) (*Oncorhynchus mykiss irideus* pop. 10) – Federal Endangered, State Candidate
- tidewater goby (*Eucyclogobius newberryi*) – Federal Endangered
- tricolored blackbird (*Agelaius tricolor*) – State Threatened
- white-tailed kite (*Elanus leucurus*) – State Fully Protected

The species that can be reasonably anticipated to occur were determined based on their reported ranges and tracked occurrences, and the type, extent, and condition of habitat available at the site assessed through aerial review.

Potential impacts to the special status species above would be evaluated through the California Environmental Quality Act (CEQA) environmental review process and would require technical studies such as a Biological Resources Assessment (BRA) / Biological Assessment (BA) supported by field surveys, and further focused surveys to determine presence/absence (e.g., Belding's savannah sparrow, tidewater goby) depending on specific habitat impacts. Permitting agencies would also likely require biological studies, including a jurisdictional delineation to support their permit decisions on the project. Additionally, potential impacts to federally listed species would require an Endangered Species Act (ESA) Section 7 Consultation with the USFWS as part of the USACE permitting process. If impacts to state listed species are unavoidable, then a California Fish and Game Code (CFGC) Section 2081 Incidental Take Permit may be required.

The project has the potential to impact protected birds, including the Cooper's hawk and common birds protected under the Migratory Bird Treaty Act (MBTA) and CFGC, if an active nest is present within or adjacent to the project site. To comply with the MBTA and CFGC, nesting bird pre-construction surveys and nest avoidance measures may be required if vegetation would be removed during the nesting season (typically February 1 through August 31).

Pipe Bursting Option

The 18-inch force main measures approximately 8,000 feet in length, with bursting pit locations requiring up to 4,200 square feet (0.09 acre) ground disturbance proposed every 400 feet, several of which would occur adjacent to or within the slough. Implementation of the pipe bursting option would increase the risk to biological resources in the area. Similar to the force main option, pipe bursting would be evaluated through the CEQA environmental review process and would require technical studies such as a BRA/BA supported by field surveys, further focused surveys to determine presence/absence depending on specific habitat impacts, consultation with the USFWS, and compliance with the MBTA and CFGC.

Jurisdictional Waters and Resource Agency Permitting

The USFWS National Wetlands Inventory Wetlands Mapper[5] and the USGS National Hydrography Dataset (NHD)[6] were utilized to determine presence of aquatic resources in the project site. The results of these queries were used to evaluate whether jurisdictional waters have the potential to occur within or adjacent to the project site. Review of the NHD and NWI indicated Goleta Slough is a combination of Estuarine and Marine Wetland and Freshwater Emergent Wetland. Tecolotito Creek is listed as an Estuarine and Marine Deepwater Tidal System. Tecolotito Creek converges with the Goleta Slough southwest of the project site and ultimately flows into the Pacific Ocean.

Both Goleta Slough and Tecolotito Creek are subject to the jurisdiction of the United States Army Corps of Engineers (USACE), the Central Coast Regional Water Quality Control Board (RWQCB), and the CDFW.

Based on a review of the Primus Line Access Pits Plan, the proposed locations of Pits 4 and 6 would be located within Goleta Slough, and excavation could occur at any point along the pipeline alignment within Goleta Slough. As such, permitting with these three agencies is anticipated to be necessary. The other project components are anticipated to be constructed within uplands or within roadways. Nationwide Permit (NWP) 58 from the USACE, which authorizes utility line activities for water, may be applicable for the project.

The State Water Resources Control Board (SWRCB) has adopted new regulatory procedures requiring an Alternatives Analysis and Compensatory Mitigation Plan for projects where individual 401 Certifications are needed. It is not expected the project will qualify for any of the SWRCB Alternative Analysis exemptions because there are impacts to rare, threatened, or endangered species habitat in waters of the state, wetlands, or Areas of Special Biological Significance. As required by the SWRCB's regulatory procedures, an Alternatives Analysis will be required to confirm the proposed action constitutes the "least environmentally damaging practicable alternative." The project could qualify for a Tier 1 analysis which need only a description of any steps that have been or will be taken to avoid and minimize loss of, or significant adverse impacts to, beneficial uses of waters of the state.

The agencies may require a field delineation of the limits of the Goleta Slough and Tecolotito Creek to determine appropriate jurisdictional boundaries and conditions. The federal waters permit application (USACE) would also require submittal of a BA describing effects on federally listed species and critical habitat, a mitigation or restoration plan, and an archaeological study for compliance with Section 106 of the National Historic Preservation Act. The BA would be used by the USACE to complete ESA Section 7 Consultation with the National Marine Fisheries Service (NMFS) and USFWS.

Pipe Bursting Option

Pipe bursting operations have the potential to release drilling fluids into the surface environment through frac-outs. A frac-out is the condition where drilling mud is released through fractured bedrock into the surrounding rock and sand and travels toward the surface. In this case, a fracturing force is exerted on the existing pipe, breaking it and temporarily expanding the diameter of the cavity. While

[5] USFWS. 2022. National Wetlands Inventory. https://www.fws.gov/wetlands/data/mapper.html (accessed January 2023)
[6] United States Geological Survey (USGS). 2022. National Hydrography Dataset. https://www.usgs.gov/national-hydrography (accessed January 2023)

pipe bursting is not intended to be a compactive method of installation, installation errors can lead to compaction around the installed pipe. This unintended compactive effort can lead to frac out and/or lifting of the soils.

As a result, large volumes of drilling fluid during a frac-out are possible. Once a frac-out has occurred, future releases in the vicinity or from the same ground conduits should be anticipated. Lowering a bore profile does not necessarily ensure that the probability of frac-out is reduced. In addition, there are many stakeholders involved when a project experiences frac-outs (e.g., CDFW, RWQCB, Coastal Commission).

Similar to the previous option, the pipe bursting option would require permitting with the three agencies, including the preparation of a Frac-out and Surface Spill Contingency Plan. Nationwide Permit (NWP) 58 from the USACE, which authorizes utility line activities for water, may be applicable for the project.

Compensatory Mitigation

Compensatory mitigation for impacts to aquatic and riparian habitat and/or special-status species habitat would be required as a part of each regulatory permit. Based on the limited disturbance footprint, compensatory mitigation may be achieved through on-site restoration with a subsequent five-year mitigation monitoring and reporting program. However, Rincon recommends evaluating other potential options, such as an in-lieu fee program or mitigation bank to compensate for permanent impacts. Mitigation ratios are typically 3:1 for permanent impacts and 1:1 for temporary impacts. Permanent impacts are those that result in permanent, adverse alteration of the aquatic ecosystem such as placement of exposed concrete or other structures in Goleta Slough. Temporary impacts are those that are necessary to complete the project but will be restored to existing conditions (contours and vegetation) when the project is complete. Compensatory mitigation costs vary based on conditions set by the regulatory agencies, including ratios and monitoring requirements.

Pipe Bursting Option

Compensatory mitigation for impacts to aquatic and riparian habitat and/or special-status species habitat would be similar to the force main lining project.

Cultural Resources Constraints

This cultural resources constraints analysis consisted of a desktop review of available historical aerial imagery and topographic maps, prehistoric watercourses, and Rincon's library of existing cultural resources data.

All project areas have been previously disturbed from installation of the existing pipeline; however, the 18-inch diameter asbestos-cement pipe has been in service since 1963 prior to the implementation of CEQA and state laws protecting cultural resources. A review of available historical aerial imagery from 1928 indicates that the project alignment was an undeveloped wetland at that time. Grading for the construction of the airport is visible in imagery from 1941 and roadway and residential development in the surrounding area is depicted on a topographic map from 1942. By 1944, the airport and associated runways/taxiways had been constructed, with grading and infrastructure development also observed within the Goleta Sanitary District site and the adjacent Southern California Gas Company facility. The airport was constructed using imported soil from areas outside, but adjacent to, the airport site.

The Goleta Slough and the Pacific Ocean, located approximately 0.3 mile to the south of the project site, would have provided a variety of subsistence resources including fresh water, plants, and terrestrial and marine animals that would have made the area desirable for prehistoric habitation/occupation. This is supported by the presence of at least three previously recorded prehistoric archaeological sites (CA-SBA-46, CA-SBA-49, CA-SBA-4010) within 0.25 mile of the project alignment.

The project alignment is located within an area of increased cultural resource sensitivity. A review of Rincon's library of existing cultural resources data indicates the eastern portion of the alignment is located within and adjacent to CA-SBA-46, a known habitation site with burials. CA-SBA-46 has been previously disturbed from modern development; however, intact archaeological deposits considered potentially significant under CEQA have been identified within CA-SBA-46. The western terminus of the project alignment is located within close proximity to a previously recorded prehistoric habitation site with burials (CA-SBA-49) that was situated on a bluff overlooking the Goleta Slough.

Based on existing records, the current alignment falls within an area considered to be highly sensitive for cultural resources with a very active Native American community. Although much of the local soils have been disturbed and redistributed, the potential to encounter cultural resources remains high. Previously disturbed resources are typically not considered significant under CEQA, however, this does not preclude heritage value of the resources to local tribes who want these resources protected or treated with sensitivity. Tribes local to the Goleta area typically expect monitoring for projects in and around CA-SBA-46. Further, human remains, regardless of their condition or context, require consideration under California Health and Safety Code Section 7050.5 and Public Resources Code Section 5097.98. The protocols for the treatment of human remains after identification present a potential risk to the project with regard to cost and time. If the human remains are determined to be of Native American origin, the Coroner will notify the Native American Heritage Commission, which will determine and notify a most likely descendant (MLD). The MLD has 48 hours from being granted site access to make recommendations for the disposition of the remains. Rincon's recent experience with local MLDs has led to extended timelines for treatment as the parties involved delayed on-site meetings and delayed providing guidance.

In an effort to minimize the risk of such delays, Rincon recommends a Cultural Resources Assessment report (CRA) be prepared for the project in addition to an exploratory Extended Phase I (XPI) testing program. XPI testing would include excavation of a series of shovel test pits (STPs) or hand auger units to determine the presence or absence of subsurface cultural materials within the project's proposed excavation locations. Typically, STPs measure approximately 35 centimeters (cm) in diameter and between 60 and 100 cm in depth. STPs would be conducted in areas of unpaved pit locations (Pits 4-8) prior to the start of construction. If, after the start of construction activities, additional areas are identified along the pipeline alignment that require excavation, Rincon can mobilize field archaeologists to the project site to test the new pit locations prior to the start of project-related excavations. For the purposes of estimating costs and timeline for this constraints analysis (see Table 1 at the end of this memorandum), Rincon assumes 10 to 15 STPs will be needed to address the known pit locations (Pits 4 through 8), as well as additional excavation areas along the alignment. Depending on soil conditions, typically three to five STPs can be excavated per day. If no subsurface cultural materials or human remains are identified within the STPs, then work may proceed. If subsurface archaeological deposits are encountered and the deposits cannot be avoided by project design, a Phase 2 significance evaluation may be necessary to evaluate the deposit for significance under CEQA. If the deposits are determined significant and the deposits cannot be avoided by project design, a Phase 3 data recovery excavation may be necessary to mitigate impacts to significant subsurface archaeological deposits.

The CRA will include background research, a California Historical Resources Information System records search, a Sacred Lands File search conducted by the Native American Heritage Commission, an archaeological pedestrian field survey, and report preparation. Following the CRA, an exploratory XPI testing program should then be implemented at the proposed pit locations to assess the presence of cultural resources (including human remains) within those pit locations. The results of the XPI can then be used to determine if alternative pit locations would be necessary and to address the potential for human remains and treatment needs prior to the mobilization of construction crews where delays can be even more costly. The results and analysis of the exploratory XPI testing program would be incorporated into the CRA.

Pipe Bursting Option

The 18-inch force main measures approximately 8,000 feet in length, with bursting pit locations requiring ground disturbance proposed every 400 feet. If the pipe bursting option is implemented, XPI testing is recommended at the proposed bursting pit locations to assess the presence or absence of subsurface cultural materials and to minimize the risk of delays if cultural resources or human remains are identified. XPI testing should be observed by a local Native American representative. Approximately 960 feet of the 18-inch force main is paved and XPI testing within those areas would not be feasible. Therefore, Rincon assumes XPI testing will be conducted at the 18 proposed bursting pit locations, in addition to the pit locations previously identified for the project. Rincon further assumes one STP will be excavated at each proposed bursting pit location for a total of 18 STPs. Depending on soil conditions, typically three to five STPs can be excavated per day. If no subsurface cultural materials or human remains are identified within the STPs, then work may proceed.

Similar to the force main option, if subsurface archaeological deposits are encountered and the deposits cannot be avoided by project redesign, a Phase 2 significance evaluation may be necessary to evaluate the deposit for significance under CEQA. If the deposits are determined significant and the deposits cannot be avoided by project redesign, a Phase 3 data recovery excavation may be necessary to mitigate impacts to significant subsurface archaeological deposits. The results and analysis of the XPI testing program within the bursting pit locations would be incorporated into the CRA.

Hazards and Hazardous Materials Constraints

Rincon reviewed the following resources to evaluate the potential for past releases of hazardous materials within 0.25 mile of the project site:

- SWRCB online GeoTracker database
- Department of Toxic Substances Control's (DTSC) online EnviroStor database
- DTSC online Hazardous Waste and Substances Sites (Cortese) List

Four closed Leaking Underground Storage Tank (LUST) locations,[7] one inactive DTSC site cleanup program site,[8] and two closed Military Privatized Sites (UCSB Naval Air Station - UCSB Building 331, Tank 7&8) are located within 0.25 mile of the project site.[9] One open cleanup program site is located at the airport adjacent to the project site.

The nearest LUST site is the Goleta West Sanitary District – UCSB LUST site, located at the District office near the western end of the project site. Of the three closest monitoring locations listed in the Case Closure Summary Report for this case, the two closest groundwater monitoring wells (MW-9, MW-18) did not detect petroleum hydrocarbons, and low petroleum hydrocarbon levels were detected in soil in the nearest soil boring location to the project site (B-5).

Santa Barbara Municipal Airport (500 James Fowler Road, Santa Barbara, California) is adjacent to the north and west of the project. Documents available on GeoTracker indicate that in response to a SWRCB investigative order, several per- and polyfluoroalkyl substances (PFAS) investigations were completed at the airport property from 2019 to 2021. The investigation reports indicate that PFAS was detected in soil, groundwater, and surface water samples collected at the airport site and within the Goleta Slough Ecological Reserve at concentrations exceeding applicable notification and/or response/screening levels established by the SWRCB and San Francisco Bay RWQCB, respectively.[10] If dewatering of the PFAS-containing groundwater is required, then treatment of the affected groundwater will be needed and a permit from the RWQCB would be required. In addition, if contaminated soils are encountered, soil testing and disposal at an appropriately licensed facility would also be needed.

No sites were found on the DTSC online Hazardous Waste and Substances Sites (Cortese) List.

Based on this preliminary desktop review, the project would not create a significant hazard to the public or the environment related to mapped hazardous materials sites.

Pipe Bursting Option

Because the pipe bursting option does not expand the project site, there are no additional hazardous materials constraints or considerations associated with this option.

Coastal Development Permit

The project site is located within the jurisdiction of both the City of Santa Barbara and the County of Santa Barbara. City jurisdiction extends from the District office north of Mesa Road to the Goleta Slough and along the perimeter of the Santa Barbara Municipal Airport east to Moffett Place. County jurisdiction includes the area east of Moffett Place to the Goleta Sanitary District facility. In addition, the pipeline route is located within the Coastal Commission's area of retained permit jurisdiction. The Coastal Commission's retained jurisdiction appears to encompass the majority of the pipeline route where located within the extent of the Goleta Slough. In order to determine precisely where the project

[7] SWRCB. 2022. GeoTracker. Lust Cleanup Site: https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0608302757
SWRCB. 2022. GeoTracker. Lust Cleanup Site: https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0608369320
SWRCB. 2022. GeoTracker. Lust Cleanup Site: https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0608300568
SWRCB. 2022. GeoTracker. Lust Cleanup Site: https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0608300145
[8] SWRCB. 2022. GeoTracker. Cleanup Program Site: https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T10000014952
[9] SWRCB 2002 GeoTracker Military Privatized Site: https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0608300144
SWRCB 2002 GeoTracker Military Privatized Site: https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0608300582
[10] SWRCB. 2022. GeoTracker. Cleanup Program Site: https://geotracker.waterboards.ca.gov/profile_report?global_id=T10000012769

falls within Coastal Commission jurisdiction, it will be necessary to coordinate with the Coastal Commission prior to application submittal and obtain a detailed boundary determination.

Although repair and maintenance activities on existing public infrastructure and pipeline projects are typically exempted from Coastal Development Permits (CDP) in City, County, and Coastal Commission jurisdictions, the project's location within a designated Environmentally Sensitive Habitat Area (ESHA) precludes such exemptions in both the City and Coastal Commission permit jurisdiction areas. As such, separate CDPs from both the City of Santa Barbara and Coastal Commission will be required. In situations where there is dual permitting authority for the same project, the City's CDP process typically occurs prior to the Coastal Commission review. However, given this is an important public infrastructure project, Rincon recommends pre-submittal consultation with both City and Commission staff to determine the appropriate and most expeditious permitting process, and whether simultaneous processing is possible.

Within the small area of the County's jurisdiction east of Moffett Place, it appears the pipeline and construction corridor are located outside of any mapped ESHA and therefore can qualify for a CDP exemption. Again, Rincon recommends pre-application consultation with County staff to confirm the project can qualify as an exempt project under the County's repair and maintenance provisions or, alternatively, whether some form of expedited processing is available given the majority of the project is located outside of County jurisdiction.

Related to timing, the City's CDP process for a project of this scale and complexity is expected to take between 6 to 8 months, while Coastal Commission permitting could be one year or greater, depending on both the level of controversy and staff availability. Meanwhile, County processing for an exemption should be no more that 30 to 60 days and a CDP (if necessary) may take between four to six months.

Pipe Bursting Option

Because the pipe bursting option is located within the same jurisdictional boundaries, no additional permitting would be required. The applications could be processed concurrently as a single project under the CDP from each jurisdiction. Therefore, it is recommended that single CDP applications which include the pipe bursting option be submitted to each lead agency. While the pipe bursting option would include additional project details, it is not anticipated to increase agency review time.

CEQA Options Analysis

Implementation of the project would require environmental review under CEQA. The District would be the lead agency under CEQA (Public Resources Code Section 21067) and is responsible for complying with its requirements. Unless exempt, the project's CEQA document would be adopted or certified by District and would be required for any other state or local agency for which discretionary permits/approvals are required. Jurisdictional and coastal permitting agencies would be designated as responsible agencies under CEQA.

Pipeline repair projects are typically exempt from CEQA under a Class 1 Categorical Exemption, which covers the repair or minor alteration of existing public facilities involving negligible or no expansion of existing or former use. CEQA Guidelines Section 15300.2 contains exceptions to the listed Categorical Exemptions. CEQA Guidelines Section 15300.2(c) specifically states: "A categorical exemption shall not be used for an activity where there is a reasonable possibility that the activity will have a significant effect on the environment due to *unusual circumstances*." This is a determination of whether the project has some feature that distinguishes it from others in the exempt class, such as its size or location, and whether the unique circumstances might result in significant environmental impacts.

As previously discussed in this memorandum, the project site is highly sensitive for biological and cultural resources. As such, the project site's proximity to regulated environmental resources, paired with proposed ground disturbance, could constitute an unusual circumstance that might result in significant environmental impacts. In addition, jurisdictional and coastal permitting agencies would also be responsible for independently reviewing and approving the CEQA document for the project, and may require a more thorough environmental analysis. An Initial Study-Mitigated Negative Declaration (IS-MND) is likely the appropriate level of CEQA documentation for the project considering these factors.

Ultimately, the District, as CEQA lead agency, would be responsible for determining the appropriate level of CEQA documentation. We recommend presenting the proposed CEQA pathway to responsible agencies at the onset of the environmental review process to confirm an IS-MND will be acceptable for their permitting purposes. If it is determined through the environmental analysis that the project may result in significant and unavoidable environmental impacts, then an Environmental Impact Report would be required.

Pipe Bursting Option

The pipe bursting option does not change the anticipated CEQA pathway and considerations identified for the force main project. An IS-MND is likely the appropriate level of CEQA documentation. However, similar to the previous discussion, we recommend presenting the proposed CEQA pathway to responsible agencies at the onset of the environmental review process. The pipe bursting option would be a consideration for the responsible agencies in providing input on the CEQA pathway.

Similar to the force main option, if it is determined through the environmental analysis that the project may result in significant and unavoidable environmental impacts, then an Environmental Impact Report would be required.

Summary and Recommendations

The project site is sensitive for biological and cultural resources, and is situated in the Coastal Zone. Biological and cultural studies will be required to support the environmental findings in the CEQA document and environmental permits. Environmental permitting needs include regulated species, jurisdictional resources, CDPs, and CEQA. Table 1 presents a summary of Rincon's recommended approach and estimated costs for environmental permitting needs.

Pipe Bursting Option

As described in this memorandum and quantified in Table 1, the pipe bursting option would introduce additional costs associated with biological and cultural monitoring needs triggered by the extended construction duration and additional ground disturbance in environmentally sensitive areas. No additional environmental permits are anticipated to be required beyond those previously identified.

Table 1 Summary of Environmental Permitting Needs

Environmental Issue Area	Potentially Required Permits/Studies	Force Main Lining		Pipe Bursting Option (If Different)	
		Estimated Cost	Estimated Timeline	Estimated Additional Cost	Estimated Additional Timeline
Regulated Species Permitting	Biological Resources Assessment (BRA)	~$15k	6 weeks (can be prepared concurrently with BA and botanical survey if practicable)	--	--
	Federal Biological Assessment (BA)	~$10k	6 weeks (can be prepared concurrently with BRA and botanical survey if practicable)	--	--
	Botanical surveys	$4k - $6k	April – May	--	--
	Focused surveys for special-status wildlife	$6k - $10k per species, estimated $20k-$25k total	Dependent on species and survey protocol timing	--	--
	Endangered Species Act (ESA) Section 7 consultation with USFWS/NMFS for federally listed species [7]	$8k - $12k	90 – 135 days	--	--
	CFGC Section 2081 Consultation with CDFW for state-listed plants and wildlife [7]	$15k - $20k (additional $7,500 - $43,770 fee, dependent on total cost to implement project and complexity)	6 – 12 months	--	--
	Compensatory Mitigation Plan [7]	$5k - $10k	4 – 6 months (linked to 2081)	--	--
	Pre-construction surveys and construction monitoring	$1,200 per day per biologist, estimated at 10 -15 days, for a total of $12k - $18k	Prior to initiation of construction activities and within and/or adjacent to sensitive habitat	Estimated additional 40-60 days of biological monitoring for an additional $48k - $72k	Prior to initiation of construction activities and within and/or adjacent to sensitive habitat for an additional 16 weeks
Jurisdictional Resources Permitting	Aquatic Resources Delineation	~$10k	6 weeks, can be conducted concurrently with BRA/BA	--	--
	USACE Section 404 Permit with Section 7 Consultation [7]	$6k - $8k	6 – 9 months	--	--
	RWQCB Section 401 Water Quality Certification for NWP 58 with Tier 1 Alternative Analysis [7]	$6k - $10k (additional $2,734 application fee)	6 – 9 months	--	--

Environmental Issue Area	Potentially Required Permits/Studies	Force Main Lining		Pipe Bursting Option (If Different)	
		Estimated Cost	Estimated Timeline	Estimated Additional Cost	Estimated Additional Timeline
	CDFW Notification of Lake/Streambed Alteration [7]	$6k - $8k (additional $700 - $6,236 fee, dependent on total cost to implement project)	4 – 6 months	--	--
	Compensatory Mitigation Plan [7]	$5k - $10k	4 – 6 months (linked to CDFW notification)	--	--
	Frac-Out Plan	~$5k	4 – 6 months (linked to CDFW notification)	--	--
Cultural Resources	Cultural Resources Assessment (CRA) Report and Exploratory Extended Phase I (XPI) Testing	~$30 – 40k [3]	6 – 8 months	Additional ~$40k – 45k[8]	--
	Archaeological and Native American construction monitoring	$45k - $50k	20 day construction period	Additional ~$95k - 100k[8]	Assumes archaeological and Native American monitoring will be limited to 8 weeks of the 16 week construction period
	Archaeological construction monitoring technical memo (assuming negative findings)	$5k	5 weeks upon completion of monitoring	Additional ~$3k - 5k	--
Coastal Development Permits (CDPs)	City of Santa Barbara CDP	$10k - $15k (additional $23k City processing fee [4])	6 – 8 months	--	--
	California Coastal Commission CDP [5]	$15k - $25k	9 – 14 months	--	--
	County of Santa Barbara ▪ CDP Exemption; or ▪ CDP (if necessary)	▪ $2k - $3k (additional $269 application fee[6]); or ▪ $8k - $12k (additional $1,263 deposit, plus planner time [6])	▪ 30 – 60 days; or ▪ 4 – 6 months	--	--
CEQA	Initial Study – Mitigated Negative Declaration (IS-MND)[1]	$40k - $50k[2]	4 – 6 months	--	--
Total Cost Estimate Range		**~$275k - $364k (plus $34k to $77k in filing fees)**		**Additional ~$186k - $222k**	

USFWS = United States Fish and Wildlife Service; NMFS = National Marine Fisheries Service; CFGC = California Fish and Game Code; CDFW = California Department of Fish and Wildlife; USACE = United States Army Corps of Engineers; RWQCB = Regional Water Quality Control Board; NWP = Nationwide Permit; WEAP = Worker's Environmental Awareness Program

[1] If it is determined through the environmental analysis that the project may result in significant and unavoidable environmental impacts, then an Environmental Impact Report would be required.

Environmental Issue Area	Potentially Required Permits/Studies	Force Main Lining		Pipe Bursting Option (If Different)	
		Estimated Cost	Estimated Timeline	Estimated Additional Cost	Estimated Additional Timeline

[2] This cost range does not include the BRA and cultural resources technical memorandum, which are identified separately in this table and would be appended to the CEQA document.

[3] This cost range does not include costs for compensatory mitigation, treatment of intact cultural materials or human remains if they are identified during exploratory XPI testing, or archaeological and Native American monitoring because the level of effort is not known at this time.

[4] This is an estimate for the City to process the fee; actual fee may vary.

[5] The California Coastal Commission typically waives permit application fees for public agencies; however, application fees may apply.

[6] This is an estimate for the County to process the fee; actual fee may vary, and County planner time spent processing the application would incur additional cost.

[7] Implementation of mitigation requirements will have additional costs which are not included here because they are unknown at this time.

[8] Conservatively assumes no overlap between force main pits and pipe bursting pits. Overlapping pits would decrease costs.

Note: If required, costs for management (e.g., permit actions, treatment, disposal) of PFAS-contaminated soil and groundwater are not included in this estimate because they are unknown at this time.

Recommendations

- Early consultation with the regulatory agencies, including pre-application meetings with the RWQCB, are mandatory and would help streamline the permitting process. During these meetings, the regulatory agencies may outline additional conditions, surveys, reporting, and compensatory mitigation that may be necessary for them to authorize the project.
- Present the proposed CEQA pathway to responsible agencies at the onset of the environmental review process to confirm an IS-MND is the appropriate level of CEQA documentation to support their permitting reviews.
- Based on the very high cultural resources sensitivity of the area, Rincon recommends a CRA be prepared for the project in addition to an exploratory XPI testing program. The results of the XPI can then be used to determine if alternative ground disturbance locations would be necessary and to address the potential for human remains and treatment needs prior to the mobilization of construction crews where delays can be even more costly.
- To inform the CDP pathways, we recommend the following pre-submittal consultations with coastal permitting staff: (1) meet with City and Commission staff to determine the appropriate and most expeditious permitting process, and whether simultaneous processing is possible, and (2) meet with County staff to confirm that the project can qualify as an exempt project under the County's repair and maintenance provisions or, alternatively, whether some form of expedited processing is available given the majority of the project is located outside of County jurisdiction.
- Focused special status species surveys are dependent on seasonal requirements; thus, it is important to consider initiating surveys early during the planning process to avoid project delays.
- Once the project is approved, schedule vegetation removal activities and natural area disturbance activities between September 15 and February 1 (outside of the typical nesting season) to avoid disturbance or loss of active bird nests during construction.
- Targeted PFAS sampling in areas where there will be project-related disturbance or dewatering is recommended to determine the need for permitting, treatment and disposal. Coordination with the SWRCB regarding the ongoing investigation at Santa Barbara Airport is recommended as this may streamline sampling and investigation efforts.

We appreciate the opportunity to assist MNS with this assignment. If you have questions about this analysis, please contact us.

Sincerely,
Rincon Consultants, Inc.

Amanda Antonelli

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Figure 1 Proposed Force Main Lining Pit Locations

Figure Source: Draft Wastewater Force Mains Condition and Lining Assessment Technical Memo prepared by MNS, dated 1/20/2023