



COLORADO
Department of Transportation

Applied Research and Innovation Branch

EVALUATION AND PERFORMANCE OF HDPE PIPES UNDER CDOT HIGHWAYS, T-REX, AND OTHER LOCATIONS

Albert Molinas, Amanullah Mommandi, Aziz Khan, Brett Sollenberger

Report No. CDOT-2018-09
March 2018

The contents of this report reflect the views of the author(s), who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views of the Colorado Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

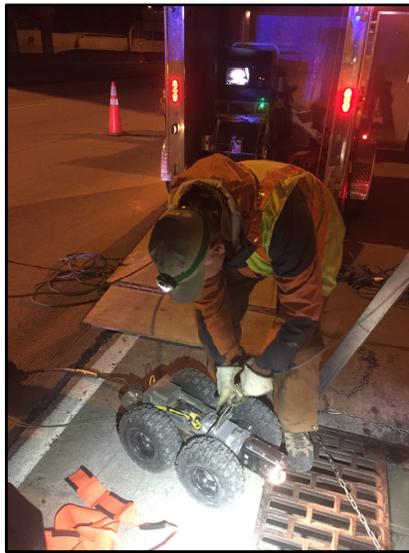
Technical Report Documentation Page

1. Report No. CDOT-2018-09		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle EVALUATION AND PERFORMANCE OF HDPE PIPES UNDER CDOT HIGHWAYS, T-REX AND OTHER LOCATIONS				5. Report Date March 2018	
				6. Performing Organization Code	
7. Author(s) Albert Molinas, Amanullah Mommandi, Aziz Khan, and Brett Sollenberger				8. Performing Organization Report No. CDOT-2018-09	
9. Performing Organization Name and Address Hydrau-Tech, Inc. 363 West Drake Road, Suite 3B Fort Collins CO 80526				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address Colorado Department of Transportation - Research 4201 E. Arkansas Ave. Denver, CO 80222				13. Type of Report and Period Covered Final Report	
				14. Sponsoring Agency Code 106.02	
15. Supplementary Notes Prepared in cooperation with the US Department of Transportation, Federal Highway Administration					
16. Abstract <p>HDPE pipes used in CDOT drainage systems are expected to have a 50-year design life. During the T-Rex project in 2003 a number of HDPE pipes were installed with shallow cover. Later, the majority of these pipes had to be removed and replaced after they were damaged by construction equipment driving over installed pipes, and excavations occurring near installed pipes. In this study, performance of HDPE pipes under CDOT highways was evaluated by: an extensive literature review; field studies utilizing manual inspection, CCTV video inspection, and laser-ring profiling technology; and, by observing a CDOT HDPE pipe installation project. Since CDOT has a limited number of such sites, a literature search was conducted to determine if cities and counties within Colorado or other state DOTs have evaluated the performance of HDPE pipes in climate zones, terrain, and construction-zone conditions similar to those found in Colorado.</p> <p>In general, review of other DOTs' experiences revealed that most have encountered HDPE performance problems in the form of excess deformation (greater than 5%). That review also has shown that structural integrity of installed HDPE pipelines tested by the DOTs generally is below acceptable levels of serviceability. The review also determined that not adhering to strictly-enforced HDPE pipe-installation procedures was the cause of many of the performance problems.</p> <p>Field inspections carried out for this research project were limited in scope. However, laser-ring profiling of 5 HDPE pipes in 2016 near Colorado Springs confirmed a trend for progression of pipe deformation through time under shallow-cover conditions. After 4 years of operation, 3 of the 5 pipes experienced 5% deflection. HDPE pipe segments observed by CCTV video monitoring along the T-Rex Project site had in excess of 10 feet of cover. These pipes did not show any visible deformations, but they could not be laserring profiled due to the amount of debris in the system. The study recommends that these pipes be cleaned and fully inspected.</p> <p>In Colorado, due to the limited number of HDPE pipe installations which have been in operation for more than 15 years, further laser-ring profiling of pipes is needed to evaluate their long-term performance. In general, it is recommended that all previous monitoring points established on prior research projects be measured and evaluated for long-term hydraulic and structural performance. Studies by Kentucky, Ohio, Missouri, South Carolina transportation departments and others demonstrated the difficulty of achieving problem-free installations of HDPE pipes, and that the pipes do not always perform in accordance with idealized, theoretical results. Significant-to-severe deflection, corrugation "growth," crown and invert flattening, racking, sagging, and radial cracking have been observed in pipe sections in numerous test cases.</p> <p>Experiences by other DOTs demonstrate that not adhering to strictly-enforced installation procedures was the cause of some performance issues. A typical installation of an HDPE pipeline observed as part of this study showed that standards for trench width, depth, and cover were not being followed. It is recommended that these standards be strictly enforced.</p> <p>Implementation</p>					
17. Keywords High density polyethylene pipe, HDPE, laser ring, laser profiling, CCTV video inspection, deflection, corrugation "growth," crown flattening, invert flattening, racking, sagging, radial cracking.			18. Distribution Statement This document is available on CDOT's website http://www.coloradodot.info/programs/research/pdfs		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 277	22. Price

FINAL REPORT

EVALUATION AND PERFORMANCE OF HDPE PIPES UNDER CDOT HIGHWAYS, T-REX, AND OTHER LOCATIONS

Albert Molinas and Brett Sollenberger, Hydrau-Tech, Inc.
Amanullah Mommandi and Aziz Khan, CDOT



Prepared by Hydrau-Tech, Inc.

Sponsored by: Colorado Department of Transportation in Cooperation with the U.S. Department of
Transportation and Federal Highway Administration

February 2018

ACKNOWLEDGEMENTS

This study was sponsored by Colorado Department of Transportation, Division of Transportation Development Research Branch. The authors gratefully acknowledge the Colorado Department of Transportation's financial support during the course of this study. The authors also wish to acknowledge the support of Amanullah Mommandi, Research Branch Manager, for his advice throughout the project and refinement of the project goals, and John Fleckenstein for laser-ring data collection. The authors also wish to thank Pamela Livesay, CDOT Maintenance, and other CDOT Maintenance personnel for their assistance in traffic control, collecting video recordings, and logistical support. Lastly, the authors would like to extend their deep appreciation to the members of the Colorado Department of Transportation Research Study Panel, consisting of Aziz Khan (Research), Alfred Gross (Staff Hydraulics), Lynn Croswell (Staff Bridge), Mike Banovich (Environmental), Scott Leiker (R-1 Hydraulics), C.K. Su (Materials and Geotech), Dave Wieder (Maintenance), Carl Valdez (R-2 Maintenance); and Ken MacKenzie (UDFCD Manager), Saeed Farahmandi (City and County of Denver), and Matt Greer (FHWA) for their technical assistance, guidance, and review of this document.

EXECUTIVE SUMMARY

HDPE pipes used in CDOT drainage systems are expected to have a 50-year design life. Some HDPE pipes installed on CDOT projects have failed due to shallow cover, moving and static loads (from construction equipment), and disturbances in or near the pipe trenches. CDOT's experience with failed HDPE pipes has led to uncertainty regarding the cost effectiveness of using this material. During the T-Rex project in 2003, a number of HDPE pipes were installed with shallow cover. Later, the majority of these pipes had to be removed and replaced after they were damaged by construction equipment driving over installed pipes, and excavations occurring near installed pipes.

In this study, the performance of HDPE pipes under CDOT highways was investigated by: an extensive literature review; field studies utilizing manual inspection, CCTV video inspection, and laser-ring profiling technology; and, by observing a CDOT HDPE pipe-installation project. Since CDOT has a limited number of such sites, a literature search was conducted to determine if cities and counties within Colorado or other state DOTs have evaluated the performance of HDPE pipes in climate zones, terrain, and construction-zone conditions similar to those found in Colorado.

In Chapter 1 of this report, the objectives of the study and methodologies to achieve those objectives are presented. Chapter 2 presents results of an extensive literature review covering various aspects of HDPE problems. Methodology, including the equipment and procedures used in conducting field inspections, is described in Chapter 3. Field-data collection and measurement results are presented in Chapter 4, and results of data analysis are discussed in Chapter 5.

In general, review of other DOTs' experiences revealed that most have encountered HDPE performance problems in the form of excess deformation (greater than 5%). That review also has shown that structural integrity of the installed HDPE pipelines tested by various DOTs generally is below acceptable levels of serviceability. The review also determined that not adhering to strictly-enforced HDPE pipe installation procedures was the cause of many performance problems.

Field inspections carried out for this research project were limited in scope. However, laser-ring profiling of 5 HDPE pipes in 2016 near Colorado Springs confirmed a trend for progression of pipe deformation through time under shallow-cover conditions. After 4 years of operation, 3 of the 5 pipes experienced 5% deflection. HDPE pipe segments observed by CCTV video monitoring along the T-Rex Project site had in excess of 10 feet of cover. These pipes did not show any visible deformations, but they could not be laser-ring profiled due to the amount of debris in the system. The study recommends that these pipes be cleaned and fully inspected.

In Colorado, due to the limited number of HDPE pipe installations which have been in operation for more than 15 years, further laser-ring profiling of pipes is needed to evaluate their long-term performance. In general, it is recommended that all previous monitoring points established on prior research projects be measured and evaluated for long-term hydraulic and structural performance. Studies by Kentucky, Ohio, Missouri, South Carolina transportation departments and others demonstrated the difficulty in achieving problem-free installations of HDPE pipes, and that the pipes do not always perform in accordance with idealized, theoretical results. Significant-to-severe deflections, corrugation "growth," crown and invert flattening, racking, sagging, and radial cracking have been observed in pipe sections in numerous test cases.

Experiences by other DOTs demonstrate that not adhering to strictly-enforced installation procedures was the cause of some performance issues. A typical installation of an HDPE pipeline observed as part of this study showed that standards for trench width, depth, and cover were not being followed. It is recommended that these standards be strictly enforced.

IMPLEMENTATION RECOMMENDATIONS

Review of the experiences of other states' DOTs, conducted as part of this study, found that most DOTs have encountered HDPE performance issues in the form of excess deformation (greater than 5%). It is apparent that structural integrity of the installed HDPE pipelines which were tested by Texas DOT and other DOTs is generally below acceptable levels of serviceability.

The field inspections carried out for this research project were limited in scope. However, laser-ring profiling of 5 HDPE pipes inspected in 2016 near Colorado Springs confirmed a trend for progression of pipe deformation through time under shallow-cover conditions. After 4 years of operation, 3 of the 5 pipes experienced 5% deflection. HDPE pipe segments observed by CCTV video monitoring along the T-Rex Project site had in excess of 10 feet of cover. These pipes did not show any visible deformation, but they could not be laser-ring profiled due to the amount of debris in the system. It is recommended that the pipes be cleaned and fully inspected.

In order to assess the long-term performance of CDOT HDPE pipe installations, and to minimize excess deformation issues, application and acceptance of laser-ring technology used by Florida, Ohio, Kentucky, California and other state DOTs is recommended. This technology allows accurate measurement of deformation which in the long term results in severe deflection, corrugation "growth," crown and invert flattening, racking, sagging, and radial cracks.

For existing HDPE installations, laser-ring profiling accomplished through periodic inspections is recommended for a more accurate assessment and record keeping of pipe performance.

Experiences by other DOTs revealed that not adhering to strictly-enforced installation procedures was the cause of some performance issues. A typical installation of an HDPE pipeline observed as part of this study showed that trench width, depth, and cover standards were not being followed. It is recommended that these standards be strictly enforced.

EVALUATION AND PERFORMANCE OF HDPE PIPES UNDER CDOT HIGHWAYS, T-REX, AND OTHER LOCATIONS

TABLE OF CONTENTS

1. INTRODUCTION	11
1.1 BACKGROUND	11
1.2 PROBLEM STATEMENT	11
1.3 OBJECTIVES	12
1.4 RESEARCH TASKS.....	13
1.5 STUDY BENEFITS	13
2. CURRENT METHODOLOGIES REVIEW AND LITERATURE SURVEY	14
2.1 MODELING OF HDPE PIPES FOR STRUCTURAL PROPERTIES	14
2.2 HDPE FIRE HAZARD	16
2.3 PIPE MATERIAL-SELECTION STUDIES.....	16
2.4 EVALUATION OF HDPE PIPE PERFORMANCE.....	16
3. METHODOLOGY	19
3.1 FIELD-INSPECTION METHODOLOGIES	19
3.2 BENEFITS OF LASER-RING INSPECTION	21
3.3 LASER-RING INSPECTION CONCEPT.....	24
4. FIELD DATA COLLECTION	29
4.1 HDPE PIPE INSTALLATION AND TRENCH-DIMENSIONS DATA	29
4.2 HDPE PIPE PERFORMANCE INSPECTIONS	32
5. DATA ANALYSIS	37
5.1 FIELD-DATA COLLECTION RESULTS	37
5.1.1 T-REX AREA PIPES ON I-25.....	37
5.1.2 FOUNTAIN COLORADO PIPES.....	40
5.2 DATA FROM LITERATURE REVIEW	43
5.3 CDOT EXPERIENCE AT T-REX PROJECT	46
6. SUMMARY AND CONCLUSIONS	47
REFERENCES	48

LIST OF FIGURES

Figure 1.	Typical HDPE installation project in Colorado	11
Figure 2.	Typical HDPE installation project in Colorado	11
Figure 3.	CDOT's T-Rex project in Denver, Colorado	12
Figure 4.	Manual inspection of HDPE pipes	12
Figure 5.	HDPE pipes with metal outlets across Interstate 25	13
Figure 6.	Typical mandrel	19
Figure 7.	Mandrel being pulled through a culvert pipe	19
Figure 8.	Personnel conducting visual inspection and recording physical attributes	20
Figure 9.	Observed pipe failure detected through visual inspection	20
Figure 10.	CCTV inspection of an HDPE pipe under CDOT T-Rex project	20
Figure 11.	CCTV inspection of an HDPE pipe under CDOT T-Rex project	20
Figure 12.	Laser-ring profiler with a skid system	21
Figure 13.	Typical laser ring projected onto the internal surface of failed pipe	22
Figure 14.	Setting up for laser-ring equipment inside an HDPE pipe under I-25	22
Figure 15.	Close-up of a separated joint using CCTV recording	23
Figure 16.	Reported output from Laser Profiler software	23
Figure 17.	Reported output from Laser Profiler	23
Figure 18.	Robotic trolley with mounted, rotatable CCTV camera	24
Figure 19.	Remote video display and recording system	24
Figure 20.	Calibration of laser-ring device	26
Figure 21.	Calibration of laser-ring device	26
Figure 22.	Recorded video imagery along with location and other pertinent information	27
Figure 23.	Recorded video imagery with location information under CDOT's T-Rex project	27
Figure 24.	Mobilizing the robotic trolley during the inspection process	28
Figure 25.	Laser ring reflected on the pipe surface under Interstate 25 at Fountain Creek	28
Figure 26.	Preparation for the installation of a 3,000-ft HDPE pipeline	29
Figure 27.	Preparation for the installation of a 3,000-ft HDPE pipeline	29
Figure 28.	Trench dimensions for HDPE pipe installation	30
Figure 29.	Trench dimensions for HDPE pipe installation	30
Figure 30.	Trench dimensions for HDPE pipe installation	31
Figure 31.	HDPE pipe installation	31
Figure 32.	Pipe inspection site near Colorado Springs, CDOT Region 2	32
Figure 33.	Location of HDPE pipe-inspection site on Interstate 25 along CDOT's T-Rex project site	33
Figure 34.	Location of pipe-inspection site along T-Rex project	33
Figure 35.	Motorized robot carrying CCTV entering HDPE pipe near Colorado Springs, CDOT Region 2	34
Figure 36.	Motorized robot carrying CCTV entering HDPE pipe along T-Rex project site on I-25	34
Figure 37.	CDOT Maintenance providing access to T-Rex HDPE site	35
Figure 38.	CDOT Maintenance providing access to T-Rex HDPE site	35
Figure 39.	CDOT Maintenance providing access to T-Rex HDPE site	36
Figure 40.	CDOT Maintenance providing access to T-Rex HDPE site	36
Figure 41.	CCTV inspection of T-Rex HDPE pipes	37
Figure 42.	Photos from CCTV inspection of HDPE pipes along CDOT's T-REX project site	38

LIST OF FIGURES (continued)

Figure 43. Photos from CCTV inspection of HDPE pipes along CDOT's T-REX project site..... 39
Figure 44. Manual inspection of I-25 HDPE cross-culverts near Colorado Springs..... 41
Figure 45. States covered in University of Texas at Arlington, 2010, HDPE pipe-performance study..... 43
Figure 46. Experience with Kentucky DOT's HDPE pipe performance 45

LIST OF TABLES

Table 1. Summary results of laser-ring profiling near Colorado Springs, CDOT Region 2 40
Table 2. Summary results of laser-ring profiling near Colorado Springs, CDOT Region 2 (2013) 41
Table 4. States included in the University of Texas at Arlington 2010 study 44
Table 5. Percentage of HDPE pipe failures in each state 44
Table 6. Maximum observed HDPE pipe deformations in each state 45

1. INTRODUCTION

1.1 BACKGROUND

Some high-density polyethylene (HDPE) pipes used on CDOT projects have failed due to shallow cover, moving and static loads (construction equipment), and disturbances in or near the pipe trenches. It is assumed that HDPE pipes used in CDOT drainage systems will have a 50-year service life. In addition to existing corrosion and abrasion guidelines, CDOT must develop new guidelines to determine how and where HDPE pipes may be safely installed. The performance of buried HDPE pipes is influenced by earth loads, vehicle (live) loads, backfill materials, trench dimensions, backfilling compaction, and in-situ soils. For corrugated HDPE pipes, the failure mechanisms are ductile failure due to high stresses, brittle cracking due to intermediate stress levels, and corrosion cracking caused by low stress levels.

In order to evaluate the performance of HDPE pipe with regard to site conditions, a research study was conducted to investigate sites where HDPE pipe has been used in Colorado. Since CDOT has a limited number of such sites, the team conducted a literature search to determine if other cities and counties within Colorado, and other state DOTs have evaluated the performance of HDPE pipes in climate zones, and terrain and construction-zone conditions similar to those found in Colorado.



Figures 1 and 2. Typical HDPE installation project in Colorado

1.2 PROBLEM STATEMENT

In accordance with SAFETEA-LU, the CDOT Pipe-Selection Policy requires consideration of HDPE pipes for cross drains, side drains, and subsurface drains. Currently, any pipe that meets the corrosion and abrasion criteria in this policy, and is installed per the plans and specifications, is assumed to have a 50-year service life. However, there is uncertainty regarding the cost effectiveness of using HDPE pipes based on CDOT's experience with failed HDPE pipes. During the T-Rex project in 2003, a number of HDPE pipes were installed with shallow cover. Later the pipes had to be removed and replaced after they were damaged by construction equipment running over installed pipes, and excavations occurring near installed pipes.



Figure 3. CDOT's T-Rex project in Denver, Colorado

HDPE pipes have been used successfully in some states, but in Colorado designers must consider extremes of climate and terrain in addition to construction practices. There is insufficient information regarding local performance of HDPE pipes. In particular, there is a lack of information that correlates construction practices, depth of cover, and trench configuration with cracking of HDPE pipes.

1.3 OBJECTIVES

The objectives of this research study were:

- Determine performance of HDPE pipes for use under roadways and other facilities
- Inspection of existing HDPE pipes currently utilized by CDOT
- Accurate data collection and verification using various methods:
 - Information from routine past maintenance inspections
 - Physical investigation of potential damage or failure (larger pipes)
 - Physical measurements of pipe diameter (H:V:D) and potential joint separation
 - CCTV video investigation of all joints and pipe-wall lengths
 - Laser-ring and video investigation and analysis



Figure 4. Manual inspection of HDPE pipes

1.4 RESEARCH TASKS

The tasks delineated by CDOT for this research project included:

- Task 1 - perform a literature review to determine if there has been similar research that will aid CDOT;
- Task 2 - conduct a national survey of state DOTs to determine if other states have had similar problems;
- Task 3 - prepare the field-work plan;
- Task 4 - inform personnel from traffic, maintenance, residencies, and HQ about field activities and visits at least three weeks in advance;
- Task 5 - field inspection of all HDPE pipes by laser-ring method (the preferred method of inspection), and/or other applicable methodologies commonly used by CDOT and other state transportation agencies;
- Task 6 - analyze data collected in above tasks; and
- Task 7 - submit draft and final reports addressing findings of the study.

1.5 STUDY BENEFITS

Benefits of this study include:

- Improved design methodologies
- Updated materials specifications
- Improved construction techniques
- Improved maintenance and inspection practices
- Updated information to incorporate into CDOT's *Drainage Design Manual*
- Potential cost savings
- Prevention of failures of HDPE pipes



Figure 5. HDPE pipes with metal outlets across Interstate 25

2. CURRENT METHODOLOGIES REVIEW AND LITERATURE SURVEY

This report contains a bibliography from a comprehensive literature survey, including library searches and surveys of CDOT and other state DOTs, in the List of References. This survey has shown that, in general, literature on HDPE pipes can be classified under several broad categories:

- Modeling of HDPE pipes to determine structural strength and deformation under different soil and burial conditions. This information was derived from:
 - Laboratory and field experiments to determine structural properties of HDPE materials under different soil and loading conditions
 - Numerical modeling of stress fields around HDPE pipes under different soil properties
- Performance of HDPE pipes under fire conditions
- Pipe material-selection studies
- Performance of HDPE pipes in highway applications

Information from the literature review is presented in the following sections.

2.1 MODELING OF HDPE PIPES FOR STRUCTURAL PROPERTIES

Performance of HDPE pipes under deep-burial conditions has been the subject of numerous studies, both numerically and experimentally. Among the large-scale experimental studies, the Sargand et al. (2000) study was conducted to determine the performance of larger HDPE pipes under deep-soil cover using 42-in pipes. The burial depths used in the experiments were 20 ft and 40 ft. In the experiments, HDPE pipes with three different wall profiles were studied. These profiles were smooth-wall (PVC), corrugated (PVC and HDPE), and honey-comb (HDPE). After approximately 2 years of field-data collection, it was noted that all pipes were functioning satisfactorily. No pipe had more deformation than 2.5% vertically, and 1% horizontally.

In a different study, Sargand et al. (2009) examined the performance of HDPE pipes under deep-burial conditions after 20 years of operation. In the study entitled “Pennsylvania Thermoplastic Pipe Deep-Burial Project: 20th-Year Investigations,” 24-in diameter corrugated HDPE pipe under 100-ft burial were examined. The pipe under study was located on I 279 near Pittsburgh, on the 20-year anniversary of the research project. Visual inspections along with an in-situ pipe-drilling experiment found that the pipe-drilling-induced strains in the pipe wall completely dissipated within 5 seconds. During a 2002 inspection, cracking was observed on one of the joints. However, these cracks did not seem to have increased substantially during the 2007 inspection (buried under 70 ft). Measurements showed that the horizontal deflection changed only by 0.3% over a period of 17 years, and the vertical deflection changed only by 0.2% over a period of 18 years.

Tafreshi and Khalaj (2007) studied structural properties of HDPE pipes in a controlled, laboratory environment. In the study entitled “Laboratory Test of Small-Diameter HDPE Pipes Buried in Reinforced Sand Under Repeated Load,” Tafreshi and Khalaj applied loads to simulate the axle load of a 18,000 kg truck over two pairs of twin wheels. This load translates to 8.5 kg/cm². Without 5 cm of rigid asphalt, the maximum applied load was reduced to 5.5 kg/cm². Their conclusions were:

- For all tests, the larger portion of deformation of the pipe and settlement of soil surface happened at the end of the first pulse, compared with its total deformation due to a number of load cycles. The ratio of deformation of the pipe from the first to the last cycle changed from 0.5 to 0.9 in different tests.
- The rate of pipe deformation decreases significantly as the number of loading cycles increases. Consequently, a steady-response condition is achieved as the number of further cycles of loading reaches approximately 140 cycles.
- The optimum length of geogrid is approximately 4-5 times the pipe diameter. The optimum embedded depth of the first reinforced layer is approximately 0.35 times the loading-surface width.
- Both the percent vertical-diameter change and settlement of soil surface of the pipe decrease with increased relative density of soil.
- The geogrid-reinforced sand decreased the pipe deformation and settlement of the soil surface significantly. Also, the performance of geogrid-reinforced loose soil is greater than unreinforced medium or dense soil.
- The vertical-diameter change of a pipe decreases, and settlement of the soil surface increases as the embedment depth of the pipe increases.
- The maximum deformation of the buried pipe is reduced approximately 54% by using 3 layers of reinforcement and an embedment depth of 3 times the external pipe diameter. This is based on a pipe-strain reduction factor, *PDRF*, of 0.46 for loose sand. The deformation is reduced by approximately 40% for dense sand using a PRDF of 0.6.
- The maximum settlement reduction due to five layers of reinforcement and the embedment depth of $3D$ reached approximately 58% for loose sand, and 51% for dense sand.
- In all tests performed on embedded pipes in weakly-compacted sand (relative loose state), and for embedment depth of the pipe below 2.5 times the external pipe diameter, the value of vertical diameter change was greater than 5%, regardless of the number of reinforced layers. Based on the accepted limit of 5% for vertical-diameter change, in this case the failure of the pipe occurred due to large deformation of the pipe, together with excessive settlement of the ground surface. For this relative density, the safety of the pipe is provided by embedment depth, and using the number of reinforced layers equal to 3 times the external pipe diameter. Leaving the surrounding soil uncompacted may result in serious damages to pipes during repeated loads.
- The pipe in medium-dense and dense sand with sufficient embedment depth of the pipe and a number of reinforced layers remained mostly undamaged at the time of the failure, which happened due to excessive settlement of the soil surface.

In a separate study, Kang et al. (2009) investigated short-term and long-term behavior of buried, corrugated, high-density polyethylene (HDPE) pipes using the finite-element method and soil models. Equations for deflections, wall stresses, arching factors, etc., were derived using soil-structure models and externally introduced into the numerical finite-element-method model. The main objective of the study was to investigate the considerable differences in the mechanics of short-term and long-term performance of buried HDPE pipes. The study found that while earth loads were significantly affected by time-dependent material properties and interface conditions, the deflections were not significantly affected by these factors.

2.2 HDPE FIRE HAZARD

It is documented in numerous field observations that HDPE pipes are subject to a fire hazard during ditch-burning operations. In a study by the Florida DOT, Kessler and Powers (1994) investigated HDPE fire risks. In their “High Density Polyethylene Pipe-Fire Risk Evaluation” study, Kessler and Powers examined recent concerns related to flammability of HDPE pipes. Under FDOT standards, it was shown that there was no significant risk from fire to HDPE pipes, and that the heat gain in pipes was not sufficient to cause softening or weakening of the pipe. The expected burn rate was found to be very low (1.7 ft/hr). The pipe manufacturer’s claim that there is insufficient oxygen within a pipe to support a fire was not confirmed.

2.3 PIPE MATERIAL-SELECTION STUDIES

Numerous studies in the extended literature are devoted to pipe-material-selection guidelines developed by various DOTs. As part of these studies, HDPE pipe was investigated for appropriate applications. An extensive review of these studies is summarized in Molinas and Mommandi (2009); NCHRP Synthesis Report 254, “Service Life of Drainage Pipe,” 1998; and, NCHRP Synthesis 474, “Service Life of Culverts,” 2015.

2.4 EVALUATION OF HDPE PIPE PERFORMANCE

The Blackwell and Yin (2002) study for the Missouri Department of Transportation investigated the installation and initial performance of two 60-in ADS HDPE pipes. This deflection/performance study examined how two large HDPE pipes with the same diameter performed when placed under crossroads with different installation procedures. Pipe 1 had only 4 in of bedding and a lower compaction than Pipe 2. Neither pipe installation met Missouri DOT standards. However, Pipe 2 was considered to have a better installation than Pipe 1, and was found to have far less deflection. The study determined that deflection over time increased for both pipes. Pipe 1 started at a maximum of 4.6% deflection, and after 26 months the deflection increased to 8.2%. There was less installation data for Pipe 2, but it ultimately experienced 5% (maximum allowable) deflection. The study showed how installation procedures influence immediate and long-term performance and deflection of pipes.

The Gassman et al. (2000) study entitled “Performance Evaluation of HDPE Culvert Pipes” inspected 45 HDPE pipes in South Carolina. Methods included both a mandrel set to 5% deflection, and visual inspections using a video camera. From these tests it was found that 36% of pipes inspected had circumferential cracks, localized bulges, tears or punctures, or deflections greater than 5% with the following details:

- 18% of the pipes had circumferential cracks
- 20% had localized bulges
- 7% had tears or punctures
- 20% had deflections greater than 5%

Of these results, Gassman et al. attributed most of the issues to poor construction techniques or incorrect backfill materials.

- 40% of the pipes backfilled with Class 4 soils did not pass the mandrel test
- Only 12% with Class 2 did not pass the mandrel test
- Class 3 backfill had no failed tests

- All pipe end damage was attributed to installation practices, mowers, and vehicle loads

Evaluation of HDPE Pipe Performance on Kentucky DOT and Ohio DOT Construction Projects was studied independently by Pipeline and Drainage Consultants (2005), utilizing visual observation through video inspections and laser-ring technology. For the Kentucky DOT projects, 7 installations were evaluated. The key findings of the study were:

- The average-maximum recorded corrugation in originally smooth-walled pipes was 0.5 in. As a result, it is suggested that the Manning's n may be more than two times higher (0.024) than the manufacturer's suggested value of 0.010.
- The authors were uncertain about how cracking affected the pipe structurally. However, it was observed that it caused problems when the inner liner pushed up and caught debris. Radial cracking was observed in approximately 20% of pipe sections.
- Sagging and ponding were observed in 26% of pipe sections.
- The majority of the pipes would fail a 5%-deflection test, and most pipes also would fail a 10%-deflection test.

Recommendations for the Kentucky DOT were:

- Further monitoring should be conducted.
- Post-installation deflection and video inspection should be required.
- Deflection should be limited to a maximum of 5%, with the anticipation of some post-construction creep.

Thirteen installations were evaluated for the Ohio DOT projects. The key findings of the study were:

- The maximum-recorded corrugation depth was 0.56 inch, with a typical average depth of approximately 0.39 inch. These pipes had a manufacturer's-suggested Manning's n value of 0.012. A typical corrugated metal pipe with 0.5 inch corrugations has Manning's n of 0.022.
- Of the cross drains that were inspected, cracking had increased by a factor of 4-7 since 2001.
- Several types of cracks were observed, including: radial cracks in the inner wall of the liner; cracking of dimpled areas; cracking in flattened inverts; longitudinal cracking in the crown in heavily-deflected areas; diagonal cracking in buckled wall sections; and, cracking in inverts resulting from bulges caused by improper bedding.
- The majority of the pipes would fail a 5%-deflection test, and most pipes also would fail a 10%-deflection test.

Recommendations from the Ohio DOT were:

- Further monitoring of HDPE pipe installations should be conducted.
- Post-installation video inspection and deflection testing should be required for quality control and quality assurance.
- Deflection should be limited to 5%, with the anticipation of some post-construction creep.
- All monitoring points established on a previous research project should be measured and evaluated for long-term performance.

- Specifications should ensure that correct bedding and backfill requirements, proper densities, and proper compaction efforts are achieved as outlined in ASTM D 2321 and AASHTO Section 30.
- A uniform pipe assessment/inspection program should be adopted for quality control and for long-term performance monitoring.
- A quality control / quality assurance inspection program should be established for all drainage materials and structures.
- Video inspection and laser profiling should be evaluated for adoption into the ODOT specification for quality control and quality assurance.

More recently, Abolmaali et al. (2010), University of Texas at Arlington, conducted a comprehensive study entitled "Evaluation of HDPE Pipelines' Structural Performance." As part of this study, 61 sites in 10 states were analyzed, utilizing visual observation through video inspections and laser-ring technology. In their study, Abolmaali et al. identified six structural-failure modes. They are:

- Cracking/fracture failure (fracture, rip, and rupture), where cracks may be in either longitudinal, diagonal, or radial directions
- Excessive-deformation failure – the common limit of 5% was adopted for indicating excessive deformation
- Inverse-curvature failure due to buckling phenomena, which creates inverse curvature from excessive loads on the pipe
- Joint-displacement failure, where excessive joint displacement results in a gap between two adjacent pipe segments
- Corrugation-growth failure, where plastic deformation of pipes' interior liners due to the transfer of stress from the outer to the inner wall causes waviness of the interior pipe surface
- Buckling failure, which results in deformation due to large circumferential stresses, and causes radial wavy surfaces of the pipe

The recommendations from the University of Texas at Arlington study were:

- Due to the different and multiple modes of failure experienced by the pipes identified in the study, it is evident that the knowledge of the long-term performance properties of HDPE pipes subjected to diverse service load is limited. Further studies are needed to identify HDPE's long-term properties in order to avoid the unexpected failures observed in that study.
- Since 100% of the pipes experienced corrugation growth, a comprehensive study should be conducted to establish post-installation Manning's n values.
- Since 69% of the pipes tested experienced an excessive-deformation mode of failure (as high as 34% deformation), the long-term stiffness properties of HDPE pipes should be investigated.
- The progressive-failure characteristics of HDPE pipes should be investigated in order to identify the causes of multiple failure modes in most of the pipes investigated.

3. METHODOLOGY

In this section, the methodology followed in HDPE pipe inspections is presented and discussed. First, field-inspection methodologies are presented. Next, the advantages of laser-ring technology are discussed.

3.1 FIELD-INSPECTION METHODOLOGIES

The four commonly-used methods of HDPE pipe inspections are:

Mandrel Inspection (used commonly for new pipe installations)

Mandrels (Figures 6 and 7), which are sized physically to stop at any deflection or ovality exceeding design tolerance in a pipe, are pulled through pipes.



Figure 6. Typical mandrel

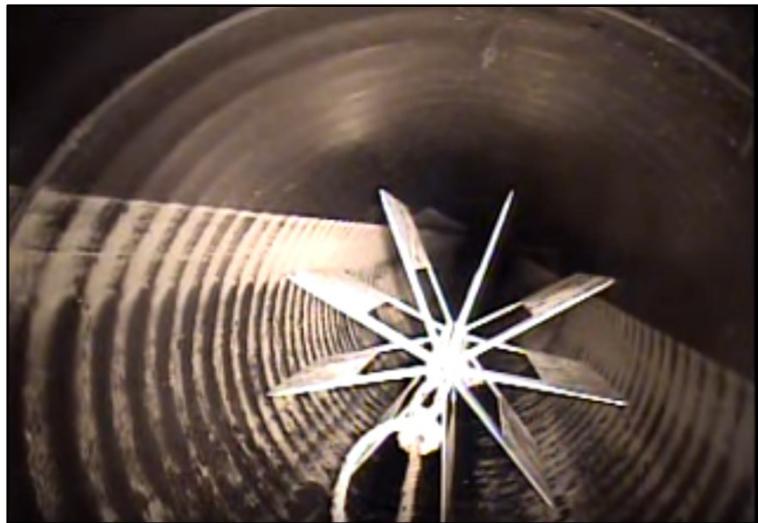


Figure 7. Mandrel being pulled through a culvert pipe

Manual Inspection (when possible)

Visual inspections are used to determine locations and extents of potential problems. Physical measurements are made at specific pipe locations to record:

- Deflections
- Joint separation
- Extent of deterioration or puncture of pipe walls



Figure 8. Personnel conducting visual inspection and recording physical attributes

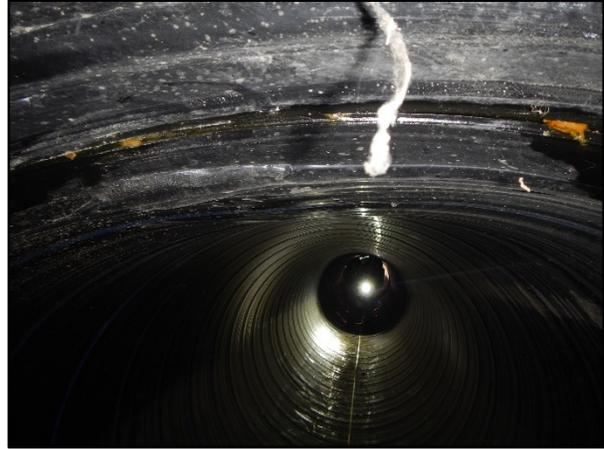


Figure 9. Observed pipe failure detected through visual inspection

Video Inspection (CCTV or other)

Inspections using closed-circuit television (CCTV) or other video-recording methods are frequently performed. For video inspections in this study a CUES K2 portable CCTV system, coupled with a P&T zoom camera, steerable Pipe Ranger camera transporter, a wheeled dolly with a 500-ft Gold M/C TV cable, wired and wireless controllers, and DVR-SD digital recording were used. CCTV inspection has the following advantages:

- Provides a thorough inspection of pipe walls, joints, and potential deterioration of pipe material
- Provides a historical record of the condition of the pipe to determine performance over time
- Can be used on the majority of sizes and materials of pipes
- Inspecting with video is particularly effective when coupled with manual inspection and measurements



Figure 10. CCTV inspection of an HDPE pipe under CDOT T-Rex project



Figure 21. CCTV inspection of an HDPE pipe under CDOT T-Rex project

Laser-Ring Inspection in Conjunction with CCTV Operation

The laser-ring profiler is a tool for use with a CCTV survey system and camera to collect survey data containing measurements of faults and other features inside a pipeline. The data obtained includes measurements of pipe size, laterals, and water levels, as well as automatic analysis of pipe ovality and capacity up to 30 times a second. With this technology a ring of laser light is projected onto the internal pipe surface. The laser image is in the field of view of a camera as the camera moves through the pipe and a video recording is made. Analysis is performed on the ring of light using Laser Profiler software to build a digital pipe profile. The technology is for use live or with pre-recorded video (tape, CD, or DVD). For the present study, a CUES laser profiling and measurement system with a six-head laser, skid assemblies, laser profiler, and measurement software was used.



Figure 32. Laser-ring profiler with a skid system

3.2 BENEFITS OF LASER-RING INSPECTION

Benefits of laser-ring inspections include:

- Provides the ability to measure:
 - Pipe length
 - Pipe diameter (360°)
 - Deviations in pipe diameter (deflections) along the pipe length
 - Locations of pipe joints
- Provides the ability to inspect all sizes of common highway pipes
- Relatively-quick inspection times, improving the efficiency of inspections
- Minimal field calibrations are required for analysis
- Provides a detailed analysis with data and reports on the condition of the pipe

- Equipment can be operated with relatively minimal training
- Analysis only requires knowledge of common issues with pipes and how they correlate with the resulting data
- Provides the ability to monitor pipe performance and deterioration over time to help prevent pipe failure



Figure 43. Typical laser ring projected onto the internal surface of failed pipe



Figure 14. Setting up for laser-ring equipment inside an HDPE pipe under I-25



Figure 55. Close-up of a separated joint using CCTV recording

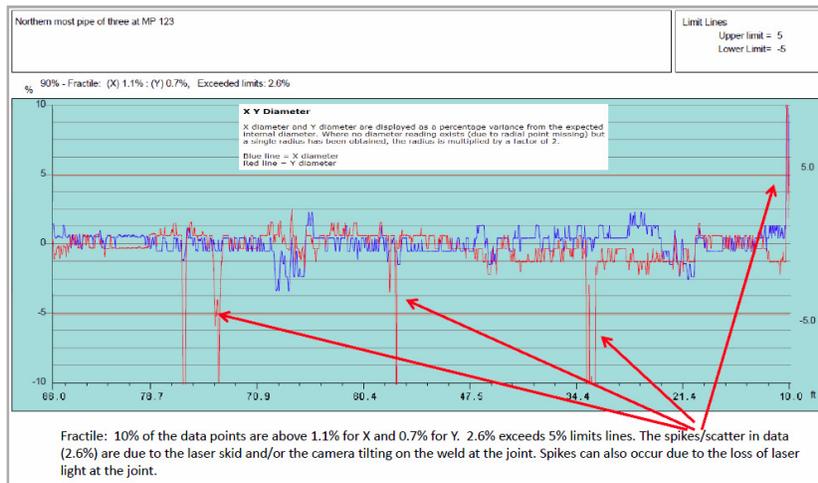


Figure 66. Reported output from Laser Profiler software

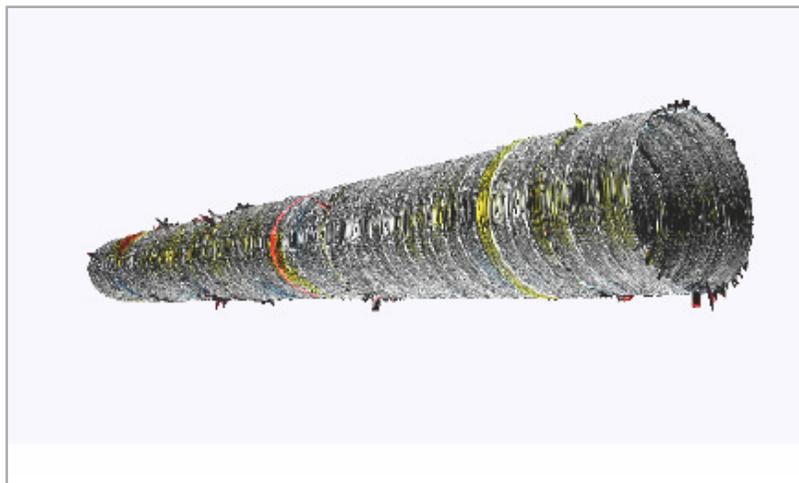


Figure 17. Reported output from Laser Profiler

3.3 LASER-RING INSPECTION CONCEPT

Camera Unit

- The camera unit consists of a robotic trolley with a mounted, rotatable CCTV camera.
- The trolley is connected to the video display system via a strong cable, with the CCTV cabling running parallel to it.
- The video-display system is attached to a winch system that sends cable release and retract lengths for the purpose of determining the location of the camera with respect to the pipe length.
- The camera trolley can be operated at variable speeds.



Figure 18. Robotic trolley with mounted, rotatable CCTV camera



Figure 19. Remote video display and recording system

Laser-Ring Unit

- The laser-ring unit consists of a sled of variable sizes for different pipes, with an attached 360° ring laser and battery.
- The laser-ring sled is attached to the camera unit via rope or cabling, and is pulled behind the camera unit at a slow speed.
- The laser-ring calibration is conducted after the pipe inspection, and consists of setting the laser behind the camera unit at the same distance used during inspection.
- A measuring device (meter/yard stick) is then held horizontally on top of the laser while the camera is recording. This provides distance measurements that will correlate to pixel distance of the video.

Inspection Process

- Manual inspections, photographs, and measurements of diameter and damage should always be completed if possible.
- Initially, the camera unit is sent through the pipe being inspected to video all joints and pipe walls for visual inspection.
- The laser unit (sled) is then attached to the camera unit on the other end of the pipe.
- A 360° laser ring is emitted onto the internal surface of the pipe.
- The laser unit and camera should sit horizontally, parallel to the pipe to provide video of the “perfect circle” of the laser. The projected laser ring should stay perpendicular to the angle of the camera.
- Minor debris accumulation in the pipe (sediment, leaves, etc.) should have minimal impact on the accuracy of the analysis.
- Major debris may either prevent passage through the pipe, or may cause errors in the results. Major debris should be cleared from the pipe if possible.
- If the laser and camera are separate units, the laser unit sits behind the camera unit within view of the camera at a distance of roughly 2 to 3 times the pipe diameter.
- Once the laser has been set at the appropriate distance, the pipe ends should be covered to eliminate as much light as possible. This allows the camera to record the laser light as clearly as possible.
- The camera-unit trolley then records the laser as it is pulled back through the pipe.
- A slow speed works best for collecting accurate data.
- With a system where the laser and camera are separate units, data may not be able to be collected towards the end of the pipe due to the distance between the camera and the laser.
- Once the inspection is complete the calibration is conducted.



Figure 20. Calibration of laser-ring device



Figure 21. Calibration of laser-ring device



Figure 22. Recorded video imagery along with location and other pertinent information



Figure 7. Recorded video imagery with location information under CDOT's T-Rex project

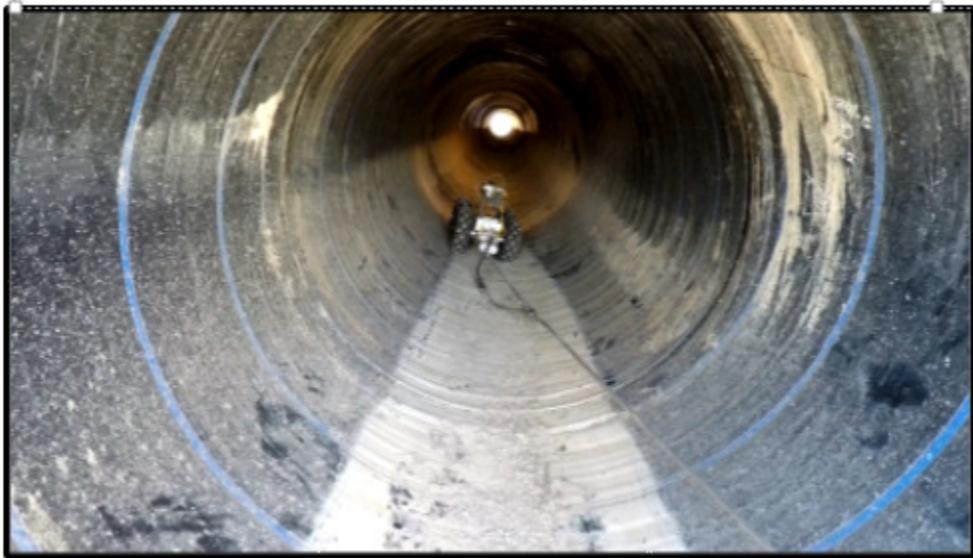


Figure 24. Mobilizing the robotic trolley during the inspection process



Figure 25. Laser ring reflected on the pipe surface under Interstate 25 at Fountain Creek

4. FIELD-DATA COLLECTION

4.1 HDPE PIPE INSTALLATION AND TRENCH-DIMENSIONS DATA

As a part of the HDPE pipe-performance study, a field trip to CDOT Region 3, Grand Junction, Colorado, was conducted to observe one of the stages of a 3,000-ft HDPE pipe installation. Figures 26 through 32 show the observed stages of a typical CDOT HDPE pipe installation for trench width, depth, and material placement.



Figure 26. Preparation for the installation of a 3,000-ft HDPE pipeline



Figure 27.8 Preparation for the installation of a 3,000-ft HDPE pipeline



Figure 28. Trench dimensions for HDPE pipe installation



Figure 29. Trench dimensions for HDPE pipe installation



Figure 30. Trench dimensions for HDPE pipe installation



Figure 31. HDPE pipe installation

4.2 HDPE PIPE PERFORMANCE INSPECTIONS

Two sites were selected for pipe-performance inspections. The first site was on Interstate 25 near Colorado Springs, in CDOT Region 2 (Figure 32). This site offered a close proximity to eight 48-inch HDPE cross culverts, and had easy access for the CCTV equipment. The site was also desirable since in 2013 a laser-ring pipe inspection had been performed to document the initial pipeline properties. The pipes along the inspection site had minimal cover (approximately 12 inches). However, they had been fortified using a spiral steel belt.



Figure 32. Pipe inspection site near Colorado Springs, CDOT Region 2

The second HDPE performance test section was along the CDOT's T-Rex project site in Denver. To locate HDPE pipes along T-Rex was challenging since, due to complaints about their performance, they had been removed from a majority of the drainage lines along the project. Figures 33 and 34 provide the site information of the I-25 segment selected for the inspections. As shown in these figures, the HDPE pipe drainage lines are located in the shoulder region of the Interstate 25 highway and are buried 11 ft. As such, they do not carry heavy, cyclic highway traffic (the reason they were left in place).

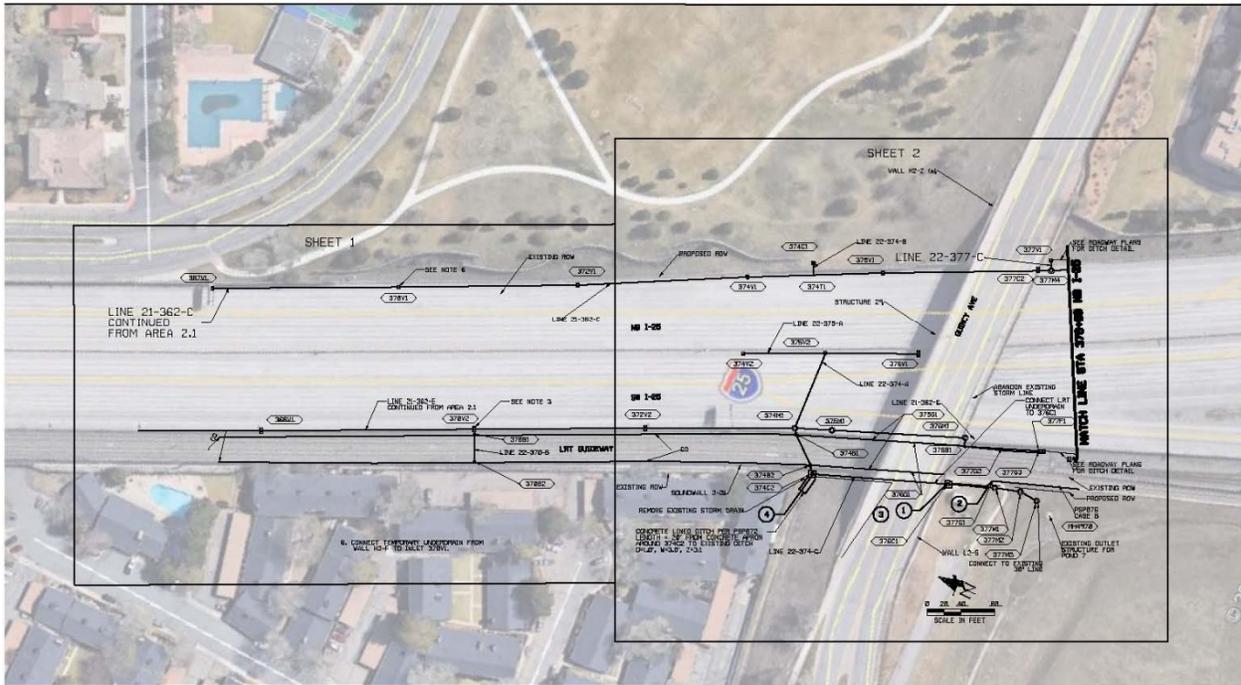


Figure 33. Location of HDPE pipe-inspection site on Interstate 25 along CDOT’s T-Rex project site

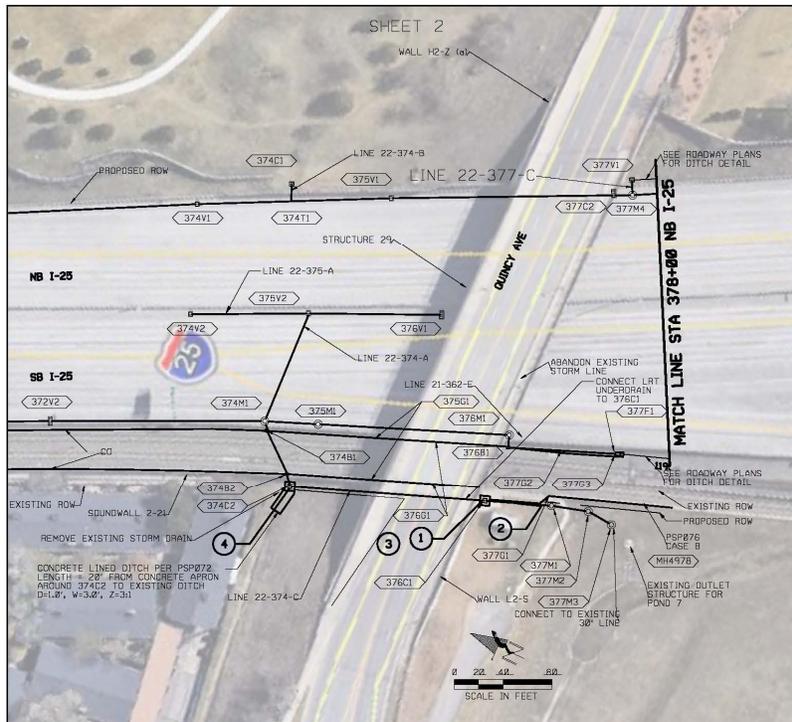


Figure 34. Location of pipe-inspection site along T-Rex project



Figure 35. Motorized robot carrying CCTV entering HDPE pipe near Colorado Springs, CDOT Region 2

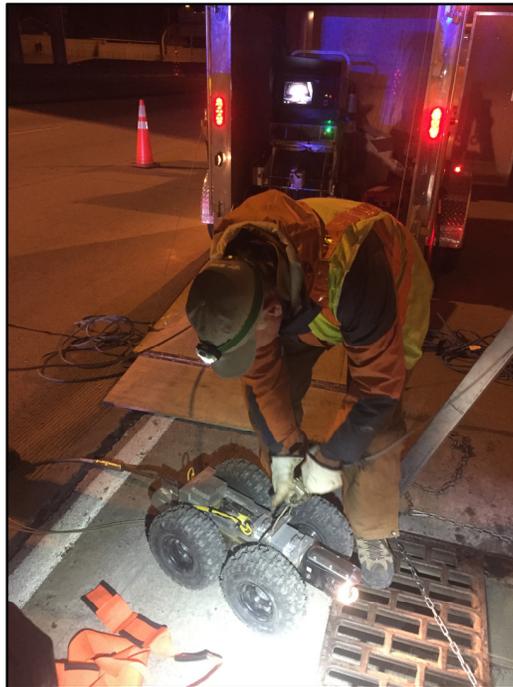


Figure 3610. Motorized robot carrying CCTV entering HDPE pipe along T-Rex Project site on I-25

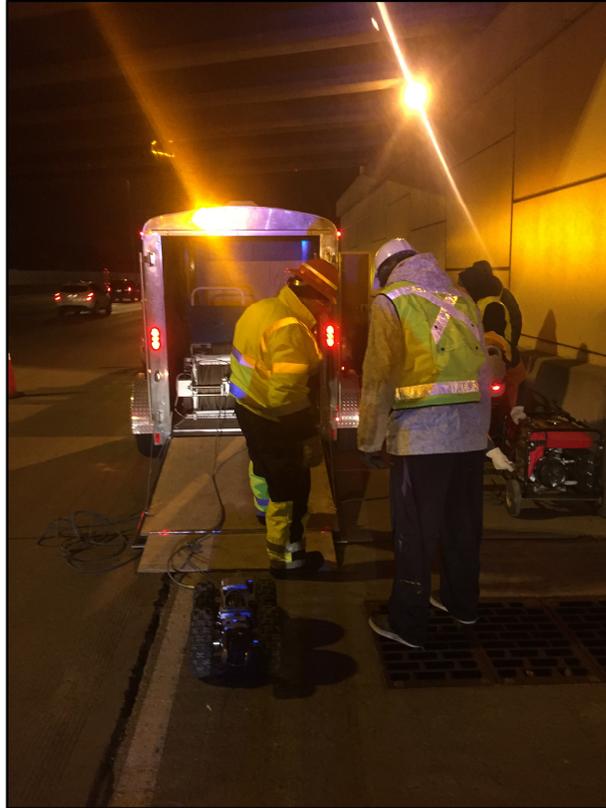


Figure 37. CDOT Maintenance providing access to T-Rex HDPE site

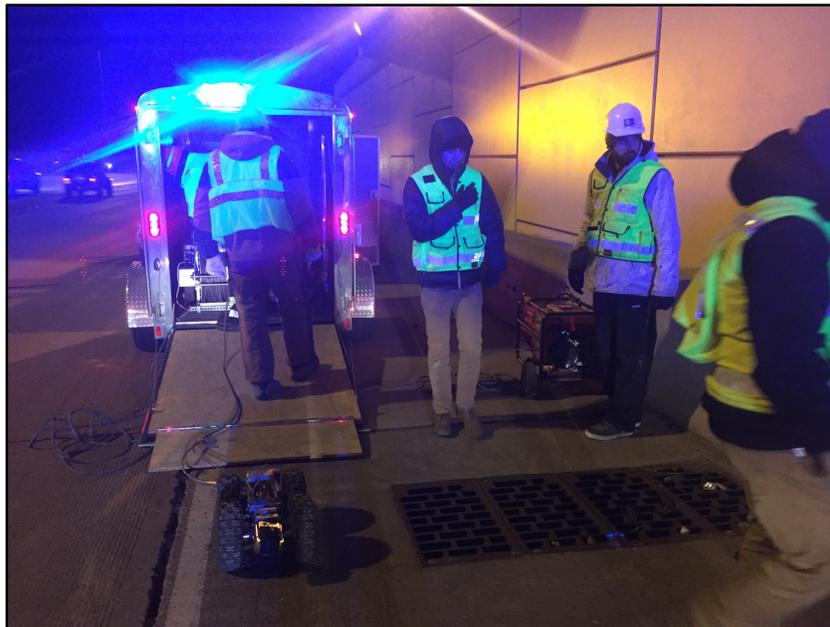


Figure 38. CDOT Maintenance providing access to T-Rex HDPE site

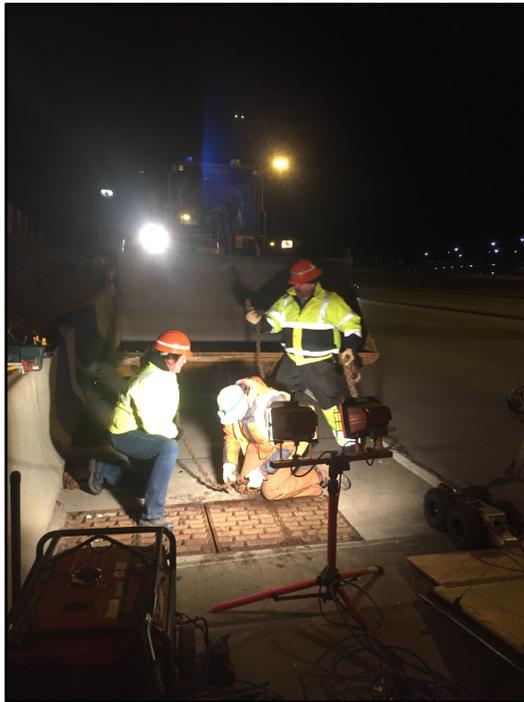


Figure 39. CDOT Maintenance crew providing access to T-Rex HDPE site



Figure 40. CDOT Maintenance crew providing access to T-Rex HDPE site

5. DATA ANALYSIS

5.1 FIELD-DATA COLLECTION RESULTS

5.1.1 T-Rex Area Pipes on I-25

A section of I-25 near the Quincy overpass was coned off on December 5, 2016 to conduct a performance inspection of the HDPE storm drains in the area. Several factors limited the amount of pipe that could be inspected, including difficulties in removing the bolts attaching the grates on the drop inlets, and removing the grates themselves. Also, heavy loads of sediment were in the inverts of the pipes. The inspection was limited to approximately 182 ft of estimated 36-inch HDPE. The pipe was inspected with a Cues robotic pipeline-inspection system. Figures 42 and 43 present photos from a CCTV inspection of HDPE pipes along CDOT's T-REX Project site and show the heavy loads of sediment. As stated above, this section of the drainage pipeline lies on the shoulder region of I-25 and therefore is not subject to heavy cyclic loading. The pipeline is buried 11 ft below the highway pavement and appeared to be sagging in areas. The overall shape of the structure appeared to be round, and the joints appeared to be performing as expected. A laser profile could not be conducted due to the amount of debris in the system. Some of the adjacent pipes coming into the two drop inlets were observed and appeared to be performing satisfactorily. It is recommended that the pipes be cleaned and fully inspected.

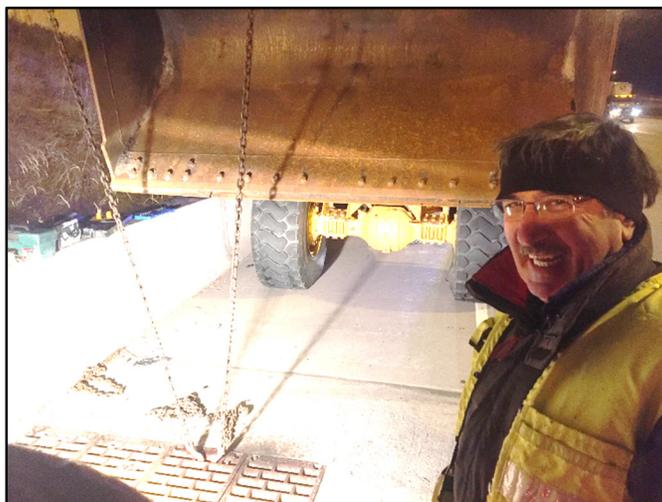


Figure 111. CCTV inspection of T-Rex HDPE pipes

Project Name: I-25 Denver		
Date: 12/5/2016	Pipe ID:	
Asset Location:	Start ID: Drop Inlet	
Length Surveyed: 183.2	End ID: Drop Inlet	
Run Number:	Direction: Downstream	
Pipe Size: 36	Pipe Type: HDPE	

Distance	Fault Observation	Picture
0.0	Start Inspection	
37.0	Heavy Debris in Invert	
56.8	View down barrel	
90.0	Debris in invert	
120.2	View down barrel	

Figure 42. Photos from CCTV inspection of HDPE pipes along CDOT's T-REX project site

Distance	Fault Observation	Picture
154.9	View down barrel	
169.5	Debris coming into drop inlet	
183.2	Drop Inlet	
183.2	End Inspection	

Figure 43. Photos from CCTV inspection of HDPE pipes along CDOT's T-REX project site

5.1.2 Fountain Colorado Pipes

Along I-25 near Colorado Springs in CDOT Region 2 a total of 5 pipes were video and laser profiled on September 30, 2013 and December 5, 2016. Also, a manual inspection was conducted on three additional pipes during the 2016 inspection. In 2013 a straight line, non-pan-and-tilt, portable camera unit was utilized for the inspection. In 2016 a robotic pan-and-tilt camera was utilized.

Table 1 presents the summary results of laser-ring profiling near Colorado Springs, CDOT Region 2 in a comparative analysis with 2013 measurements (Table 2). The 5 pipes inspected in 2016 had been previously inspected in 2013 after their installation, and provide insight into the development of deformation in HDPE pipes. As shown in the last column of Table 1, none of the pipes under study had exceeded the 5% deflection in 2013. After 4 years of operation, however, 3 of the 5 pipes had reached 5% deflection. It is recommended that these pipes be inspected in the future to ensure that their performance does not deteriorate.

Table 1. Summary results of laser-ring profiling near Colorado Springs, CDOT Region 2

Location	Date	Pipe Type	Pipe Size	Distance (ft)	Start ID	End ID	Deflection (2.5%)	Deflection (5%)	Observations
MP 123, Northern Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	100% of readings below 2.5%		Max deflection less than 2.5%, slight dent in left springline, wooden stake driven through crown near inlet end. No significant change in deflection since 2013.
MP 123, Center Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	92% of readings below 2.5%	100% of readings below 5%	Max deflection approximately 4% at 23 ft, small dent at left springline at 73 ft, wooden stakes driven through crown of pipe near inlet end. Deflection at 5% in 2016.
MP 123, Southern Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	100% of readings below 2.5%		Max deflection approximately 2.5% at 24 ft, wooden stake driven through crown of pipe near inlet. Deflections still below 5%. No significant change in deflection since 2013.
MP 122.5	9/30/2013	DuroMaxx	48-inch	102	Outlet	Inlet	86.8% of reading below 2.5%	100% of readings below 5%	Max deflection approximately 2.8% at 88 ft. Deflection at 4.8% in 2016
MP 122	9/30/2013	DuroMaxx	48-inch	103	Outlet	Inlet	77.2% of readings below 2.5%	<1.9% of readings above 5%	Max deflection approximately 5.30% near inlet end (approx. 90 to 88 ft). Deflection at 5.8% in 2016, crown flattening and possible inverse curvature has occurred. Pipe moderately racked in right crown. Remainder of pipe 4% or less. Small puncture due to stake near outlet, pipe slightly racked at 8 ft. Slight hump at right haunch at 46 ft. Slight dent in invert at 56 ft

Location: Fountain Colorado
Route: I-25
Pipe Use: Culvert/Cross Drain
Date Inspected: 9/30/13 (Red indicating potential changes in deflection since 2013).



Deflection data was gathered at a frame rate of approximately 1 frame per every 0.1 ft. With 180 measurements taken per frame of video. Total readings per pipe section ranged from approximately 712,000 to 770,000.

Table 2. Summary results of laser-ring profiling near Colorado Springs, CDOT Region 2 (2013)

Location: Fountain Colorado
 Route: I-25
 Pipe Use: Culvert/Cross Drain
 Date Inspected: 9/30/13

Location	Date	Pipe Type	Pipe Size	Distance (ft)	Start ID	End ID	Deflection (2.5%)	Deflection (5%)	Observations
MP 123, Northern Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	100% of readings below 2.5%		Max deflection less than 2.5%, slight dent in left springline, wooden stake driven through crown near inlet end.
MP 123, Center Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	92% of readings below 2.5%	100% of readings below 5%	Max deflection approximately 4% at 23 ft, small dent at left springline at 73 ft, wooden stakes driven through crown of pipe near inlet end.
MP 124, Southern Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	100% of readings below 2.5%		Max deflection approximately 2.5% at 24 ft, wooden stake driven through crown of pipe near inlet.
MP 122.5	9/30/2013	DuroMaxx	48-inch	102	Outlet	Inlet	86.8% of readings below 2.5%	100% of readings below 5%	Max deflection approximately 2.8% at 88 ft
							77.2% of readings below 2.5%	<1.9% of readings above 5%	Max deflection approximately 5.30% near inlet end (approx. 90 to 88 ft). Pipe moderately racked in right crown. Remainder of pipe 4% or less. Small puncture due to stake near outlet, pipe slightly racked at 8 ft. Slight hump at right haunch at 46 ft. Slight dent in invert at 56 ft.
MP 122	9/30/2013	DuroMaxx	48-inch	103	Outlet	Inlet			



Figure 4412. Manual inspection of I-25 HDPE cross-culverts near Colorado Springs

Table 3. Summary of manual-inspection results near Colorado Springs, CDOT Region 2 (2013)

12/5/2016 - Fountain, CO - Mile Marker 122.5 - 48" HDPE Pipe - Start at East End

Pipe Station (ft)	Vertical Diameter (ft)	Horizontal Diameter (ft)	Diagonal Diameter (ft)	Notes
9	3.66	3.56	3.54	3 punctures at STA 8
20	3.61	3.63	-	
24	3.63	3.67	3.51	STA 26.25 joint separation 2 in max
35	3.65	3.68	3.65	
50	3.60	3.73	3.71	STA 48.16 joint separation 1.06 in max
56	3.54	3.73	3.59	Minor bulge at pipe invert
70.25	3.47	3.67	3.50	STA 70.25 joint separation 1.13 in max
86	3.65	3.67	3.60	
92.08	3.43	3.68	3.48	Deflection at joint
100	3.63	3.65	3.62	

12/5/2016 - Fountain, CO - Mile Marker 123.01 - 36" HDPE Pipe - Start at East End

Pipe Station (ft)	Vertical Diameter (ft)	Horizontal Diameter (ft)	Diagonal Diameter (ft)	Notes
0	2.69	2.68	2.67	Inlet damaged by traffic
25	2.52	2.75	2.60	
50	2.63	2.73	2.69	
75	2.67	2.71	2.69	
90	2.67	2.58	2.58	

12/5/2016 - Fountain, CO - Mile Marker 123.02 - 36" HDPE Pipe - Start at East End

Pipe Station (ft)	Vertical Diameter (ft)	Horizontal Diameter (ft)	Diagonal Diameter (ft)	Notes
0	2.69	2.58	2.71	Inlet damaged
25	2.52	2.75	2.60	
45	2.63	2.71	2.67	
75	2.67	2.71	2.69	
90	2.65	2.60	2.65	

5.2 DATA FROM LITERATURE REVIEW

One of the objectives of the current research study was to investigate the existence of HDPE performance data from states similar to CDOT. As pointed out in the literature review section of this report in Section 2, the University of Texas at Arlington (UT) conducted such a study in 2010 covering 10 states, including nearby Utah and Kansas. In the University of Texas study, structural performance of 191 HDPE pipelines located in 10 different states throughout the nation was investigated. The sites were selected to cover diverse geographical locations. In the study, manual inspections using qualitative and quantitative observations, a detailed quantitative pipeline-inspection camera, and pipeline laser-profiling-unit measurements were performed utilizing the same equipment and methodologies followed in the current inspection program. The failure modes identified for all tested pipelines included:

- Excessive deformation
- Cracking/fracture
- Inverse curvature
- Joint displacement
- Buckling
- Corrugation growth

All of these are commonly recognized as failure modes in the literature, and do not represent any controversial definitions. The UT study showed that 100% of the pipelines tested suffered from some or many of these failure modes. As shown in Table 5, in 68% of the pipes tested, the limiting maximum deformation (Y, X, and/or ovality) of 5% was exceeded. A maximum deformation value of 34% was observed, and the average of maximum deformations was 7.6% for all pipelines inspected. This study indicates that the structural health and integrity of the installed HDPE pipelines tested are generally below acceptable levels of serviceability.

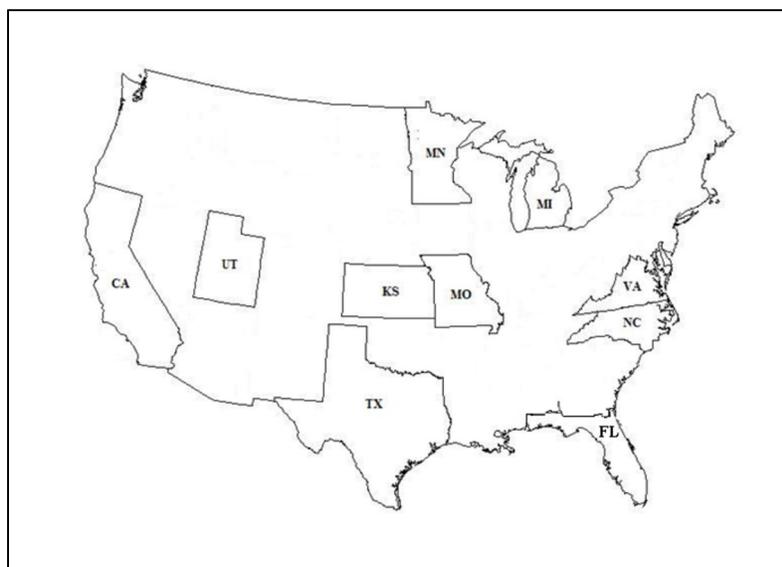


Figure 45. States covered in University of Texas at Arlington, 2010, HDPE pipe-performance study

Table 4. States included in the University of Texas at Arlington 2010 study

State	Number of site locations	Number of pipelines	Total length of the pipelines	
			(ft)	(m)
Texas	9	22	2,800	854
North Carolina	6	11	600	183
Virginia	8	21	3,000	915
Minnesota	9	31	8,700	2,652
Kansas	3	10	1,655	505
Missouri	4	13	1,400	427
California	2	29	2,545	776
Utah	2	10	1,525	465
Michigan	16	29	5,149	1,570
Florida	2	15	4,405	1,343
Total	61	191	31,779	9,689

Table 5. Percentage of HDPE pipe failures in each state

State	Excessive deformation	Cracking / Fracture	Inverse Curvature	Joint Displacement	Buckling	Corrugation Growth
Texas	38%	23%	18%	27%	18%	100%
North Carolina	75%	73%	0%	73%	27%	100%
Virginia	100%	26%	11%	32%	16%	100%
Minnesota	58%	26%	0%	26%	3%	100%
Kansas	70%	50%	30%	0%	20%	100%
Missouri	69%	20%	0%	0%	0%	100%
California	56%	69%	21%	7%	3%	100%
Utah	100%	40%	40%	20%	20%	100%
Michigan	82%	33%	10%	19%	23%	100%
Florida	73%	42%	17%	100%	42%	100%
Total	69%	40%	15%	30%	17%	100%

Table 6. Maximum observed HDPE pipe deformations in each state

State	Number of site locations	Number of pipelines	Total length of the pipelines		Maximum deformation (%)	Average of maximum deformation (%)	Percentage of pipelines with excessive deformation (>5%) (%)
			(ft)	(m)			
Texas	9	22	2,800	854	22.5	6.8	38
North Carolina	6	11	600	183	10.4	6.3	75
Virginia	8	21	3,000	915	22.3	10.5	100
Minnesota	9	31	8,700	2,652	15	6.4	58
Kansas	3	10	1,655	505	10.4	6.8	70
Missouri	4	13	1,400	427	8.8	5	69
California	2	29	2,545	776	15.3	5.9	52
Utah	2	10	1,525	465	34	10.4	100
Michigan	16	29	5,149	1,570	23.1	10.5	82
Florida	2	15	4,405	1,343	10.3	6.3	73
Total	61	191	31,779	9,689	34	7.5	69

Figure 46 presents a summary of experience with Kentucky DOT’s HDPE pipeline installations. Measurements show that after the initial-installation phase, recorded deflections continually increased through time. In almost all Kentucky DOT pipe installations, measured deflections exceeded the maximum 5% failure limit.

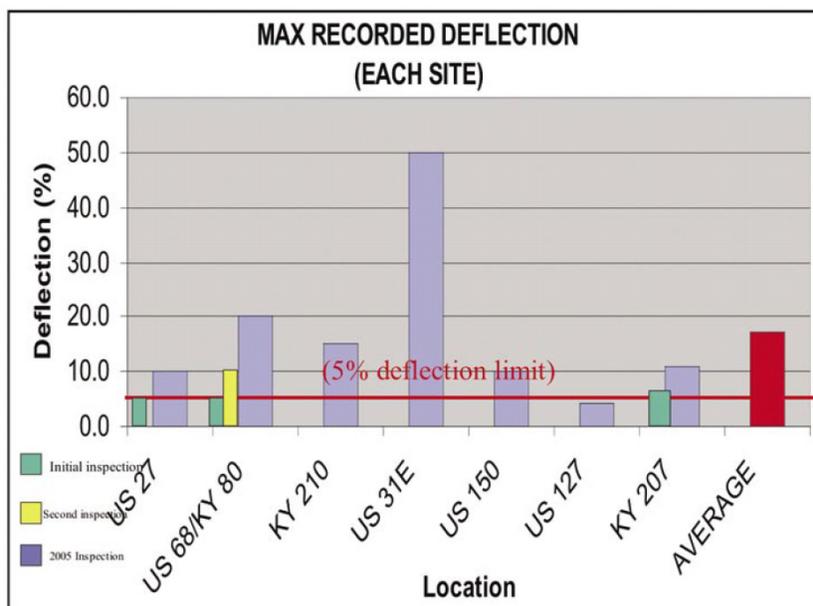


Figure 13. Experience with Kentucky DOT’s HDPE pipe performance.

5.3 CDOT EXPERIENCE AT T-REX PROJECT

During construction of the T-Rex Project there were numerous Nonconformance Report and Evaluation (NCR/NCE) forms submitted by Southeast Corridor Constructors (SECC). Appendix 4 presents a compilation of these reports. Some of these reports state that HDPE pipe problems were encountered in the field with shallow cover and excavation around HDPE pipes. It is noted that at some locations it may be necessary to remove previously-installed HDPE and replace it with RCP. In order to resolve these nonconformance issues, SECC requested to change all remaining HDPE to RCP (6/23/2003).

6. SUMMARY AND CONCLUSIONS

In this study, performance of HDPE pipes under CDOT highways was investigated by:

- Conducting an extensive literature review
- Field studies utilizing manual inspection
- CCTV video inspections
- Laser-profiling technology
- Observing CDOT HDPE pipe-installation projects

The objectives of the study and methodologies used to achieve these objectives are presented in Section 1 of this report. Section 2 presents results of an extensive literature review covering various aspects of HDPE problems. Methodology, including equipment and procedures used in conducting field inspections, is described in Section 3. Field data collection and measurement results are presented in Section 4, and the Data Analysis results are discussed in Section 5.

An extensive literature search was conducted in order to assess the current methodologies used by CDOT and other highway agencies to measure the performance of HDPE pipe installations. In general, most DOTs have encountered HDPE performance problems in the form of excess deformation (greater than 5%). The general conclusion from the literature review is that structural integrity of the installed HDPE pipelines which were tested by various DOTs is generally below acceptable levels of serviceability. Further testing is needed to evaluate the long-term performance of HDPE pipes.

In general, it is recommended that all monitoring points established on prior research projects be measured and re-evaluated for long-term hydraulic and structural performance. Studies by Kentucky, Ohio, Missouri, South Carolina transportation departments and others have demonstrated the difficulty in achieving problem-free installations of HDPE pipes, and that these pipes do not always perform in accordance with idealized, theoretical conditions. In numerous test cases significant-to-severe deflections, corrugation growth, crown and invert flattening, racking, sagging, and radial cracking have been observed in pipe sections.

REFERENCES

1. Abolmaali A., Motahari, A., Hutcheson, J., Le, T. "Evaluation of HDPE Pipelines Structural Performance," University of Texas, Arlington Center for Structural Engineering Research, 2010.
2. Adams, D. N., Muindi, T., and Selig, E. T. ,1989. "Polyethylene pipe under high fill," Transportation Research Record. No. 1231, Transportation Research Board, National Research Council, Washington D.C., 88-95.
3. American Association of State Highway and Transportation Officials (AASHTO), Highway Drainage Guidelines, 3rd ed., *Volume XIV—Highway Drainage Guidelines for Culvert Inspection and Rehabilitation*, AASHTO, Washington D.C., 1999, revised 2000.
4. American Association of State Highway and Transportation Officials (AASHTO), Highway Drainage Guidelines, 4th ed., "Chapter 14 - Culvert Inspection, Material Selection, and Rehabilitation Guidelines," AASHTO, Washington D.C., 2007.
5. American Association of State Highway and Transportation Officials (AASHTO), *LRFD Bridge Construction, Specifications*, AASHTO, Washington D.C., 2010.
6. American Association of State Highway and Transportation Officials (AASHTO), *LRFD Bridge Design Specifications, Customary U.S. Units*, 6th ed., 2013 Interim Revisions, AASHTO, Washington D.C., 2013.
7. American Association of State Highway and Transportation Officials (AASHTO), "PP-6309 Standard Practice for Pipe Joint Selection for Highway Culvert and Storm Drains," AASHTO, Washington D.C., 2009.
8. American Association of State Highway and Transportation Officials (AASHTO). 1998. *AASHTO LRFD Bridge Design Specifications*, Washington DC.
9. Arockiasamy, M., Chaallal, O., Limpeteeparakarn, T., 2006, "Full-scale Field Tests on Flexible Pipes Under Live-Load Application," *Journal of Performance of Constructed Facilities*, ASCE, 2001.
10. ASM International, ASM Handbook Volume 13A, *Corrosion: Fundamentals, Testing, and Protection*, ASM International, Novelty, OH, 2003.
11. ASTM 2005a, "Standard Specification for Polyethylene Plastic Pipe and Fittings Materials," ASTM standard D3350–04, 2005 *Annual Book of ASTM Standards*, Vol. 08.02. American Society for Testing and Materials, Philadelphia, PA, pp. 40-46.
12. ASTM 2005b, "Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter," ASTM Standard F714–03, 2005 *Annual Book of ASTM Standards*, Vol. 08.04, American Society for Testing and Materials, Philadelphia, PA, pp. 913-921.
13. Brachman, R.W.I., and Gudina, S.K., "A New Laboratory-Apparatus for Testing Geomembranes Under Large Earth Pressures," *Proceedings of the 55th Canadian Geotechnical Conference, CGS 2002, Niagara Falls, ONT, 20–23 October 2002*, Canadian Geotechnical Society, Richmond, BC, pp. 993-1000.
14. Brachman, R.W.I., and Krushelnitzky, R.P., "Stress Concentrations Around Circular Holes in Perforated Drainage Pipes," *Geosynthetics International*, 9(2): pp. 189-213.

15. Brachman, R.W.I., Moor, I.D., Rowe, R.K., 2000, "The Design of a Laboratory Facility for Evaluating the Structural Response of Small Diameter Buried Pipe," *Canadian Geotechnical Journal* 37 (2), pp. 281-295.
16. Brachman, R.W.I., Moore, I.D., and Rowe, R.K., 2001. "The Performance of a Laboratory Facility for Evaluating the Structural Response of Small Diameter Buried Pipes," *Canadian Geotechnical Journal*, 38(2): pp. 260-275.
17. Britto, A. M., 1979, "Thin-Walled Buried Pipes," PhD Thesis, Cambridge University, UK.
18. Bueno, B.D.S., 1987, "The Behavior of Thin Walled Pipes in Trenches," PhD Thesis, Civil Engineering Department, Leeds University, UK.
19. Burns, J.Q., and Richard, R.M., "Attenuation of Stresses for Buried Cylinders," *Proceedings of Symposium on Soil-Structure Interaction*, Engineering Research Laboratory, University of Arizona, Tucson, 1964, pp. 378-392.
20. California Department of Transportation (Caltrans), "Caltrans Supplement to FHWA Culvert Repair Practices Manual," Design Information Bulletin No. 83-02, Caltrans, Sacramento, 2011.
21. California Department of Transportation (Caltrans), "Caltrans Supplement to FHWA Culvert Repair Practices Manual," Design Information Bulletin No. 83-03, Caltrans, Sacramento, 2013.
22. California Department of Transportation (Caltrans), *Corrosion Guidelines*, Version 2.0, Caltrans Division of Engineering Services, Materials Engineering and Testing Services, Sacramento, 2012.
23. California Department of Transportation (Caltrans), *Highway Design Manual*, Caltrans, Sacramento, 2001.
24. California Department of Transportation (Caltrans), *Highway Design Manual*, Caltrans, Sacramento, 2011.
25. Carter, J.P., and Balaam, N.P., 1980. Program AFENA: A general FEA, Rev 4.0 (computer program), Centre for Geotechnical Research, University of Sydney, Sydney, Australia.
26. Carter, J.P., Booker, J.R., and Davis, E.H., 1977, "Finite Deformation of an Elasto-Plastic Soil," *International Journal for Numerical and Analytical Methods in Geomechanics*, 1(1): pp. 25-43.
27. Chambers, R.E., McGrath, T.J., and Heger, F.J., NCHRP Report 225: "Plastic Pipe for Subsurface Drainage of Transportation Facilities," TRB, National Research Council, Washington D.C., 1980.
28. Colorado Department of Transportation (CDOT), "Development of New Corrosion/Abrasion Guidelines for Selection of Culvert Pipe Materials," Report CDOT-2009-11, 2009.
29. Cowland, J.W., "The Use of Geosynthetics in Landfills in Hong Kong," *Proceedings of the 2nd Asian Geosynthetics Conference*, Kuala Lumpur, Malaysia, 29-31 May 2000, pp. 111-117.
30. Culvert Study Report RI91-11, Research, Development and Technology, Missouri Department of Transportation, 2000.
31. Davis, E.H., 1969, "Theories of Plasticity on the Failure of Soil Masses," *Soil Mechanics Selected Topics*, edited by I.K. Lee Butterworth, London, UK, pp. 341-374.
32. DeCou, G. and Davies, P., "Evaluation of Abrasion Resistance of Pipe and Pipe Lining Materials," Report FHWA/CA/ TL-CA01-0173, California Department of Transportation, Sacramento, 2007.
33. DeMerchant, M.R., 2002, "Plate Load Tests on Geogrid-Reinforced Expanded Shale Lightweight Aggregate," *Geotextile and Geomembranes*, 20 (2): pp. 173-190.

34. Dhar, A.S., and Moore, I.D., 2001, "Liner Buckling In Profiled Polyethylene Pipes," *Geosynthetics International*, 8(4): pp. 303-326.
35. Doherty, I.J. and Angelo, T.J., "Using UVC CIPP and GIPP in Multi-Year Culvert Rehabilitation Program on the 407ETR Electronic Toll Highway," *No-Dig Show 2012*, North American Society for Trenchless Technology (NASTT), Nashville, TN, 2012.
36. Faragher, E., Fleming, P.R., Rogers, C.D.F., 2000, "Analysis of Repeated Load Field Testing of Embedded Plastic Pipes," *Transportation Research Record*, 1514.
37. Federal Highway Administration (FHWA), "Culvert Inspection Manual, Supplement to the Bridge Inspector's Training Manual," Report FHWA-IP-86-2, FHWA, Washington D.C., July 1986.
38. Federal Highway Administration (FHWA), *Federal Lands Highway Project Development and Design Manual*, draft, FHWA, Washington D.C., February 2011.
39. Federal Highway Administration (FHWA), *Federal Lands Highway Project Development and Design Manual*, FHWA, Washington D.C., March 2008.
40. Federal Highway Administration (FHWA), "FHWA Culvert Management Case Studies," Report FHWA-HIF-14-008, Washington D.C., April 2014.
41. Florida Department of Transportation (FDOT), *Drainage Manual - Optional Pipe Material Handbook*, Drainage Section, Office of Design, FDOT, Tallahassee, 2012.
42. Florida Department of Transportation (FDOT), "Florida Method of Test for Determining Stress Crack Resistance of HDPE Corrugated Pipes," Florida Department of Transportation Testing Method: FM 5-572, FDOT, Tampa, 2008.
43. Florida Department of Transportation (FDOT), Florida Method of Test for Predicting the Crack Free Service Life of HDPE Corrugated Pipes, Florida Department of Transportation Testing Method: FM 5-573, FDOT, Tampa, 2008.
44. Florida Department of Transportation (FDOT), Florida Method of Test for Predicting the Oxidation Resistance of HDPE Corrugated Pipes, Florida Department of Transportation Testing Method: FM 5-574, FDOT, Tampa, 2008.
45. Florida Department of Transportation, (FDOT), "Florida Method of Test for Predicting Long-Term Modulus of HDPE Corrugated Pipes," Florida Department of Transportation Testing Method: FM 5-577, FDOT, Tampa, 2008.
46. Florida Department of Transportation, (FDOT), "Florida Method of Test for Determining Slow Crack Growth Resistance of HDPE Corrugated Pipes," Designation, FM 5-572.
47. Gabriel, L.H., Bennett, O.N., and Schneider, B., "Polyethylene Pipe Specifications," NCHRP Project 20-7, Task 68, Final Report, TRB, National Research Council, Washington D.C., January 1996.
48. Gabriel, L.H. and Moran, E.T., NCHRP Highway Synthesis 254: "Service Life of Drainage Pipe," Transportation Research Board, National Research Council, Washington D.C., 1998.
49. Gassman, S.L., Schroeder, A.J., and Ray, R.P., "Performance Evaluation of High-Density Polyethylene Culvert Pipe," *Transportation Research Record* 1814, paper 02-2042.
50. Gaube, E., and Müller, W., "12 Years of Deformation Measurements on Sewer Pipes," from *Kostalen GM 5010*, Proceedings of International Conference on Underground Plastic Pipe (B. J. Schrock, ed.), New Orleans, LA, 1981, pp. 272-278.

51. Goddard, J.B., 1998, "The Pennsylvania Deep Burial Study: Lessons Learned, Changes Made" Proceedings of 3rd Conference on Structural Performance of Pipes, Publishers' Graphics, Naperville, IL, pp. 93-106.
52. Goddard, J.B., 2002, "Pennsylvania Deep Burial Study - 15 Year Summary Report," Advanced Drainage Systems, ADS, Inc., Columbus, OH.
53. Hartley, J. D., and Duncan, J.M., "E and Its Variation with Depth," Journal of Transportation Division, ASCE, Vol. 113, No. 5, 1987, pp. 538-553.
54. Hashash, N., and Selig, E.T., "Analysis of the Performance of a Buried High-Density Polyethylene Pipe," Proceedings of 1st National Conference on Flexible Pipes, Rotterdam, Netherlands, 1990, pp. 95-103.
55. Hashash, N., and Selig, E.T., 1990, "Results of Field Measurements on Polyethylene Pipe Taken in July 1990," Technical Report to Pennsylvania Department of Transportation, Department of Civil Engineering, University of Massachusetts, Amherst, MA.
56. Höeg, K., 1968, "Stresses Against Underground Structural Cylinders," Journal of the Soil Mechanics and Foundations Division, ASCE, 94(SM4): pp. 833-858.
57. Höeg, K., 1965, "Pressure Distribution on Underground Structural Cylinders," PhD Thesis, Massachusetts, USA.
58. Howard, A. K., "Modulus of Soil Reaction (E) Values for Buried Flexible Pipe," Journal of Geotechnical Engineering Division, ASCE, Vol. 103, No. GT1, 1977, pp. 33-43.
59. Hsuan Y.G. and McGrath, T.J., "HDPE Pipe: Recommended Material Specifications and Design Requirements," NCHRP Report 429, Transportation Research Board, National Research Council, Washington DC, 1999.
60. Hsuan, Y.G. and McGrath, T.J., "Synthesis of Material Specification for 100 Years Service Life of High Density Polyethylene Corrugated Pipes," Report 04-474, Florida DOT, Tallahassee, FL, 2004.
61. Hsuan, Y.G., and McGrath, T.J., NCHRP Report 429: "HDPE Pipe: Recommended Material Specifications and Design Requirements," TRB, National Research Council, Washington D.C., 1999.
62. Hsuan, Y.G., Zhang, J.Y., and Wong, W.K., "Evaluate the Long-Term Stress Crack Resistance of Corrugated HDPE Pipes," Department of Civil, Architectural and Environmental Engineering, Drexel University, Philadelphia, PA, 2005.
63. Hsuan, Y.G. and Zhang, J.Y., "Stress Crack Resistance of Corrugated High Density Polyethylene Pipes in Different Test Environments and Temperatures," Journal of the Transportation Research Board, No. 1928, Transportation Research Board of the National Academies, Washington D.C., 2005, pp. 221-225.
64. Hsuan, Y.G. and McGrath, T.J., "Evaluation of Stress Crack Resistance of Corrugated High density Polyethylene Pipes," Plastics Pipes XII Conference, CD only, 2004, Baveno, Italy.
65. Hsuan, Y.G. and McGrath, T.J., "Protocol for Predicting Long-term Service of Corrugated High Density Polyethylene Pipes," Florida Department of Transportation, 2005.
66. Hsuan, Y.G. and McGrath, T.J., NCHRP Report 429: "HDPE Pipe: Recommended Material Specifications and Design Requirements," Transportation Research Board, National Research Council, Washington D.C., 1999.

67. Hsuan, Y.G., "Phase II of Long-term Properties of Corrugated HDPE Pipe," Research Study for the Florida Department of Transportation, Tallahassee, FL, February 2012.
68. Hufenus, R., Rueegger, R., Banjac, R., Mayor, P., Springman, S.M., Bronnimann, R., 2006, "Full-Scale Field Tests on Geosynthetic Reinforced Unpaved on Soft Subgrade," *Geotextiles and Geomembranes*, 24 (6): pp. 21-37.
69. Hunang, Y.H., 1993, *Pavement Analysis and Design*, 1st ed., Prentice-Hall Inc., Englewood Cliffs, NJ.
70. Hurd, J.O., "Field Performance of Corrugated Polyethylene Pipe Culverts in Ohio," Transportation Research Record 1087, TRB, National Research Council, Washington D.C., 1986, pp. 1-6.
71. Kang, J.S., Han, T.H., Kang, Y.J., Yoo, C.H., "Short-Term and Long-Term Behaviors of Buried Corrugated High-Density Polyethylene (HDPE) Pipes," Elsevier, *Composites: Part B*, Vol. 40 (2009), pp 404-412.
72. Katona, M.G., Smith, J.B., Odello, R.S., and Allgood, J.R. "CANDE - A Modern Approach for the Structural Design and Analysis of Buried Culverts," Report FHWA RD-77-5, FHWA, U.S. Department of Transportation, 1976.
73. Kolbuzewski, J., 1948, "General Investigation of the Fundamental Factors Controlling Loose Packing of Sands," *Proceedings of the Second International Conference on Soil Mechanics and Foundation Engineering*, Rotterdam, vol. VII, pp. 47-49.
74. Krushelnitzky, R.P. and Brachman, R.W.I., "Measured Deformations and Calculated Stresses of High-Density Polyethylene Pipes Under Very Deep Burial," *Canadian Geotechnical Journal*, Vol. 46, pp. 650-664, 2009.
75. Krushelnitzky, R.P., 2006, "Investigation of Physical, Temperature and Chemical Effects on the Short Term and Long Term Performance of High Density Polyethylene Pipe," PhD thesis, Department of Civil Engineering, Queen's University, Kingston, Ont.
76. Lapos, B., and Moore, I.D. 2002. Evaluation of the strength and deformation parameters of olimag synthetic olivine. In *Proceedings of the 55th Canadian Geotechnical Conference*, Niagara Falls, ON, 20-23 October 2002, Canadian Geotechnical Society, Richmond, BC, pp. 729-733.
77. Leatham, J.L. and Peterson, G.E., "Pipe Selection for Corrosion Resistance," Utah DOT Report UDOTIMP-76-1, Research and Development Section, Salt Lake City, UT, 1977.
78. Lupo, J.F., and Morrison, K.F., 2007, "Geosynthetic Design and Construction Approaches in the Mining Industry," *Geotextiles and Geomembranes*, 25(2): 96-108.
79. Macey, C.C. and Zurek, K., "34 Years of Quality Assurance Testing for CIPP in Winnipeg, MB, Canada," No-Dig Show 2012, North American Society for Trenchless Technology (NASTT), Nashville, TN, 2012.
80. Marston, A., and Anderson, A.O., "The Theory of Loads on Pipes in Ditches, and Tests of Cement and Clay Tile and Sewer Pipe," *The Iowa State College Bulletin*, Vol. 11, No. 31, Iowa Engineering Experiment Station, Iowa State College, Ames, 1913.
81. McGrath, T. J., and Sagan, V.E., NCHRP Report 438: "Recommended LRFD Specifications for Plastic Pipe and Culverts," TRB, National Research Council, Washington D.C., 2000.
82. Meacham, D.G., Hurd, J.O., and Shislar, W.W., "Culvert Durability Study," Report No. ODOT/LandD/82-1, Ohio Department of Transportation, Columbus, 1982.
83. Michael Maher, Gregory Hebel, and Andrew Fuggle, "NCHRP Synthesis 474, Service Life of Culverts," Transportation Research Board National Research Council, 2015.

84. Michael R. Blackwell and Xinge (Julie) Yin, "Installation and Initial Performance of 60 ADS N-12HC® HDPE Pipes," RDT02-007/RI01-037, Missouri Department of Transportation Research, Development, and Technology, June 2002.
85. Ministry of Transportation of Ontario, "MTO Gravity Pipe Design Guidelines—Circular Culverts and Storm Sewers," Toronto, ON, Canada, 2007.
86. Minnesota Department of Transportation (MnDOT), "Culvert Repair Best Practices, Specifications, and Special Provisions: Task C Research Synthesis," TRS 1209, MnDOT, St. Paul, October 2012.
87. Mir Mohammad Hosseini, S. M., Moghaddas Tafreshi, S. N., 2002, "Soil Structure Interaction of Embedded Pipes Under Cyclic Loading Conditions," *International Journal of Engineering* 15 (2), pp. 117-124.
88. *Missouri Standard Specifications for Highway Construction*, Missouri Highway and Transportation Commission, 2000.
89. Mitchell, G.F., Masada, T., Sargand, S.M., and Jobes Henderson & Associates, Inc., "Risk Assessment and Update of Inspection Procedures for Culverts," FHWA.
90. Molinas, A. and Mommandi, A., "Development of New Corrosion/Abrasion Guidelines for Selection of Culvert Pipe Materials," Report No. CDOT-2009-11, DTD Applied Research and Innovation Branch, Colorado Department of Transportation, Denver, 2009, pp. 5-25.
91. Moore, I.D., 2001, "Buried Pipes and Culverts," *Geotechnical and Geoenvironmental Engineering Handbook*, edited by R.K. Rowe, Kluwer Academic Publishers, London, UK, pp. 541-567.
92. Moore, I.D. and Hu, F., "Linear Viscoelastic Modelling of Profiled High Density Polyethylene Pipe," *Canadian Journal of Civil Engineering*, Vol. 23, 1996, pp. 395-407. National Corrugated Steel Pipe Association (NCSPA), CSP Durability Guide, NCSPA, Dallas, TX, 2000.
93. Moore, I.D., Garcia, D.B., Sezen, H., and Sheldon, T., NCHRP web-only document 190: "Structural Design Requirements for Culvert Joints," NCHRP Project 15-38, Transportation Research Board of the National Academies, Washington D.C., 2012.
94. Moser, A. P., "Structural Performance of HDPE Profile-Wall Pipe," test report submitted to Advanced Drainage Systems, Columbus, OH, October 1999.
95. Mruk, S.A., 1990, "The Durability of Polyethylene Piping," *Buried Plastic Pipe Technology*, STP 1093, edited by G.S. Buczala and M.J. Cassidy, American Society for Testing and Materials (ASTM), West Conshohocken, PA, pp. 21-39.
96. National Fire Protection Association, 2012, NFPA 704, "Standard System for the Identification of the Hazards of Materials for Emergency Response," NFPA, Quincy, MA, 2012.
97. NCHRP 4-26 Project, "Thermoplastic Drainage Pipe, Design and Testing."
98. NCHRP Project 10-86, "Alternative Bidding of Highway Drainage Systems," final report in preparation, Transportation Research Board of the National Academies, Washington D.C., 2015.
99. NCHRP Project 14-19, "Culvert Rehabilitation to Maximize Service Life While Minimizing Direct Costs and Traffic Disruption, Literature Review," final draft, Transportation Research Board of the National Academies, Washington D.C., 2010.
100. NCHRP Synthesis 254, "Service Life of Drainage Pipe," Transportation Research Board, National Research Council, 1998.

101. NCHRP Synthesis 429, "HDPE Pipe: Recommended Material Specifications and Design Requirements," Transportation Research Board National Research Council, 1999.
102. NCHRP Synthesis 474, "Service Life of Culverts," Transportation Research Board, National Research Council, 2015.
103. New York State DOT, *NYSDOT Culvert Inspection Field Guide*, NYSDOT, Albany, 2011.
104. OH- 2005/002, Ohio Department of Transportation, Ohio University and Ohio Research Institute for Transportation and the Environment (ORITE), Columbus, 2005.
105. Ohio Department of Transportation, *Location and Design Manual*, "Volume 2: Drainage Design," Ohio Department of Transportation, Columbus, 2014.
106. Ohio Department of Transportation, "Risk Assessment and Update of Inspection Procedures for Culverts," Report No. FHWA/OH-2005/0002, Ohio University, Athens, 2005.
107. Patra, C. R., Das, B. M., Atalar, C., 2005, "Bearing Capacity of Embedded Strip Foundation on Geogrid Reinforced Sand," *Geotextile and Geomembranes*, 23 (5): pp. 454-462.
108. Perrin, J., Jr., and Jhaveri, C.S., "The Economic Costs of Culvert Failures," prepared for the Transportation Research Board, 83rd Annual Meeting, CD-ROM, Washington D.C., 2004.
109. Popelar, C.H., Kenner, V.H., and Wooster, J.P., "An Accelerated Method for Establishing the Long Term Performance of Polyethylene Gas Pipe Materials," *Polymer Engineering and Science*, Vol. 31, No. 24, 1991, pp. 1693-1700.
110. Potter, J.C., "Life Cycle Cost for Drainage Structures," Technical Report GL-88-2, prepared for the Department of the Army by the Waterways Experiment Station, Vicksburg, MI, 1988.
111. PPI, 1996a, "Underground Installation of PE piping," *Handbook of Polyethylene Pipe*, Plastics Pipe Institute, Irving, TX, pp. 265-303.
112. PPI, 1996b, Standard Specifications, "Standard Test Methods and Codes for PE (Polyethylene) Piping Systems," *Handbook of Polyethylene Pipe*, Plastics Pipe Institute, Irving, TX, pp. 125-153.
113. Reddy, D. V., "Evaluation of Plastic Piping for Culverts and Storm Sewers," Florida Department of Transportation, Work Program No. 0510757, Florida Department of Ocean Engineering, April 1999.
114. Rogers, C.D.F., Fleming, P.R., Loeppky, M.W.J., Faragher, E., 1995, "Structural Performance of Profile-Wall Drainage Pipe-Stiffness Requirements Contrasted with the Results of Laboratory and Field Tests," *Transportation Research Record* 1514, Transportation Research Board, Washington DC, pp. 83-92.
115. Rogers, C.D.F., Fleming, P.R., Talby, R., 1996, "Use of Visual Methods to Investigate Influence of Installation Procedure on Pipe-Soil Interaction," *Transportation Research Record* 1514, Transportation Research Board, Washington D.C., pp. 76-85.
116. Sargand, S.M., 2007, "Long-Term Monitoring of Pipe Under Deep Cove," draft final report to Ohio Dept. of Transportation, Ohio Research Institute for Transportation and the Environment, ORITE, Ohio University, Athens, OH.
117. Sargand, S.M., Hazen, G.A., Moran, A.P., and Bhargava, A., "Comparison of Structural Response of 762-mm (30-in) Thermoplastic Pipes Under Deep Burial," presented at 80th Annual Meeting of the Transportation Research Board, Washington D.C., January 2001.

118. Sargand, S.M., Hazen, G.A., and Masada, T., "Structural Evaluation and Performance of Plastic Pipe," Report FHWA/OH-98/011, final report to the Ohio Department of Transportation, Ohio University, Athens, OH, 1998.
119. Sargand, S.M., Masada T., White K. E., and Altarawneh, B., "Profile-Wall High-Density Polyethylene Pipes, 1050 mm in Diameter, Under Deep Soil Cover, Comparisons of Field Performance Data and Analytical Predictions," Transportation Research Record 1814, paper No. 02-4038, 2000.
120. Sargand, S.M., Masada, T., Mao, B., and Yalamanchilli, V.S.R., "Performance of Buried Corrugated HDPE Pipe," proceedings of International Conference Centrifuge 94, Rotterdam, Netherlands, 1994, pp. 745-751.
121. Sargand, S.M., Masada, T., and Hurd, J.O., "Effect of Rib Spacing on Deformation of Profile-Wall Plastic Pipe Buried in Coarse Granular Backfill," Geotechnical Testing Journal, ASTM, Vol. 19, No. 2, June 1996, pp. 217-222.
122. Sargand, S.M., Masada, T., and Keatley, D., "Pennsylvania Thermoplastic Pipe Deep Burial Project: 20th Year Investigations," Journal of Performance of Constructed Facilities, ASCE, July/August 2009, pp. 262-268.
123. Selig, E.T. 1995, "Long-Term Performance of Polyethylene Pipe Under High Fill - Part 2," report No. PDT92-397F, Technical Report to Pennsylvania Dept. of Transportation, Department of Civil and Environmental Engineering, University of Massachusetts, Amherst, MA.
124. Selig, E.T., 1990, "Soil Properties for Plastic Pipe Installations," Buried Plastic Pipe Technology, STP 1093, edited by G.S. Buczala and M.J. Cassady, American Society for Testing and Materials (ASTM), West Conshohocken, PA, pp. 141-158.
125. Spangler, M.G., 1941, "The Structural Design of Flexible Pipe Culverts," Bulletin 153, Iowa Engineering, Experiment Station, Iowa State College, Ames, IA.
126. "Standard Specification for Corrugated Polyethylene Pipes, 300- to 1500-mm Diameter," AASHTO Designation: M294.
127. "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort, 2000," ASTM D1557-00, American Society for Testing and Materials, Philadelphia, PA.
128. Swanson, H.N. and Donnelly, D.E., "Performance of Culvert Materials in Various Colorado Environments," report No. FHWA-CO-77-7, State Department of Highway and Colorado Division of Highways Planning and Research Branch, Denver, CO, 1977.
129. Tafreshi, S.N., Moghaddas, and Khalaj, O., "Laboratory Tests of Small-Diameter HDPE Pipes Buried in Reinforced Sand Under Repeated Load," Geotextiles and Geomembranes, Vol. 26, 2008, pp. 145-163.
130. Taylor, C., and Marr, J., "A Research Plan and Report on Factors Affecting Culvert Pipe Service Life in Minnesota," St. Anthony Falls Laboratory, University of Minnesota, Minnesota Department of Transportation Research Services, St. Paul, MN, 2012.
131. Thiel, R., and Smith, M.E., 2004, "State of the Practice Review of Heap Leach Pad Design Issues," Geotextiles and Geomembranes, 22(6): pp. 555-568.
132. Titow, W.V., *PVC Plastic Properties and Applications*, Elsevier Applied Science, New York, 1990.
133. Tognon, A.R.M., Rowe, R.K., and Brachman, R.W.I., 1999, "Evaluation of Side Wall Friction for a Buried Pipe Testing Facility," Geotextiles and Geomembranes, 17(4): pp. 193-212.

134. Trankner, T., Hedenqvist, M. and Gedde, U.W., "Structure and Crack Growth in Gas Pipes of Medium Density and High Density Polyethylene," *Polymer Engineering and Science*, Vol. 36, No.16, 1996, Transportation Research Board, Washington D.C., pp. 271-277.
135. Treen, C.R., Murray, C.D., and Froese, C.R., 2003, "Wood Creek Dam Shear Key: Investigation, Design and Construction," *Proceedings of the 3rd Canadian Conference on Geotechnique and Natural Hazards: Geo-hazards 2003*, Geotechnical Society of Edmonton, Edmonton, AL, June 2003, CD-ROM, Bitech Publishers, Richmond, BC.
136. Trott, J.J., Taylor, R.N., Simons, I.F., 1984, "Tests to Validate Centrifuge Modeling of Flexible Pipes," *Journal of Ground Engineering*, Bentwood 4, pp. 17-28.
137. U.S. Army Corps of Engineers, *Engineering and Design, Conduits, Culverts and Pipes*, Department of the Army, Washington D.C., 1998.
138. U.S. Department of Agriculture, Forest Service, "Summary of Trenchless Technology for Use with USDA Forest Service Culverts," TTAP MTU ID#1460, USDA, Washington D.C., 2005.
139. Vasile, C. and Seymour, R.B., *Handbook of Polyolefins: Synthesis and Properties*, Marcek Dekker, New York, 1993.
140. Watkins, R.K., and Anderson, L.R., *Structural Mechanics of Buried Pipes*, CRC Press, New York, 2000.
141. Watkins, R.K., and Spangler, M.G., "Some Characteristics of the Modulus of Passive Resistance of Soil: A Study in Similitude," *Highway Research Board Proceedings*, Vol. 37, HRB, National Resource Council, Washington D.C., 1958, pp. 576-583.
142. Webb, N.H., and McGrath, T.J., 1994, "Long-Term Performance of Polyethylene Pipe Under High Fill - Part 1," Report No. PDT92-397F, Technical Report to Pennsylvania Department of Transportation, Department of Civil and Environmental Engineering, University of Massachusetts, Amherst, MA.
143. White, K. and Hurd, J.O., "Guidance for Design and Selection of Pipe," draft report for NCHRP 20-07 (264), Transportation Research Board of the National Academies, Washington D.C., 2010.
144. Wyant, D.C., NCHRP Highway Synthesis 303: "Assessment and Rehabilitation of Existing Culverts," Transportation Research Board of the National Academies, Washington D.C., 2002.
145. Zhang, C., and Moore, I.D., 1997, "Nonlinear Mechanical Response of High Density Polyethylene, Part I: Experimental Investigation And Model Evaluation," *Polymer Engineering and Science*, 37(2).
146. Zhao, J.Q., et al., "Durability and Performance of Gravity Pipes: A State-of-the-Art Literature Review," National Research Council Canada, Published by IRC Institute for Research in Construction, Ottawa, ON, Canada, 1998.

APPENDIX I – FOUNTAIN COLORADO,
DUROMAXX LASER PROFILE INSPECTION,
I-25, MP 122, MP 122.5, AND MP 123 (2013)
LEO JOHN FLECKENSTEIN



Fountain Colorado
DuroMaxx Laser Profile Inspection
I-25, MP 122, MP 122.5, and MP 123

September 30, 2013

By

Leo John Fleckenstein

Project Summary: A total of 5 pipes were video and laser profiled on September 30, 2013. A straight line/non pan and tilt portable camera unit was utilized for the inspection. Joints were noted and observed during the inspection. Joint separation was minor to moderate with no significant distress or soil migration observed. Some minor racking, dents, and sags were also noted. Limited construction information was available. Several of the structures have limited cover. Minor post construction damage was noted towards the ends of several of the structures as straw wattles were placed over the pipe ends and wooden stakes driven through the crown of the pipes. The stakes do not appear to be causing any structural issues with the performance of the pipes. Four of the five pipes were under 5% deflection for their full length. One pipe had a small localized area where pipe deflection was measured at 5.3% near the end of the structure. The non-uniform nature of the deflection and the fact that the deflected area is outside of the paved roadway would suggest that this deformation occurred during the installation process. The first 10 to 16 ft of the pipes near the outlet end of the structures could not be laser profiled due to the distance between the camera and the laser. Each pipe was totally captured/recorded on the straight line video inspection.



Location: Fountain Colorado

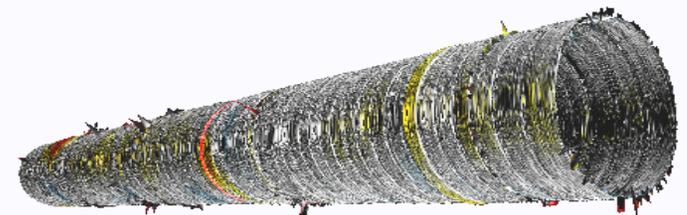
Route: I-25

Pipe Use: Culvert/Cross Drain

Date Inspected: 9/30/13

Location	Date	Pipe Type	Pipe Size	Distance (ft)	Start ID	End ID	Deflection (2.5%)	Deflection (5%)	Observations
MP 123, Northern Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	100% of readings below 2.5%		Max deflection less than 2.5%, slight dent in left springline, wooden stake driven through crown near inlet end.
MP 123, Center Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	92% of readings below 2.5%	100% of readings below 5%, .	Max deflection approximately 4% at 23 ft, small dent at left springline at 73 ftl, wooden stakes driven through crown of pipe near inlet end.
MP 124, Southern Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	100% of readings below 2.5%		Max deflection approximately 2.5% at 24 ft, wooden stake driven through crown of pipe near inlet.
MP 122.5	9/30/2013	DuroMaxx	48-inch	102	Outlet	Inlet	86.8% of reading below 2.5%	100% of readings below 5%, .	Max deflection approximately 2.8% at 88 ft
MP 122	9/30/2013	DuroMaxx	48-inch	103	Outlet	Inlet	77.2% of readings below 2.5%	<1.9% of readings above 5%	Max deflection approximately 5.30% near inlet end (approx. 90 to 88 ft). Pipe moderately racked in right crown. Remainder of pipe 4% or less. Small puncture due to stake near outlet, pipe slightly racked at 8 ft. Slight hump at right haunch at 46 ft. Slight dent in invert at 56 ft.

Deflection data was gathered at a frame rate of approximately 1 frame per every 0.1 ft. With 180 measurements taken per frame of video. Total readings per pipe section ranged from approximately 712,000 to 770,000.



MP 123, I-25, 36-Inch DuroMaxx





North





MP 123, I-25, 36-Inch DuroMaxx
Northern Pipe



Project Name: I-25, Fountain, Colorado

Date: 9/30/2013

Asset Location:

Distance: 0

Run Number:

Pipe Size: 36

Pipe ID: MP 123

Start ID: Outlet

End ID: Inlet

Direction: Upstrm

Pipe Type: DuroMaxx

ID Number: Outlet

(2.0) SI - Start Inspection

(20.0) GO - General Observation Remark:
Joint No. 1

(30.0) GO - General Observation Remark:
Slight dent left springline

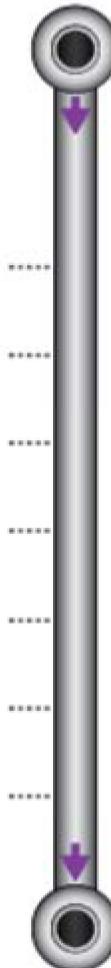
(40.0) GO - General Observation Remark:
View of joint at 40 ft.

(60.0) GO - General Observation Remark:
View of joint at 66 ft.

(80.0) GO - General Observation Remark:
Stake driven through crown of pipe at 84 ft.

(88.0) EI - End Inspection

Total Distance: 0



ID Number: Inlet

Project Name: I-25, Fountain, Colorado

Date: 9/30/2013
Asset Location:
Distance: 0
Run Number:
Pipe Size: 36

Pipe ID: MP 123
Start ID: Outlet
End ID: Inlet
Direction: Upstrm
Pipe Type: DuroMaxx

Distance	Fault Observation	Time	Picture
2.0	Start Inspection	01:14 00:00:00	
20.0	General Observation Remarks: Joint No. 1	03:13 00:00:26	
30.0	General Observation Remarks: Slight dent left springline	07:04 00:00:40	

Distance	Fault Observation	Time	Picture
40.0	<p>General Observation Remarks: View of joint at 40 ft.</p>	<p>8:10 00:00:45</p>	
60.0	<p>General Observation Remarks: View of joint at 66 ft.</p>	<p>10:33 00:01:13</p>	
80.0	<p>General Observation Remarks: Stake driven through crown of pipe at 84 ft.</p>	<p>12:37 00:01:45</p>	

Distance	Fault Observation	Time	Picture
88.0	End Inspection	13:48 00:01:55	

Created with the  POSM report generator

XY Diameter Summary Report

Pipe well under 5% deflection, spikes in data due to camera tilting at joint

Site ID
City Fountain, Colorado
Start No North Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No North Pipe
Location Inlet

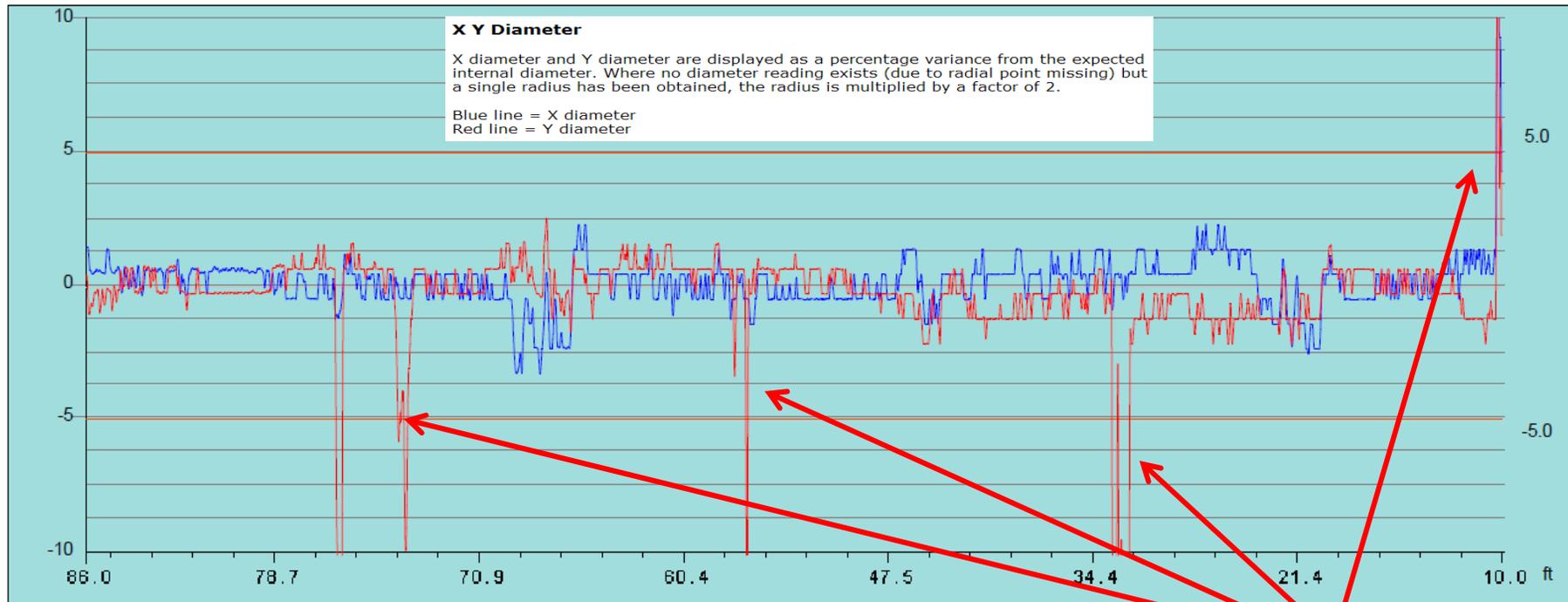
Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 34.92 in

Comments

Northern most pipe of three at MP 123

Limit Lines
Upper limit = 5
Lower Limit = -5

% 90% - Fractile: (X) 1.1% : (Y) 0.7%, Exceeded limits: 2.6%



Fractile: 10% of the data points are above 1.1% for X and 0.7% for Y. 2.6% exceeds 5% limits lines. The spikes/scatter in data (2.6%) are due to the laser skid and/or the camera tilting on the weld at the joint. Spikes can also occur due to the loss of laser light at the joint.

XY Deflection Summary Report

Pipe under 5% (Deflection based off Median I.D. per frame of video)

Site ID
City Fountain, Colorado
Start No North Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No North Pipe
Location Inlet

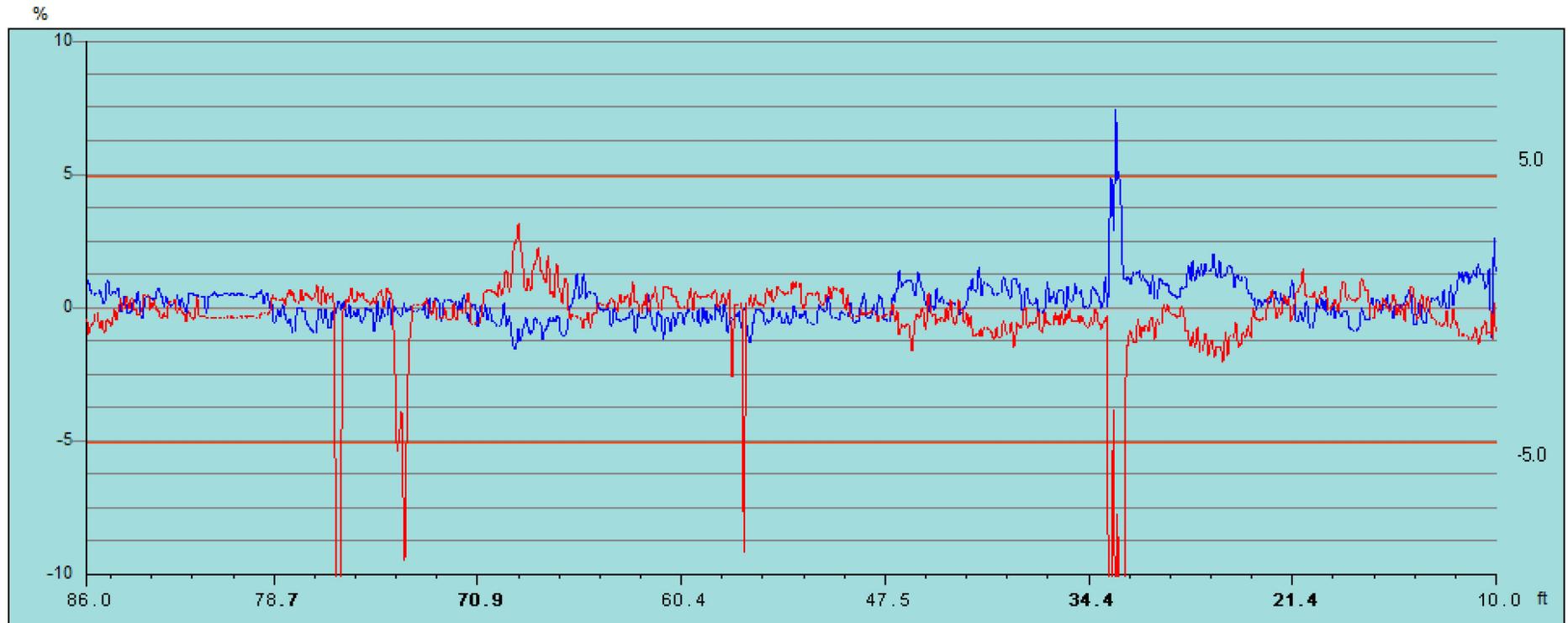
Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 34.92 in

Comments

Northern most pipe of three at MP 123

Limit Lines

Upper limit = 5
Lower Limit = -5



Ovality Summary Report

Ovality under 5%, spikes due to camera going over joints

Site ID
City Fountain, Colorado
Start No North Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No North Pipe
Location Inlet

Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 34.92 in

Comments

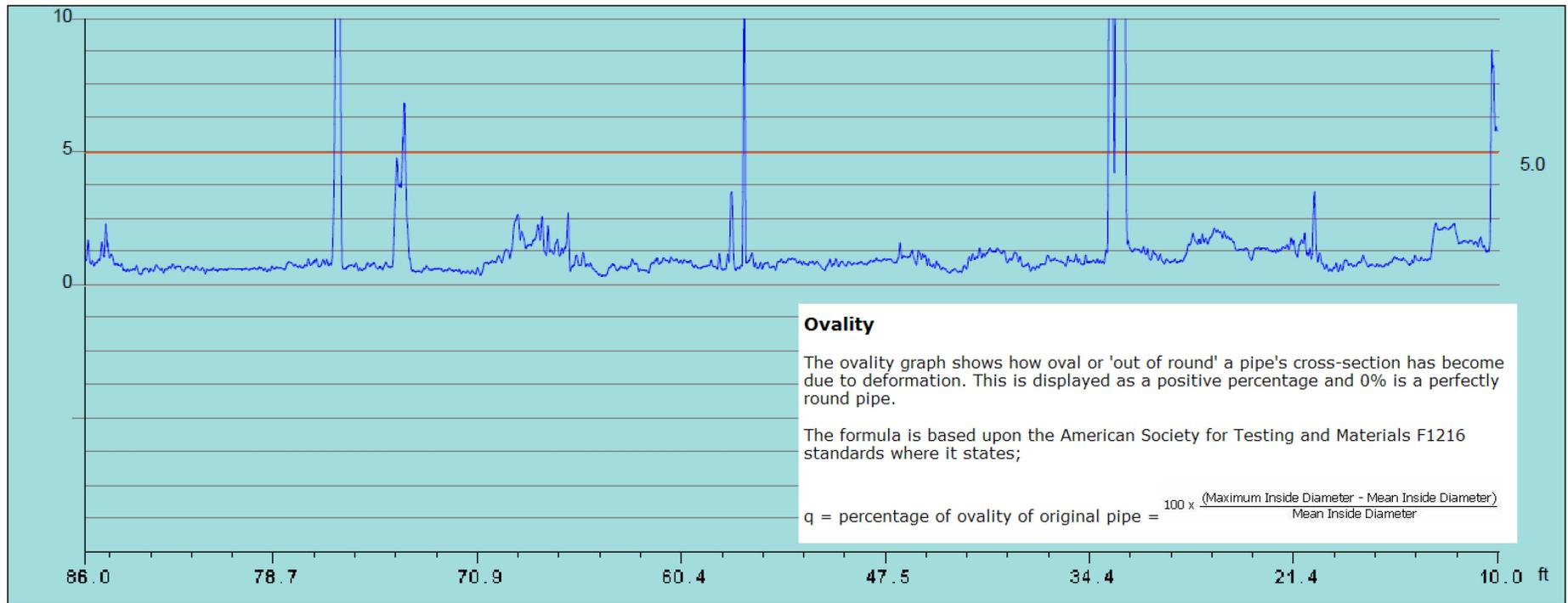
Northern most pipe of three at MP 123

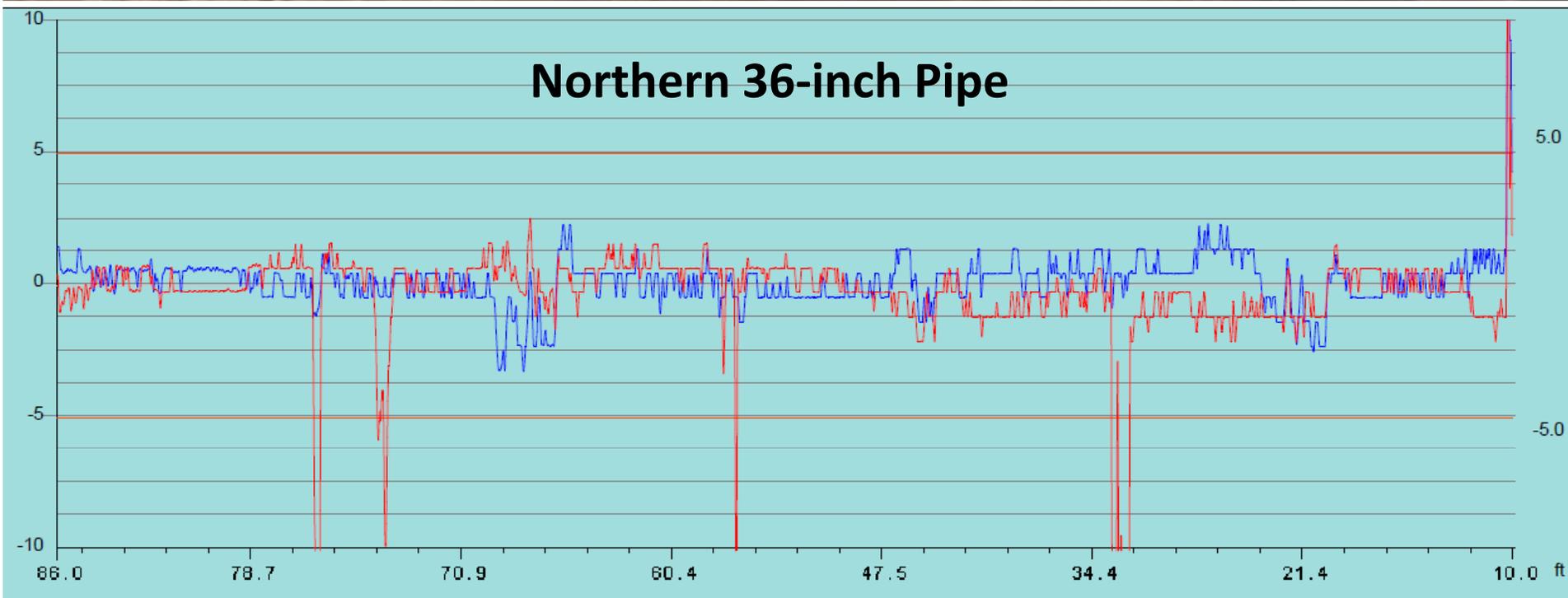
Limit Lines

Upper limit = 5
Lower Limit = 5

90% - Fractile: 1.8%, Exceeded limits: 2.7%

Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance





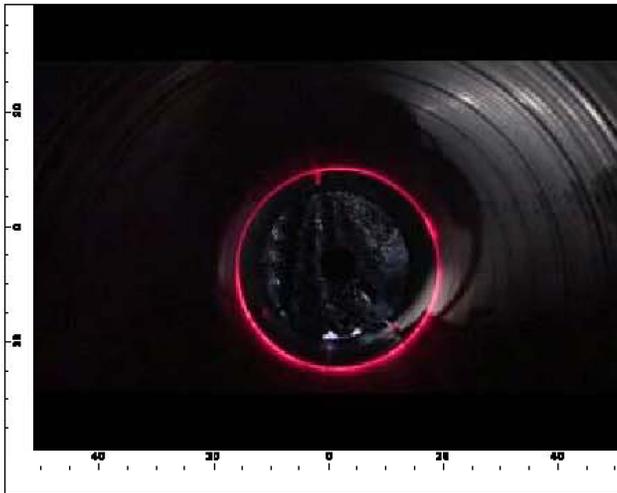
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado

Site ID
 City Fountain, Colorado
 Start No North Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No North Pipe
 Location Inlet

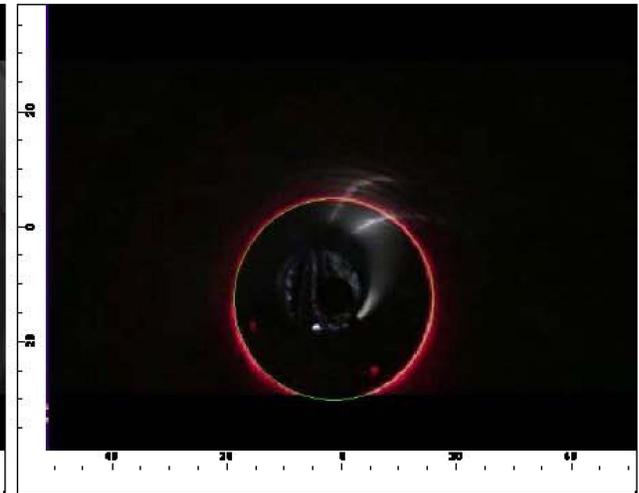
Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 34.92 in



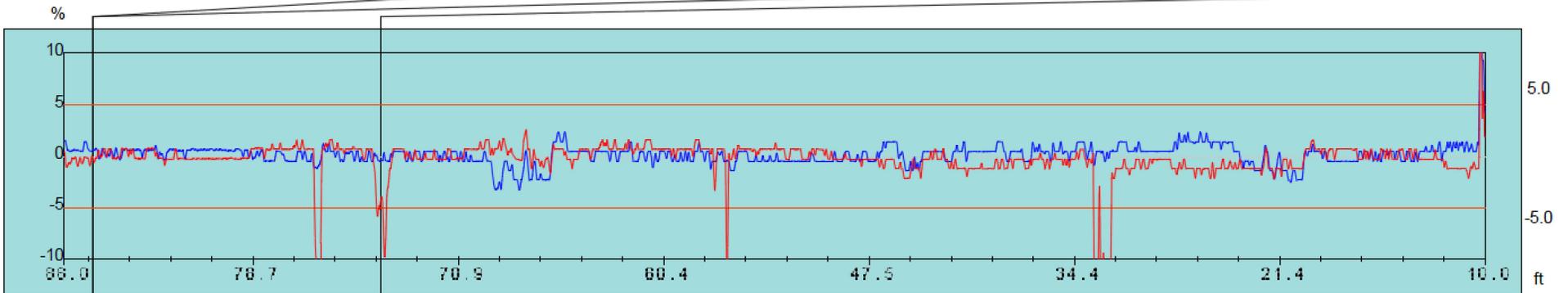
Laser reflecting off stake in crown of pipe.



Stake for erosion control driven through crown of pipe.



Camera tilted coming over joint



90% - Fractile: (X) 1.1% : (Y) 0.7%, Exceeded limits: 2.6%

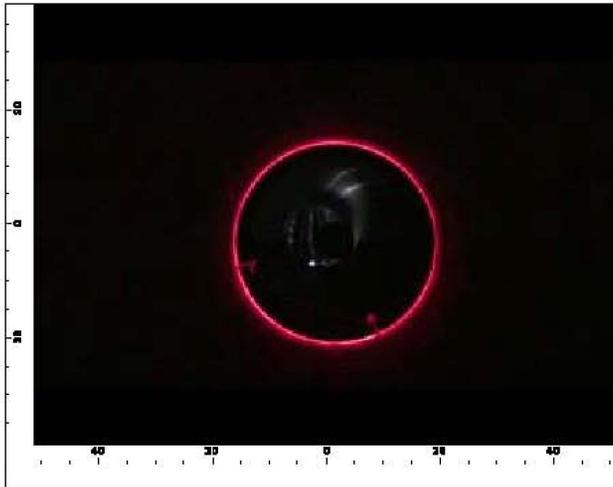
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado

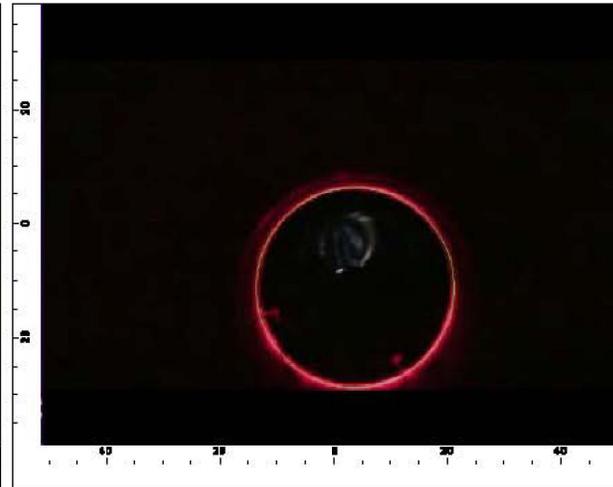
Site ID
 City Fountain, Colorado
 Start No North Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No North Pipe
 Location Inlet

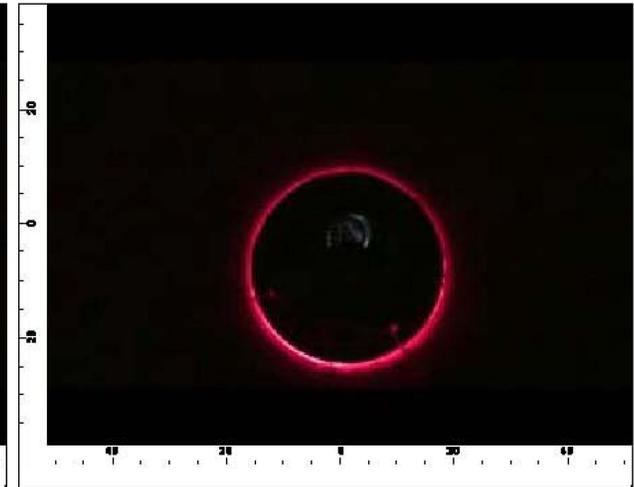
Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 34.92 in



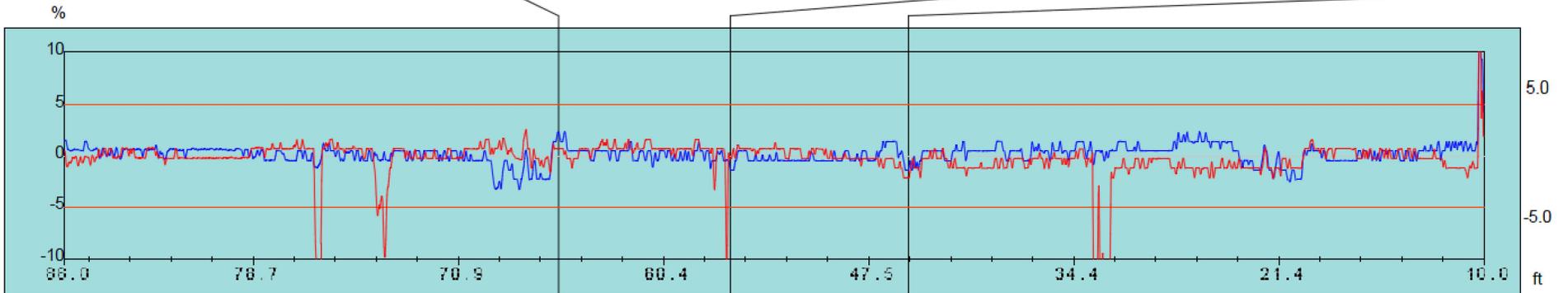
Laser at third joint



Camera tilted coming over joint



Laser at second joint



90% - Fractile: (X) 1.1% : (Y) 0.7%, Exceeded limits: 2.6%

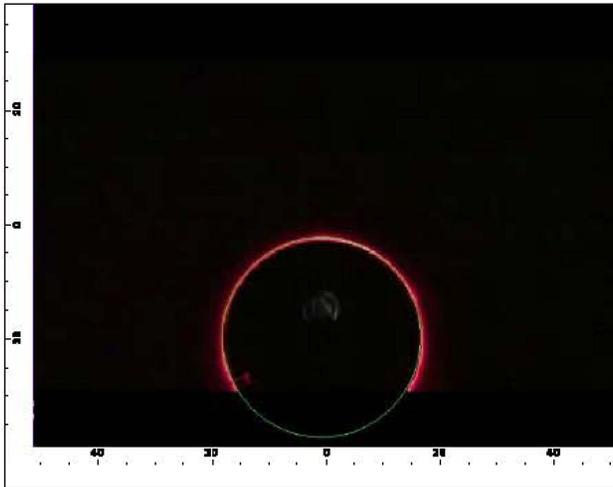
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado

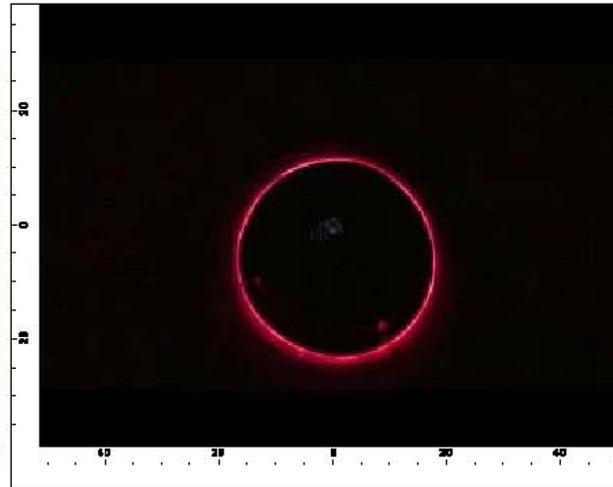
Site ID
 City Fountain, Colorado
 Start No North Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No North Pipe
 Location Inlet

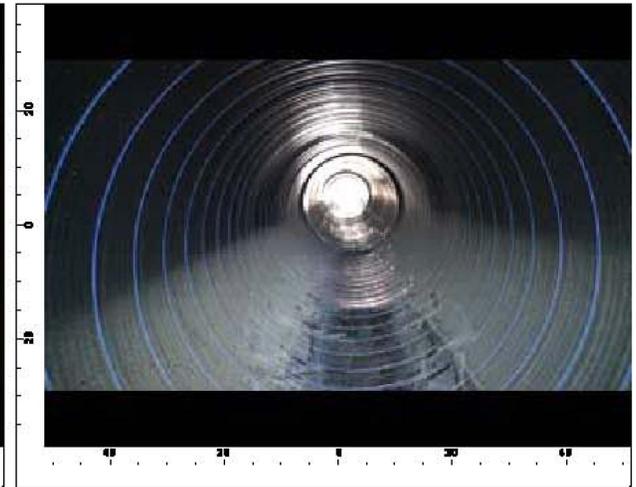
Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 34.92 in



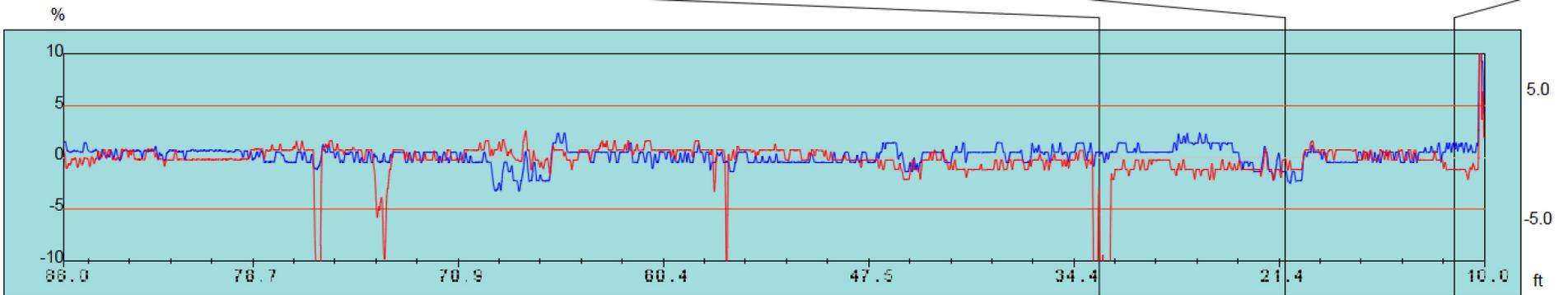
Camera tilted coming over joint



Laser at 1st joint



View of pipe at start, no noticeable deflection or defects.



90% - Fractile: (X) 1.1% : (Y) 0.7%, Exceeded limits: 2.6%

MP 123, I-25, 36-Inch DuroMaxx
Center Pipe



Project Name: I-25, Fountain, Colorado

Date: 9/30/2013

Asset Location:

Distance: 0

Run Number:

Pipe Size: 36

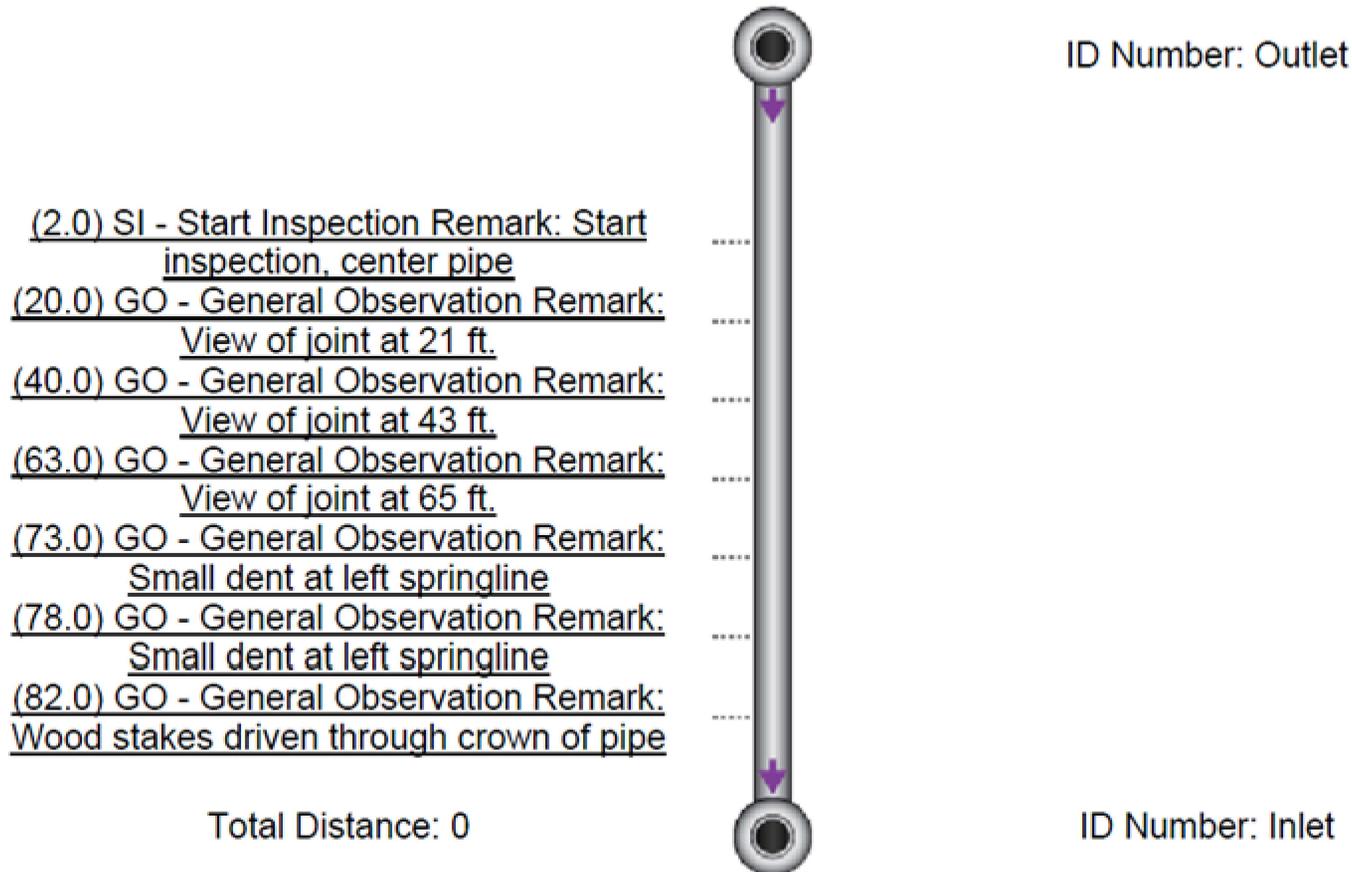
Pipe ID: MP 123, Center Pipe

Start ID: Outlet

End ID: Inlet

Direction: Upstrm

Pipe Type: DuroMaxx



Project Name: I-25, Fountain, Colorado

Date: 9/30/2013
Asset Location:
Distance: 0
Run Number:
Pipe Size: 36

Pipe ID: MP 123, Center Pipe
Start ID: Outlet
End ID: Inlet
Direction: Upstrm
Pipe Type: DuroMaxx

Distance	Fault Observation	Time	Picture
2.0	<p style="text-align: center;"> Start Inspection Remarks: Start inspection, center pipe </p>	<p style="text-align: center;"> 01:09 00:00:00 </p>	
20.0	<p style="text-align: center;"> General Observation Remarks: View of joint at 21 ft. </p>	<p style="text-align: center;"> 04:45 00:01:14 </p>	
40.0	<p style="text-align: center;"> General Observation Remarks: View of joint at 43 ft. </p>	<p style="text-align: center;"> 05:44 00:01:39 </p>	

Distance	Fault Observation	Time	Picture
63.0	<p data-bbox="569 370 972 431"> General Observation Remarks: View of joint at 65 ft. </p>	<p data-bbox="984 370 1089 431"> 07:52 00:02:14 </p>	
73.0	<p data-bbox="569 771 972 865"> General Observation Remarks: Small dent at left springline </p>	<p data-bbox="984 790 1089 852"> 09:22 00:02:30 </p>	
78.0	<p data-bbox="569 1188 972 1282"> General Observation Remarks: Small dent at left springline </p>	<p data-bbox="984 1208 1089 1269"> 10:33 00:02:53 </p>	

Distance	Fault Observation	Time	Picture
82.0	General Observation Remarks: Wood stakes driven through crown of pipe	11:40 00:03:10	

Created with the  POSM report generator

XY Diameter Summary Report

Pipe under 5% deflection, spikes in data due to camera tilting at joint

Site ID
City Fountain, Colorado
Start No Center Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Center Pipe
Location Inlet

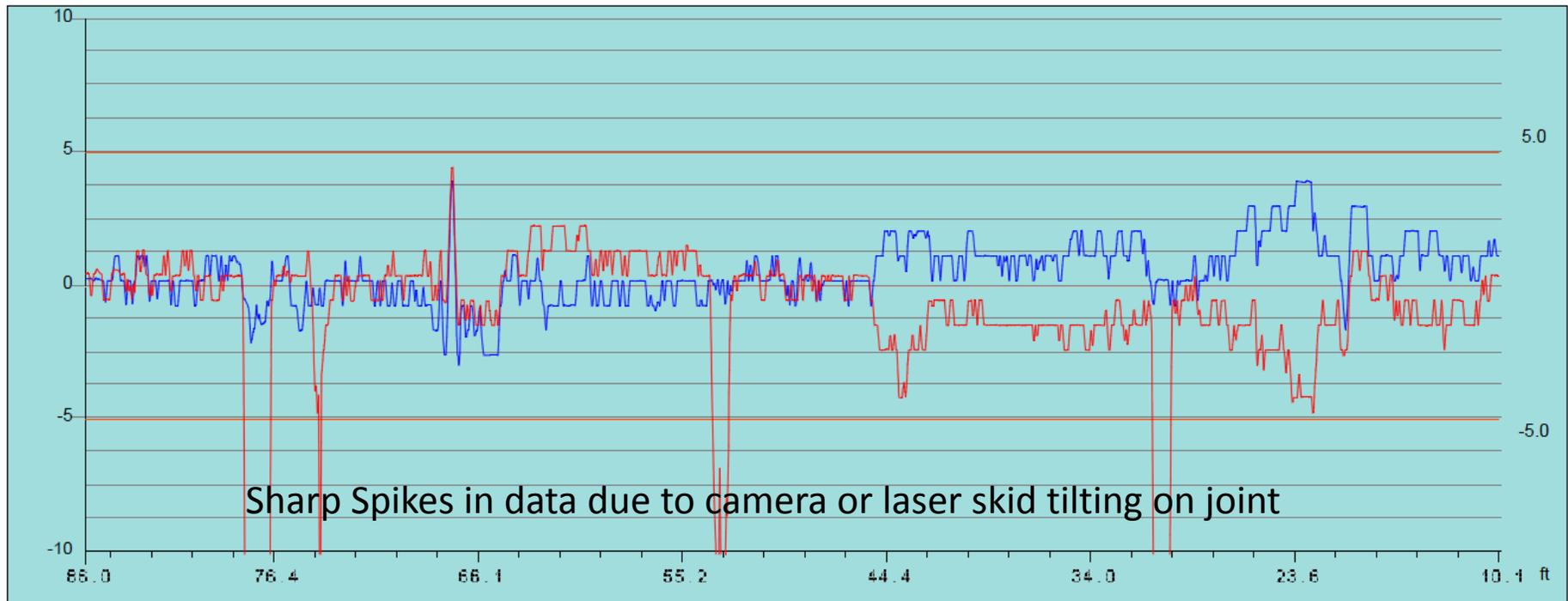
Date 10/9/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35 in

Comments

MP 123, I-25, Cross Drain, Center Pipe

Limit Lines
Upper limit = 5
Lower Limit = -5

% 90% - Fractile: (X) 2.1% : (Y) 1.3%, Exceeded limits: 4.3%



XY Deflection Summary Report

Pipe under 5% (Deflection based off Median I.D. per frame of video)

Site ID
City Fountain, Colorado
Start No Center Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Center Pipe
Location Inlet

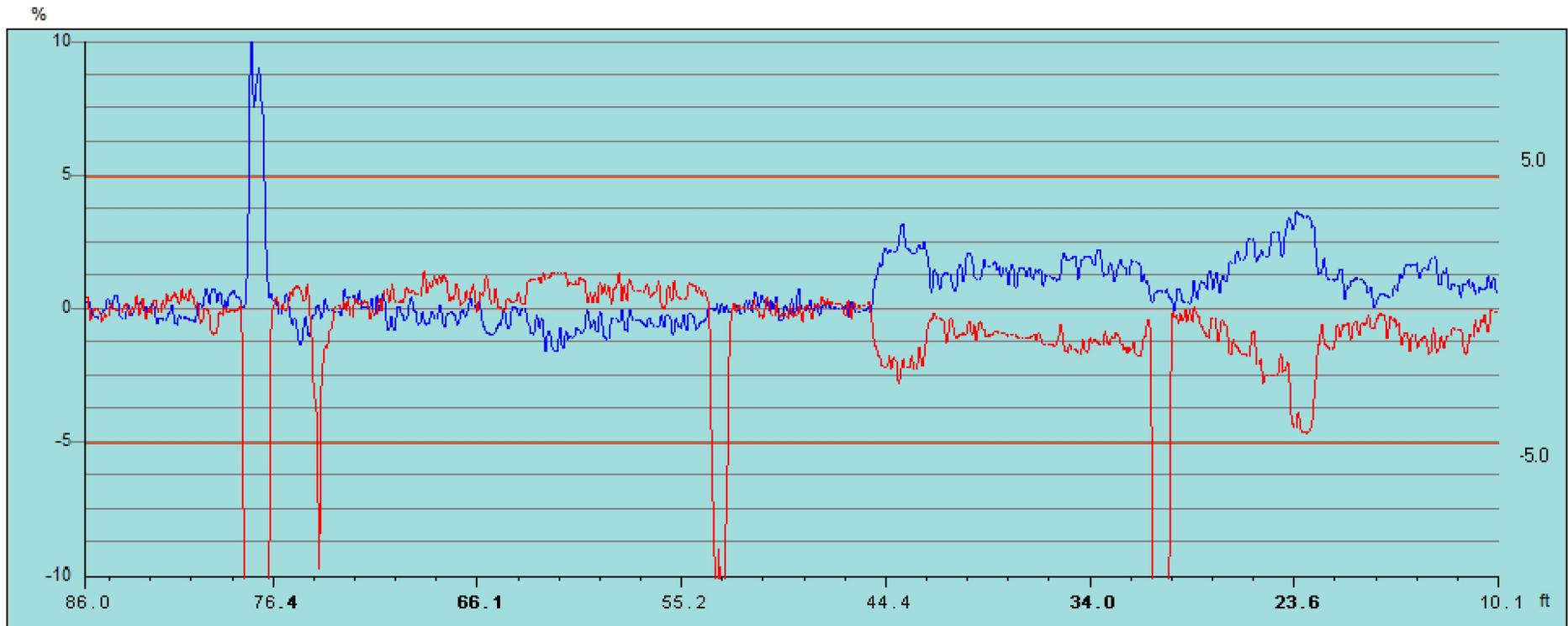
Date 10/9/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35 in

Comments

MP 123, I-25, Cross Drain, Center Pipe

Limit Lines

Upper limit = 5
Lower Limit = -5



Ovality Summary Report

Ovality under 5%, spikes due to camera going over joints

Site ID
City Fountain, Colorado
Start No Center Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Center Pipe
Location Inlet

Date 10/9/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35 in

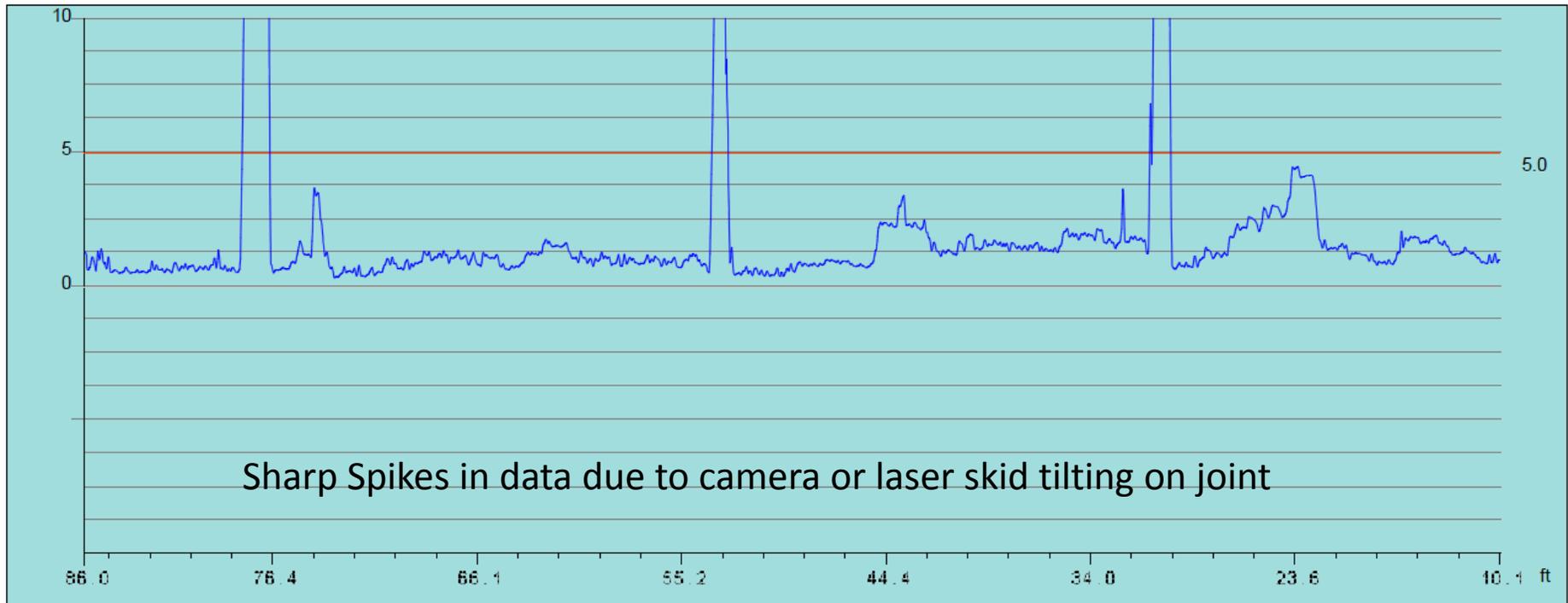
Comments

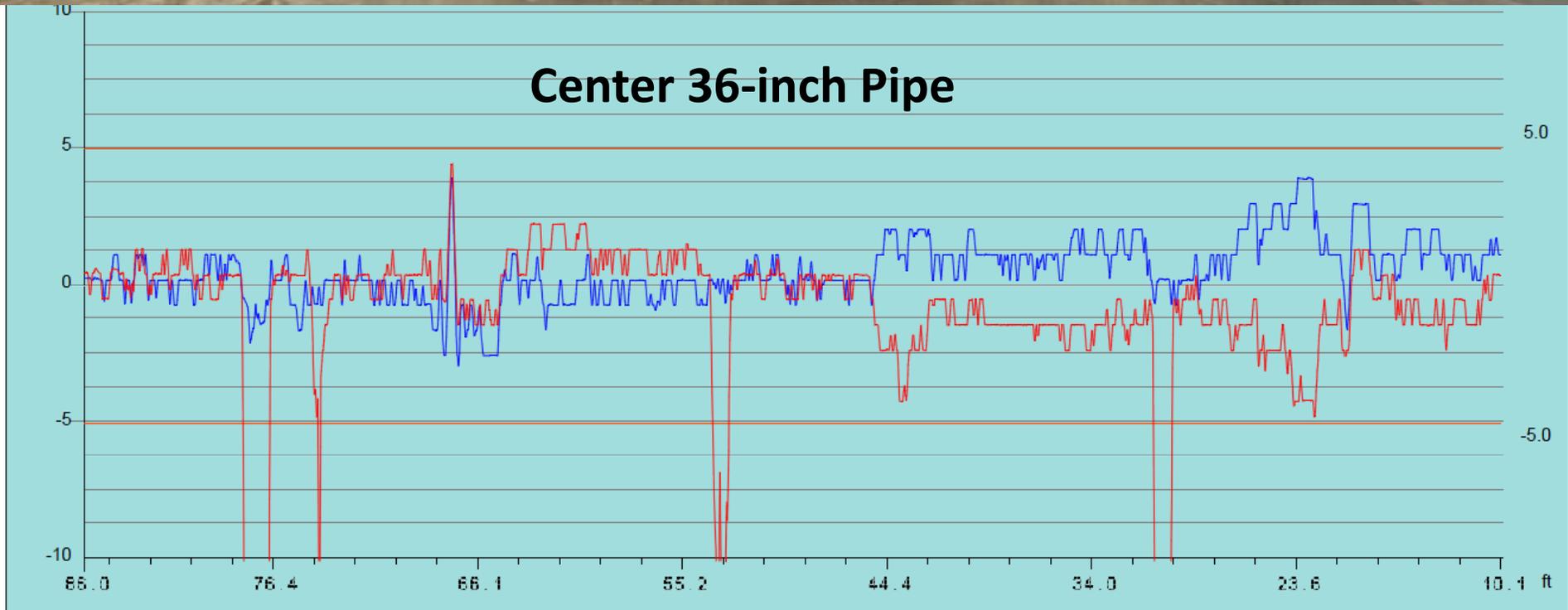
MP 123, I-25, Cross Drain, Center Pipe

Limit Lines
Upper limit = 5
Lower Limit = 5

90% - Fractile: 2.6%, Exceeded limits: 4.4%

Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance





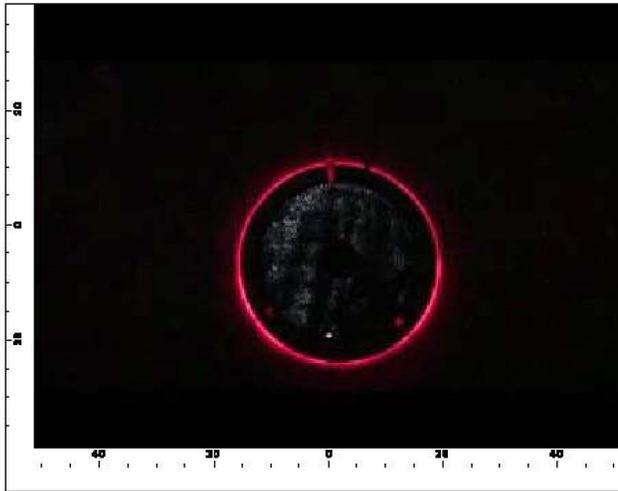
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Center Pipe)

Site ID
 City Fountain, Colorado
 Start No Center Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No Center Pipe
 Location Inlet

Date 10/9/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 35 in



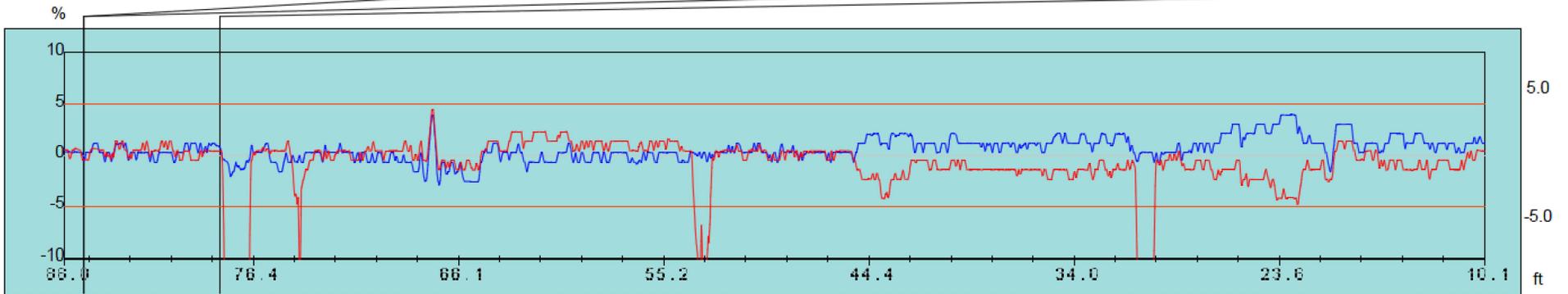
Laser picking up erosion control stakes driven through crown of pipe.



Stakes from erosion control devices.



Slight dent at left springline at 78 ft.



90% - Fractile: (X) 2.1% : (Y) 1.3%, Exceeded limits: 4.3%

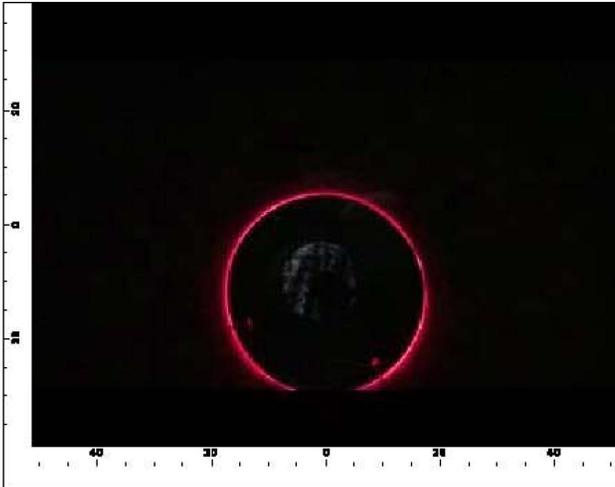
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Center Pipe)

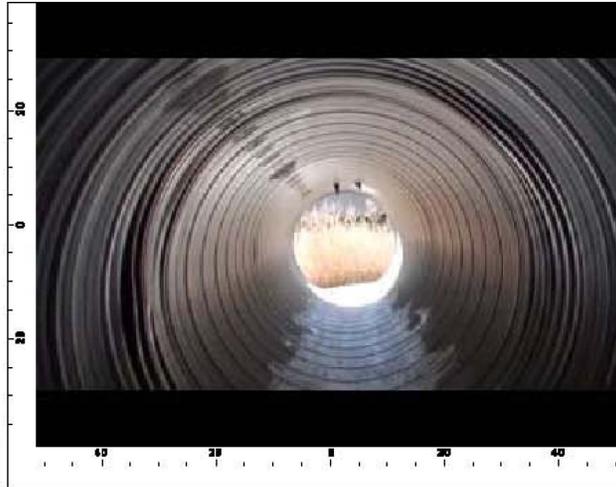
Site ID
 City Fountain, Colorado
 Start No Center Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No Center Pipe
 Location Inlet

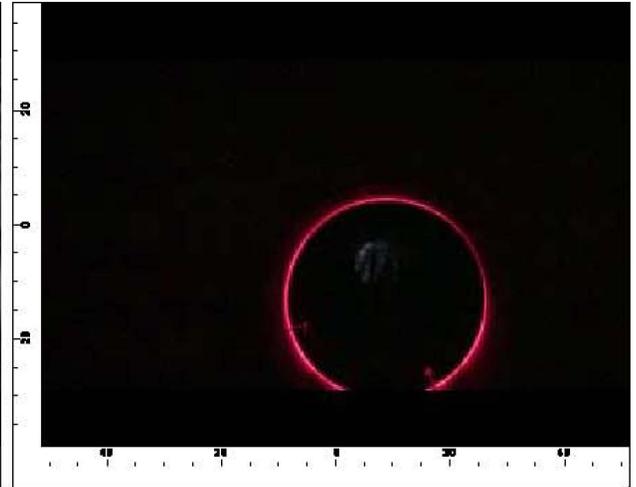
Date 10/9/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 35 in



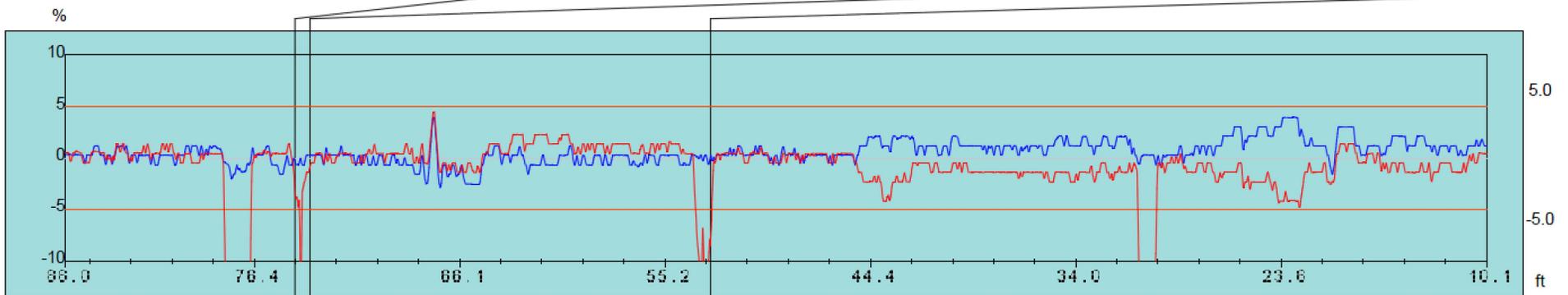
Camera tilted at joint



Slight dent at left springline at approx. 73 ft.



Camera tilting at joint



90% - Fractile: (X) 2.1% : (Y) 1.3%, Exceeded limits: 4.3%

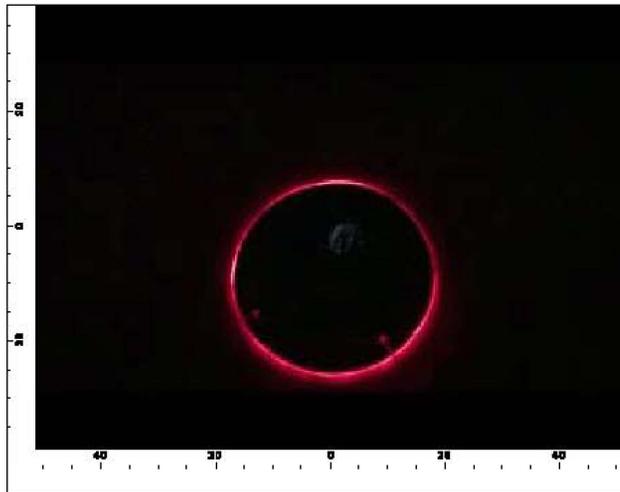
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Center Pipe)

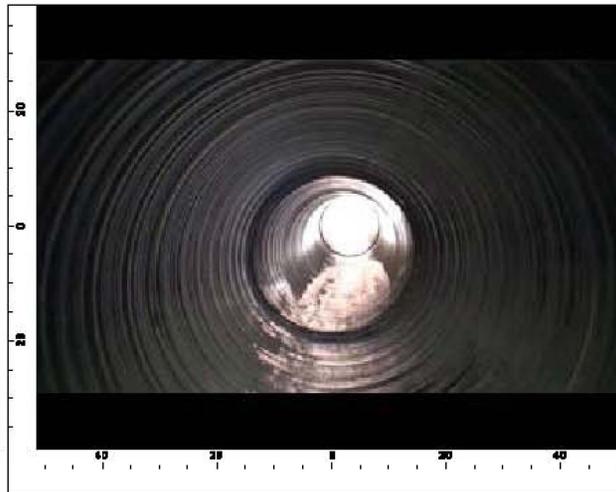
Site ID
 City Fountain, Colorado
 Start No Center Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No Center Pipe
 Location Inlet

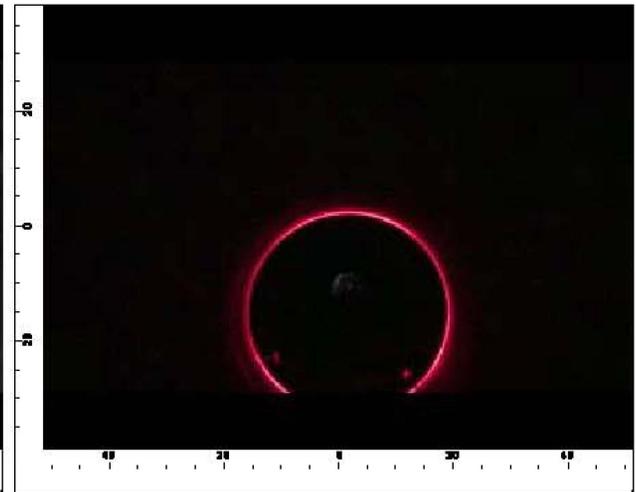
Date 10/9/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 35 in



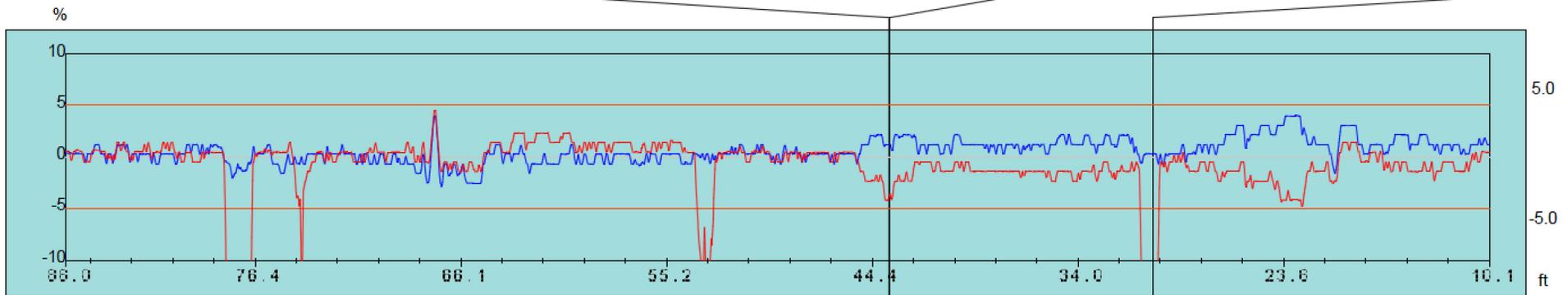
Deflection near second joint, approx. 3.8%.



View of second joint.



Camera tilting at joint



90% - Fractile: (X) 2.1% : (Y) 1.3%, Exceeded limits: 4.3%

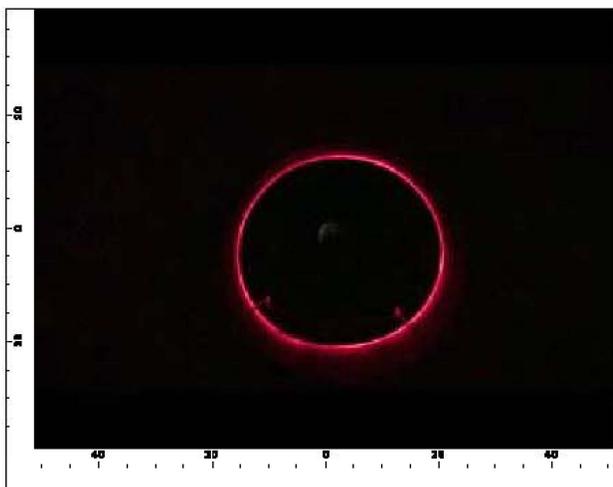
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Center Pipe)

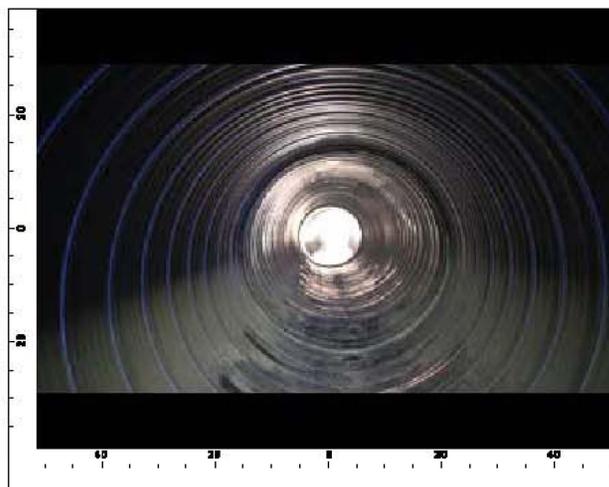
Site ID
City Fountain, Colorado
Start No Center Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Center Pipe
Location Inlet

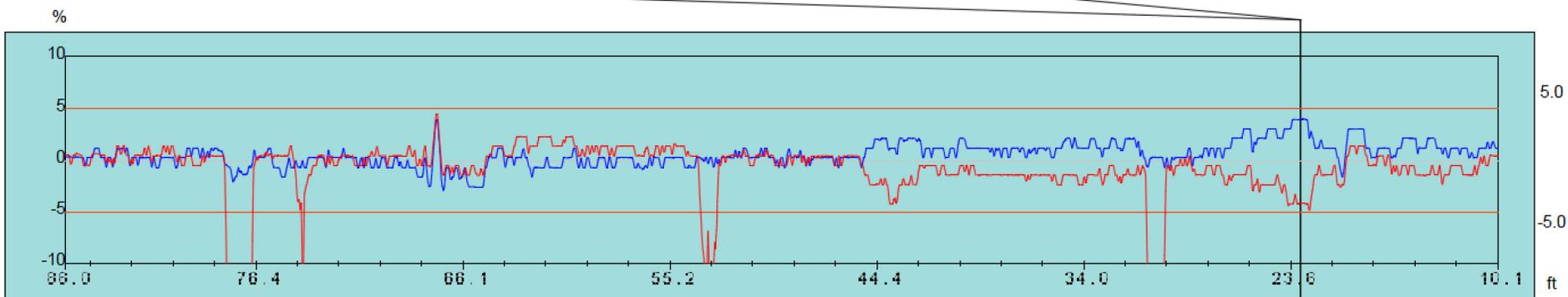
Date 10/9/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35 in



Pipe deflected approximately 4% at 23 ft.



View of pipe at first joint.



90% - Fractile: (X) 2.1% : (Y) 1.3%, Exceeded limits: 4.3%

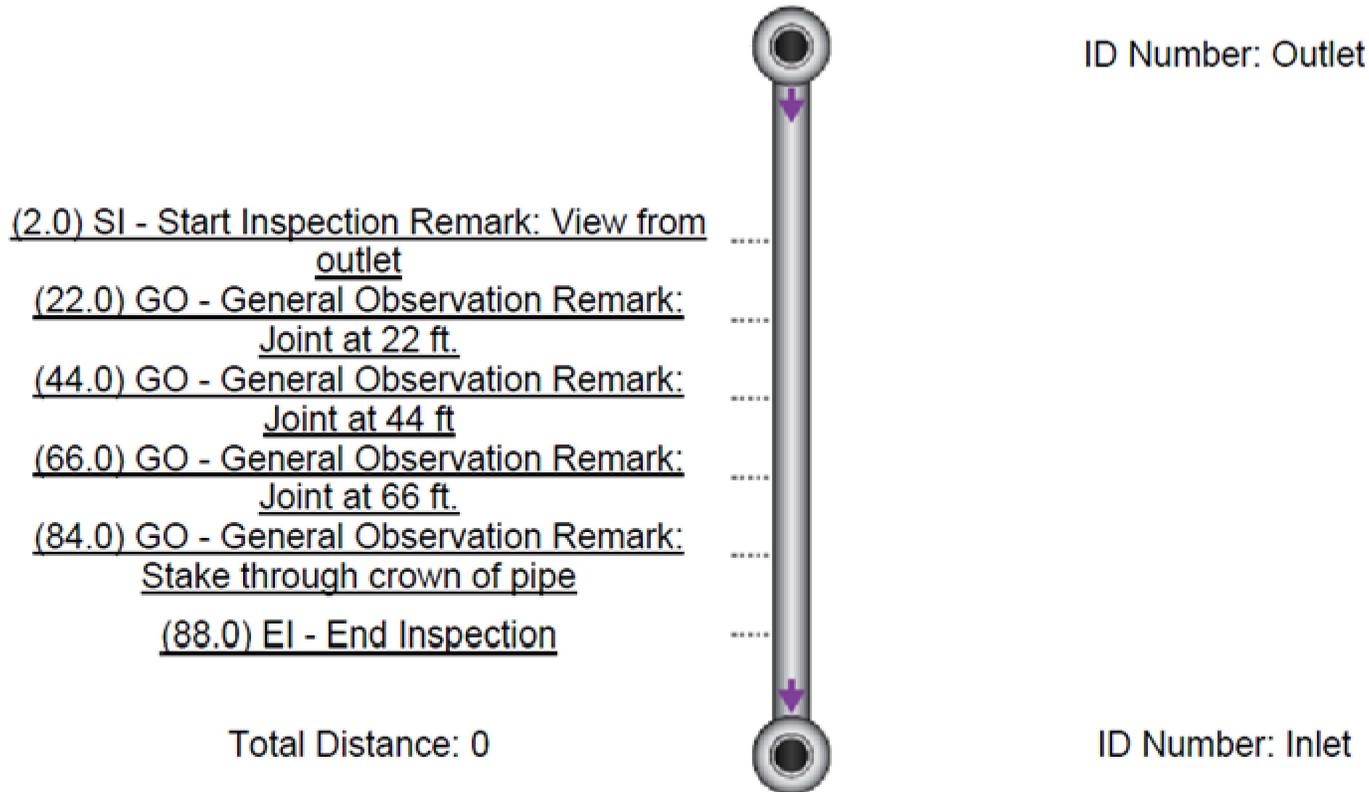
MP 123, I-25, 36-Inch DuroMaxx
Southern Pipe



Project Name: I-25, Fountain, Colorado

Date: 9/30/2013
Asset Location:
Distance: 0
Run Number:
Pipe Size: 36

Pipe ID: Southern Pipe
Start ID: Outlet
End ID: Inlet
Direction: Upstrm
Pipe Type: DuroMaxx



Project Name: I-25, Fountain, Colorado

Date: 9/30/2013
Asset Location:
Distance: 0
Run Number:
Pipe Size: 36

Pipe ID: Southern Pipe
Start ID: Outlet
End ID: Inlet
Direction: Upstrm
Pipe Type: DuroMaxx

Distance	Fault Observation	Time	Picture
2.0	Start Inspection Remarks: View from outlet	01:47 00:00:00	
22.0	General Observation Remarks: Joint at 22 ft.	2:30:17 00:00:36	
44.0	General Observation Remarks: Joint at 44 ft	2:31:30 00:01:05	

Distance	Fault Observation	Time	Picture
66.0	General Observation Remarks: Joint at 66 ft.	2:32:18 00:01:26	
84.0	General Observation Remarks: Stake through crown of pipe	2:33:18 00:01:54	
88.0	End Inspection	2:33:47 00:02:01	

XY Diameter Summary Report

Pipe under 5% deflection, spikes in data due to camera tilting at joint

Site ID
City Fountain, Colorado
Start No Southern Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Southern Pipe
Location Inlet

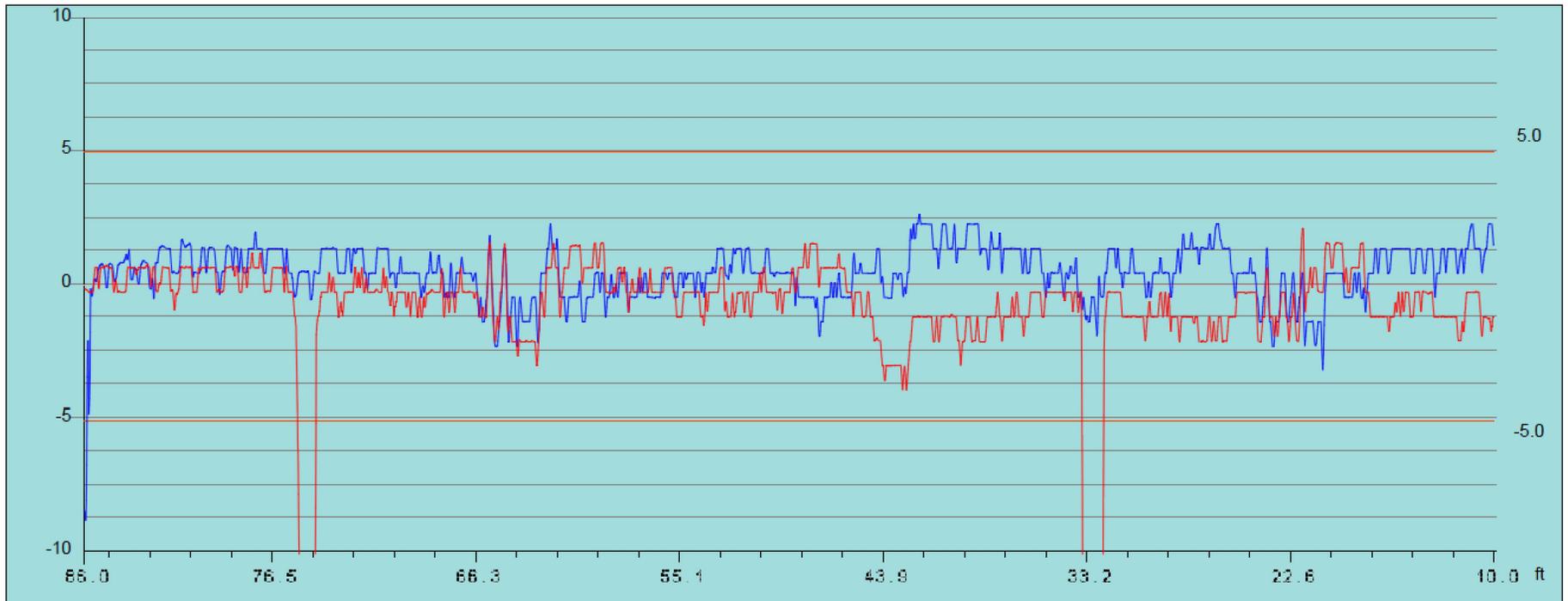
Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35.24 in

Comments

I-25, MP 123, 36-inch Southern Pipe, Cross Drain

Limit Lines
Upper limit = 5
Lower Limit = -5

% 90% - Fractile: (X) 1.4% : (Y) 0.7%, Exceeded limits: 2.9%



XY Deflection Summary Report

Pipe under 5% (Deflection based off Median I.D. per frame of video)

Site ID
City Fountain, Colorado
Start No Southern Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Southern Pipe
Location Inlet

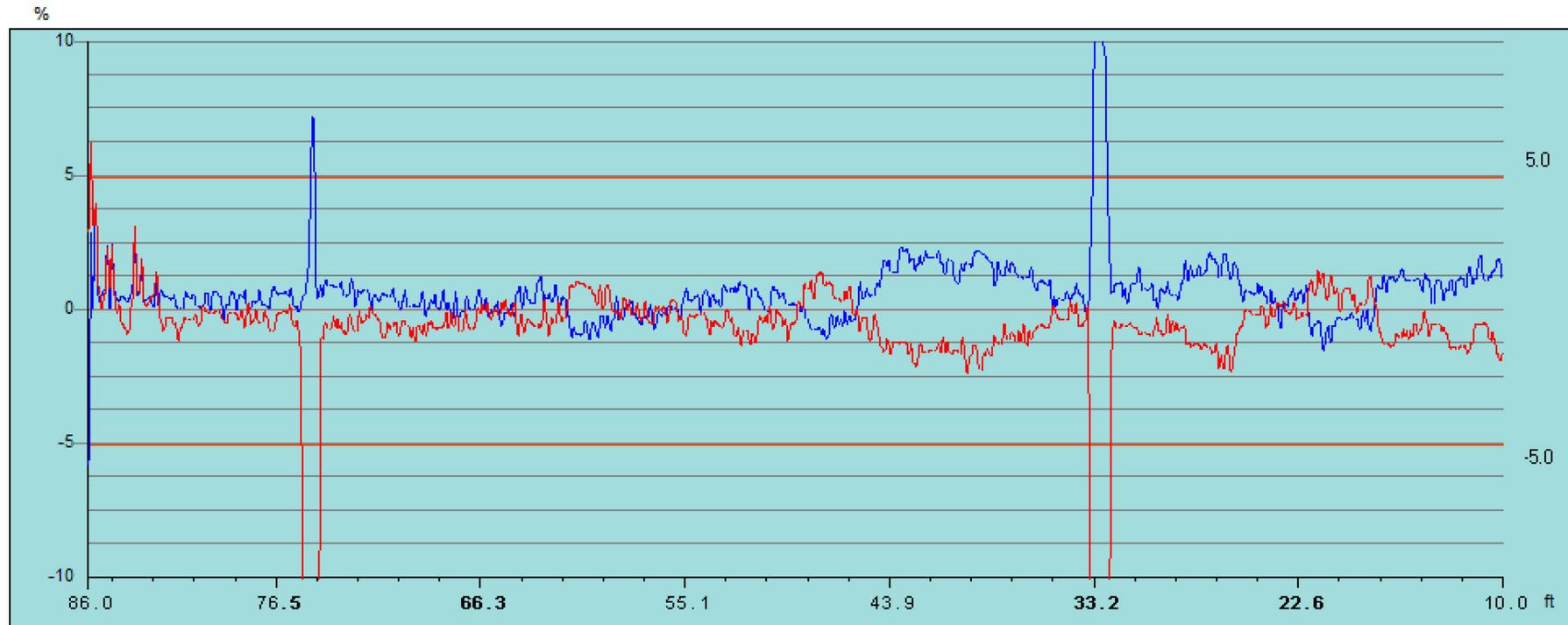
Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35.24 in

Comments

I-25, MP 123, 36-inch Southern Pipe, Cross Drain

Limit Lines

Upper limit = 5
Lower Limit = -5



Ovality Summary Report

Ovality under 5%, spikes due to camera going over joint

Site ID
City Fountain, Colorado
Start No Southern Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Southern Pipe
Location Inlet

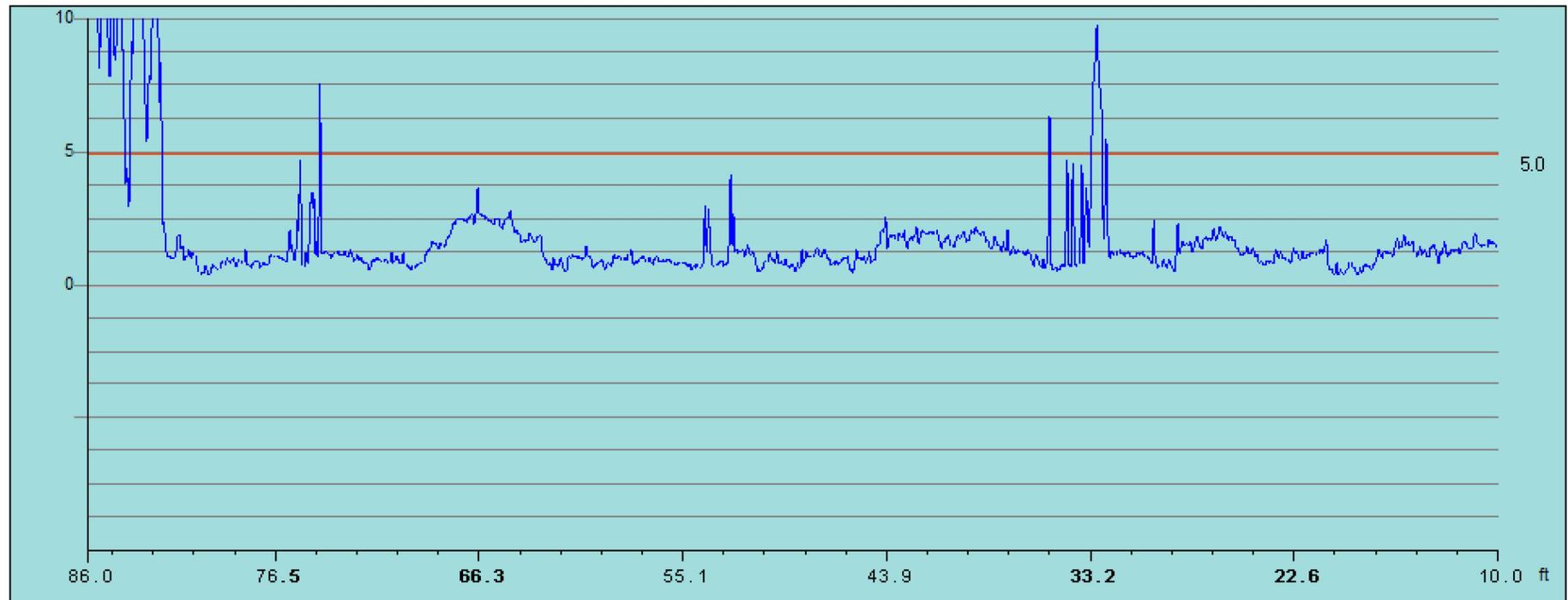
Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35.24 in

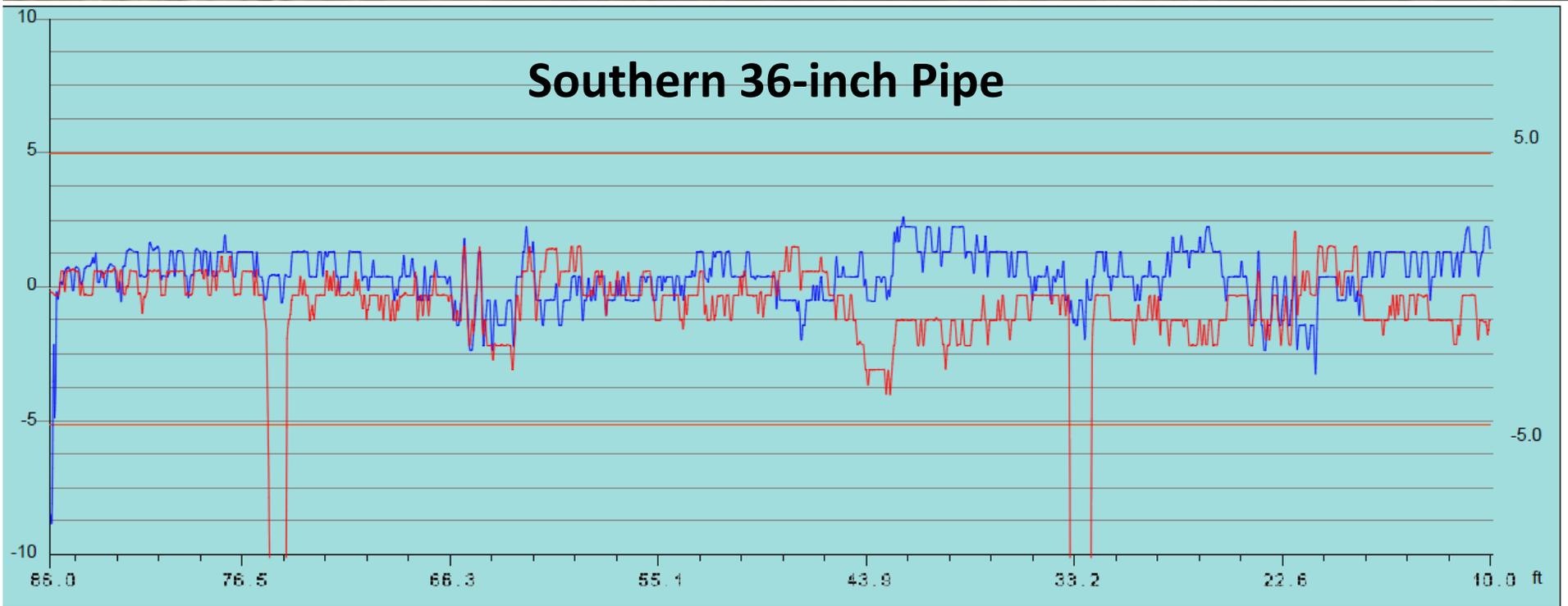
Comments

I-25, MP 123, 36-inch Southern Pipe, Cross Drain

Limit Lines
Upper limit = 5
Lower Limit = 5

90% - Fractile: 2.6%, Exceeded limits: 5.6% Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance





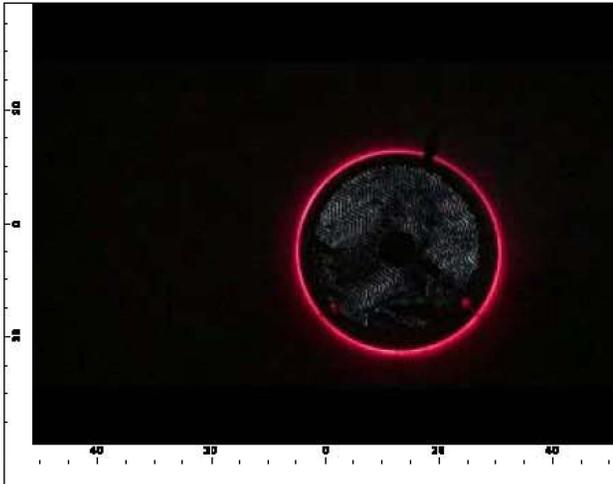
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Southern Pipe)

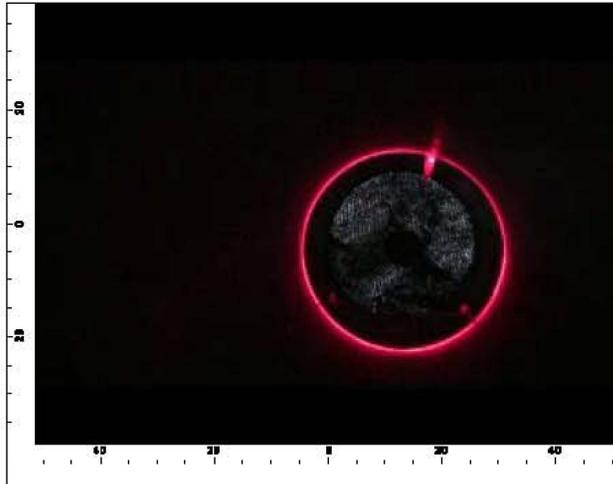
Site ID
 City Fountain, Colorado
 Start No Southern Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No Southern Pipe
 Location Inlet

Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 35.24 in



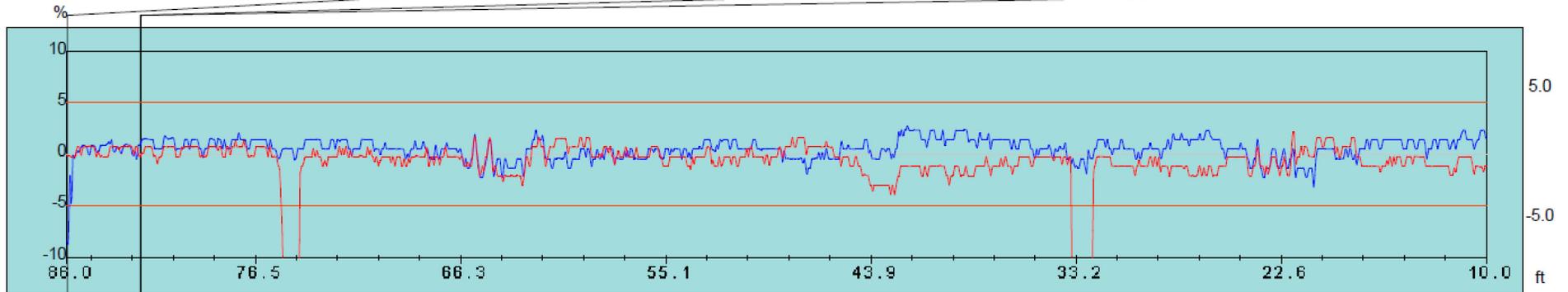
Noise in data due to outside light. Pipe okay.



Laser passing under erosion control stake driven through crown of pipe.



View of erosion control stake through crown of structure.



90% - Fractile: (X) 1.4% : (Y) 0.7%, Exceeded limits: 2.9%

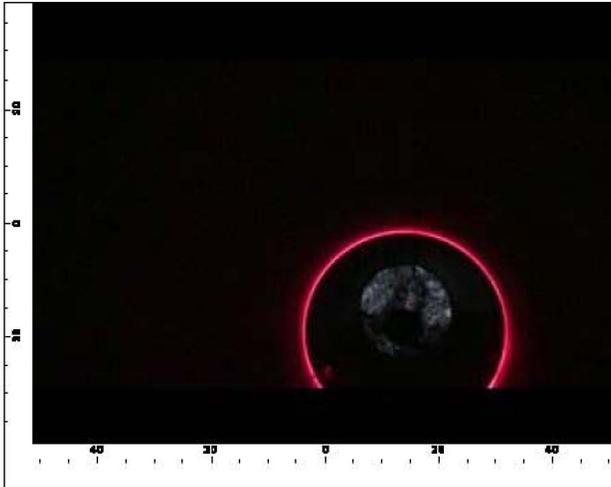
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Southern Pipe)

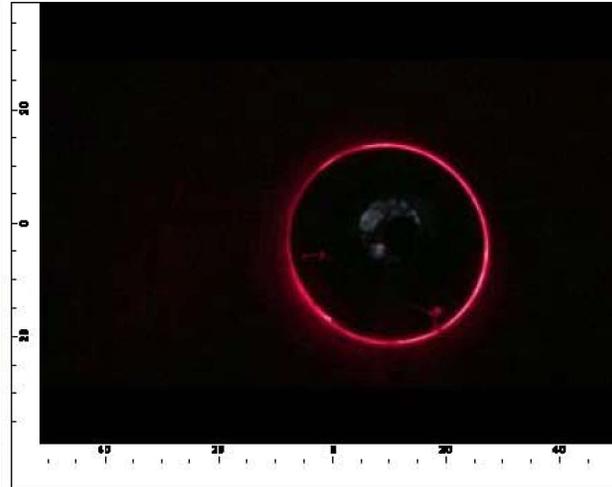
Site ID
City Fountain, Colorado
Start No Southern Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Southern Pipe
Location Inlet

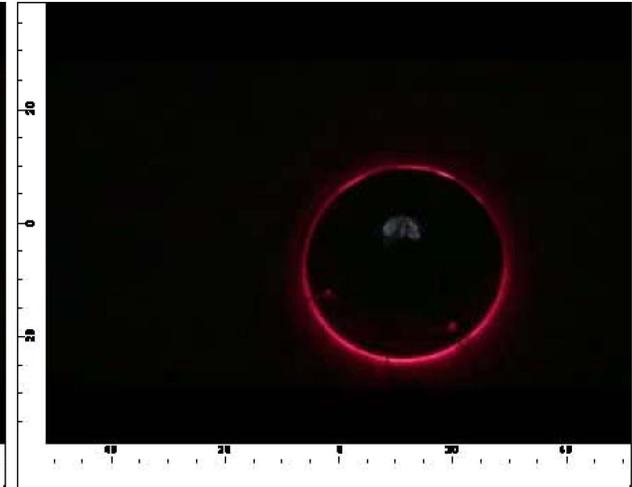
Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35.24 in



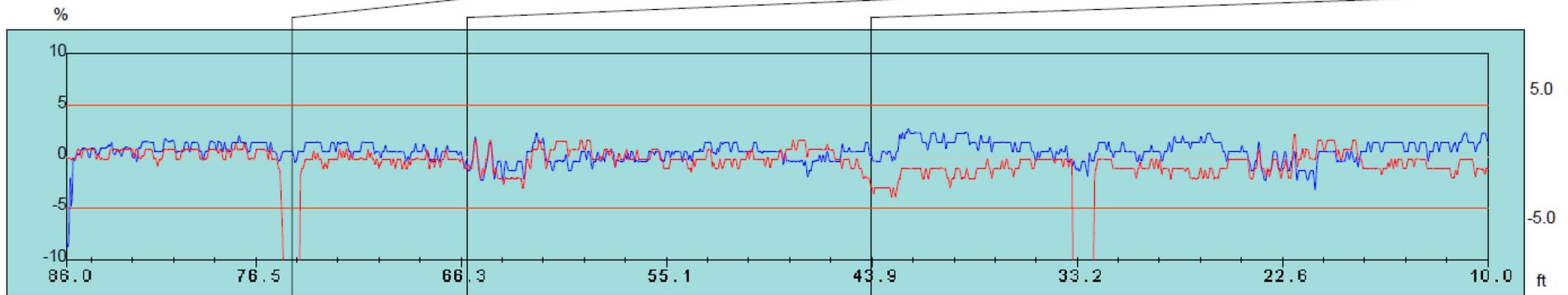
Camera tilted at joint



Laser passing over joint at 66 ft.



Laser passing over joint at 44 ft.



90% - Fractile: (X) 1.4% : (Y) 0.7%, Exceeded limits: 2.9%

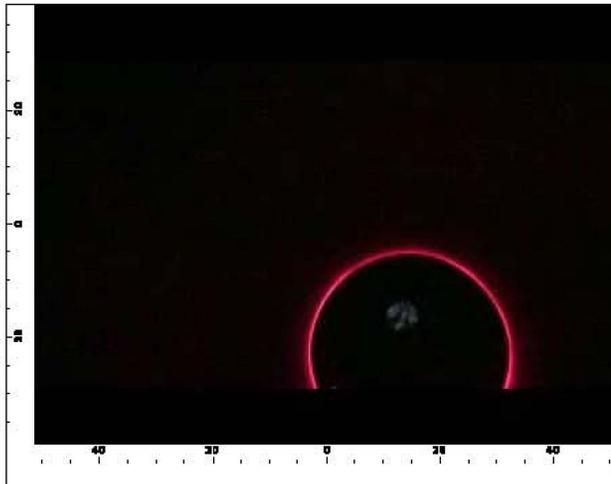
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Southern Pipe)

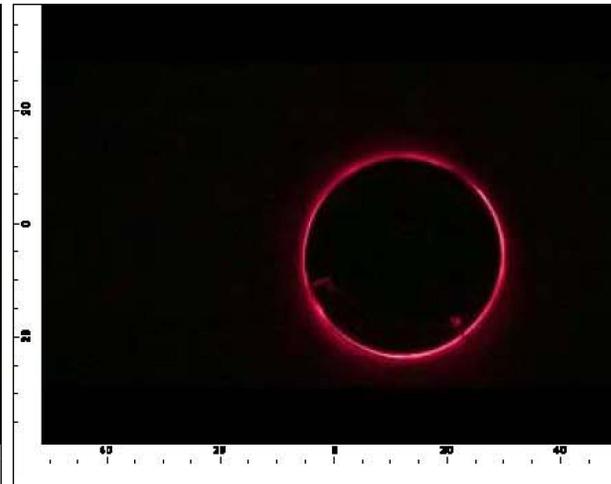
Site ID
 City Fountain, Colorado
 Start No Southern Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No Southern Pipe
 Location Inlet

Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 35.24 in



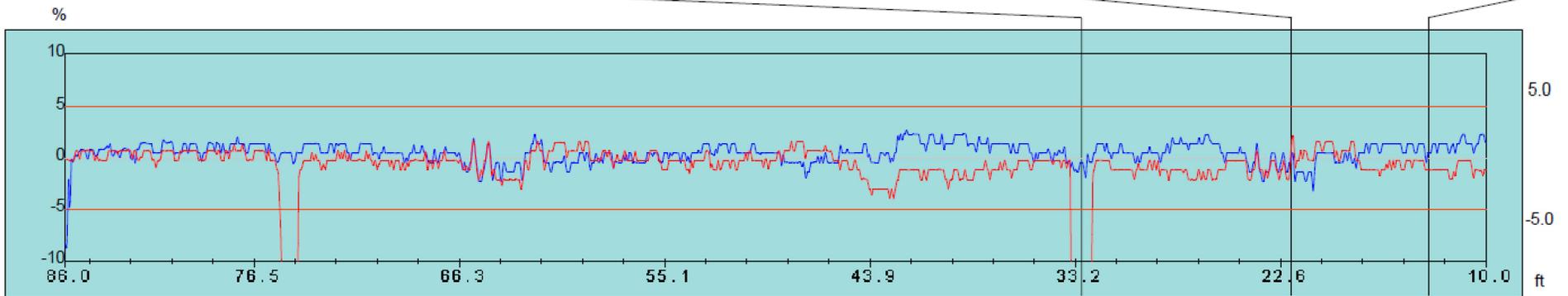
Camera tilted on second joint, pipe okay.



Laser passing over first joint at 22 ft.



View of pipe towards outlet end of the structure. Pipe appears to be round and uniform.



90% - Fractile: (X) 1.4% : (Y) 0.7%, Exceeded limits: 2.9%

MP 122.5, I-25, 48-Inch DuroMaxx







Project Name: I-25, Fountain, Colorado

Date: 9/30/2013

Asset Location:

Distance: 0

Run Number:

Pipe Size: 48-inch

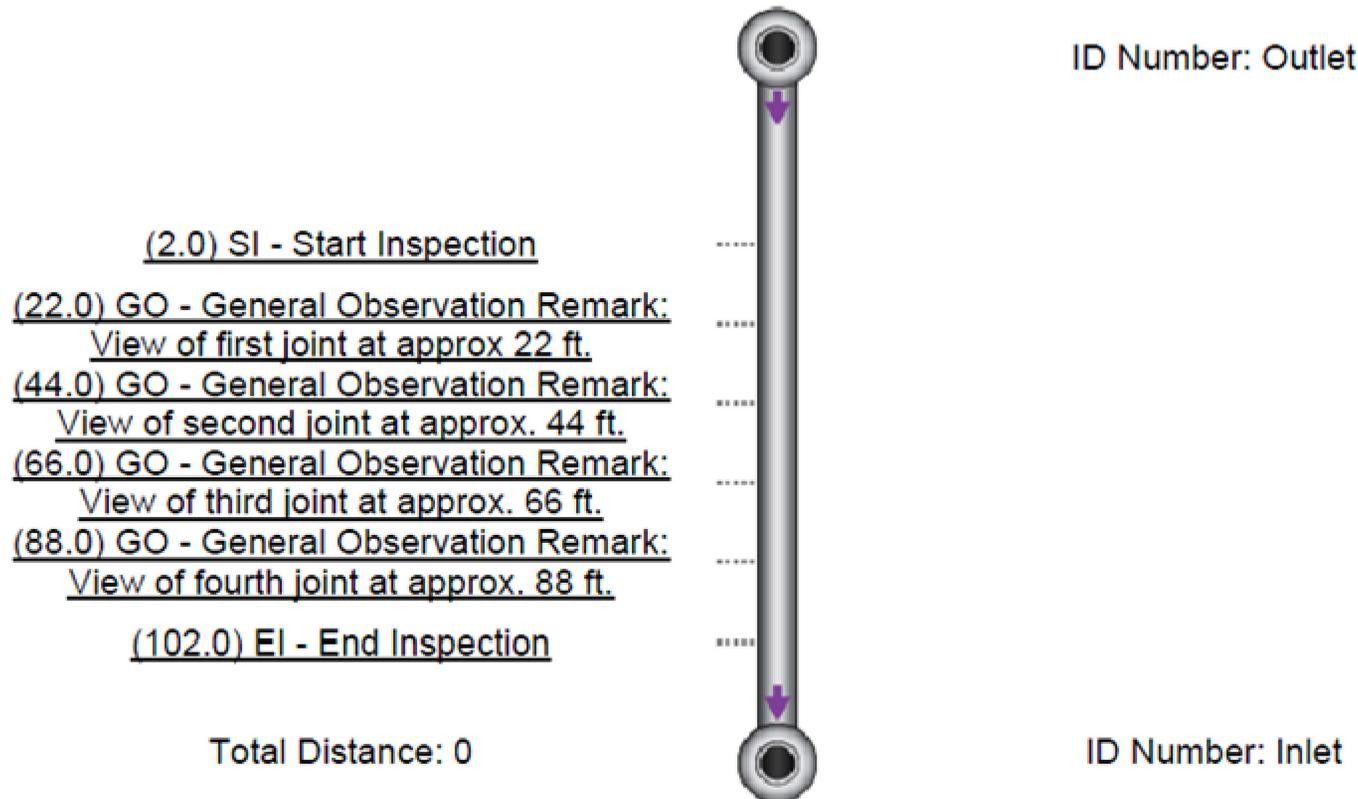
Pipe ID: MP 122.5

Start ID: Outlet

End ID: Inlet

Direction: Upstrm

Pipe Type: DuroMaxx



Project Name: I-25, Fountain, Colorado

Date: 9/30/2013

Asset Location:

Distance: 0

Run Number:

Pipe Size: 48-inch

Pipe ID: MP 122.5

Start ID: Outlet

End ID: Inlet

Direction: Upstrm

Pipe Type: DuroMaxx

Distance	Fault Observation	Time	Picture
2.0	Start Inspection	04:18 00:00:00	
22.0	General Observation Remarks: View of first joint at approx 22 ft.	06:09 00:00:48	
44.0	General Observation Remarks: View of second joint at approx. 44 ft.	07:51 00:01:24	

Distance	Fault Observation	Time	Picture
66.0	<p>General Observation Remarks: View of third joint at approx. 66 ft.</p>	<p>10:39 00:01:53</p>	 <p>01_01_1879_00:01:53-10</p>
88.0	<p>General Observation Remarks: View of fourth joint at approx. 88 ft.</p>	<p>11:51 00:02:27</p>	 <p>01_01_1879_00:02:27-00</p>
102.0	<p>End Inspection</p>	<p>13:12 00:03:15</p>	 <p>01_01_1879_00:03:15-10</p>

XY Diameter Summary Report

Pipe under 5% deflection, spikes in data due to camera tilting at joint

Site ID
City Fountain, Colorado
Start No Outlet
Location MP 122.5

Asset No. I-25, MP 122.5
Finish No Inlet
Location MP 122.5

Date 9/30/2013
Material DuroMaxx
Pipeline Length 102 ft
Internal Diameter (Expected) 46.92 in

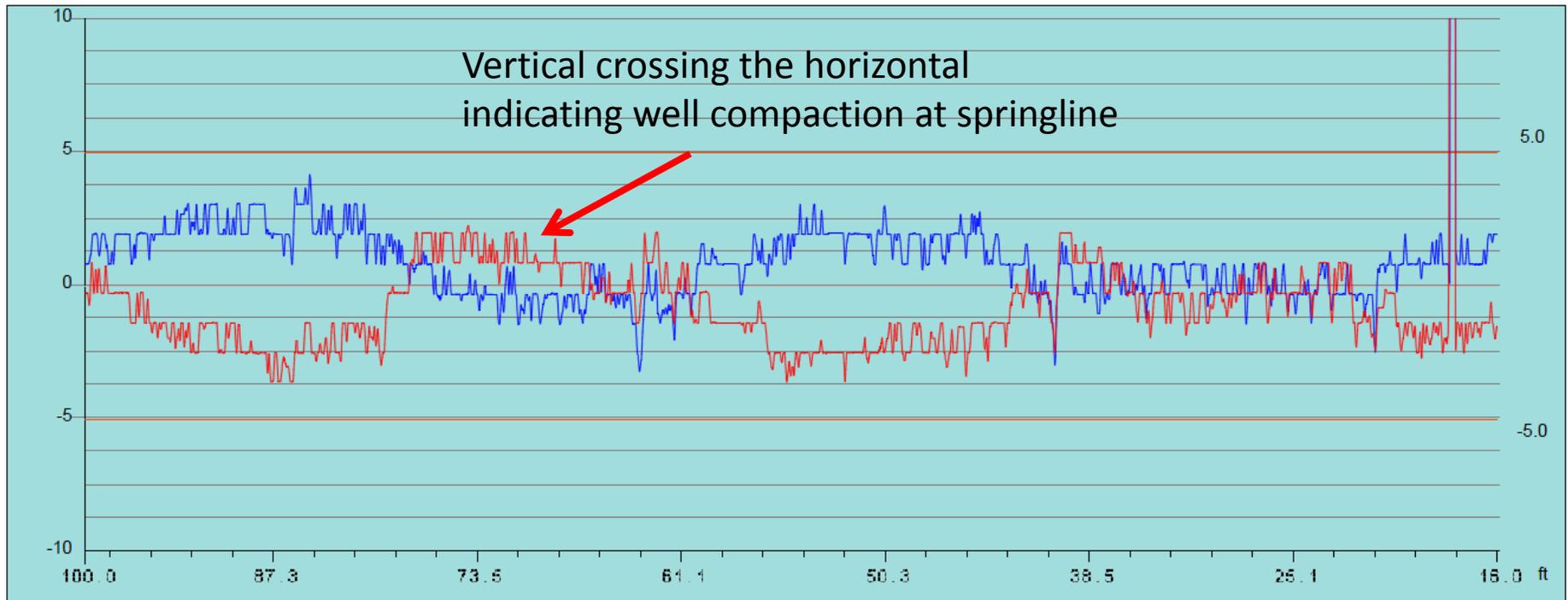
Comments

I-25, MP 122.5, 48-inch DuroMaxx

Limit Lines

Upper limit = 5
Lower Limit = -5

90% - Fractile: (X) 2.2% : (Y) 0.9%, Exceeded limits: 0.3%



XY Deflection Summary Report

Pipe under 5% (Deflection based off Median I.D. per frame of video)

Site ID
City Fountain, Colorado
Start No Outlet
Location MP 122.5

Asset No. I-25, MP 122.5
Finish No Inlet
Location MP 122.5

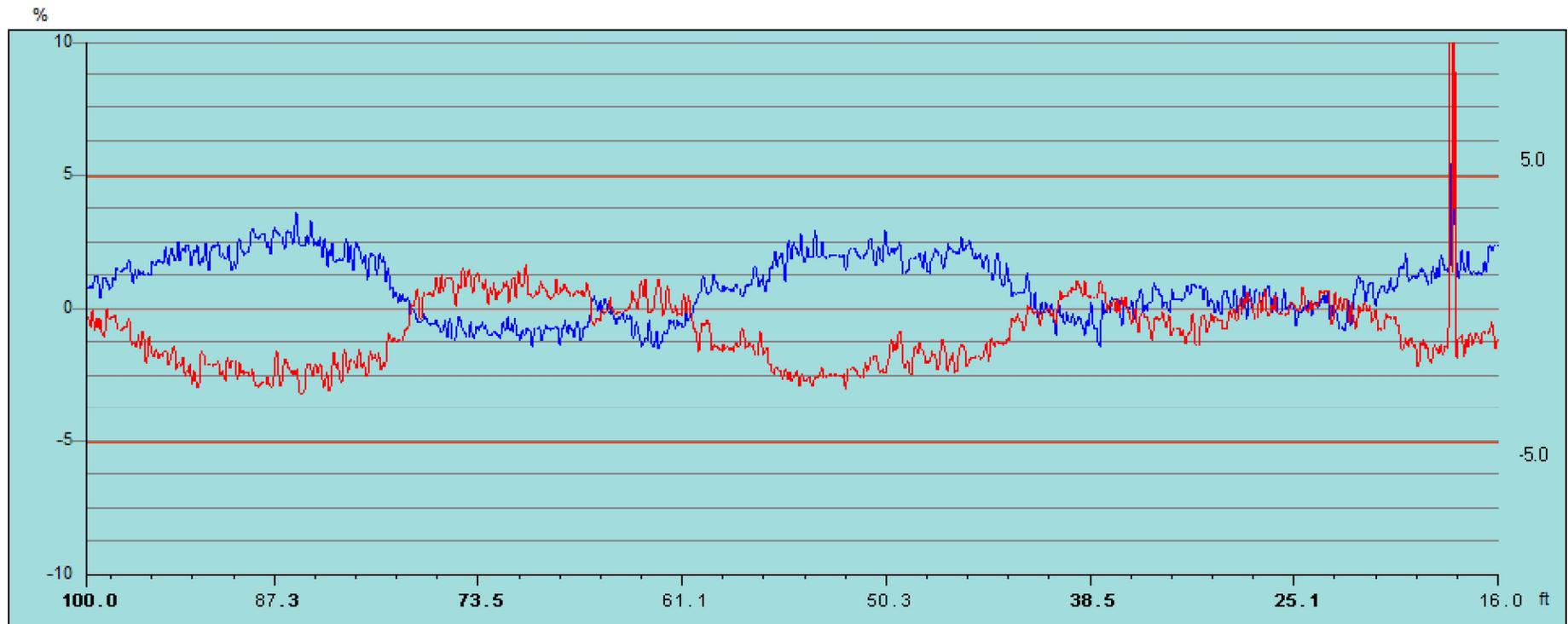
Date 9/30/2013
Material DuroMaxx
Pipeline Length 102 ft
Internal Diameter (Expected) 46.92 in

Comments

I-25, MP 122.5, 48-inch DuroMaxx

Limit Lines

Upper limit = 5
Lower Limit = -5



Ovality Summary Report

Ovality under 5%, spikes due to camera going over joint

Site ID
City Fountain, Colorado
Start No Outlet
Location MP 122.5

Asset No. I-25, MP 122.5
Finish No Inlet
Location MP 122.5

Date 9/30/2013
Material DuroMaxx
Pipeline Length 102 ft
Internal Diameter (Expected) 46.92 in

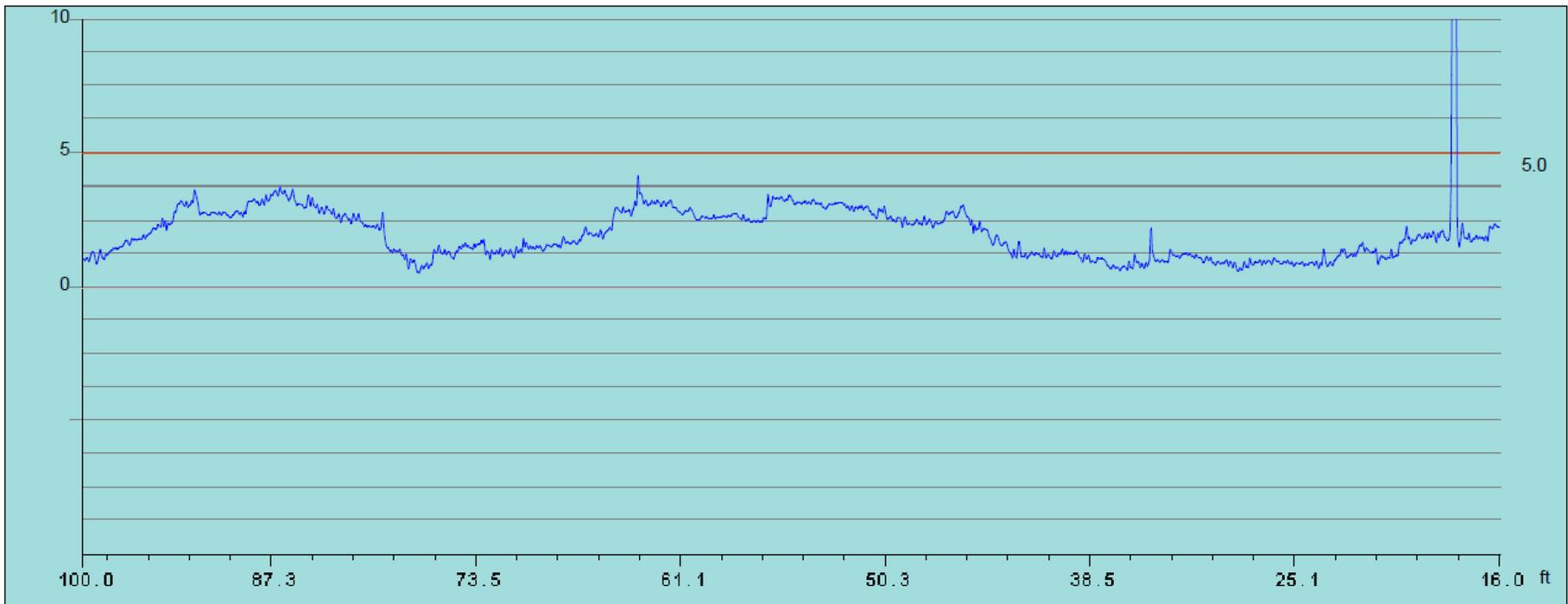
Comments

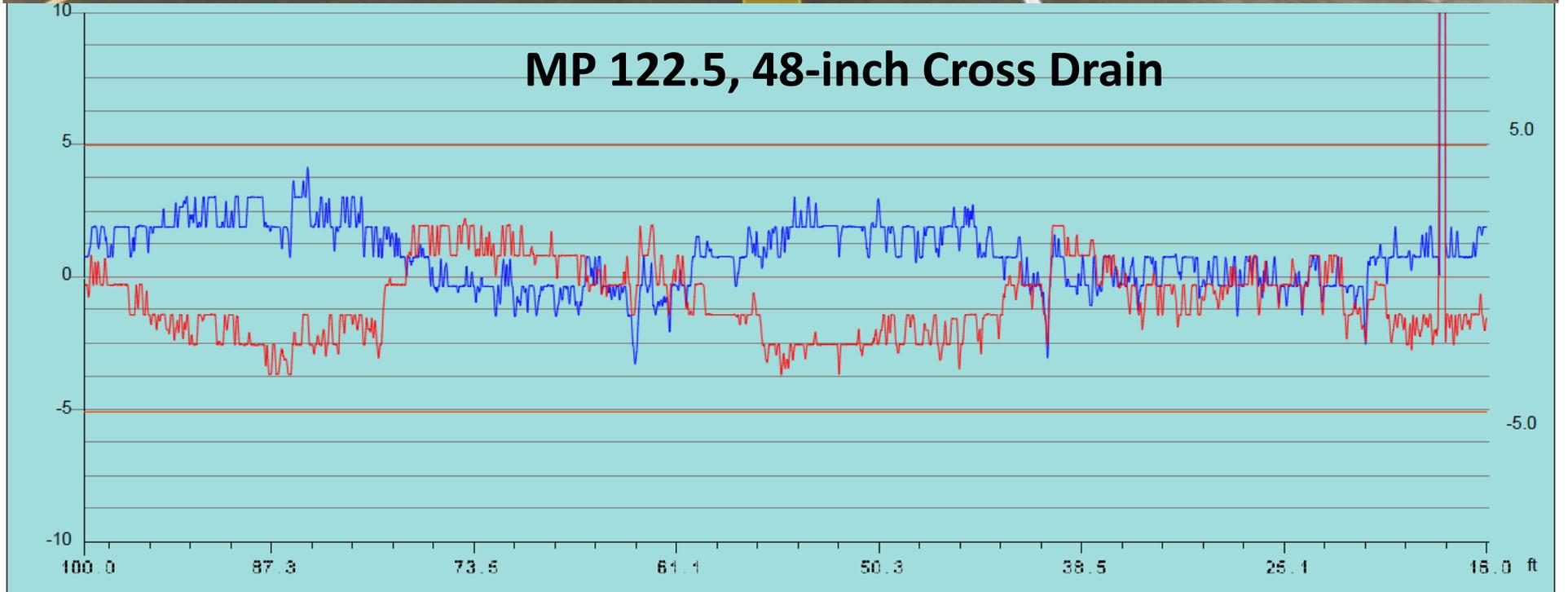
I-25, MP 122.5, 48-inch DuroMaxx

Limit Lines
Upper limit = 5
Lower Limit = 5

90% - Fractile: 3.2%, Exceeded limits: 0.3%

Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance





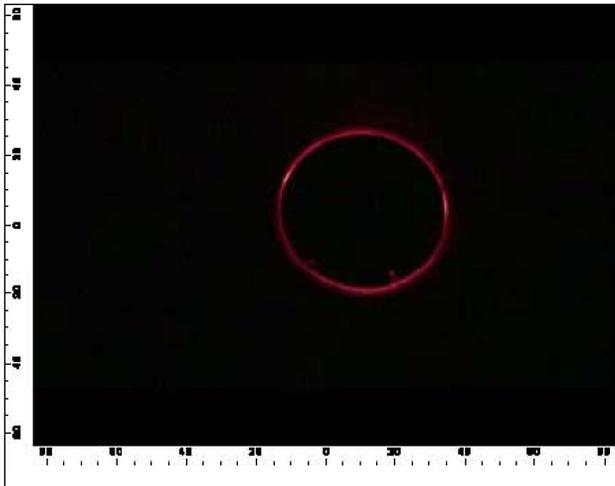
XY Deflection Observations Report

MP 122.5, I-25, DuroMaxx Installation, Fountain, Colorado

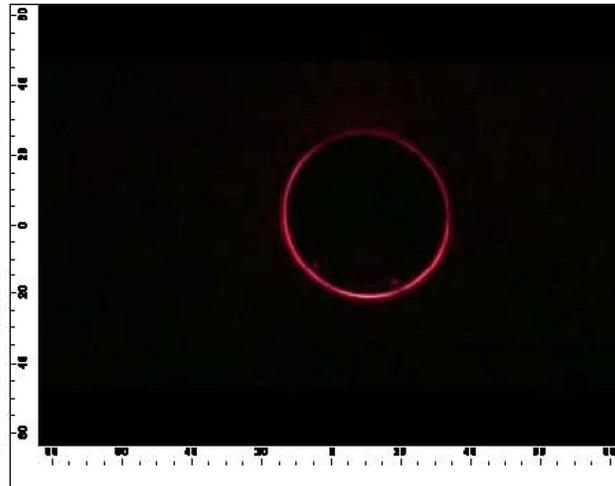
Site ID
 City Fountain, Colorado
 Start No Outlet
 Location MP 122.5

Asset No. I-25, MP 122.5
 Finish No Inlet
 Location MP 122.5

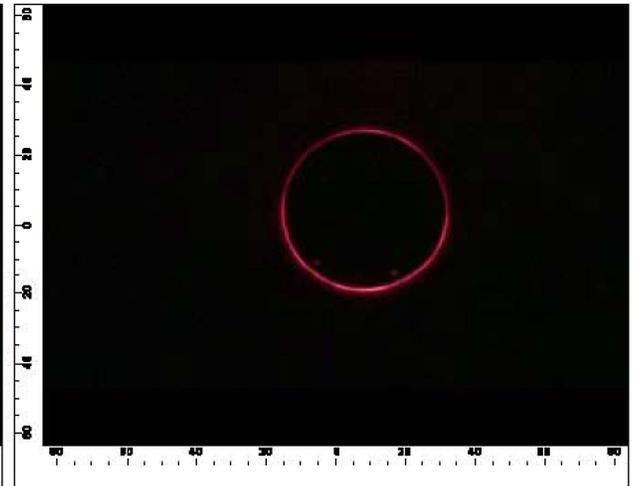
Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 102 ft
 Internal Diameter (Expected) 46.92 in



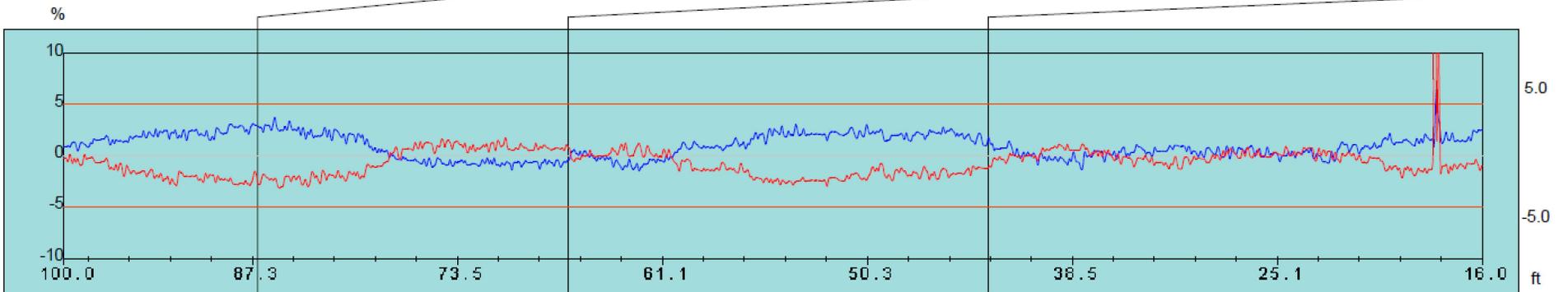
Joint at approx 88 ft.



Joint at approx. 66 ft.



Joint at approx. 44 ft.



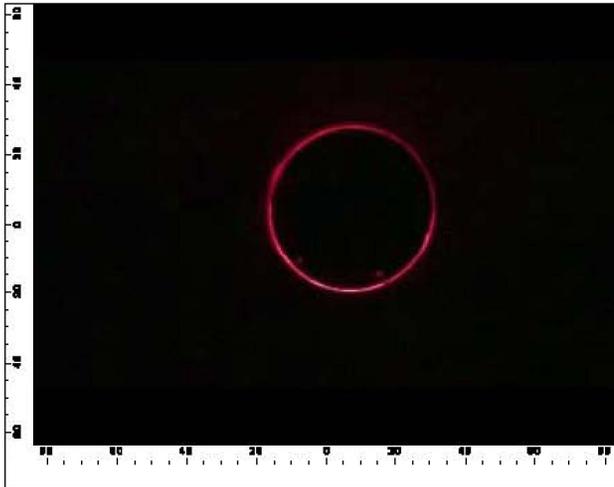
XY Deflection Observations Report

MP 122.5, I-25, DuroMaxx Installation, Fountain, Colorado

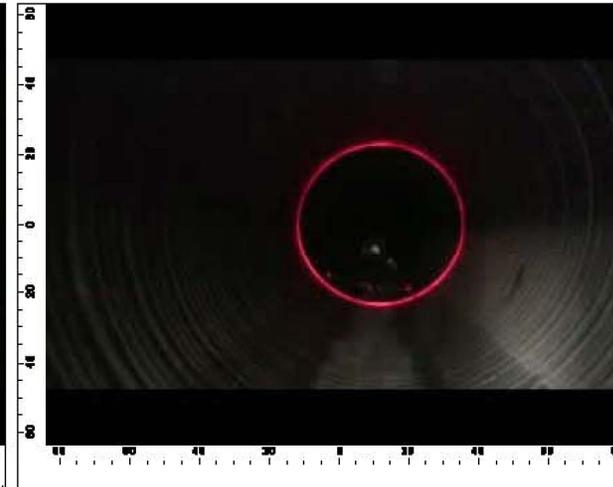
Site ID
 City Fountain, Colorado
 Start No Outlet
 Location MP 122.5

Asset No. I-25, MP 122.5
 Finish No Inlet
 Location MP 122.5

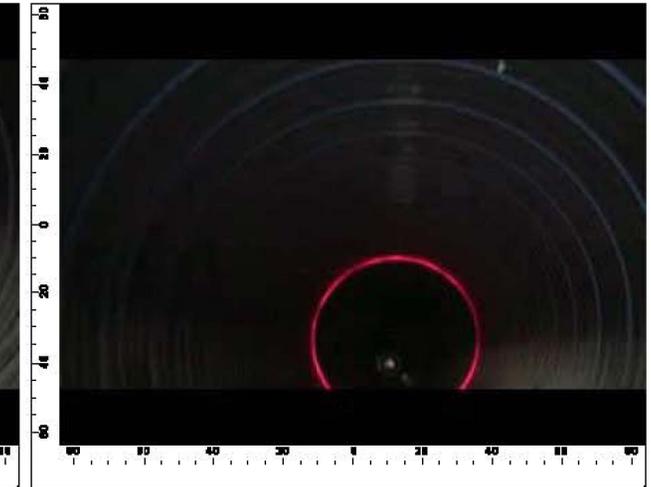
Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 102 ft
 Internal Diameter (Expected) 46.92 in



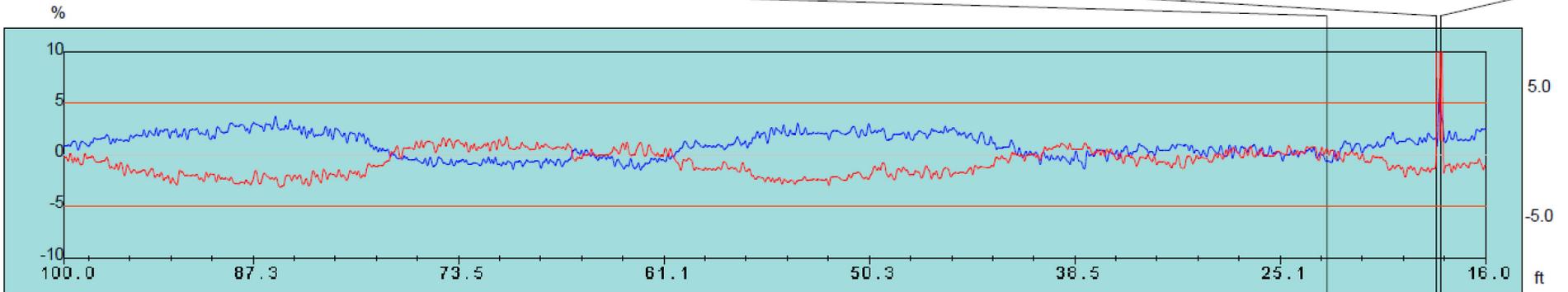
Joint at approx. 22 ft.



Spike due to outside light noise.



Camera tilted near outlet



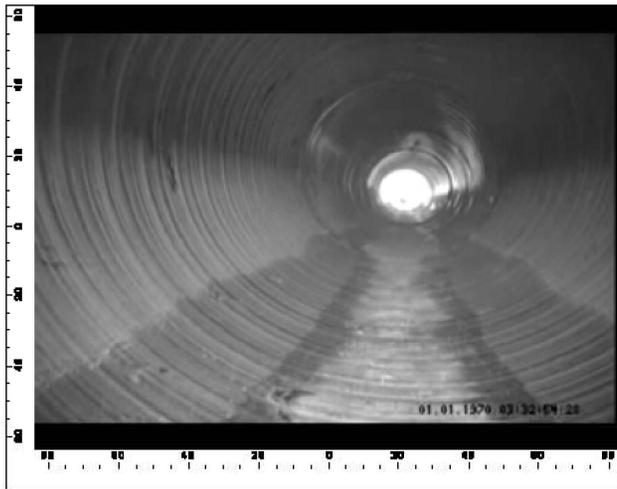
XY Deflection Observations Report

MP 122.5, I-25, DuroMaxx Installation, Fountain, Colorado

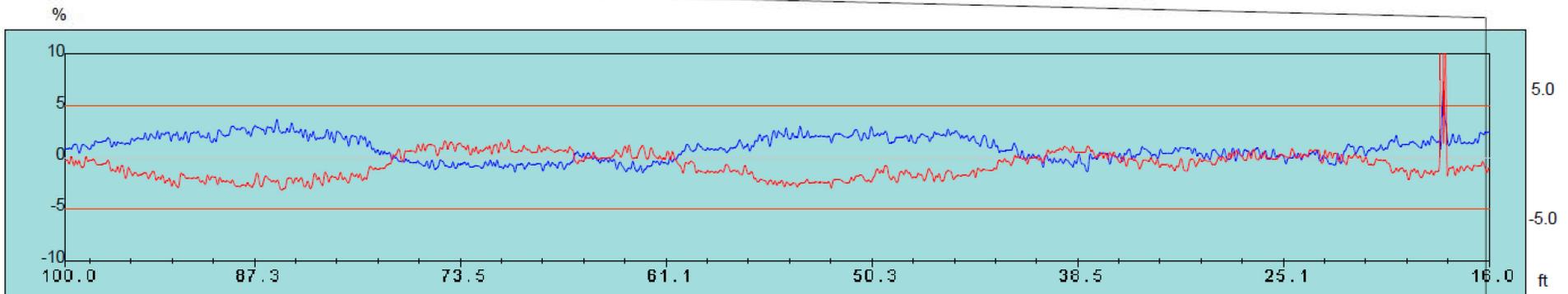
Site ID
 City Fountain, Colorado
 Start No Outlet
 Location MP 122.5

Asset No. I-25, MP 122.5
 Finish No Inlet
 Location MP 122.5

Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 102 ft
 Internal Diameter (Expected) 46.92 in



View of pipe from outlet



MP 122, I-25, 48-Inch DuroMaxx



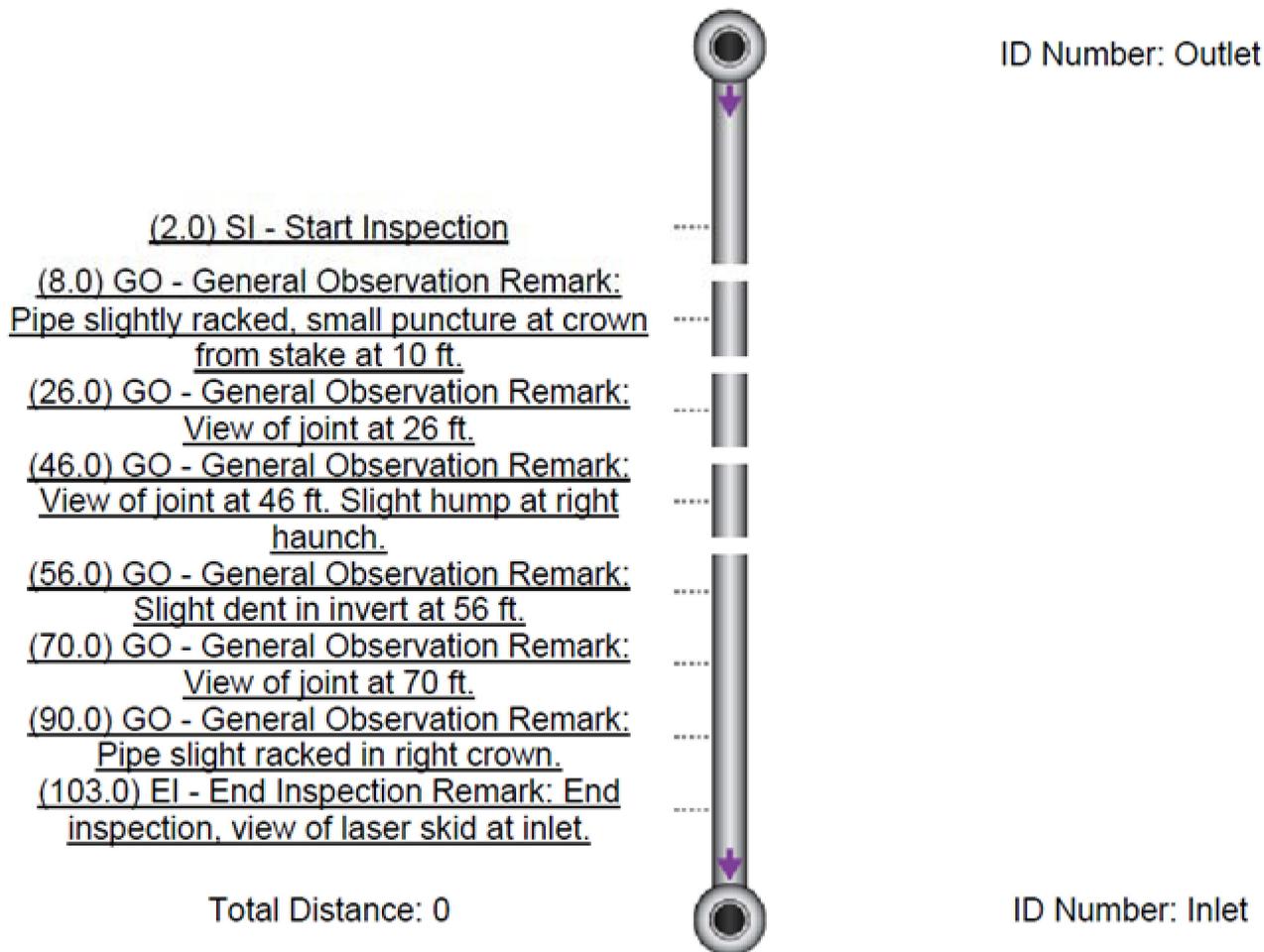






Project Name: I-25, Fountain, Colorado

Date: Pipe ID: MP 122
Asset Location: Start ID: Outlet
Distance: 0 End ID: Inlet
Run Number: Direction: Upstrm
Pipe Size: 48-inch Pipe Type: DuroMaxx



Project Name: I-25, Fountain, Colorado

Date:
Asset Location:
Distance: 0
Run Number:
Pipe Size: 48-inch

Pipe ID: MP 122
Start ID: Outlet
End ID: Inlet
Direction: Upstrm
Pipe Type: DuroMaxx

Distance	Fault Observation	Time	Picture
2.0	Start Inspection	43 00:00:00	
8.0	General Observation Remarks: Pipe slightly racked, small puncture at crown from stake at 10 ft.	02:30 00:00:43	
26.0	General Observation Remarks: View of joint at 26 ft.	12:08 00:01:27	

Distance	Fault Observation	Time	Picture
46.0	<p>General Observation Remarks: View of joint at 46 ft. Slight hump at right haunch.</p>	<p>14:40 00:02:17</p>	
56.0	<p>General Observation Remarks: Slight dent in invert at 56 ft.</p>	<p>16:11 00:02:33</p>	
70.0	<p>General Observation Remarks: View of joint at 70 ft.</p>	<p>17:18 00:03:03</p>	

Distance	Fault Observation	Time	Picture
90.0	<p style="text-align: center;">General Observation Remarks: Pipe slight racked in right crown.</p>	<p style="text-align: center;">18:41 00:03:48</p>	
103.0	<p style="text-align: center;">End Inspection Remarks: End inspection, view of laser skid at inlet.</p>	<p style="text-align: center;">21:21 00:04:14</p>	

XY Diameter Summary Report

Pipe under 5% deflection in horizontal and vertical deflection plot

Site ID
City Fountain Colorado
Start No Outlet
Location MP 122

Asset No. I-25, MP 122.0
Finish No Inlet
Location MP 122

Date 9/30/2013
Material DuroMaxx
Pipeline Length 103 ft
Internal Diameter (Expected) 47.01 in

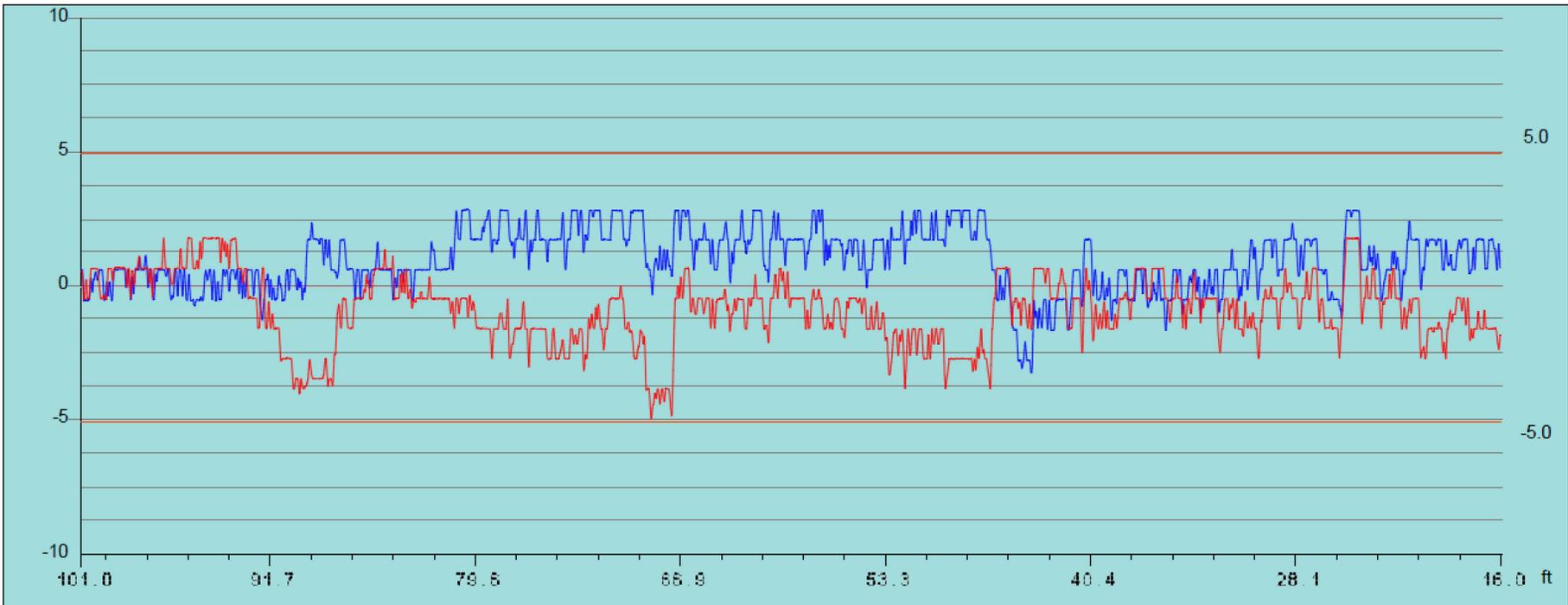
Comments

I-25, MP 122.0, 48-inch, DuroMaxx Cross Drain

Limit Lines

Upper limit = 5
Lower Limit = -5

% 90% - Fractile: (X) 2.7% : (Y) 0.7%, Exceeded limits: 0.0%



XY Deflection Summary Report

Pipe under 5% (Deflection based off Median I.D. per frame of video)

Site ID
City Fountain Colorado
Start No Outlet
Location MP 122

Asset No. I-25, MP 122.0
Finish No Inlet
Location MP 122

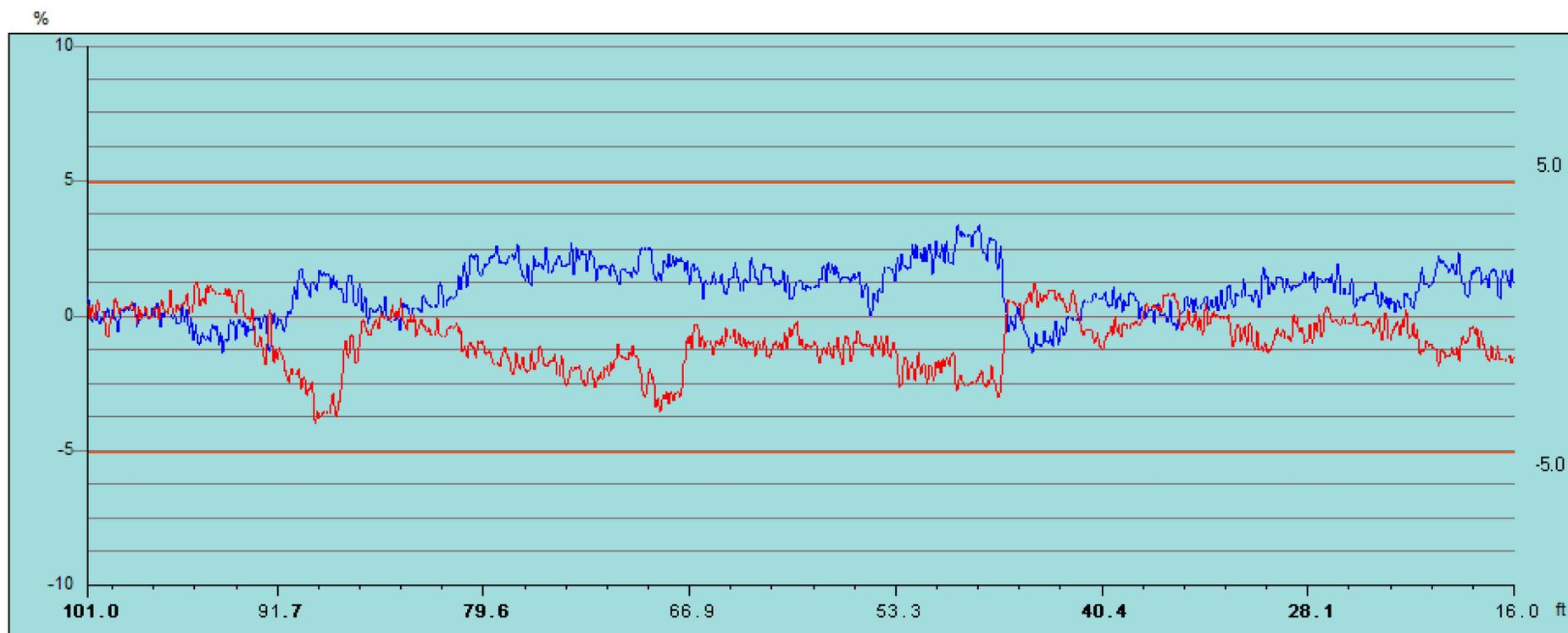
Date 9/30/2013
Material DuroMaxx
Pipeline Length 103 ft
Internal Diameter (Expected) 47.01 in

Comments

I-25, MP 122.0, 48-inch, DuroMaxx Cross Drain

Limit Lines

Upper limit = 5
Lower Limit = -5



Ovality Summary Report

Ovality slightly over 5% at 90 ft. Spike due to camera tilting at joint.

Site ID
City Fountain Colorado
Start No Outlet
Location MP 122

Asset No. I-25, MP 122.0
Finish No Inlet
Location MP 122

Date 9/30/2013
Material DuroMaxx
Pipeline Length 103 ft
Internal Diameter (Expected) 47.01 in

Comments

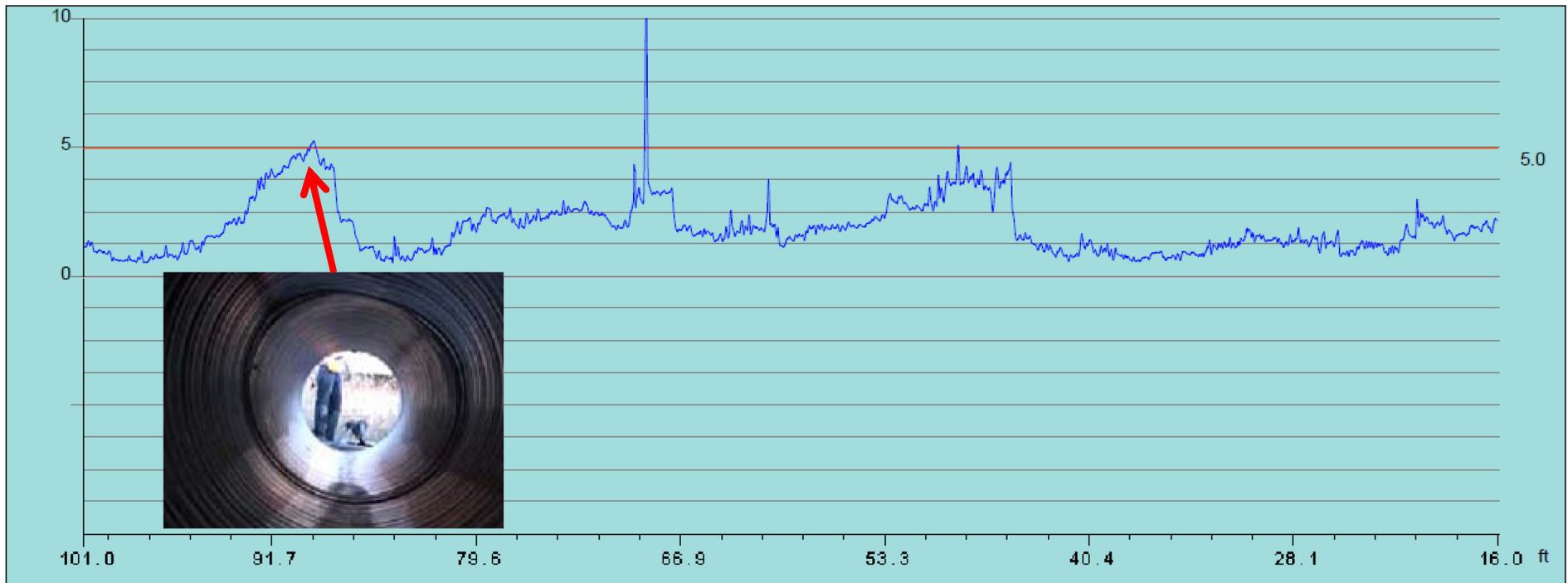
I-25, MP 122.0, 48-inch, DuroMaxx Cross Drain

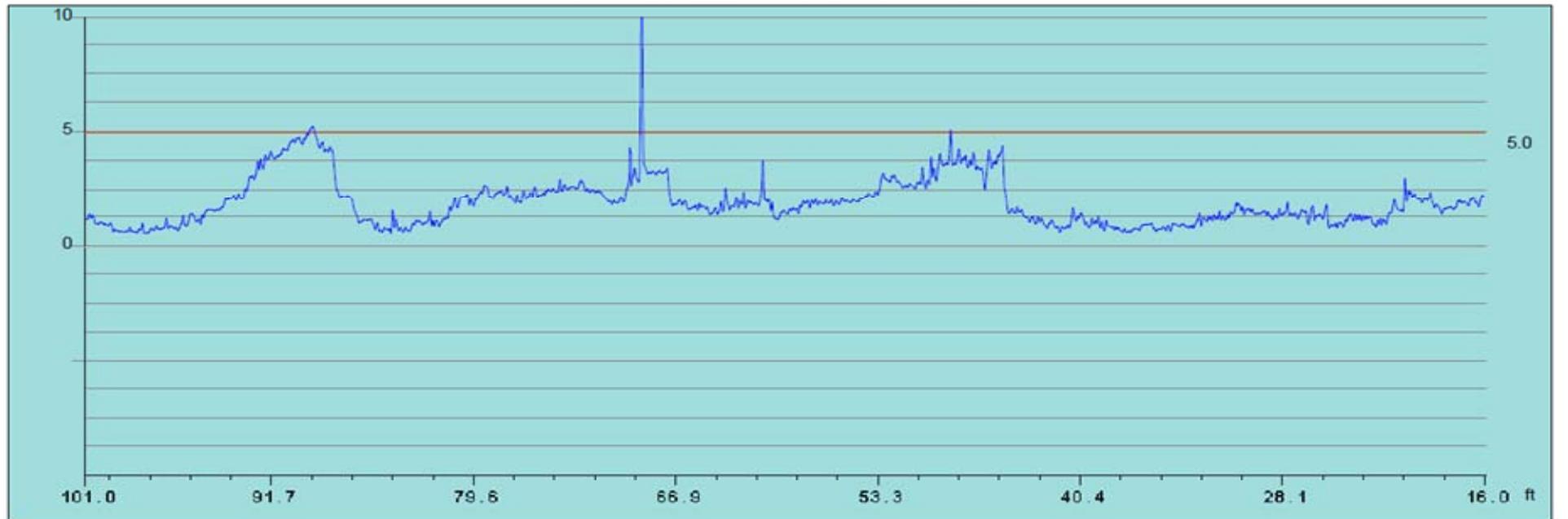
Limit Lines

Upper limit = 5
Lower Limit = 5

90% - Fractile: 3.5%, Exceeded limits: 0.8%

Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance





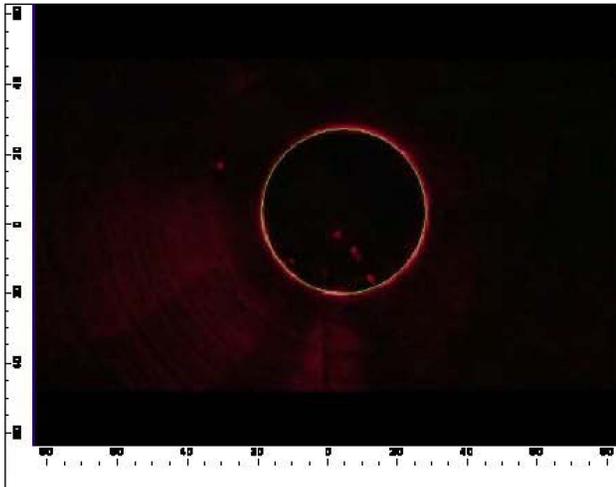
XY Diameter Observations Report

MP 122, I-25, DuroMaxx Installation, Fountain, Colorado

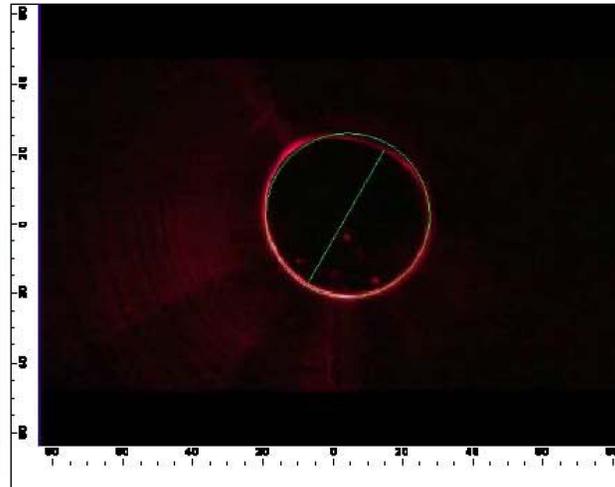
Site ID
 City Fountain Colorado
 Start No Outlet
 Location MP 122

Asset No. I-25, MP 122.0
 Finish No Inlet
 Location MP 122

Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 103 ft
 Internal Diameter (Expected) 47.01 in



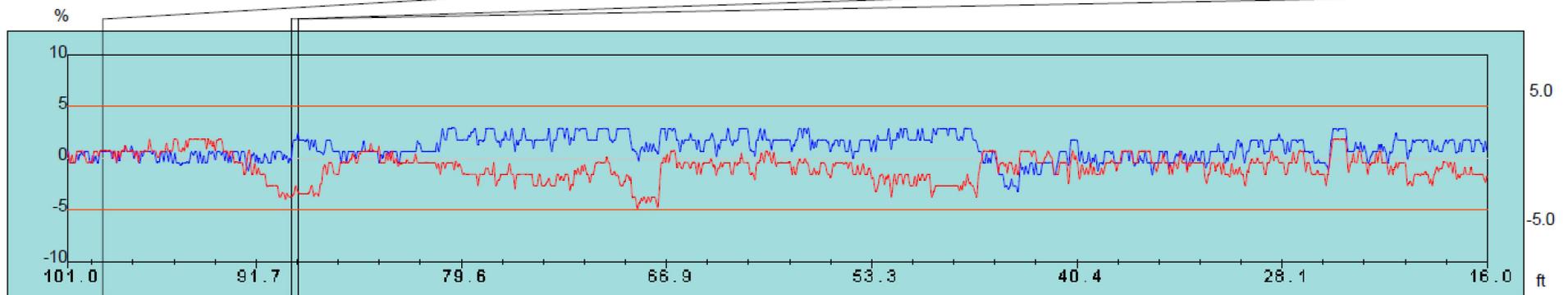
Pipe round near inlet end of structure.



Pipe compressed at 2 O'clock at approximately 90 ft. Pipe deflected approximately 5.3%.



View of compressed area at 90 ft.



90% - Fractile: (X) 2.7% : (Y) 0.7%, Exceeded limits: 0.0%

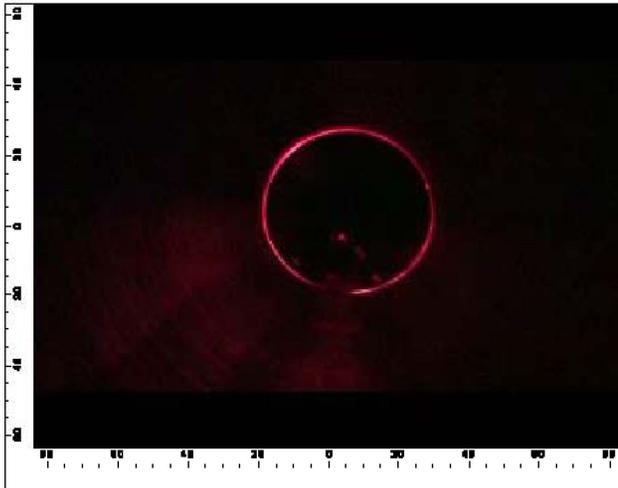
XY Diameter Observations Report

MP 122, I-25, DuroMaxx Installation, Fountain, Colorado

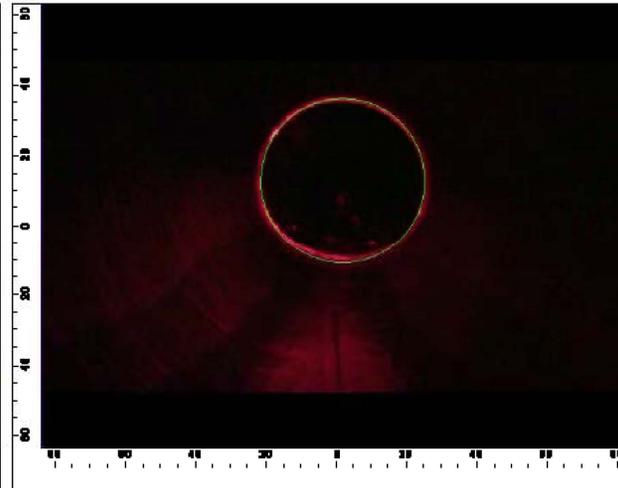
Site ID
 City Fountain Colorado
 Start No Outlet
 Location MP 122

Asset No. I-25, MP 122.0
 Finish No Inlet
 Location MP 122

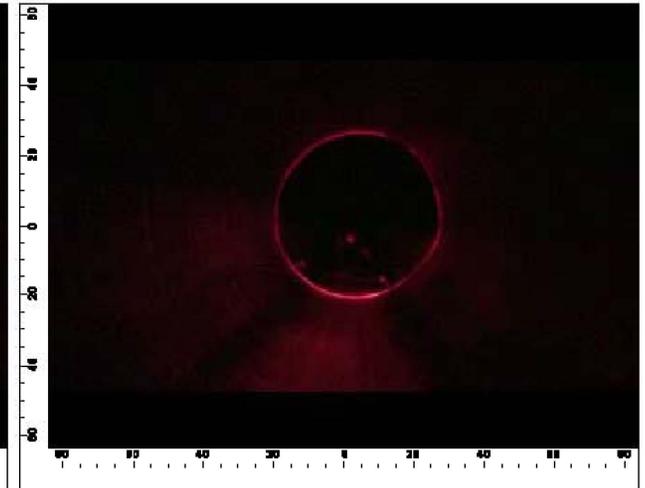
Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 103 ft
 Internal Diameter (Expected) 47.01 in



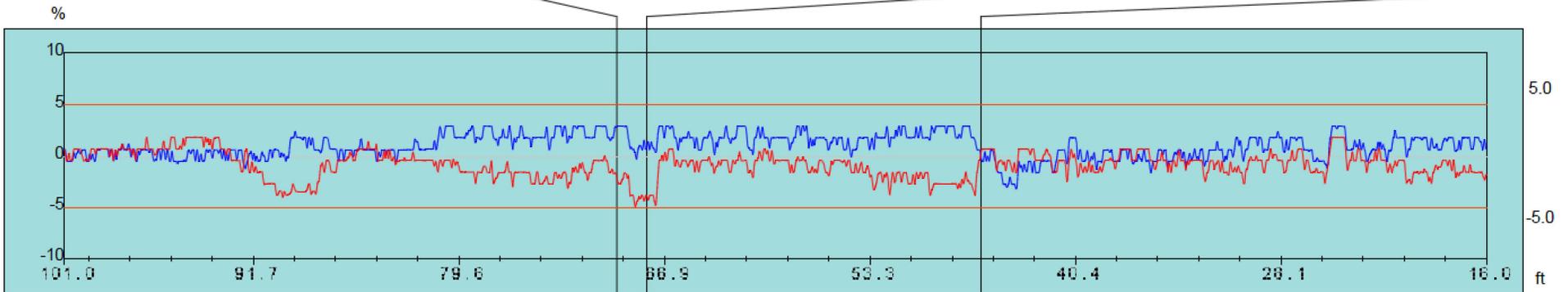
Laser passing over joint at 70 ft.



View of slightly raised invert at joint.



Laser passing over joint at approx. 46 ft.



90% - Fractile: (X) 2.7% : (Y) 0.7%, Exceeded limits: 0.0%

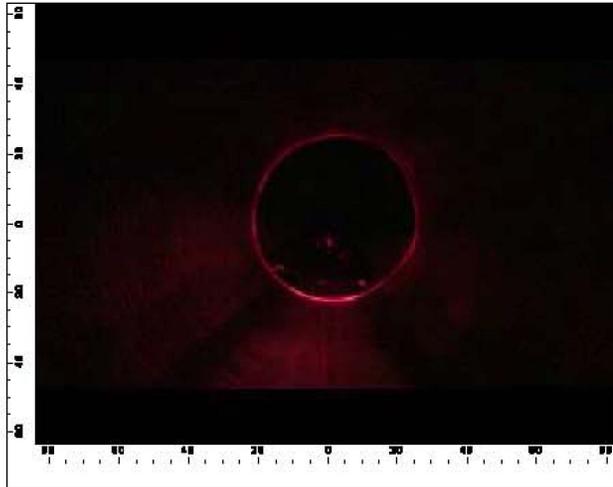
XY Diameter Observations Report

MP 122, I-25, DuroMaxx Installation, Fountain, Colorado

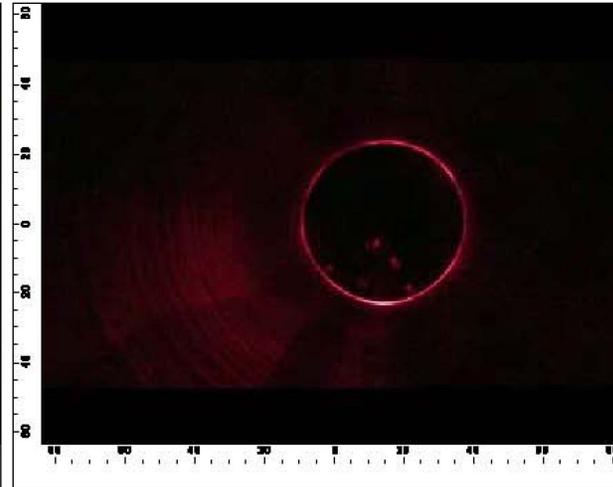
Site ID
 City Fountain Colorado
 Start No Outlet
 Location MP 122

Asset No. I-25, MP 122.0
 Finish No Inlet
 Location MP 122

Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 103 ft
 Internal Diameter (Expected) 47.01 in



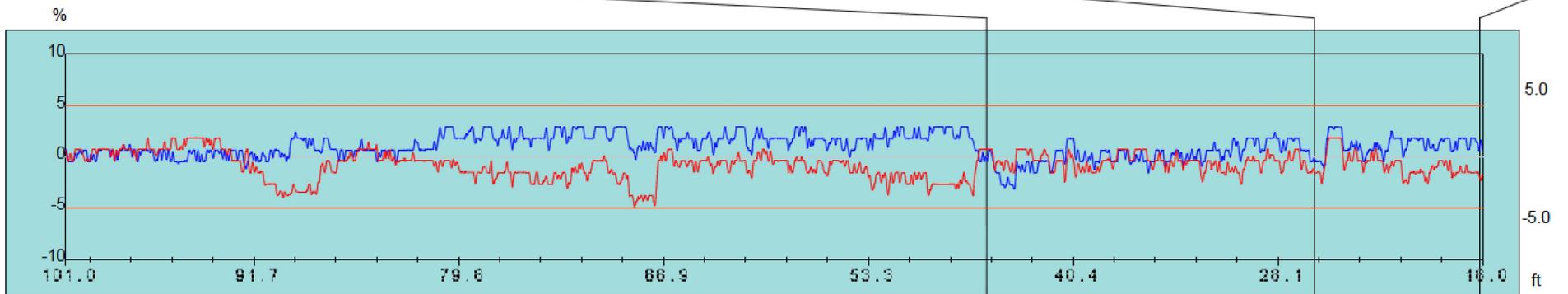
Slight compression in lower right haunch near joint.



Laser passing over joint at 26 ft.



View from outlet end, pipe slight racked near outlet end not caught by laser.



90% - Fractile: (X) 2.7% : (Y) 0.7%, Exceeded limits: 0.0%

APPENDIX II – FOUNTAIN COLORADO,
DUROMAXX LASER PROFILE INSPECTION,
I-25, MP 122, MP 122.5, AND MP 123 (2016)
LEO JOHN FLECKENSTEIN



Fountain Colorado
3 Year Performance Comparison
DuroMaxx Laser Profile Inspection1
I-25, MP 122, MP 122.5, and MP 123

September 30, 2013 vs December 5, 2016
(Draft Report December 16, 2016)

By

Leo John Fleckenstein

Hydrau-Tech, Inc,

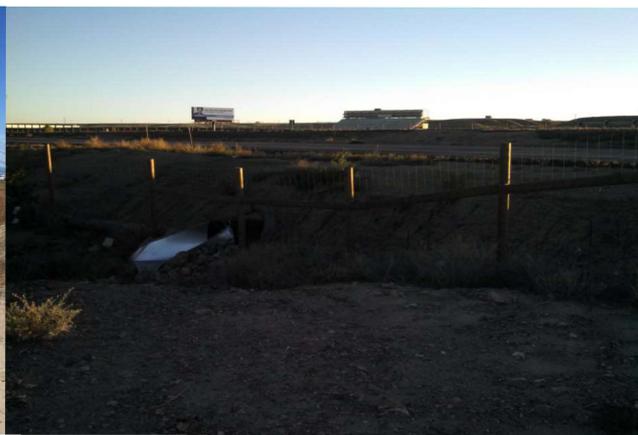
And

Colorado DOT

Project Summary: A total of 5 pipes were video and laser profiled on September 30, 2013 and December 5, 2016. (A manual inspection was conducted on three additional pipes during the 2016 inspection. In 2013 a straight line/non pan and tilt portable camera unit was utilized for the inspection. In 2016 a robotic pan and tilt camera was utilized. (Images below)



Project Summary Continued: Joints were noted and observed during the both inspections. Joint separation was minor to moderate with no significant distress or soil migration observed. Some minor racking, dents, and sags were also noted. Limited construction information was available. Several of the structures have limited cover. In 2013 minor post construction damage was noted towards the ends of several of the structures as straw wattles were placed over the pipe ends and wooden stakes driven through the crown of the pipes. The stakes do not appear to causing any structural issues with the performance of the pipes. In 2016 severe damage was noted at the inlet end in two of the three pipes located at milepost 123. Apparently due to vehicle damage. In 2013 four of the five pipes were under 5% deflection for their full length. One pipe had a small localized area where pipe deflection was measured at 5.3% near the end of the structure. The non-uniform nature of the deflection and the fact that the deflected area is outside of the paved roadway would suggest that this deformation occurred during the installation process. The first 10 to 16 ft of the pipes near the outlet end of the structures could not be laser profiled due to the distance between the camera and the laser. Since the 2013 three out of the 5 pipes are showing some slight increase in deflection.



Location: Fountain Colorado

Route: I-25

Pipe Use: Culvert/Cross Drain

Date Inspected: 9/30/13 (Red indicating potential changes in deflection since 2013).



Deflection data was gathered at a frame rate of approximately 1 frame per every 0.1 ft. With 180 measurements taken per frame of video. Total readings per pipe section ranged from approximately 712,000 to 770,000.

Location	Date	Pipe Type	Pipe Size	Distance (ft)	Start ID	End ID	Deflection (2.5%)	Deflection (5%)	Observations
MP 123, Northern Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	100% of readings below 2.5%		Max deflection less than 2.5%, slight dent in left springline, wooden stake driven through crown near inlet end. No significant change in deflection since 2013.
MP 123, Center Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	92% of readings below 2.5%	100% of readings below 5%, .	Max deflection approximately 4% at 23 ft, small dent at left springline at 73 ftl, wooden stakes driven through crown of pipe near inlet end. Deflection at 5% in 2016.
MP 123, Southern Pipe	9/30/2013	DuroMaxx	36-inch	88	Outlet	Inlet	100% of readings below 2.5%		Max deflection approximately 2.5% at 24 ft, wooden stake driven through crown of pipe near inlet. Deflections still below 5%. No significant change in deflection since 2013
MP 122.5	9/30/2013	DuroMaxx	48-inch	102	Outlet	Inlet	86.8% of reading below 2.5%	100% of readings below 5%, .	Max deflection approximately 2.8% at 88 ft. Deflection at 4.8% in 2016
MP 122	9/30/2013	DuroMaxx	48-inch	103	Outlet	Inlet	77.2% of readings below 2.5%	<1.9% of readings above 5%	Max deflection approximately 5.30% near inlet end (approx. 90 to 88 ft). Deflection at 5.8% in 2016, crown flattening and possible inverse curvature has occurred. Pipe moderately racked in right crown. Remainder of pipe 4% or less. Small puncture due to stake near outlet, pipe slightly racked at 8 ft. Slight hump at right haunch at 46 ft. Slight dent in invert at 56 ft

MP 123, I-25, 36-Inch DuroMaxx



North







MP 123, I-25, 36-Inch DuroMaxx
Northern Pipe



Project Name: I-25, Fountain, Colorado

Date: 9/30/2013

Asset Location:

Distance: 0

Run Number:

Pipe Size: 36

Pipe ID: MP 123

Start ID: Outlet

End ID: Inlet

Direction: Upstrm

Pipe Type: DuroMaxx



Project Name: MP 123 Fountain Colorado

Date: 12/5/2016

Asset Location:

Length Surveyed: 78.2

Run Number:

Pipe Size: 48-inch

Pipe ID: Northern Pipe

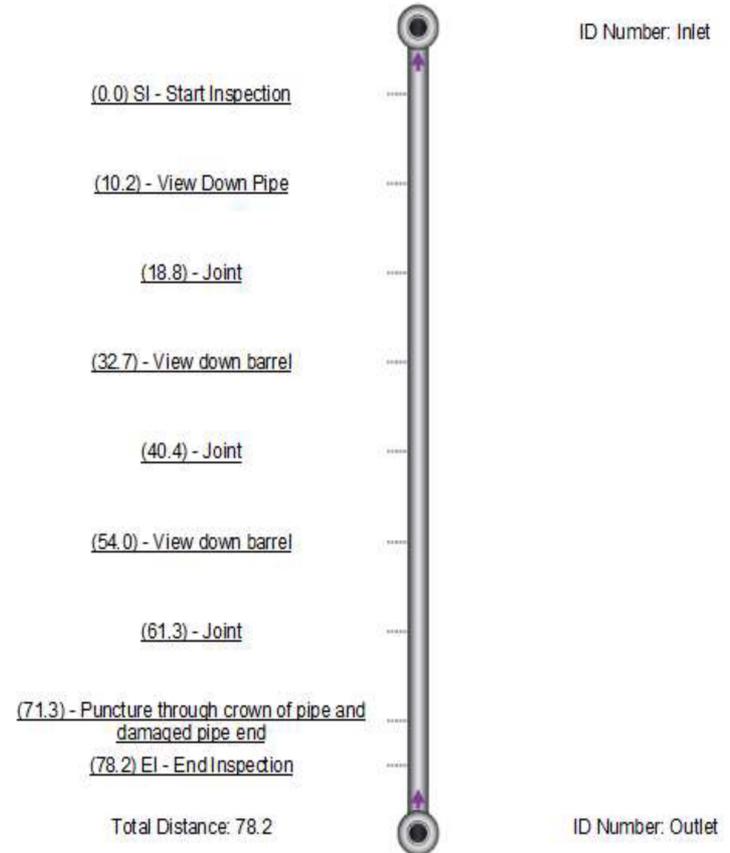
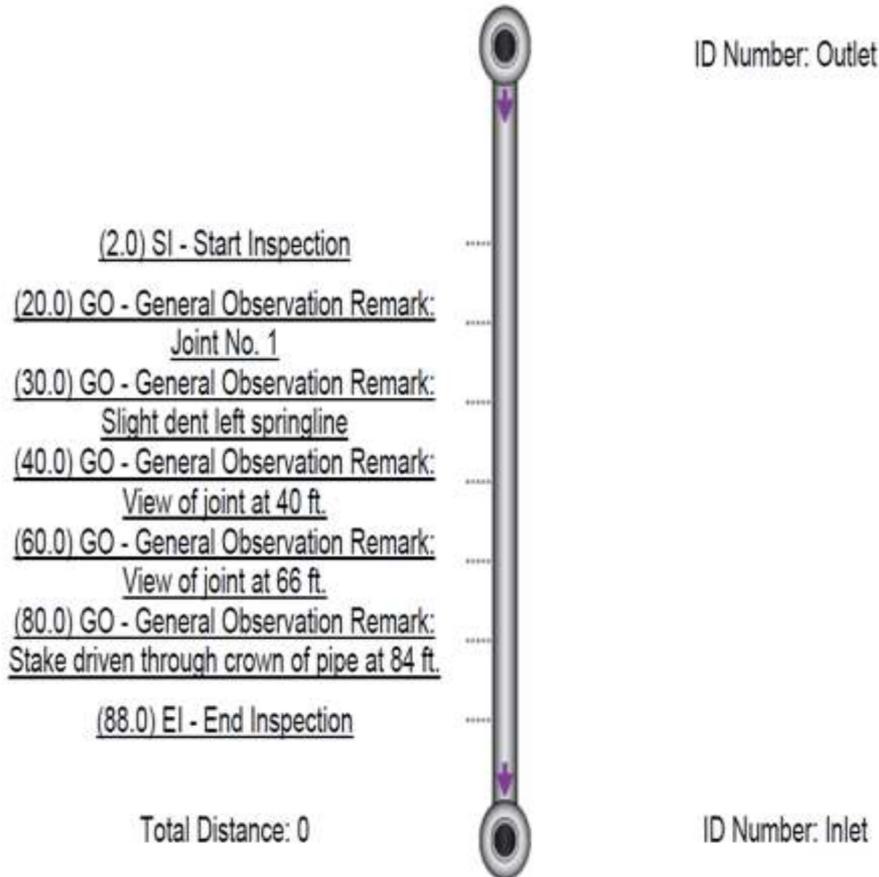
Start ID: Outlet

End ID: Inlet

Direction: Upstream

Pipe Type: DuraMaxx

Severity
Light
Moderate
Average
Heavy
Severe



Project Name: I-25, Fountain, Colorado

Date: 9/30/2013
Asset Location:
Distance: 0
Run Number:
Pipe Size: 36

Pipe ID: MP 123
Start ID: Outlet
End ID: Inlet
Direction: Upstrm
Pipe Type: DuroMaxx

Project Name: MP 123 Fountain Colorado

Date: 12/5/2016	Pipe ID: Northern Pipe
Asset Location:	Start ID: Outlet
Length Surveyed: 78.2	End ID: Inlet
Run Number:	Direction: Upstream
Pipe Size: 48-inch	Pipe Type: DuraMaxx

Distance	Fault Observation	Time	Picture
2.0	Start Inspection	01:14 00:00:00	
20.0	General Observation Remarks: Joint No. 1	03:13 00:00:26	
30.0	General Observation Remarks: Slight dent left springline	07:04 00:00:40	

Distance	Fault Observation	Picture
0.0	Start Inspection	
10.2	ViewDown Pipe	
18.8	Joint	
32.7	View down barrel	
40.4	Joint	

Distance	Fault Observation	Time	Picture
40.0	General Observation Remarks: View of joint at 40 ft.	8:10 00:00:45	
60.0	General Observation Remarks: View of joint at 66 ft.	10:33 00:01:13	
80.0	General Observation Remarks: Stake driven through crown of pipe at 84 ft.	12:37 00:01:45	

Distance	Fault Observation	Picture
54.0	View down barrel	
61.3	Joint	
71.3	Puncture through crown of pipe and damaged pipe end	
78.2	End Inspection	

Distance	Fault Observation	Time	Picture
88.0	End Inspection	13:48 00:01:55	

Created with the  POSM report generator

XY Diameter Summary Report

Pipe well under 5% deflection, spikes in data due to camera tilting at joint

Site ID	Asset No. I-25, MP 123	Date	9/30/2013
City Fountain, Colorado		Material	DuroMaxx
Start No North Pipe	Finish No North Pipe	Pipeline Length	88 ft
Location Outlet	Location Inlet	Internal Diameter (Expected)	34.92 in

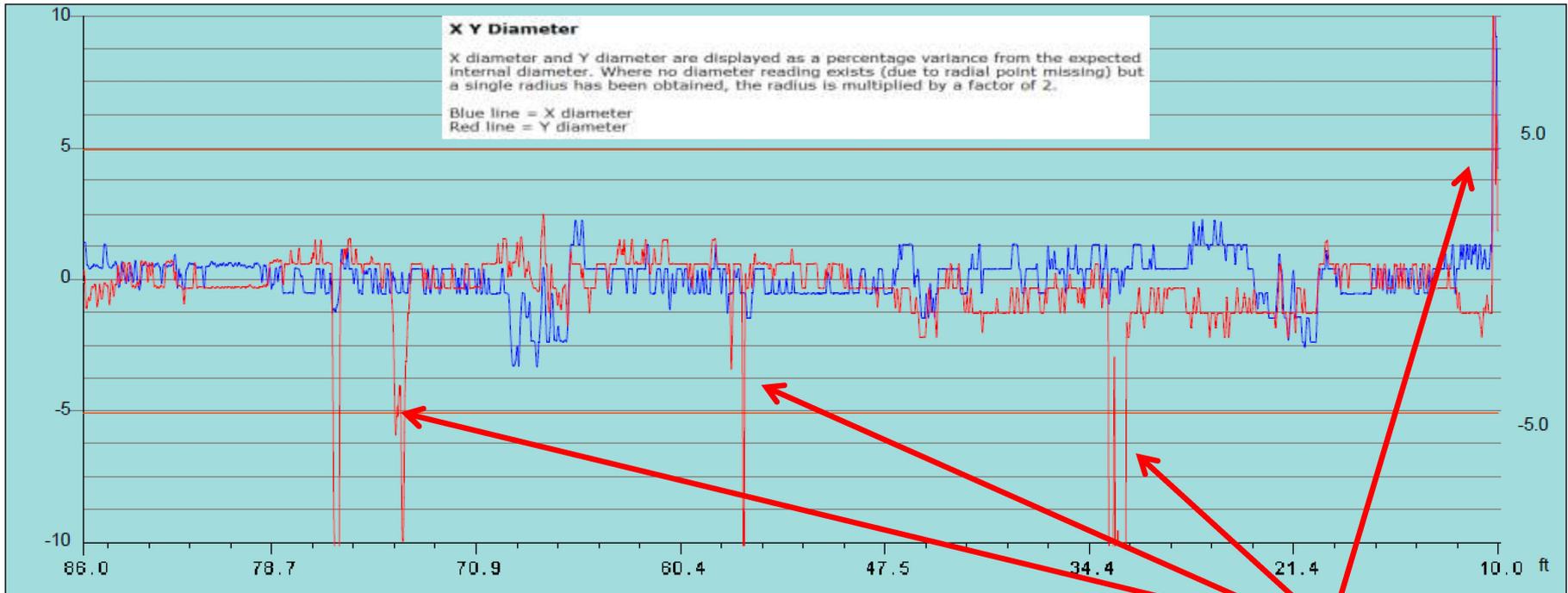
Comments

Northern most pipe of three at MP 123

Limit Lines

Upper limit = 5
Lower Limit = -5

% 90% - Fractile: (X) 1.1% : (Y) 0.7%, Exceeded limits: 2.6%



Fractile: 10% of the data points are above 1.1% for X and 0.7% for Y. 2.6% exceeds 5% limits lines. The spikes/scatter in data (2.6%) are due to the laser skid and/or the camera tilting on the weld at the joint. Spikes can also occur due to the loss of laser light at the joint.

XY Deflection Summary Report

Pipe under 5% (Deflection based off Median I.D. per frame of video)

Site ID
City Fountain, Colorado
Start No North Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No North Pipe
Location Inlet

Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 34.92 in

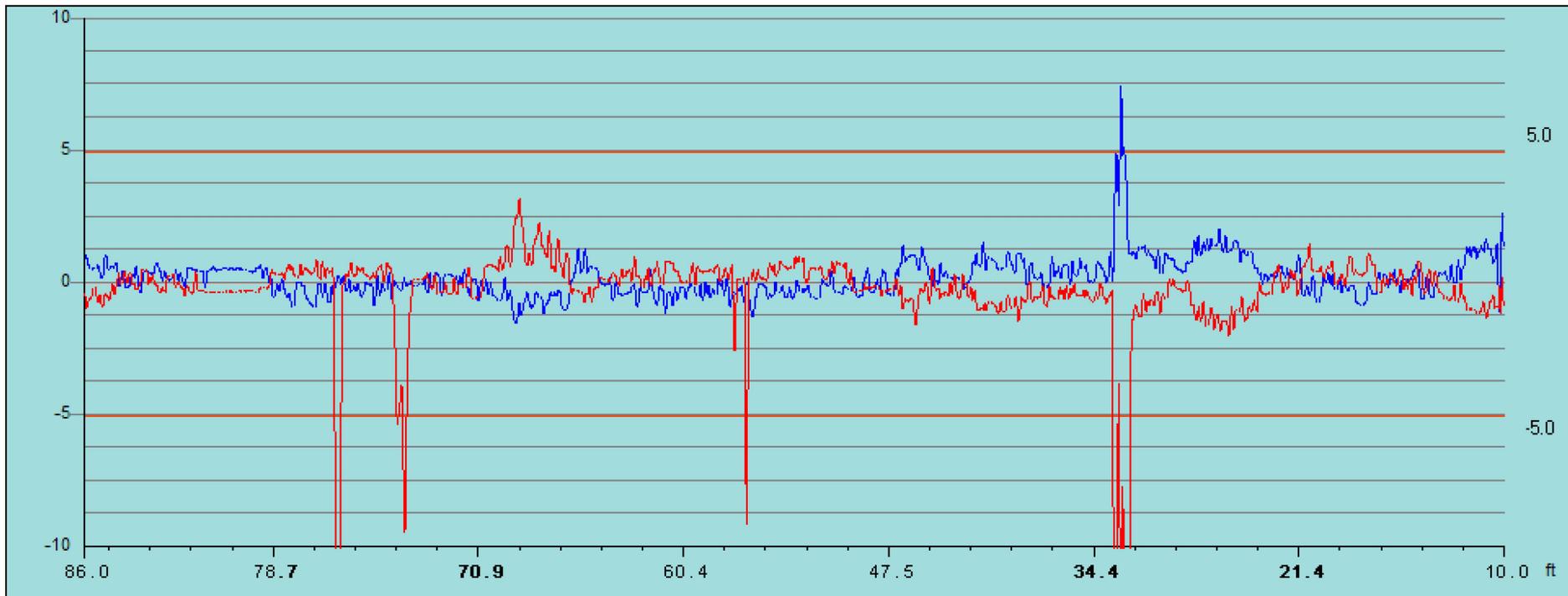
Comments

Northern most pipe of three at MP 123

Limit Lines

Upper limit = 5
Lower Limit = -5

%



Ovality Summary Report

Ovality under 5%, spikes due to camera going over joints

Site ID
City Fountain, Colorado
Start No North Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No North Pipe
Location Inlet

Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 34.92 in

Comments

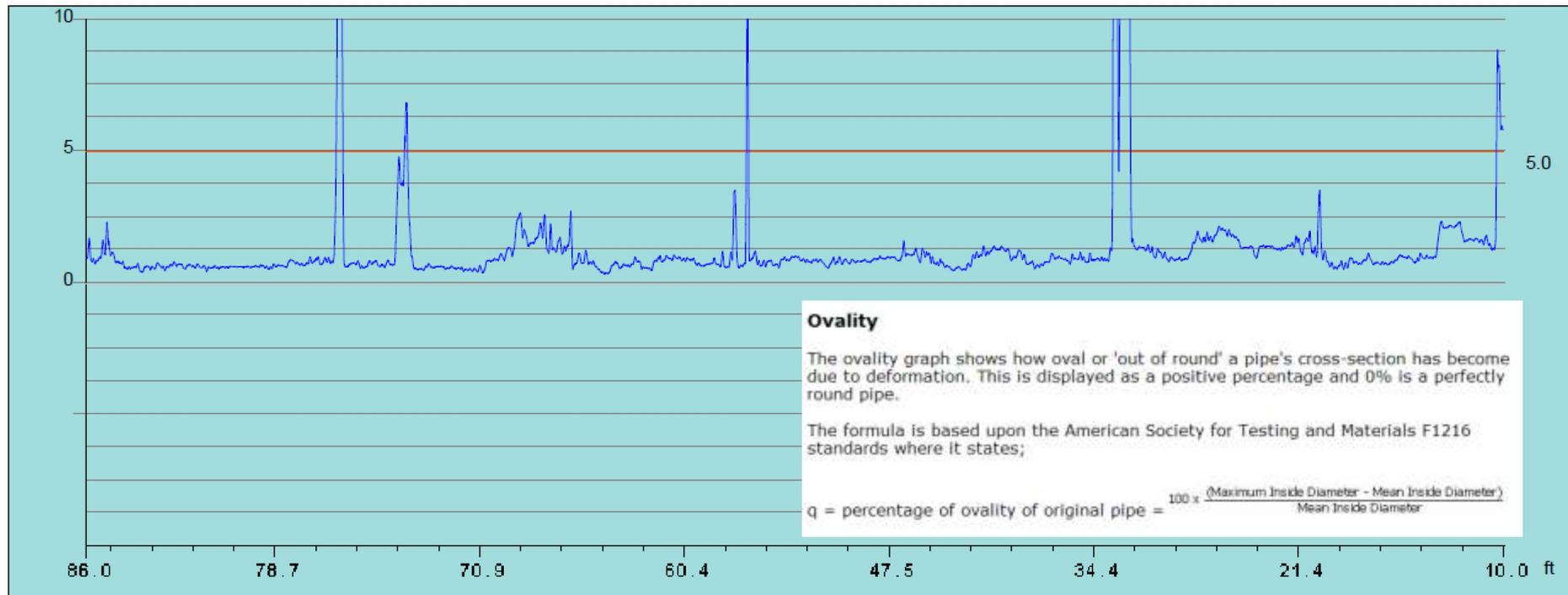
Northern most pipe of three at MP 123

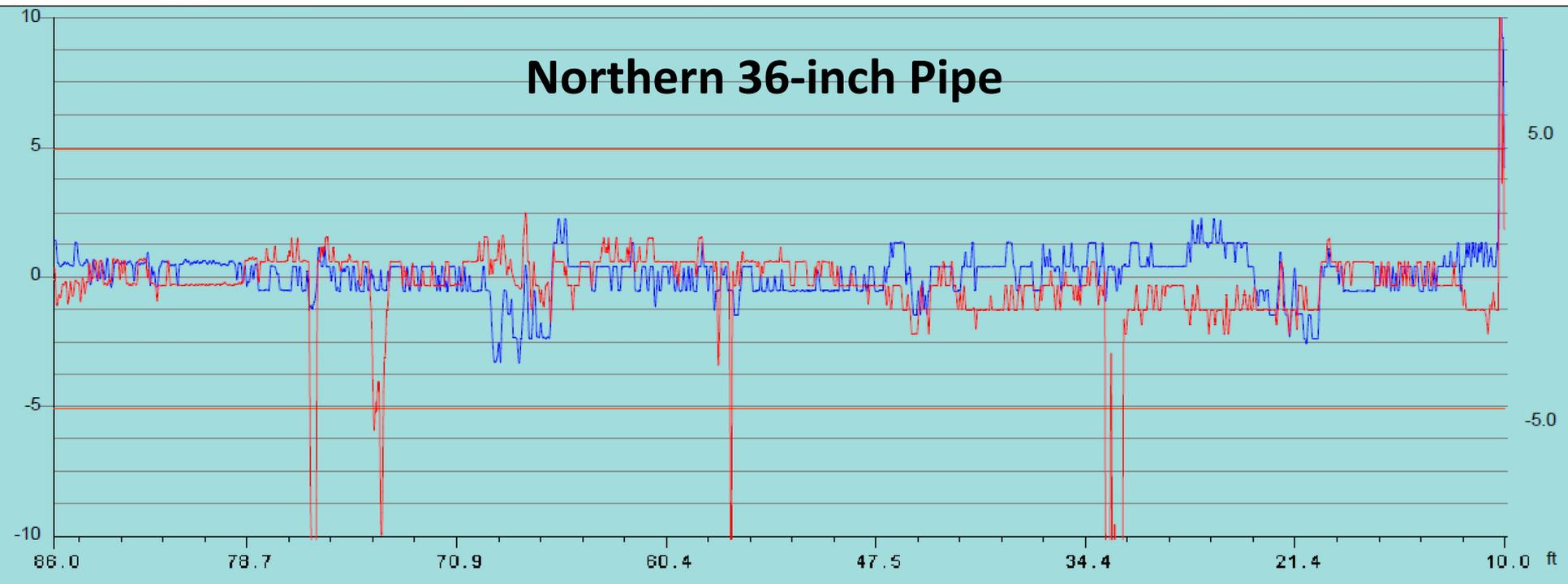
Limit Lines

Upper limit = 5
Lower Limit = 5

90% - Fractile: 1.8%, Exceeded limits: 2.7%

Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance





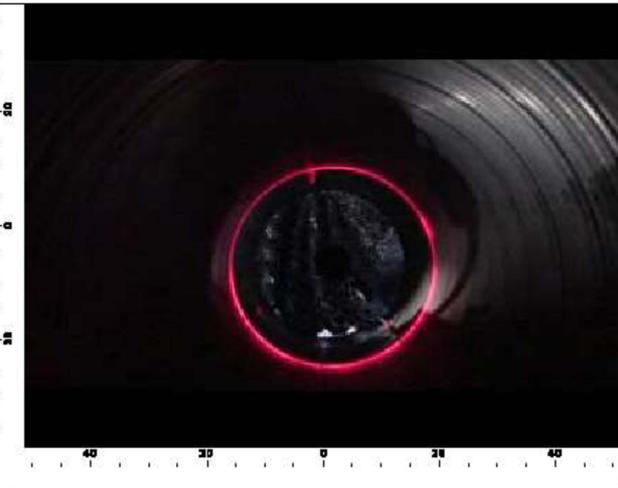
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado

Site ID
 City Fountain, Colorado
 Start No North Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No North Pipe
 Location Inlet

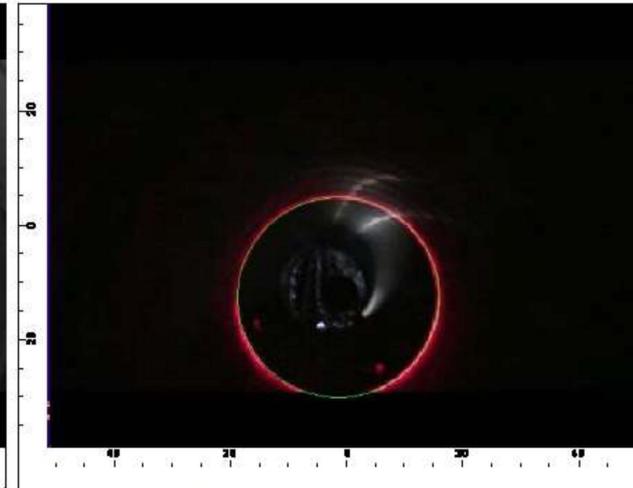
Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 34.92 in



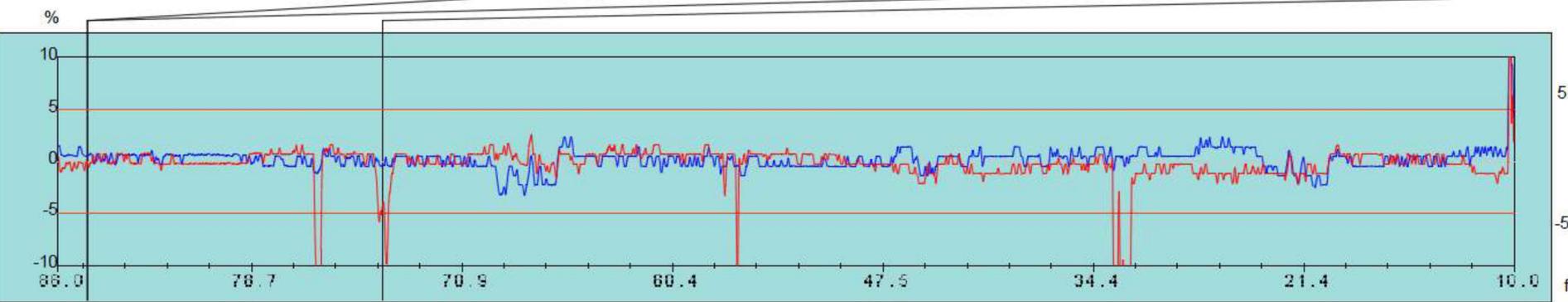
Laser reflecting off stake in crown of pipe.



Stake for erosion control driven through crown of pipe.



Camera tilted coming over joint



90% - Fractile: (X) 1.1% : (Y) 0.7%, Exceeded limits: 2.6%

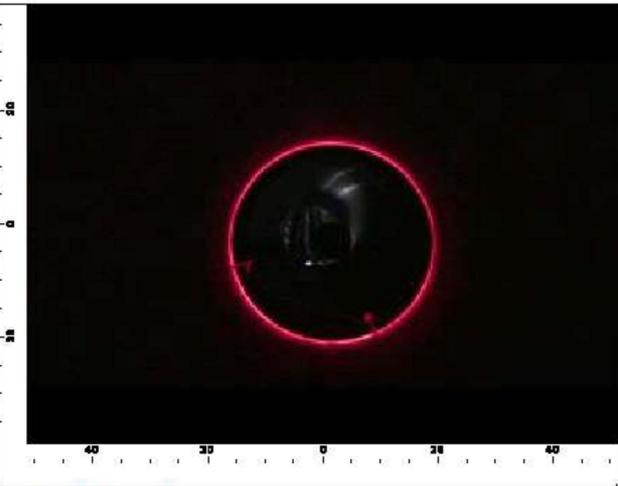
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado

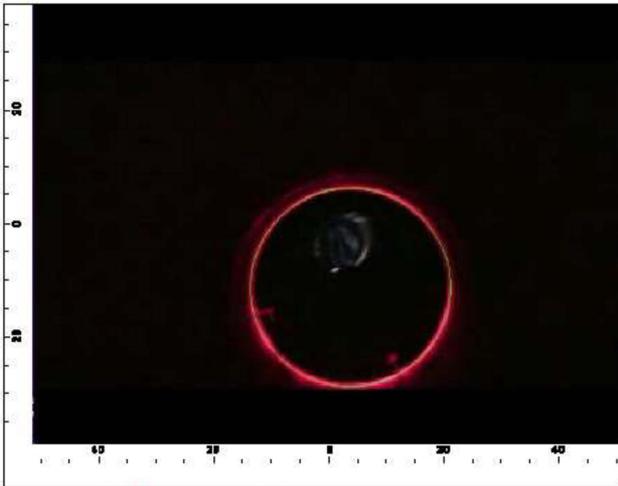
Site ID
 City Fountain, Colorado
 Start No North Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No North Pipe
 Location Inlet

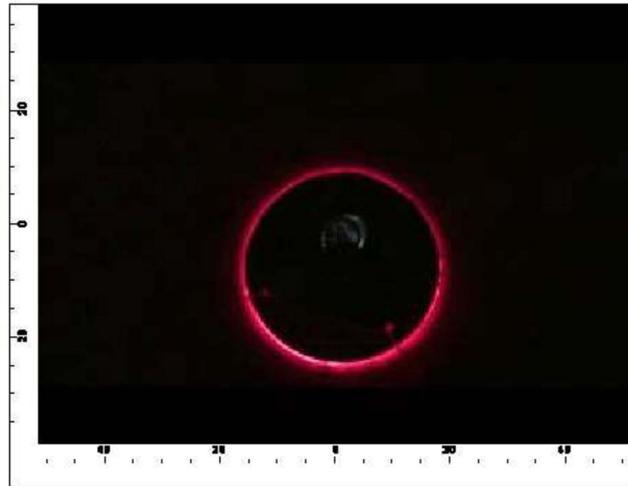
Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 34.92 in



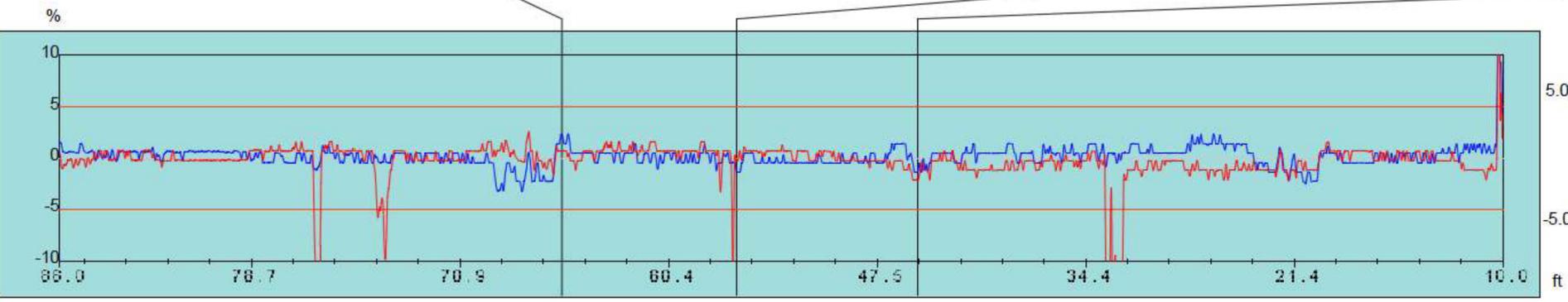
Laser at third joint



Camera tilted coming over joint



Laser at second joint



90% - Fractile: (X) 1.1% : (Y) 0.7%, Exceeded limits: 2.6%

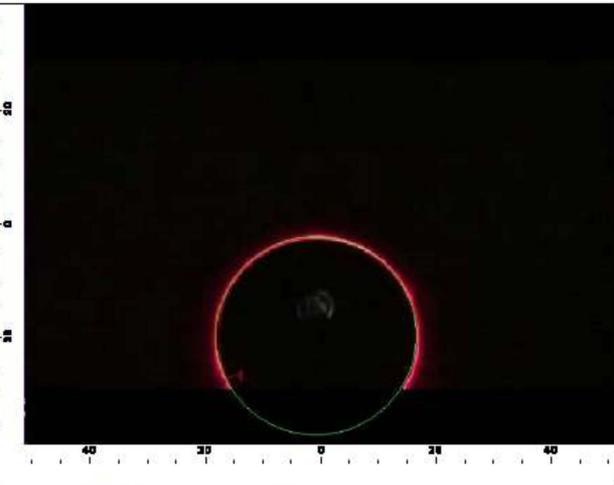
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado

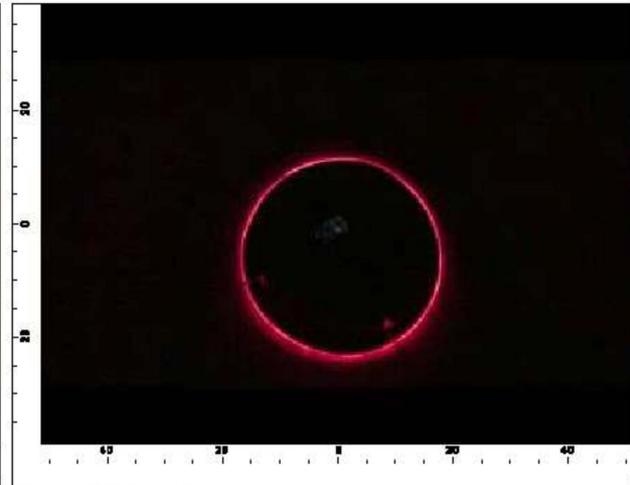
Site ID
 City Fountain, Colorado
 Start No North Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No North Pipe
 Location Inlet

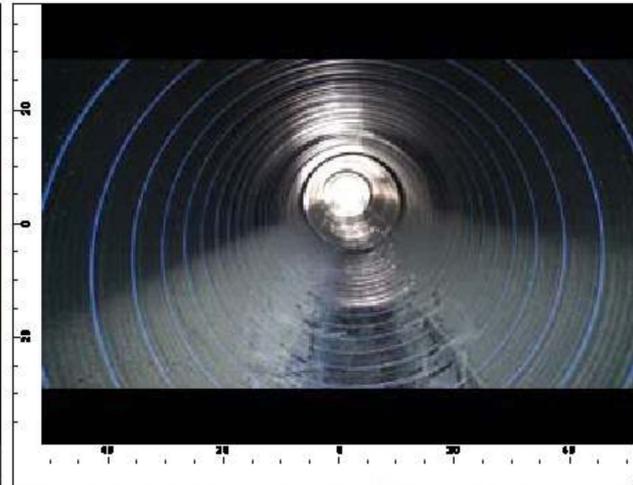
Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 34.92 in



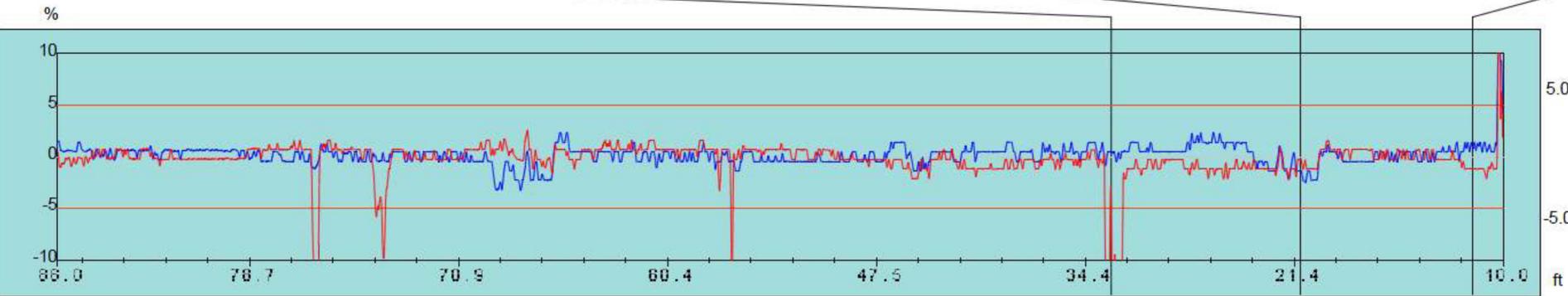
Camera tilted coming over joint



Laser at 1st joint



View of pipe at start, no noticeable deflection or defects.



90% - Fractile: (X) 1.1% : (Y) 0.7%, Exceeded limits: 2.6%

Ovality Observations Report

Pipe under 5% deflection

Site ID
City Fountain
Start No Outlet
Location

Asset No. MP 123 North
Finish No Inlet
Location

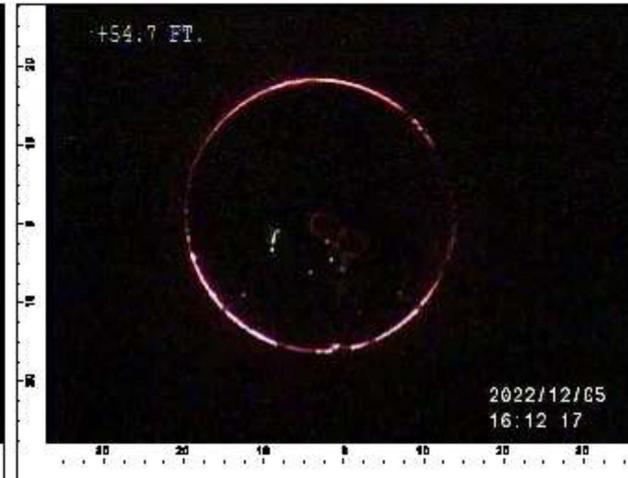
Date 12/15/2016
Material
Pipeline Length 0 ft
Internal Diameter 35.16 in



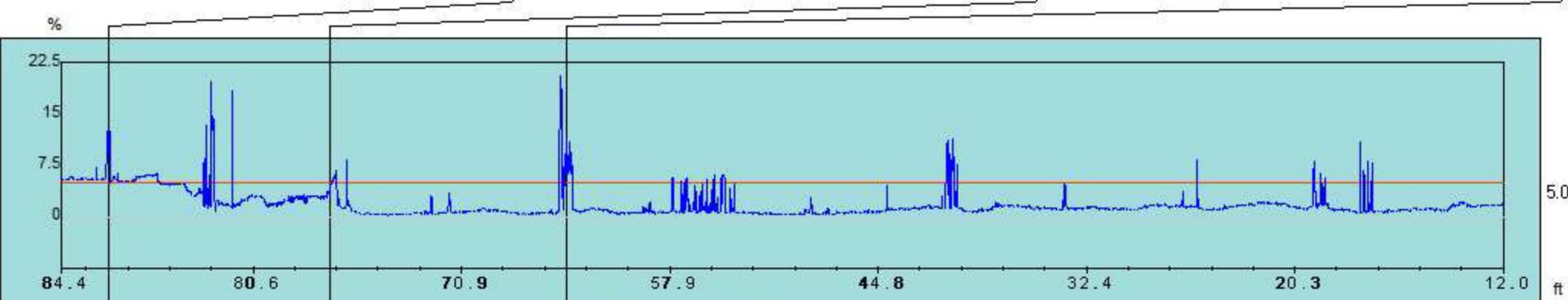
Debris in invert causing spike in vertical data.



Noise causing spike in data



Spikes at joints



Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance

90% - Fractile: 4.8%, Exceeded limits: 5.8%

XY Diameter Observations Report

Pipe under 5% Deflection

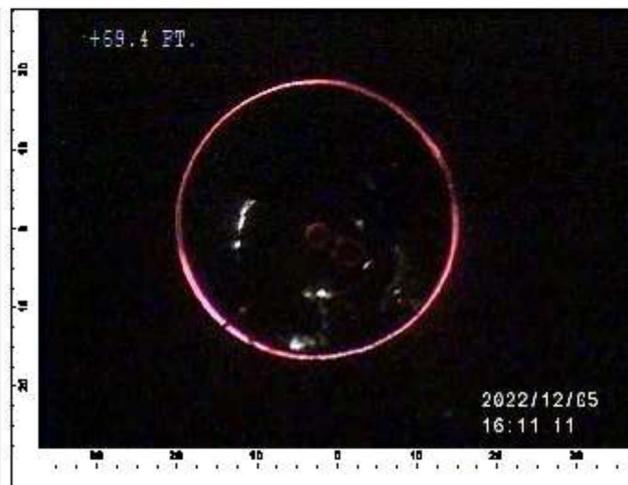
Site ID
City Fountain
Start No Outlet
Location

Asset No. MP 123 North
Finish No Inlet
Location

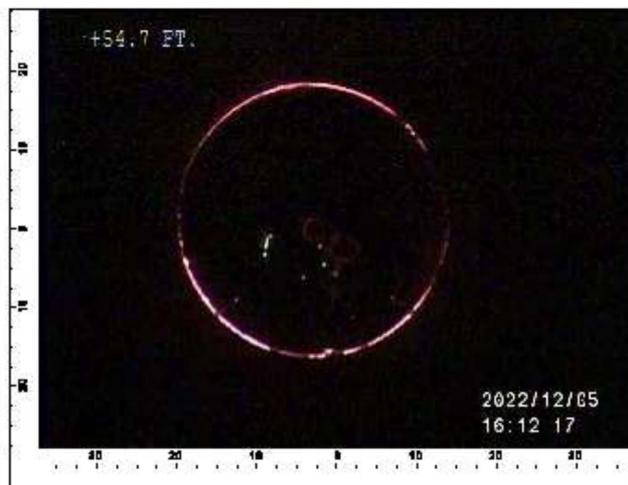
Date 12/15/2016
Material
Pipeline Length 0 ft
Internal Diameter 35.16 in



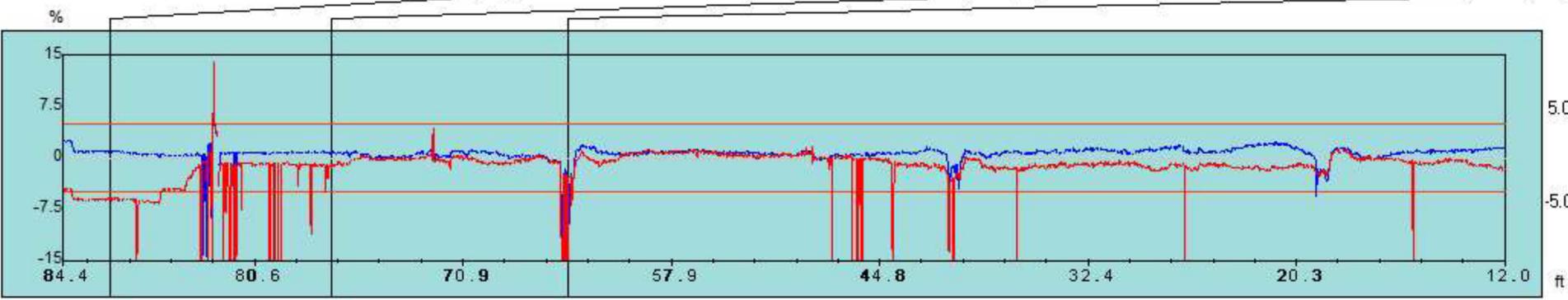
Debris in invert causing spike in vertical data.



Noise causing spike in data

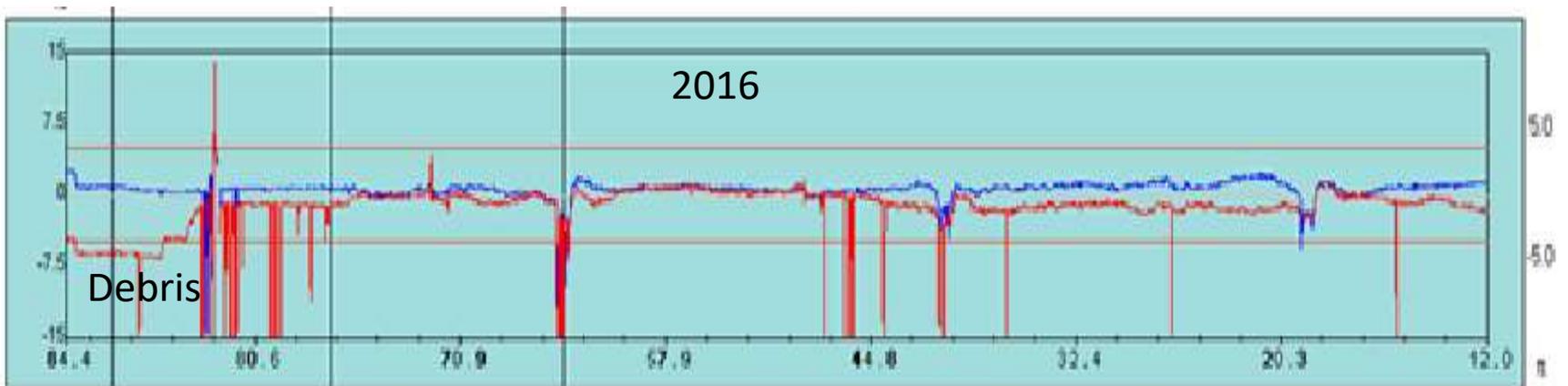
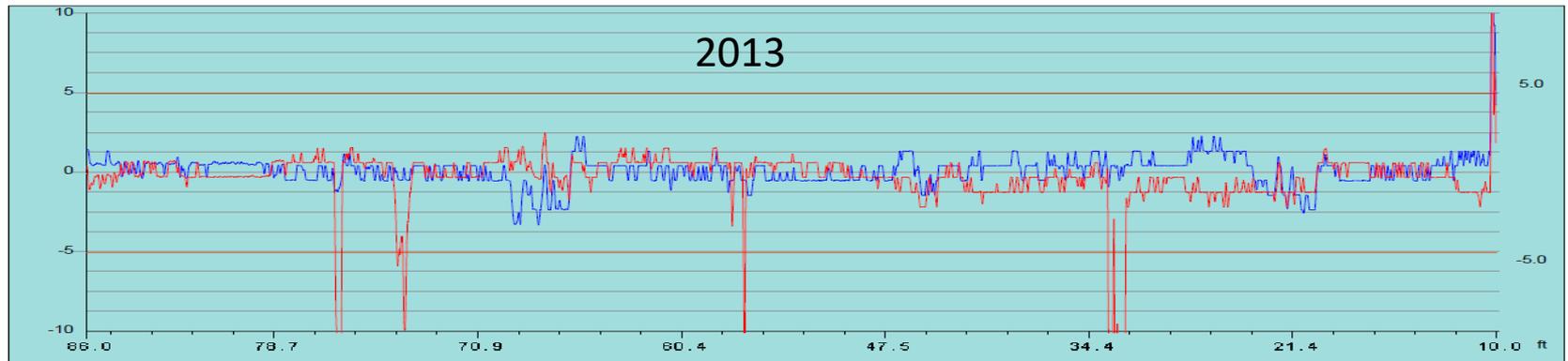


Spikes at joints



90% - Fractile: (X) 1.3% : (Y) 0.4%, Exceeded limits: 4.7%

Performance Summary MP 123 (Northern Pipe)



The inlet end of the structure had been severely damaged by a vehicle, minor punctures from construction stakes were still visible. Overall no significant change was observed in the overall condition or shape of the structure.

MP 123, I-25, 36-Inch DuroMaxx
Center Pipe



Project Name: I-25, Fountain, Colorado

Date: 9/30/2013

Asset Location:

Distance: 0

Run Number:

Pipe Size: 36

Pipe ID: MP 123, Center Pipe

Start ID: Outlet

End ID: Inlet

Direction: Upstrm

Pipe Type: DuroMaxx

Project Name: MP 123 Fountain Colorado

Date: 12/5/2016

Pipe ID: Middle Pipe

Asset Location:

Start ID: Outlet

Length Surveyed: 78

End ID: Inlet

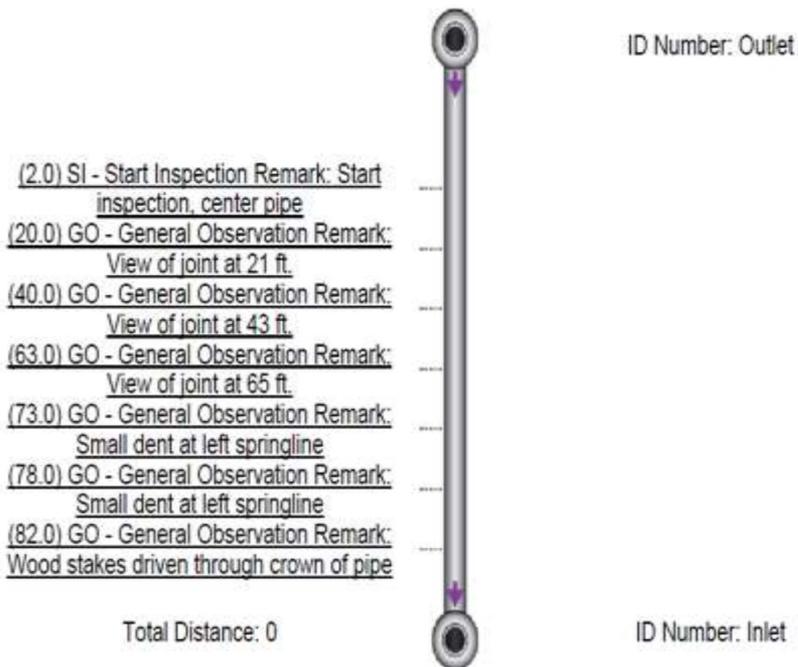
Run Number:

Direction: Upstream

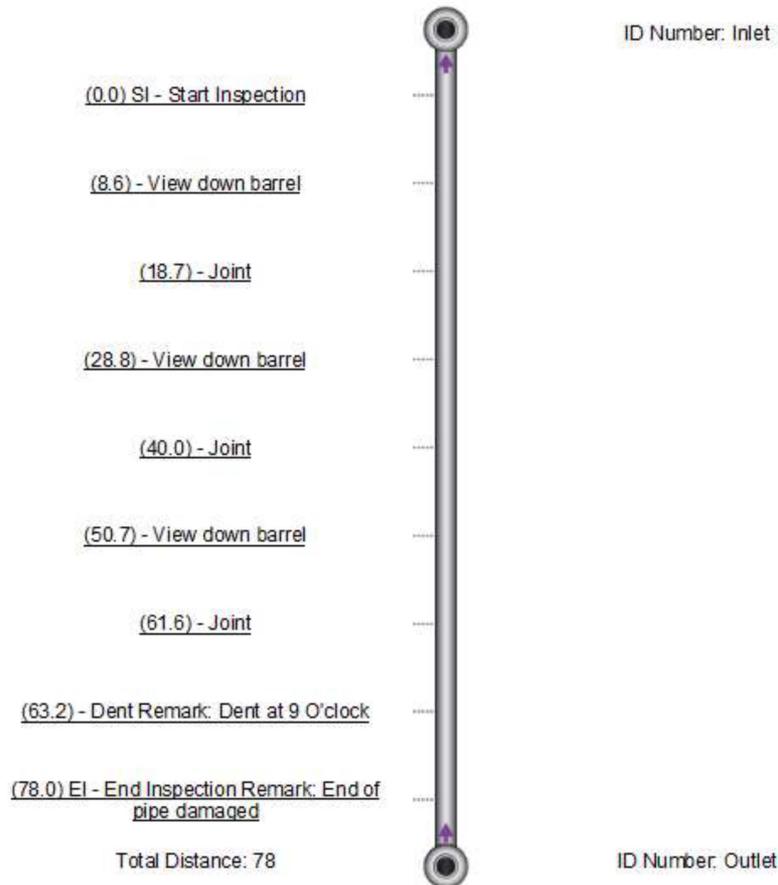
Pipe Size: 48-inch

Pipe Type: DuraMaxx

Severity
Light
Moderate
Average
Heavy
Severe



Created with the report generator



Created with the report generator [Back](#)

Project Name: I-25, Fountain, Colorado

Date: 9/30/2013
Asset Location:
Distance: 0
Run Number:
Pipe Size: 36
Pipe ID: MP 123, Center Pipe
Start ID: Outlet
End ID: Inlet
Direction: Upstrm
Pipe Type: DuroMaxx

Project Name: MP 123 Fountain Colorado

Date: 12/5/2016
Asset Location:
Length Surveyed: 78
Run Number:
Pipe Size: 48-inch
Pipe ID: Middle Pipe
Start ID: Outlet
End ID: Inlet
Direction: Upstream
Pipe Type: Duralmaxx

Distance	Fault Observation	Time	Picture
2.0	Start Inspection Remarks: Start inspection, center pipe	01:09 00:00:00	
20.0	General Observation Remarks: View of joint at 21 ft.	04:45 00:01:14	
40.0	General Observation Remarks: View of joint at 43 ft.	05:44 00:01:39	

Distance	Fault Observation	Picture
0.0	Start Inspection	
8.6	View down barrel	
18.7	Joint	
28.8	View down barrel	
40.0	Joint	

Distance	Fault Observation	Time	Picture
63.0	General Observation Remarks: View of joint at 65 ft.	07:52 00:02:14	
73.0	General Observation Remarks: Small dent at left springline	09:22 00:02:30	
78.0	General Observation Remarks: Small dent at left springline	10:33 00:02:53	

Distance	Fault Observation	Picture
50.7	View down barrel	
61.6	Joint	
63.2	Dent Remarks: Dent at 9 O'clock	
78.0	End Inspection Remarks: End of pipe damaged	

Distance	Fault Observation	Time	Picture
82.0	General Observation Remarks: Wood stakes driven through crown of pipe	11:40 00:03:10	

Created with the  POSM report generator

XY Diameter Summary Report

Pipe under 5% deflection, spikes in data due to camera tilting at joint

Site ID
City Fountain, Colorado
Start No Center Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Center Pipe
Location Inlet

Date 10/9/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35 in

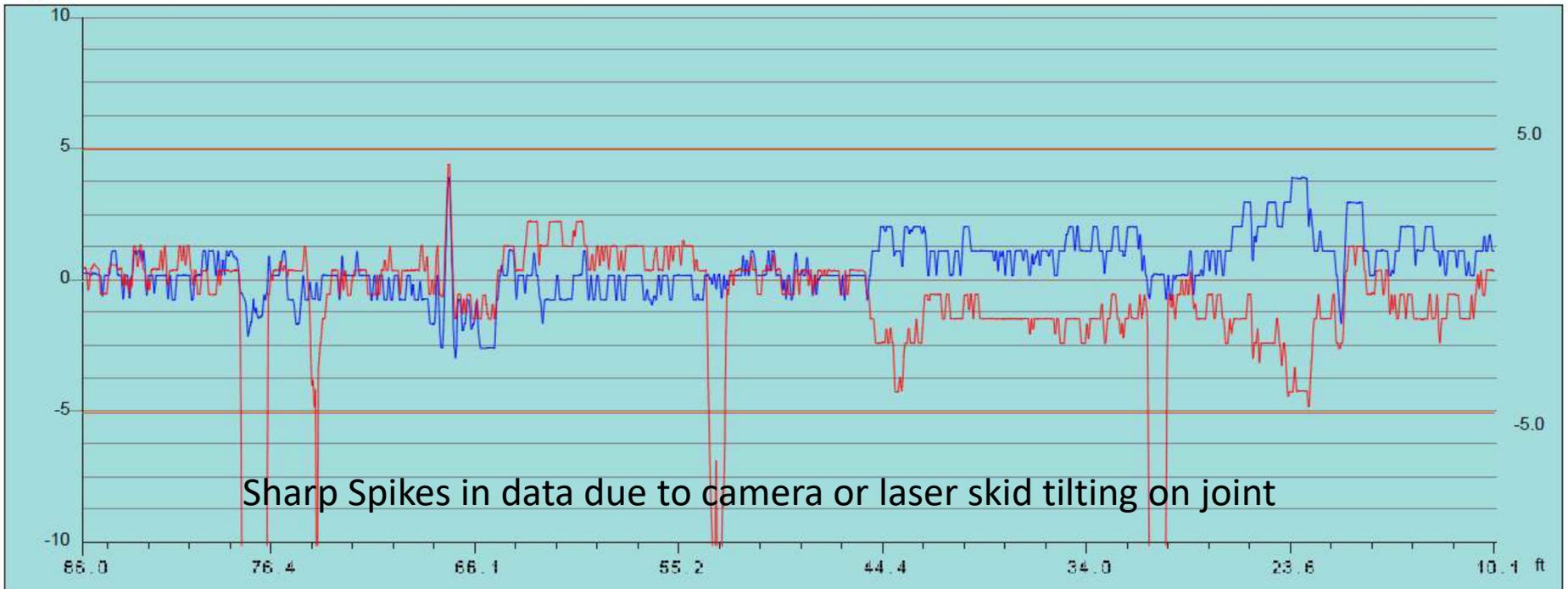
Comments

MP 123, I-25, Cross Drain, Center Pipe

Limit Lines

Upper limit = 5
Lower Limit = -5

% 90% - Fractile: (X) 2.1% : (Y) 1.3%, Exceeded limits: 4.3%



XY Deflection Summary Report

Pipe under 5% (Deflection based off Median I.D. per frame of video)

Site ID
City Fountain, Colorado
Start No Center Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Center Pipe
Location Inlet

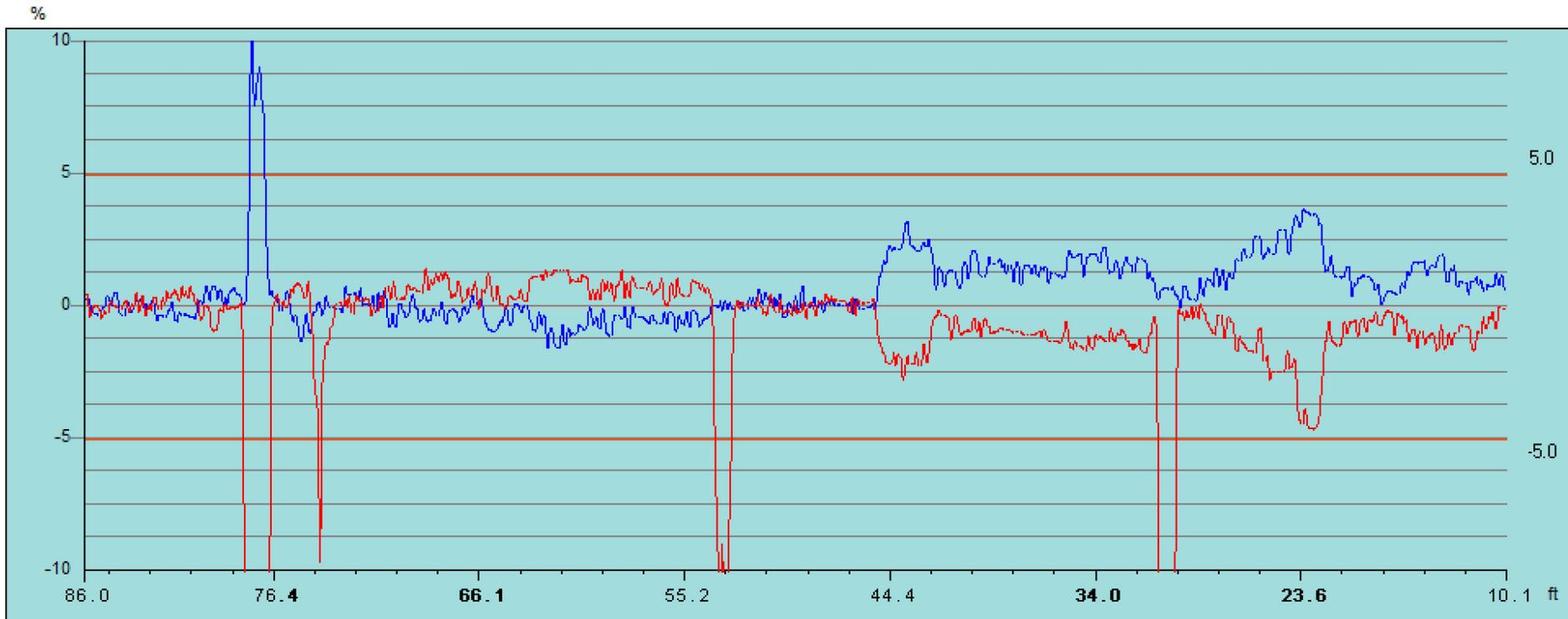
Date 10/9/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35 in

Comments

MP 123, I-25, Cross Drain, Center Pipe

Limit Lines

Upper limit = 5
Lower Limit = -5



Ovality Summary Report

Ovality under 5%, spikes due to camera going over joints

Site ID
City Fountain, Colorado
Start No Center Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Center Pipe
Location Inlet

Date 10/9/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35 in

Comments

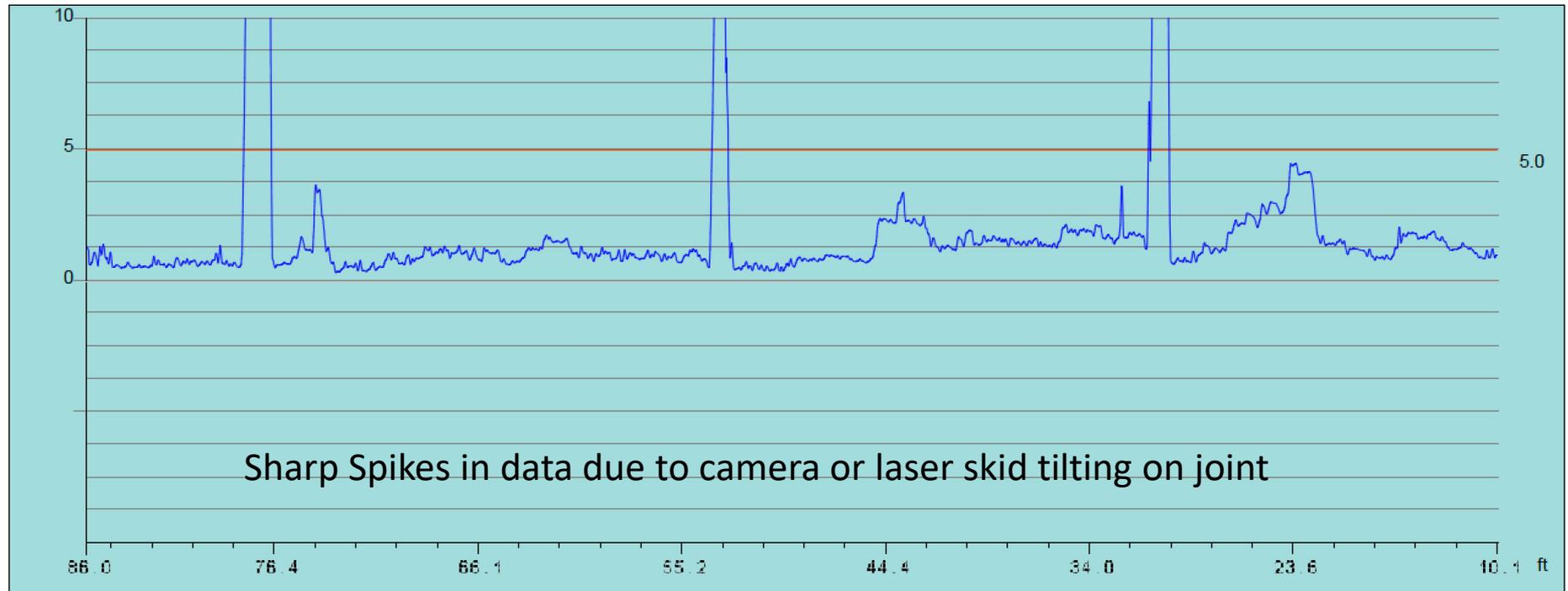
MP 123, I-25, Cross Drain, Center Pipe

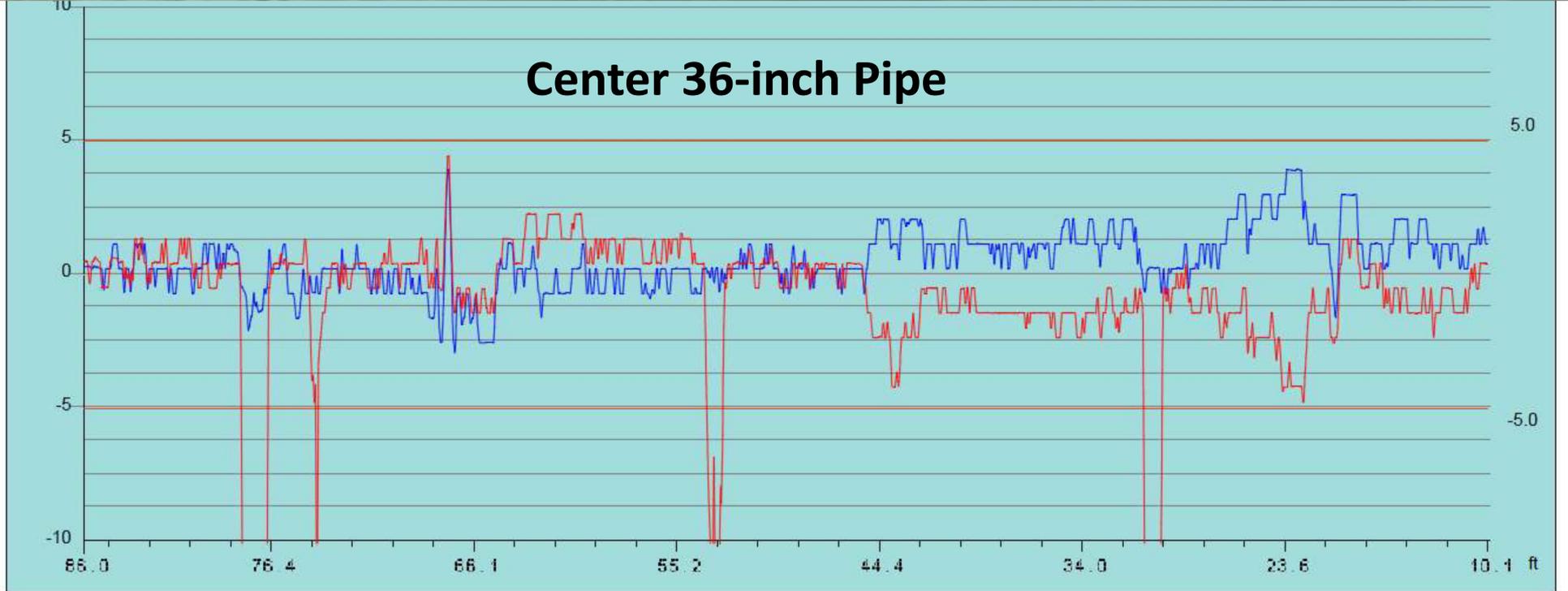
Limit Lines

Upper limit = 5
Lower Limit = 5

% 90% - Fractile: 2.6%, Exceeded limits: 4.4%

Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance





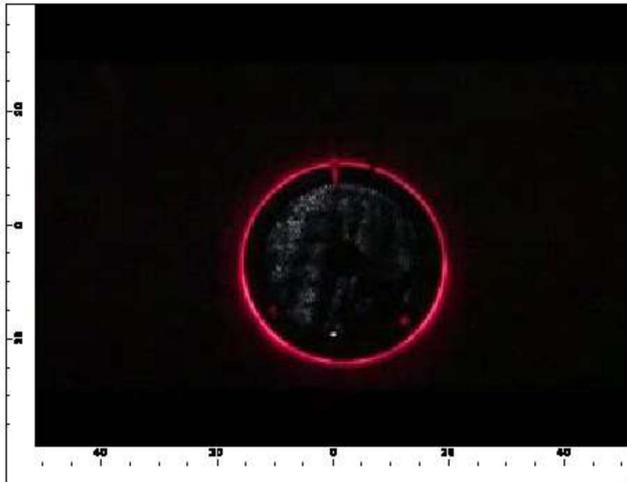
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Center Pipe)

Site ID
City Fountain, Colorado
Start No Center Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Center Pipe
Location Inlet

Date 10/9/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35 in



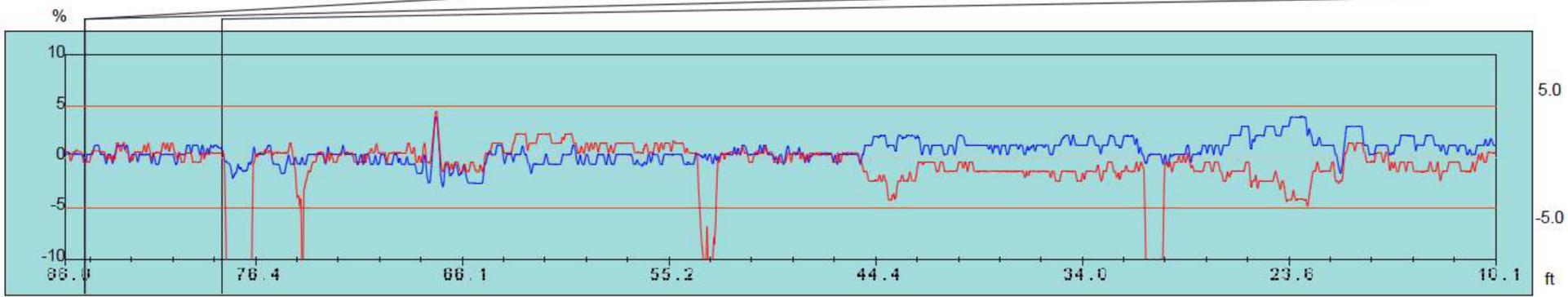
Laser picking up erosion control stakes driven through crown of pipe.



Stakes from erosion control devices.



Slight dent at left springline at 78 ft.



90% - Fractile: (X) 2.1% : (Y) 1.3%, Exceeded limits: 4.3%

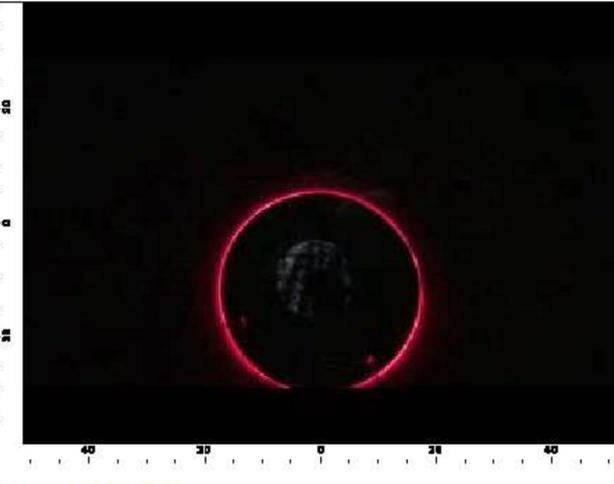
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Center Pipe)

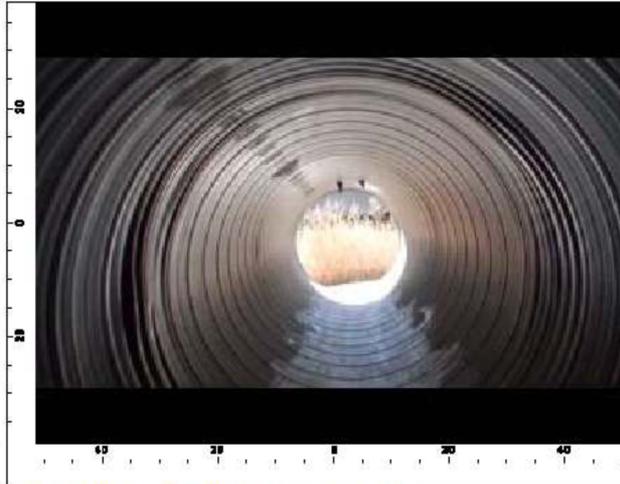
Site ID
 City Fountain, Colorado
 Start No Center Pipe
 Location Outlet

Asset No. I-25, MP 123
 Finish No Center Pipe
 Location Inlet

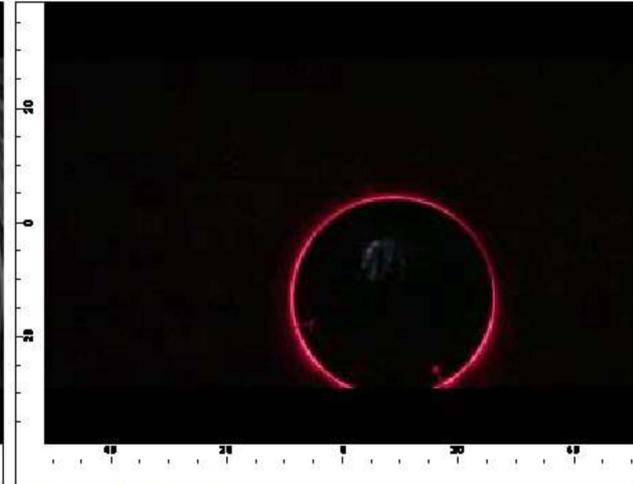
Date 10/9/2013
 Material DuroMaxx
 Pipeline Length 88 ft
 Internal Diameter (Expected) 35 in



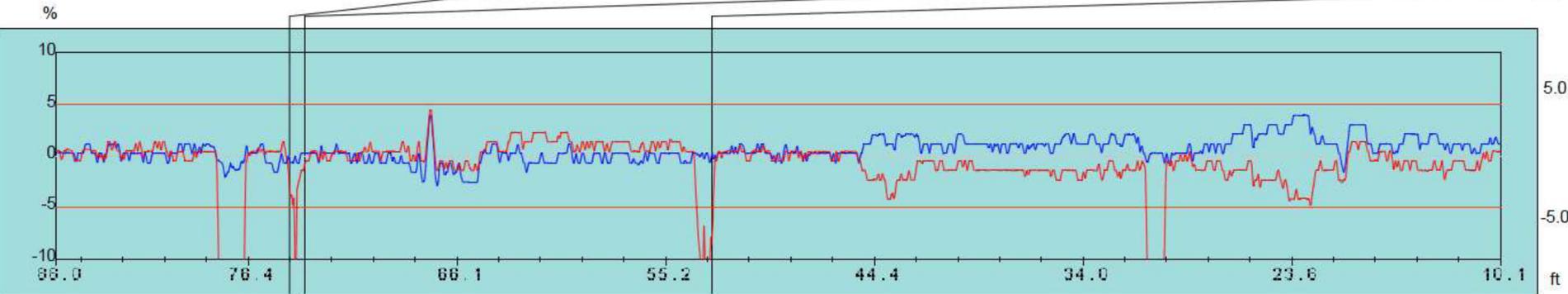
Camera tilted at joint



Slight dent at left springline at approx. 73 ft.



Camera tilting at joint



90% - Fractile: (X) 2.1% : (Y) 1.3%, Exceeded limits: 4.3%

XY Diameter Observations Report

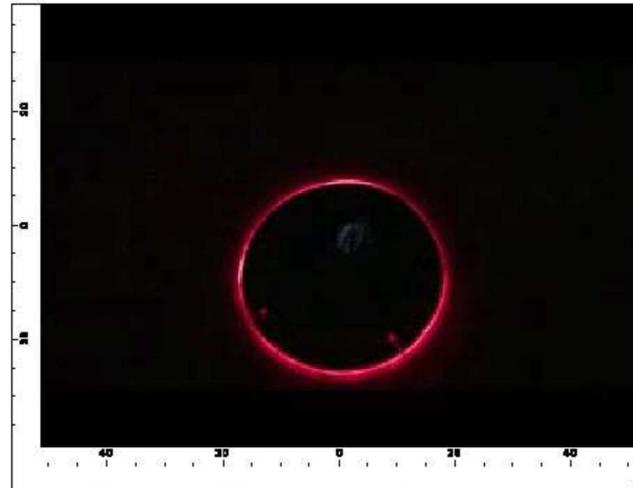
MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Center Pipe)

Site ID
City Fountain, Colorado
Start No Center Pipe
Location Outlet

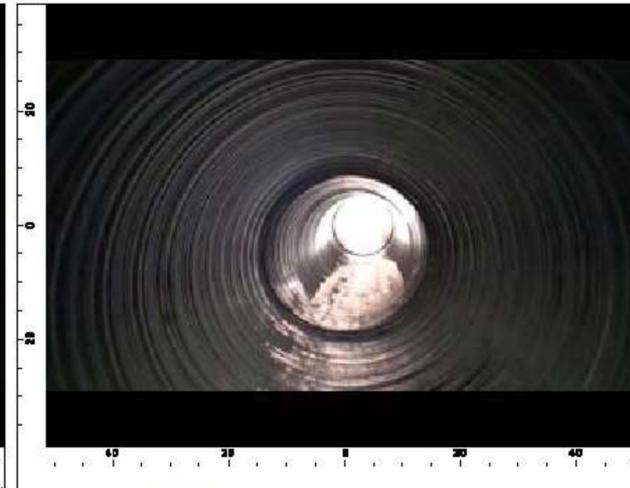
Asset No. I-25, MP 123

Finish No Center Pipe
Location Inlet

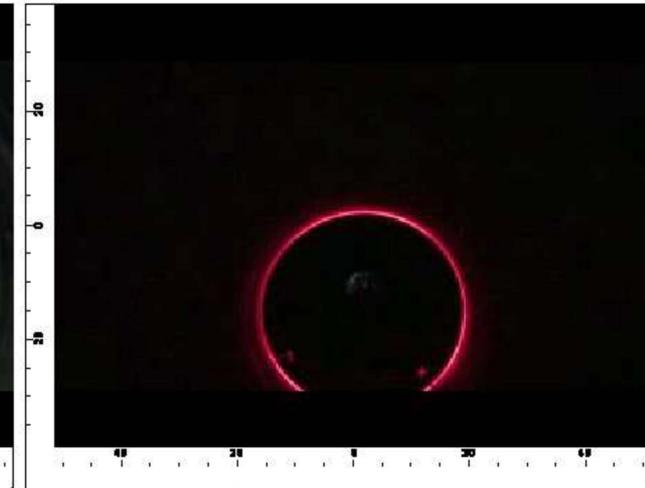
Date 10/9/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35 in



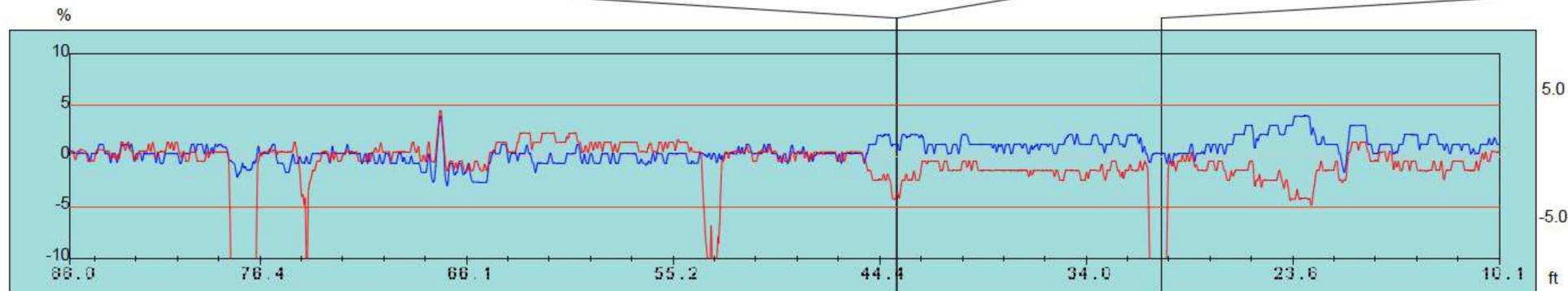
Deflection near second joint, approx. 3.8%.



View of second joint.



Camera tilting at joint



90% - Fractile: (X) 2.1% : (Y) 1.3%, Exceeded limits: 4.3%

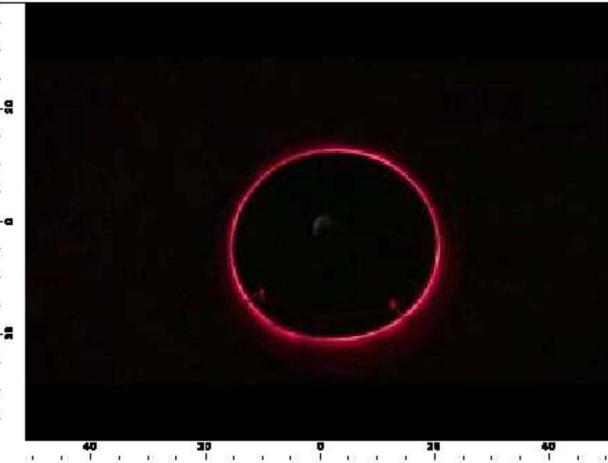
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Center Pipe)

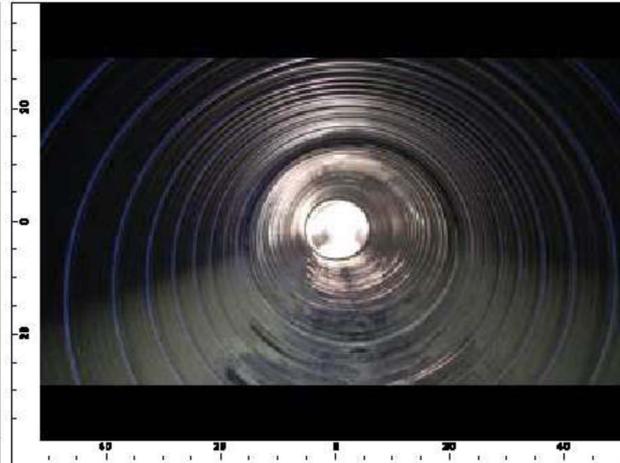
Site ID
City Fountain, Colorado
Start No Center Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Center Pipe
Location Inlet

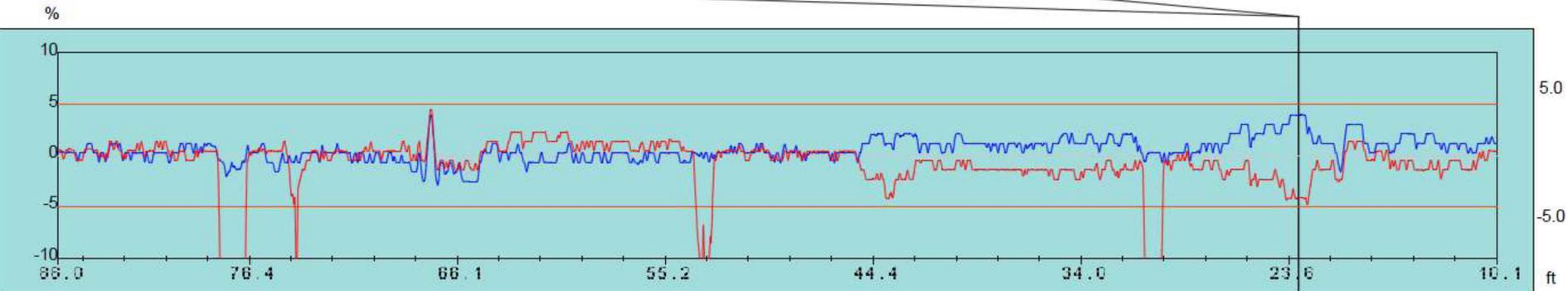
Date 10/9/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35 in



Pipe deflected approximately 4% at 23 ft.



View of pipe at first joint.



90% - Fractile: (X) 2.1% : (Y) 1.3%, Exceeded limits: 4.3%

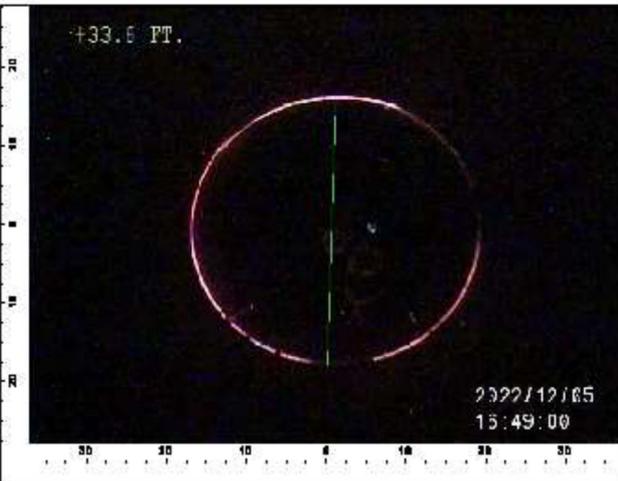
XY Diameter Observations Report

Pipe Deflected Near 5%

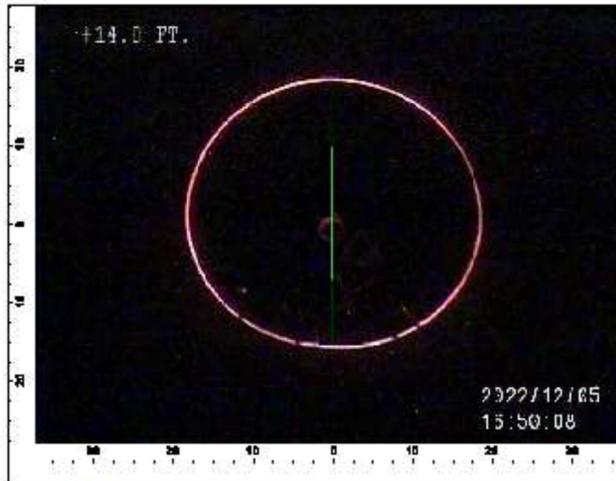
Site ID
City Fountain
Start No Outlet
Location

Asset No. MP 123 Mid
Finish No Inlet
Location

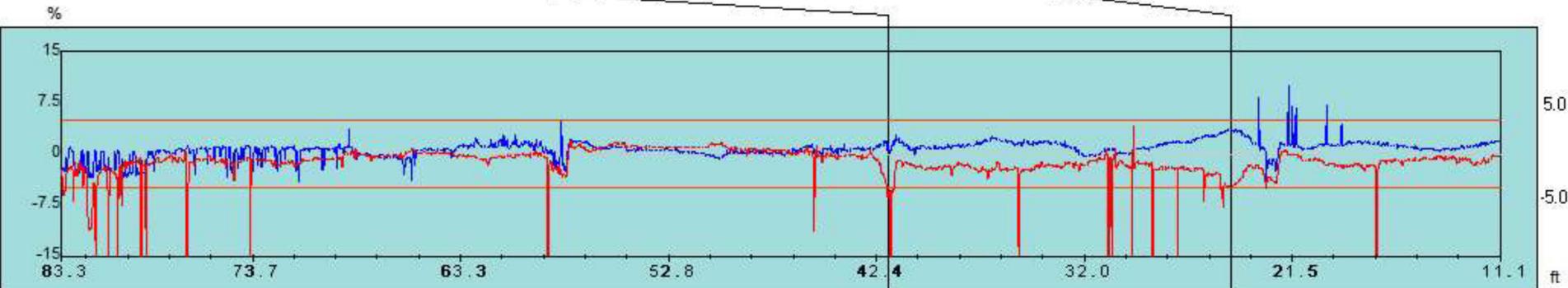
Date 12/15/2016
Material DuroMaxx
Pipeline Length 78 ft
Internal Diameter 35.4 in



Pipe deflected near 5%.

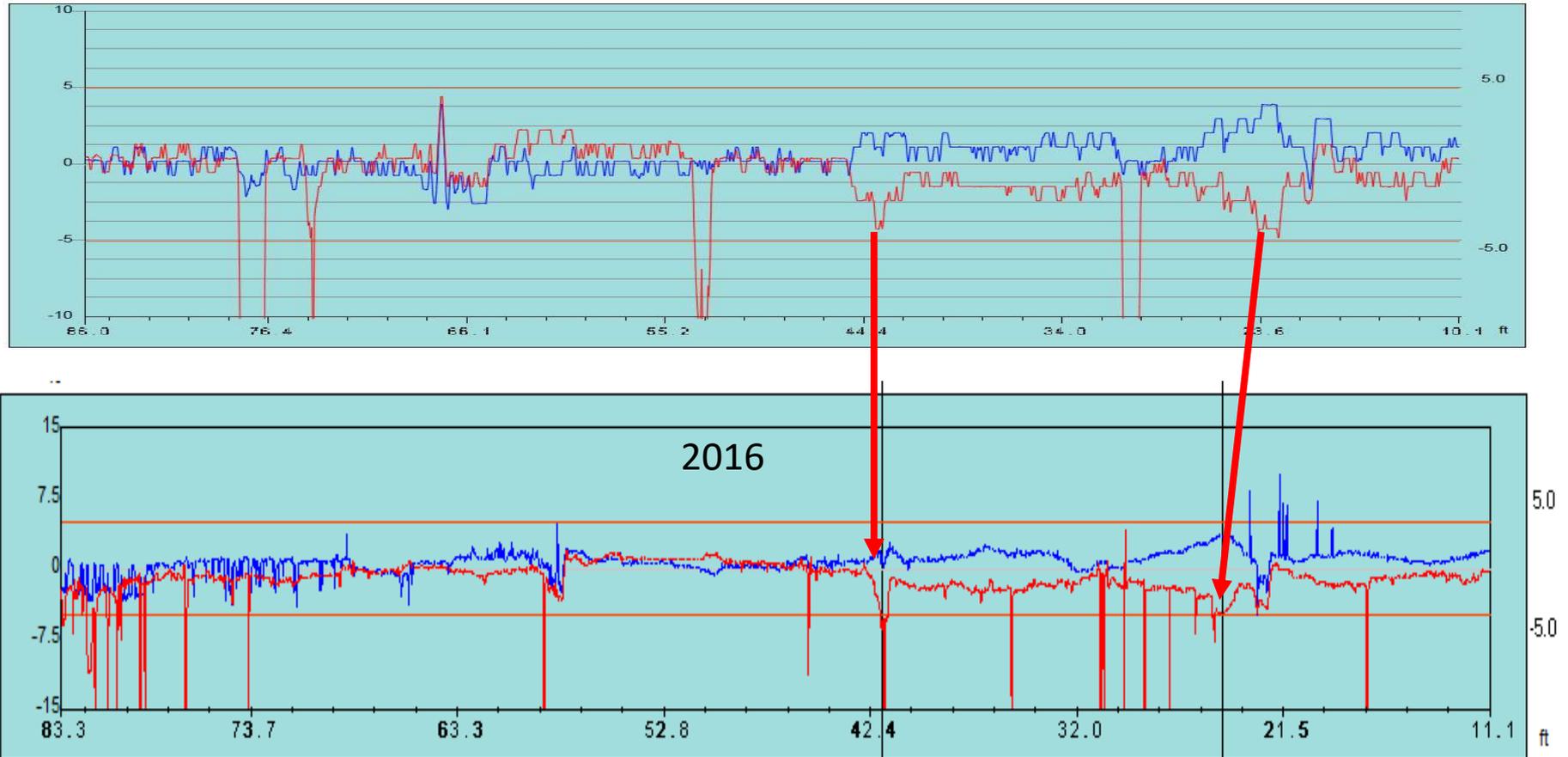


Pipe deflected approximately 4.7%.



90% - Fractile: (X) 1.8% : (Y) 0.8%, Exceeded limits: 3.4%

Performance Summary MP 123 (Middle Pipe)



The inlet end of the structure had been severely damaged by a vehicle, minor punctures from construction stakes were still visible. It appears that some possible slight increase in deflection has occurred around at 23 and 42 ft. Deflection at 5%.

MP 123, I-25, 36-Inch DuroMaxx
Southern Pipe



Project Name: I-25, Fountain, Colorado

Date: 9/30/2013
 Asset Location:
 Distance: 0
 Run Number:
 Pipe Size: 36

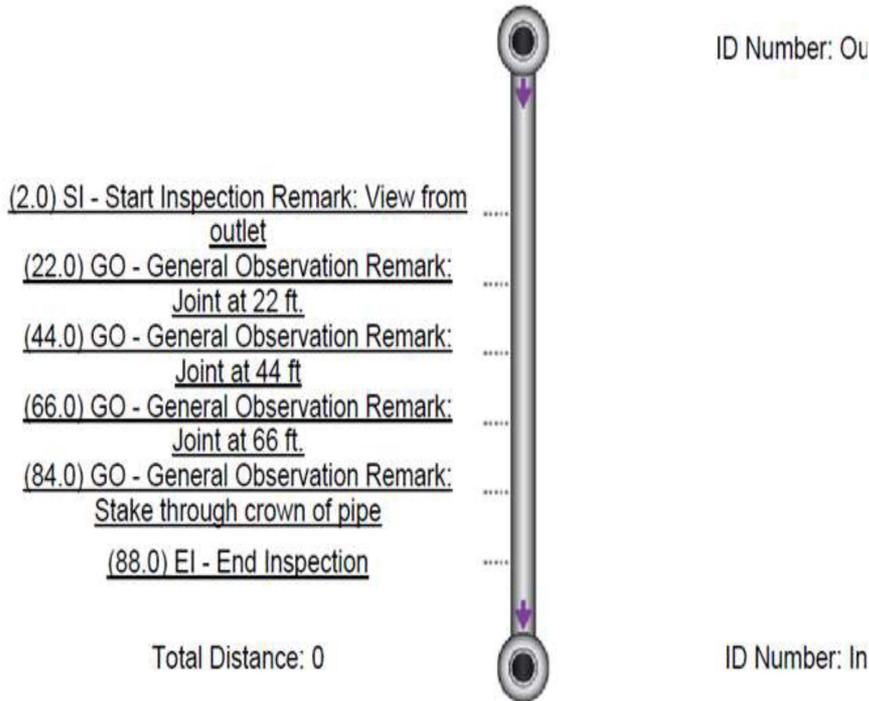
Pipe ID: Southern Pipe
 Start ID: Outlet
 End ID: Inlet
 Direction: Upstrm
 Pipe Type: DuroMaxx



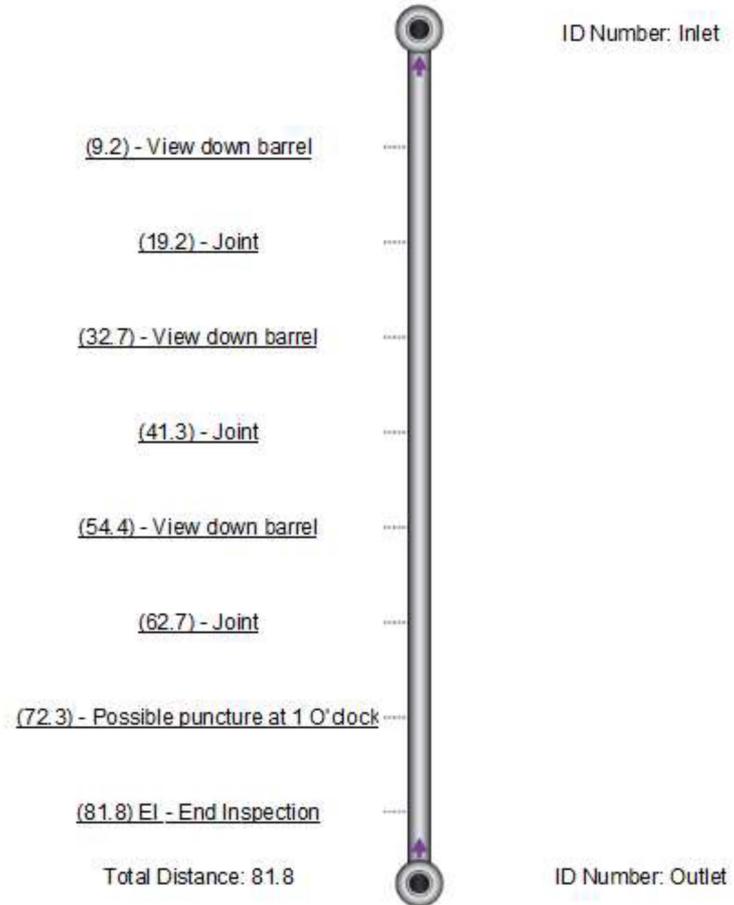
Project Name: MP 123 Fountain Colorado

Date: 12/5/2016	Pipe ID: South Pipe
Asset Location:	Start ID: Outlet
Length Surveyed: 81.8	End ID: Inlet
Run Number:	Direction: Upstream
Pipe Size: 48-inch	Pipe Type: DuraMaxx

Severity
Light
Moderate
Average
Heavy
Severe



Created with the report generator



Created with the report generator [Back](#)

Project Name: I-25, Fountain, Colorado

Date: 9/30/2013
 Asset Location:
 Distance: 0
 Run Number:
 Pipe Size: 36

Pipe ID: Southern Pipe
 Start ID: Outlet
 End ID: Inlet
 Direction: Upstrm
 Pipe Type: DuroMaxx

Distance	Fault Observation	Time	Picture
2.0	Start Inspection Remarks: View from outlet	01:47 00:00:00	
22.0	General Observation Remarks: Joint at 22 ft.	2:30:17 00:00:36	
44.0	General Observation Remarks: Joint at 44 ft	2:31:30 00:01:05	

Project Name: MP 123 Fountain Colorado

Date: 12/5/2016

Pipe ID: South Pipe

Asset Location:

Start ID: Outlet

Length Surveyed: 81.8

End ID: Inlet

Run Number:

Direction: Upstream

Pipe Size: 48-inch

Pipe Type: DuraM axx

Distance	Fault Observation	Picture
9.2	Viewdown barrel	
19.2	Joint	
32.7	Viewdown barrel	
41.3	Joint	
54.4	Viewdown barrel	

Distance	Fault Observation	Time	Picture
66.0	General Observation Remarks: Joint at 66 ft.	2:32:18 00:01:26	
84.0	General Observation Remarks: Stake through crown of pipe	2:33:18 00:01:54	
88.0	End Inspection	2:33:47 00:02:01	

Created with the  report generator

Distance	Fault Observation	Picture
62.7	Joint	
72.3	Possible puncture at 1 O'clock	
81.8	End Inspection	

Created with the  report generator [Back](#)

XY Diameter Summary Report

Pipe under 5% deflection, spikes in data due to camera tilting at joint

Site ID
City Fountain, Colorado
Start No Southern Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Southern Pipe
Location Inlet

Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35.24 in

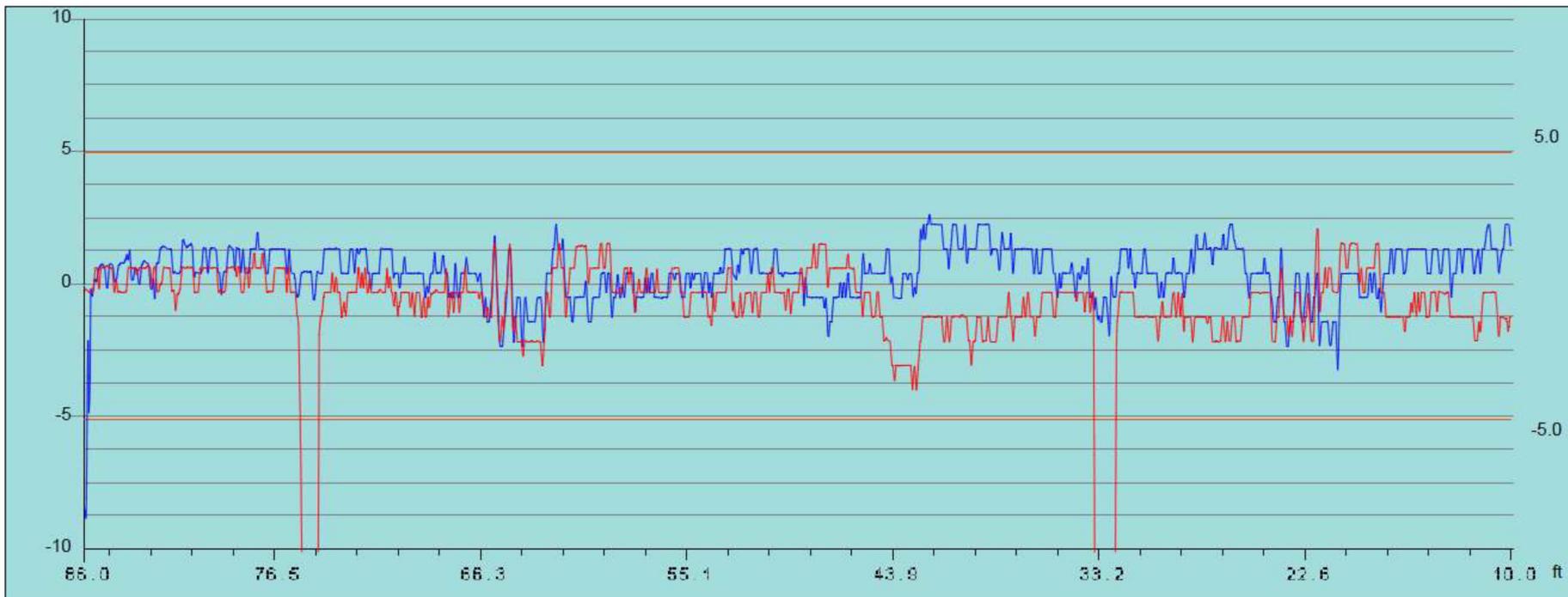
Comments

I-25, MP 123, 36-inch Southern Pipe, Cross Drain

Limit Lines

Upper limit = 5
Lower Limit = -5

% 90% - Fractile: (X) 1.4% : (Y) 0.7%, Exceeded limits: 2.9%



XY Deflection Summary Report

Pipe under 5% (Deflection based off Median I.D. per frame of video)

Site ID
City Fountain, Colorado
Start No Southern Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Southern Pipe
Location Inlet

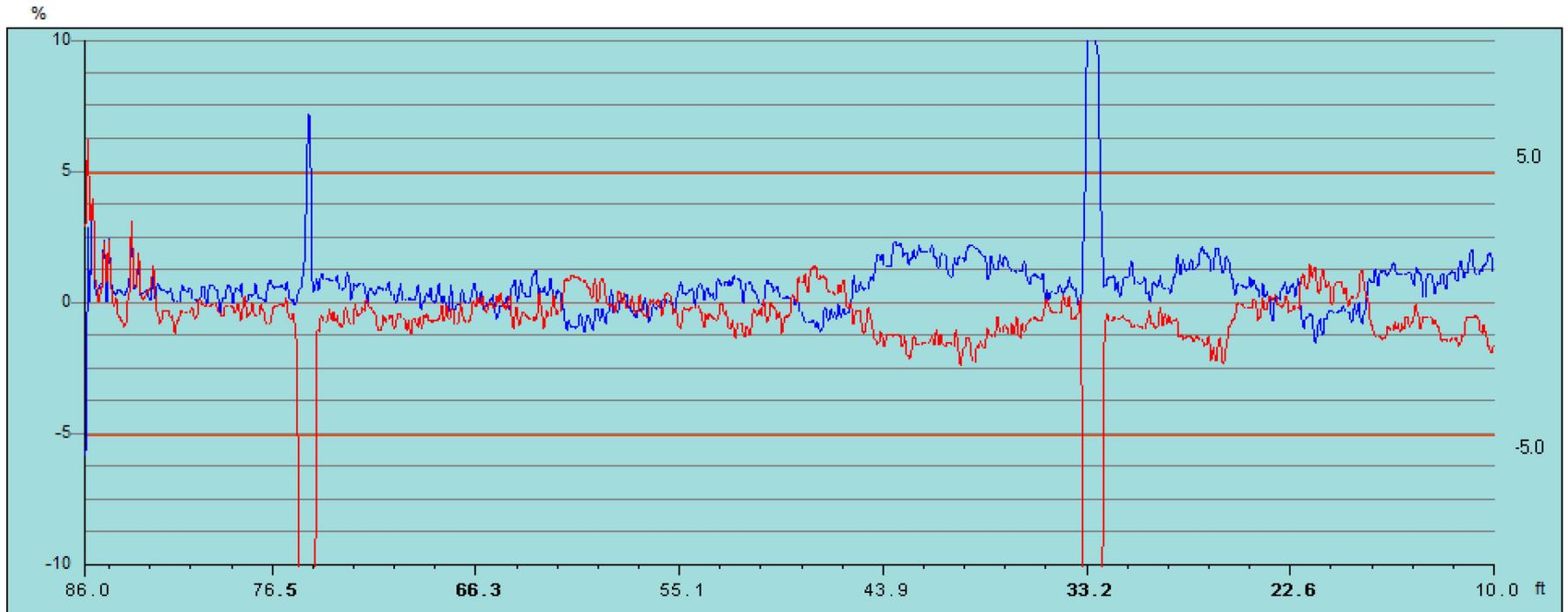
Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35.24 in

Comments

I-25, MP 123, 36-inch Southern Pipe, Cross Drain

Limit Lines

Upper limit = 5
Lower Limit = -5



Ovality Summary Report

Ovality under 5%, spikes due to camera going over joint

Site ID
City Fountain, Colorado
Start No Southern Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Southern Pipe
Location Inlet

Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35.24 in

Comments

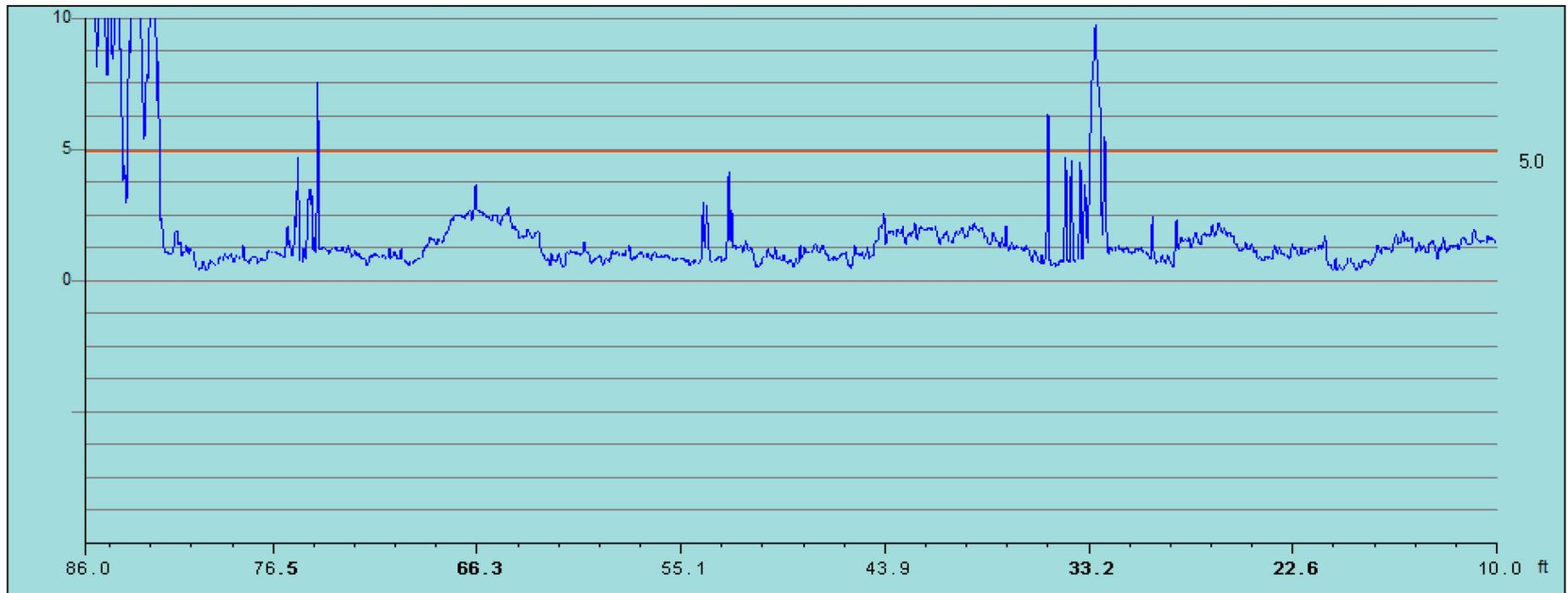
I-25, MP 123, 36-inch Southern Pipe, Cross Drain

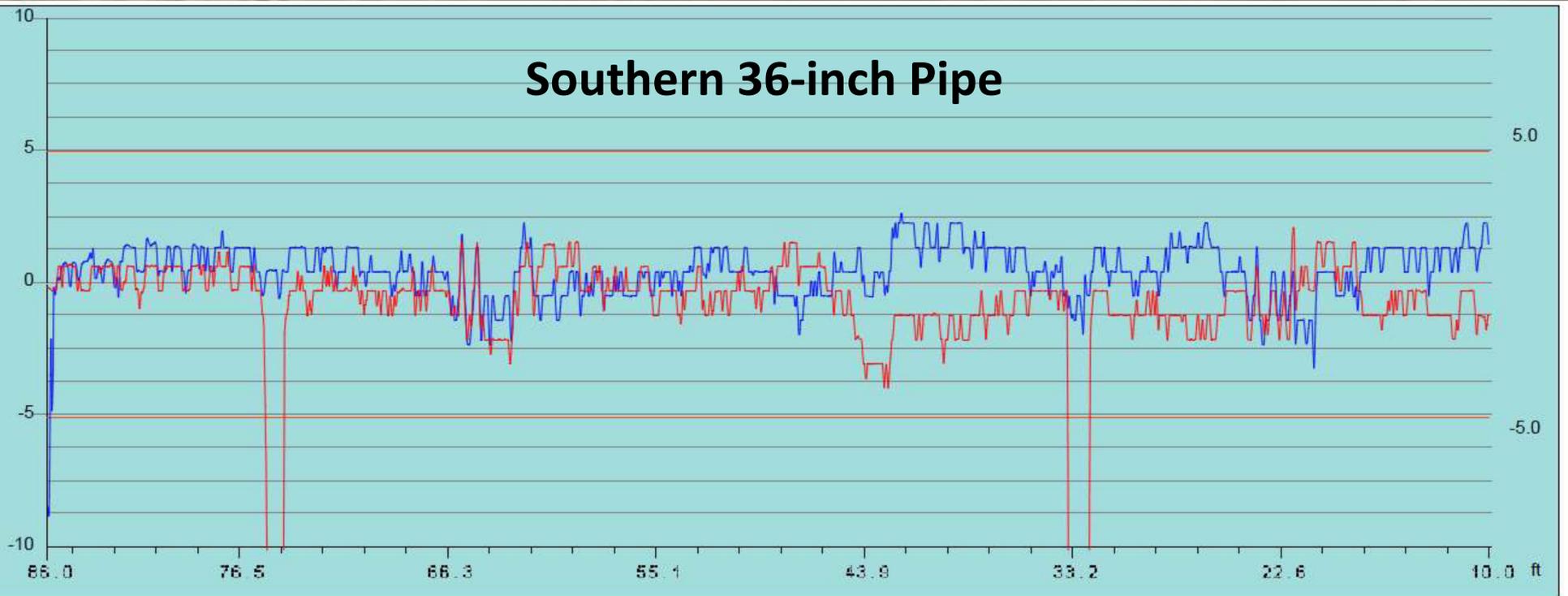
Limit Lines

Upper limit = 5
Lower Limit = 5

90% - Fractile: 2.6%, Exceeded limits: 5.6%

Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance





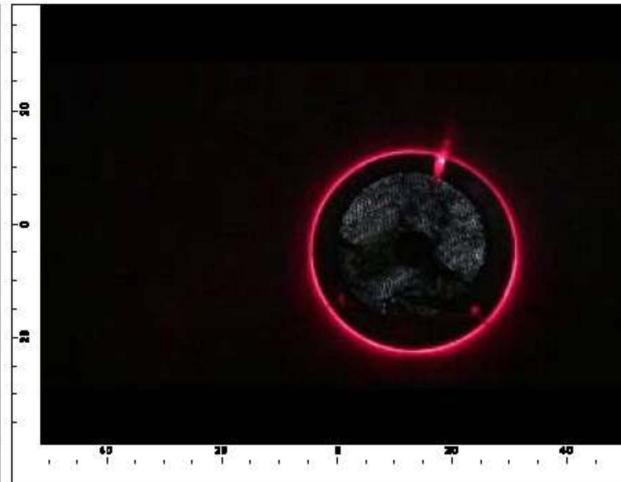
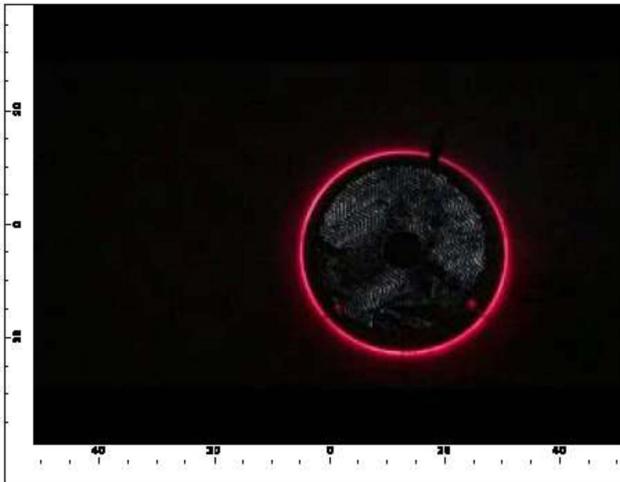
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Southern Pipe)

Site ID
City Fountain, Colorado
Start No Southern Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Southern Pipe
Location Inlet

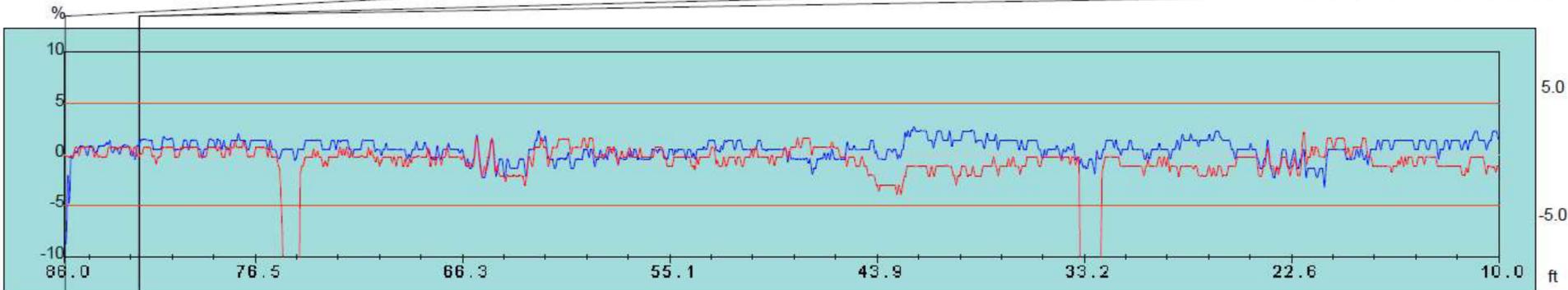
Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35.24 in



Noise in data due to outside light. Pipe okay.

Laser passing under erosion control stake driven through crown of pipe.

View of erosion control stake through crown of structure.



90% - Fractile: (X) 1.4% : (Y) 0.7%, Exceeded limits: 2.9%

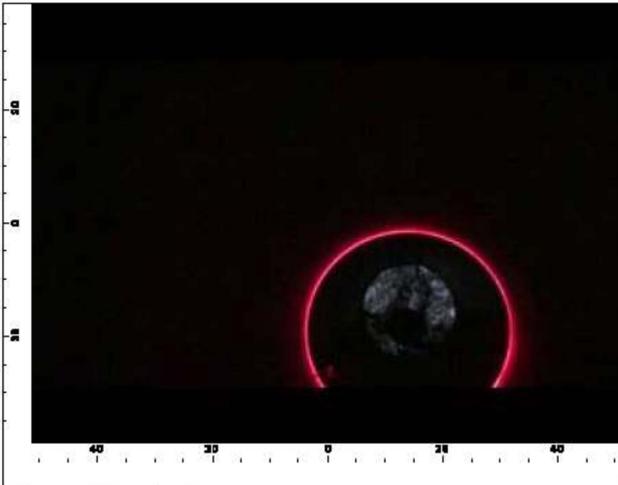
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Southern Pipe)

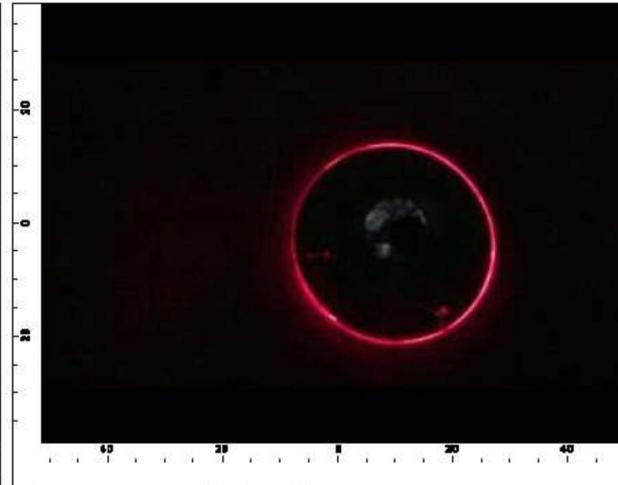
Site ID
City Fountain, Colorado
Start No Southern Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Southern Pipe
Location Inlet

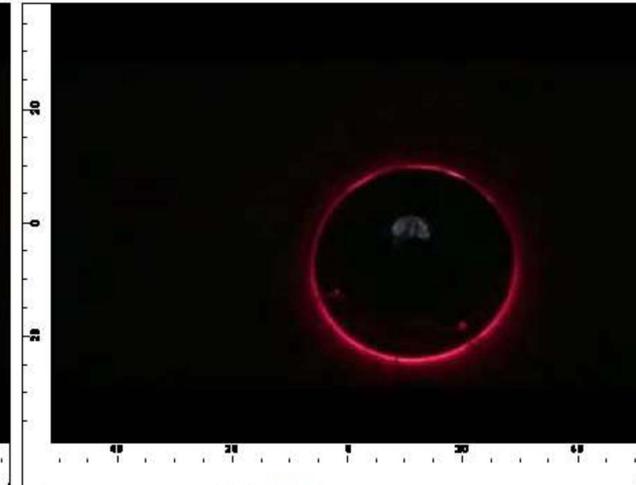
Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35.24 in



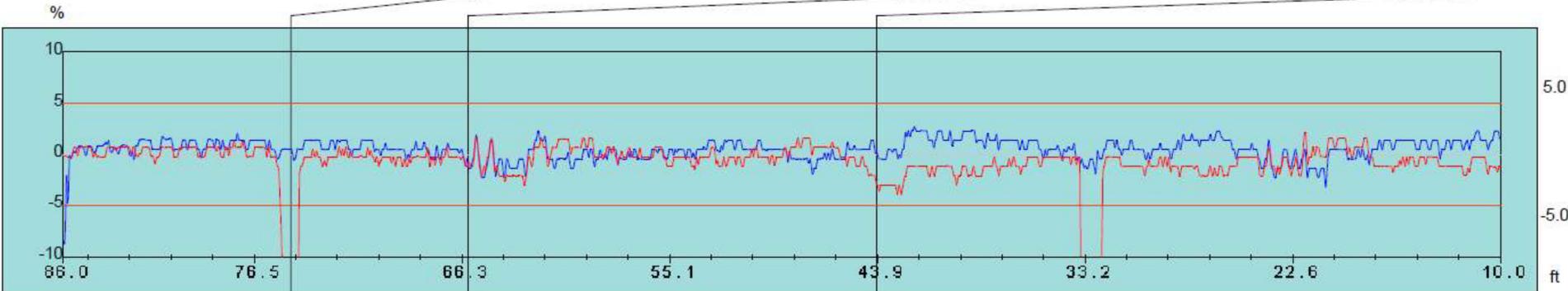
Camera tilted at joint



Laser passing over joint at 66 ft.



Laser passing over joint at 44 ft.



90% - Fractile: (X) 1.4% : (Y) 0.7%, Exceeded limits: 2.9%

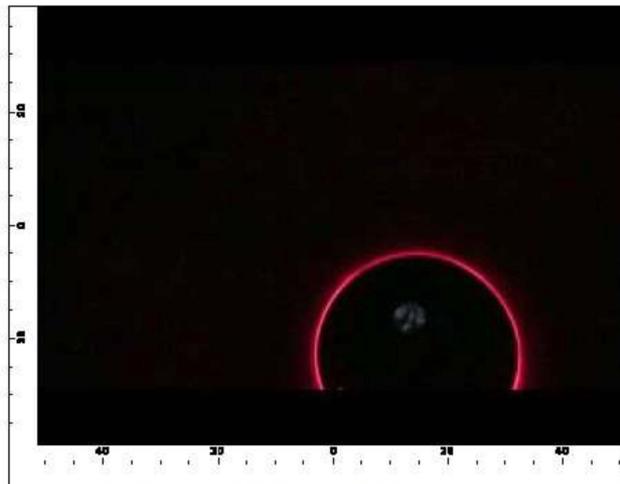
XY Diameter Observations Report

MP 123, I-25, DuroMaxx Installation, Fountain, Colorado (Southern Pipe)

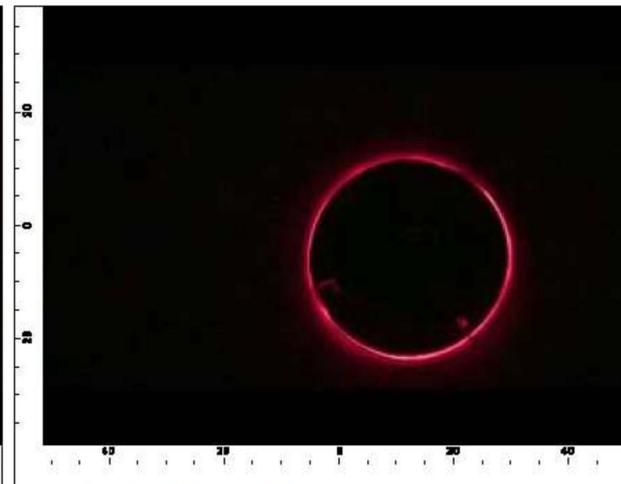
Site ID
City Fountain, Colorado
Start No Southern Pipe
Location Outlet

Asset No. I-25, MP 123
Finish No Southern Pipe
Location Inlet

Date 9/30/2013
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter (Expected) 35.24 in



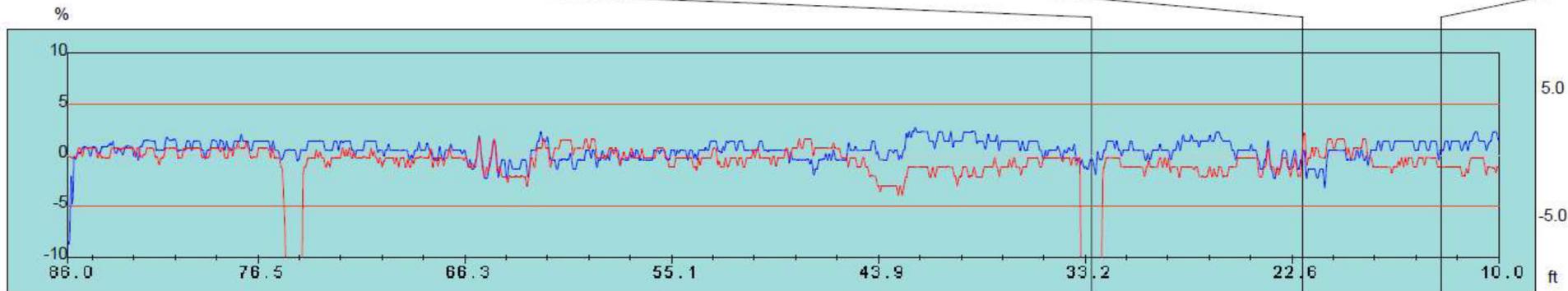
Camera tilted on second joint, pipe okay.



Laser passing over first joint at 22 ft.



View of pipe towards outlet end of the structure. Pipe appears to be round and uniform.



90% - Fractile: (X) 1.4% : (Y) 0.7%, Exceeded limits: 2.9%

XY Diameter Summary Report

Pipe under 5.0% Deflection

Site ID
City Fountain
Start No Outlet
Location

Asset No. MP 123 South
Finish No Inlet
Location

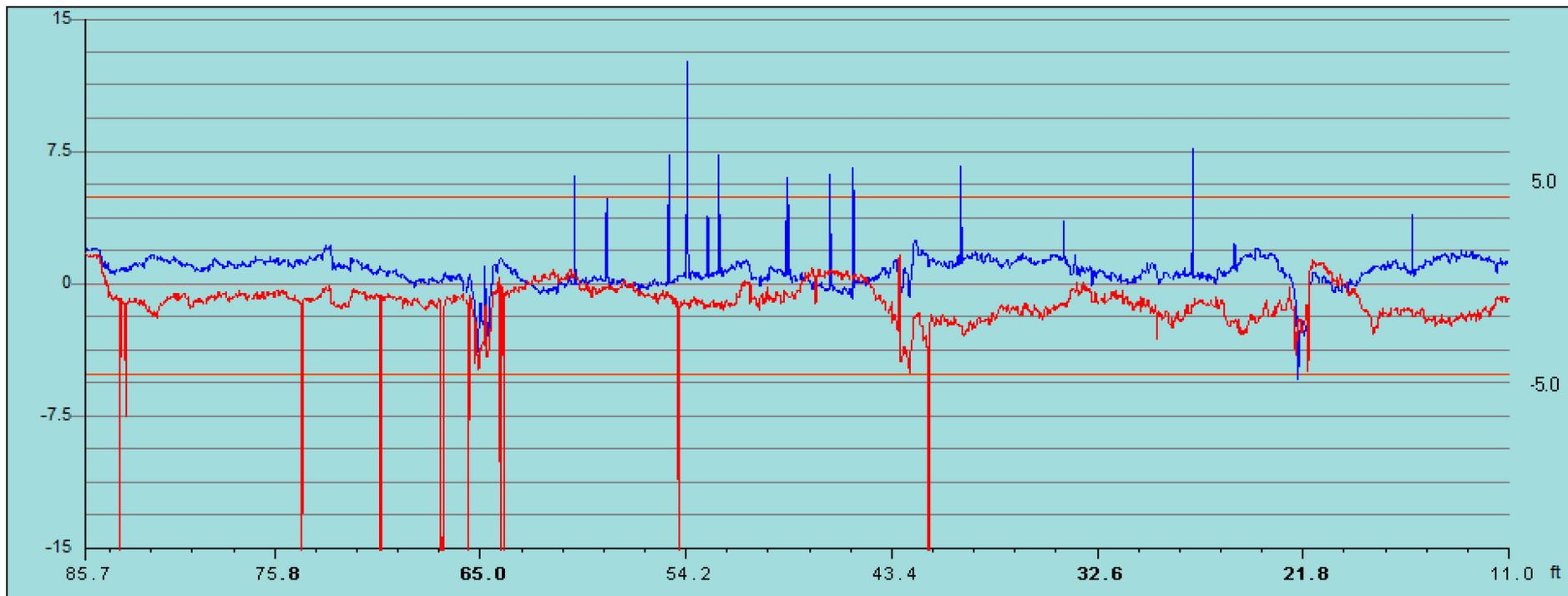
Date 12/15/2016
Material DuroMaxx
Pipeline Length 88 ft
Internal Diameter 35.39 in

Comments

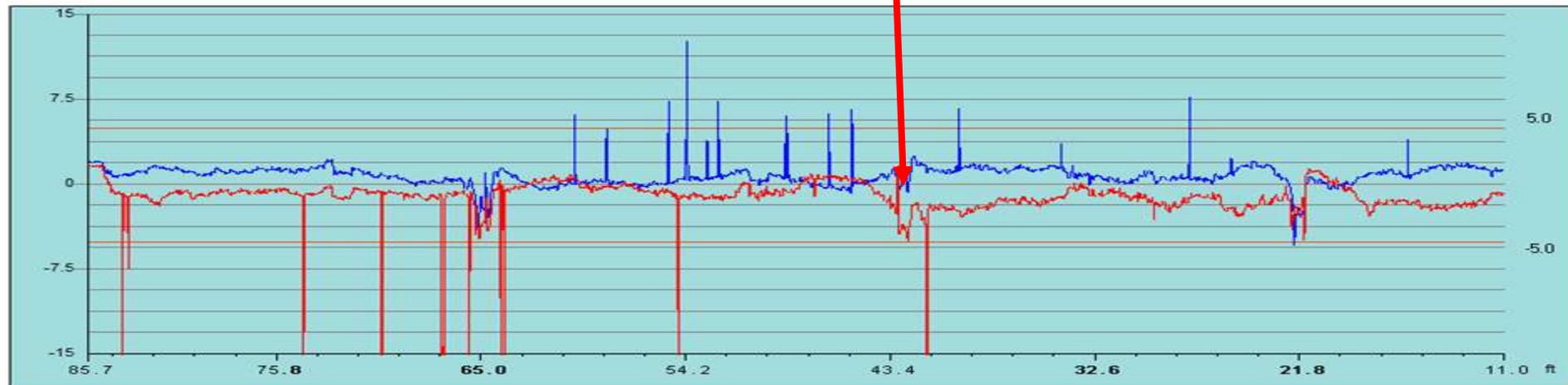
Limit Lines

Upper limit = 5
Lower Limit = -5

% 90% - Fractile: (X) 1.6% : (Y) 0.3%, Exceeded limits: 1.5%



Performance Summary MP 123 (Southern Pipe)



Minor punctures from construction stakes were still visible at the inlet end. Deflections are still below 5%. Some slight possible movement might have occurred around 44 ft.

MP 122.5, I-25, 48-Inch DuroMaxx







Project Name: I-25, Fountain, Colorado

Date: 9/30/2013

Asset Location:

Distance: 0

Run Number:

Pipe Size: 48-inch

Pipe ID: MP 122.5

Start ID: Outlet

End ID: Inlet

Direction: Upstrm

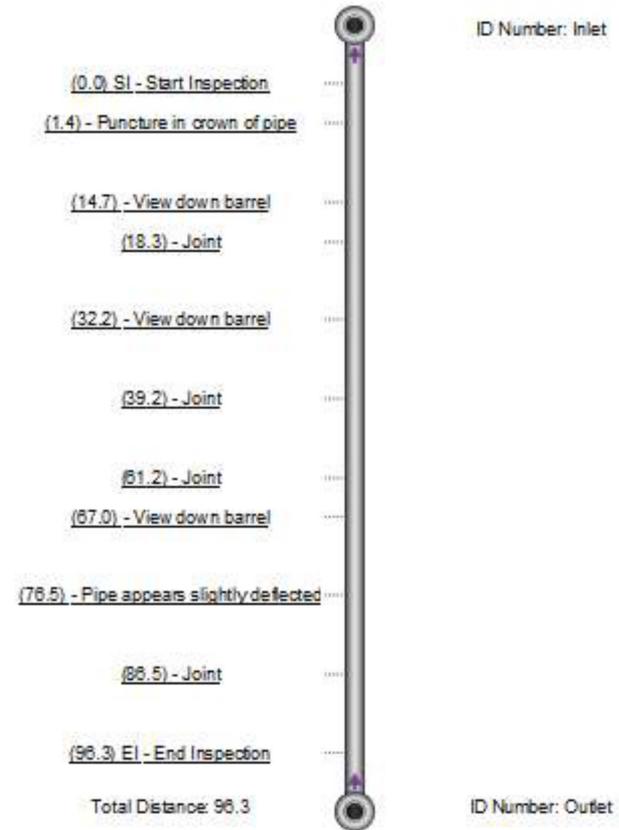
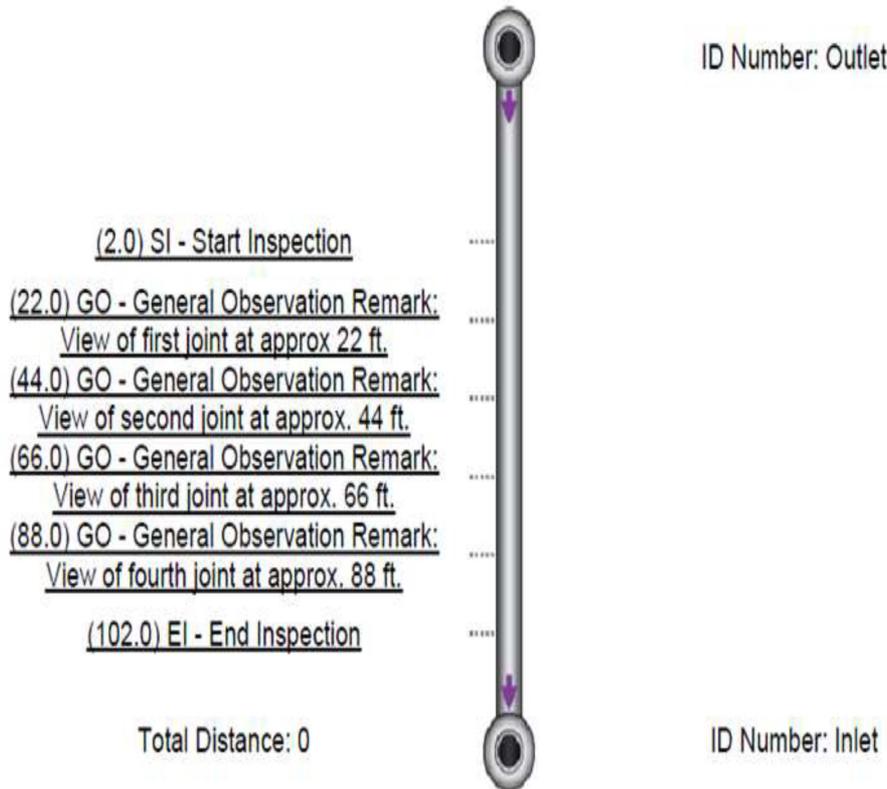
Pipe Type: DuroMaxx



Project Name: MP 122.5 Fountain Colorado

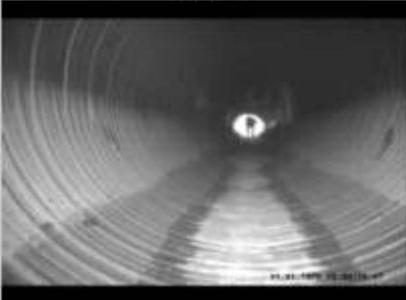
Date: 12/5/2016	Pipe ID:
Asset Location:	Start ID: Outlet
Length Surveyed: 96.3	End ID: Inlet
Run Number:	Direction: Upstream
Pipe Size: 48-inch	Pipe Type: DuraMaxx

Severity
Light
Moderate
Average
Heavy
Severe



Project Name: I-25, Fountain, Colorado

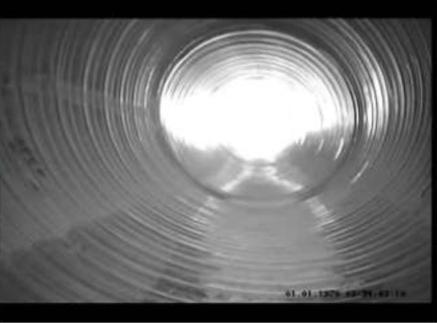
Date: 9/30/2013
 Asset Location:
 Distance: 0
 Run Number:
 Pipe Size: 48-inch
 Pipe ID: MP 122.5
 Start ID: Outlet
 End ID: Inlet
 Direction: Upstrm
 Pipe Type: DuroMaxx

Distance	Fault Observation	Time	Picture
2.0	Start Inspection	04:18 00:00:00	
22.0	General Observation Remarks: View of first joint at approx 22 ft.	06:09 00:00:48	
44.0	General Observation Remarks: View of second joint at approx. 44 ft.	07:51 00:01:24	

Project Name: MP 122.5 Fountain Colorado

Date: 12/5/2018
 Asset Location:
 Length Surveyed: 98.3
 Run Number:
 Pipe Size: 48-inch
 Pipe ID:
 Start ID: Outlet
 End ID: Inlet
 Direction: Upstream
 Pipe Type: DuraMaxx

Distance	Fault Observation	Picture
0.0	Start Inspection	
1.4	Puncture in crown of pipe	
14.7	View down barrel	
18.3	Joint	
32.2	View down barrel	

Distance	Fault Observation	Time	Picture
66.0	General Observation Remarks: View of third joint at approx. 66 ft.	10:39 00:01:53	
88.0	General Observation Remarks: View of fourth joint at approx. 88 ft.	11:51 00:02:27	
102.0	End Inspection	13:12 00:03:15	

Created with the  POSM report generator

Distance	Fault Observation	Picture
39.2	Joint	
61.2	Joint	
67.0	View down barrel	
76.5	Pipe appears slightly deflected	
86.5	Joint	
96.3	End Inspection	

Created with the  POSM report generator [Back](#)

XY Diameter Summary Report

Pipe under 5% deflection, spikes in data due to camera tilting at joint

Site ID
City Fountain, Colorado
Start No Outlet
Location MP 122.5

Asset No. I-25, MP 122.5
Finish No Inlet
Location MP 122.5

Date 9/30/2013
Material DuroMaxx
Pipeline Length 102 ft
Internal Diameter (Expected) 46.92 in

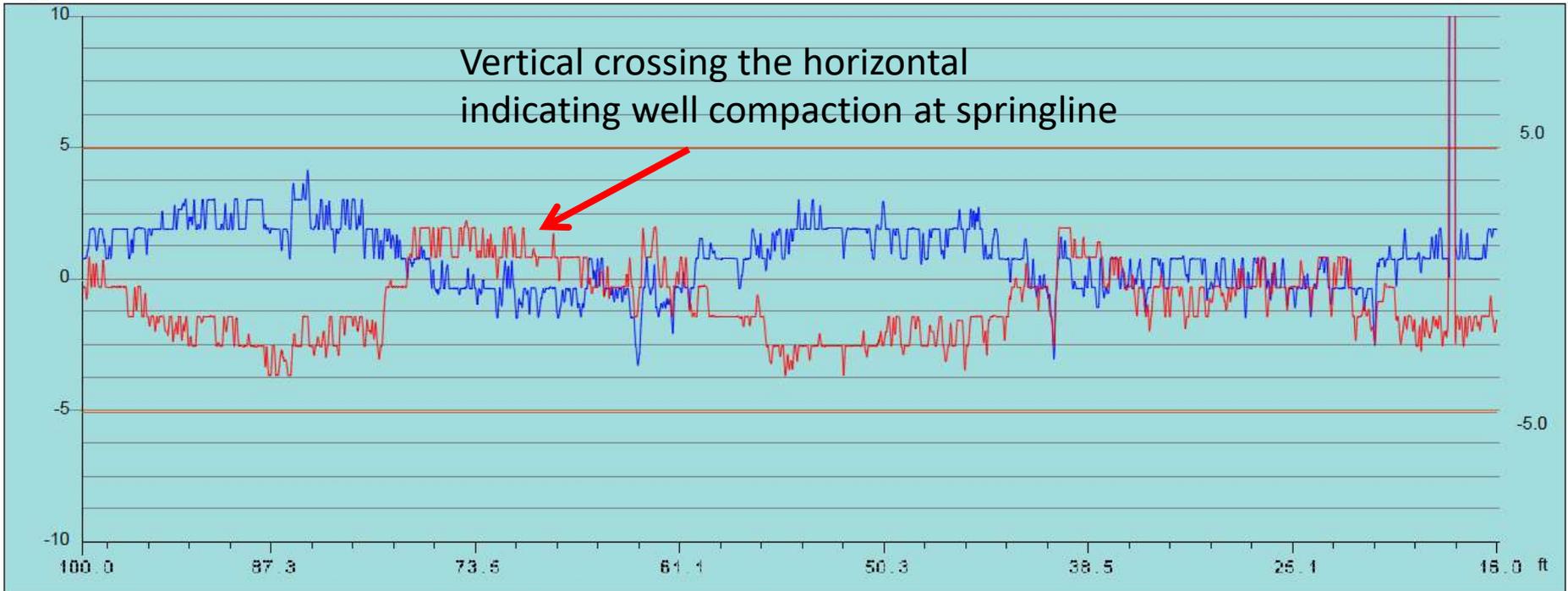
Comments

I-25, MP 122.5, 48-inch DuroMaxx

Limit Lines

Upper limit = 5
Lower Limit = -5

90% - Fractile: (X) 2.2% : (Y) 0.9%, Exceeded limits: 0.3%



XY Deflection Summary Report

Pipe under 5% (Deflection based off Median I.D. per frame of video)

Site ID
City Fountain, Colorado
Start No Outlet
Location MP 122.5

Asset No. I-25, MP 122.5
Finish No Inlet
Location MP 122.5

Date 9/30/2013
Material DuroMaxx
Pipeline Length 102 ft
Internal Diameter (Expected) 46.92 in

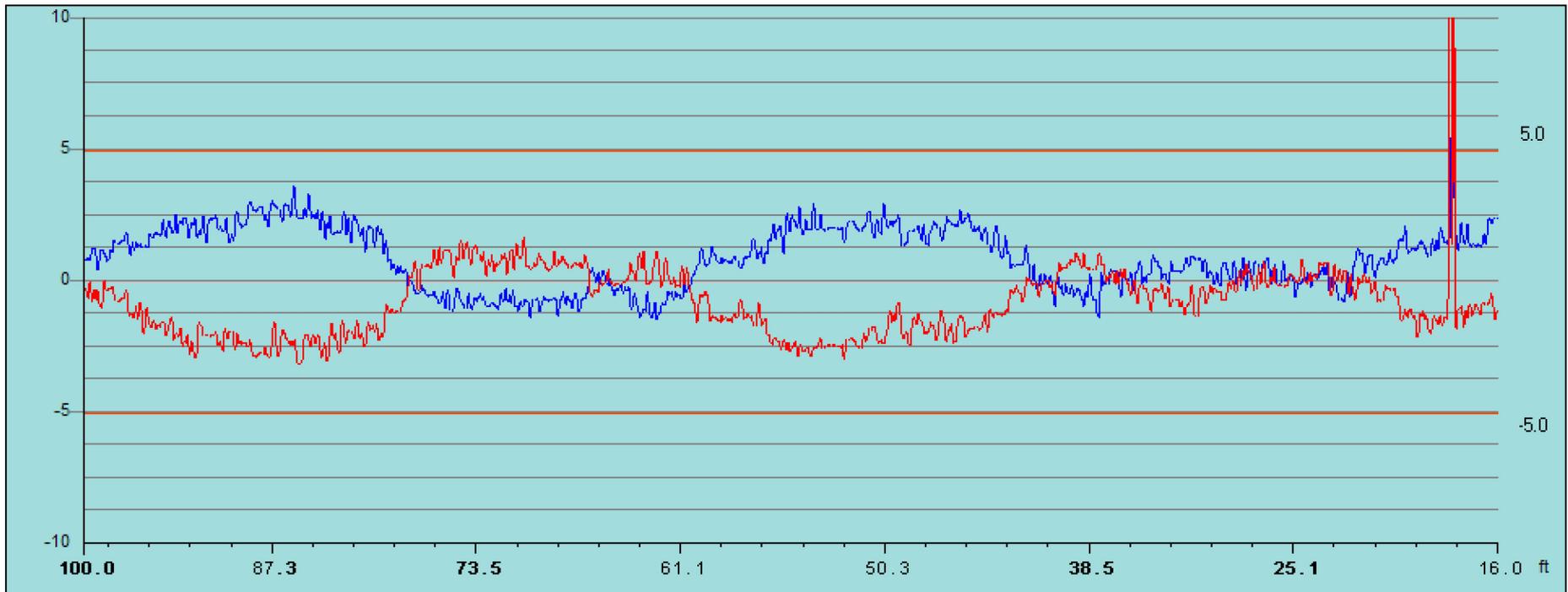
Comments

I-25, MP 122.5, 48-inch DuroMaxx

Limit Lines

Upper limit = 5
Lower Limit = -5

%



Ovality Summary Report

Ovality under 5%, spikes due to camera going over joint

Site ID	Asset No. I-25, MP 122.5	Date 9/30/2013
City Fountain, Colorado		Material DuroMaxx
Start No Outlet	Finish No Inlet	Pipeline Length 102 ft
Location MP 122.5	Location MP 122.5	Internal Diameter (Expected) 46.92 in

Comments

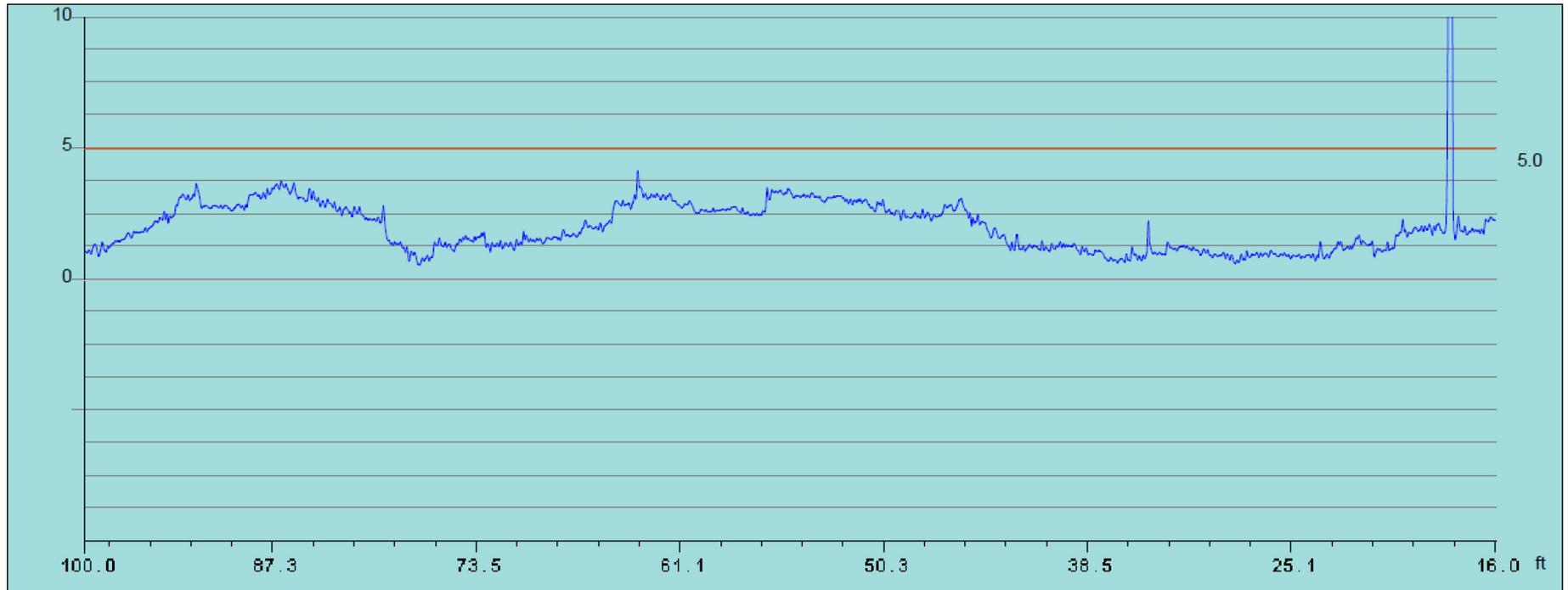
I-25, MP 122.5, 48-inch DuroMaxx

Limit Lines

Upper limit = 5
Lower Limit = 5

90% - Fractile: 3.2%, Exceeded limits: 0.3%

Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance

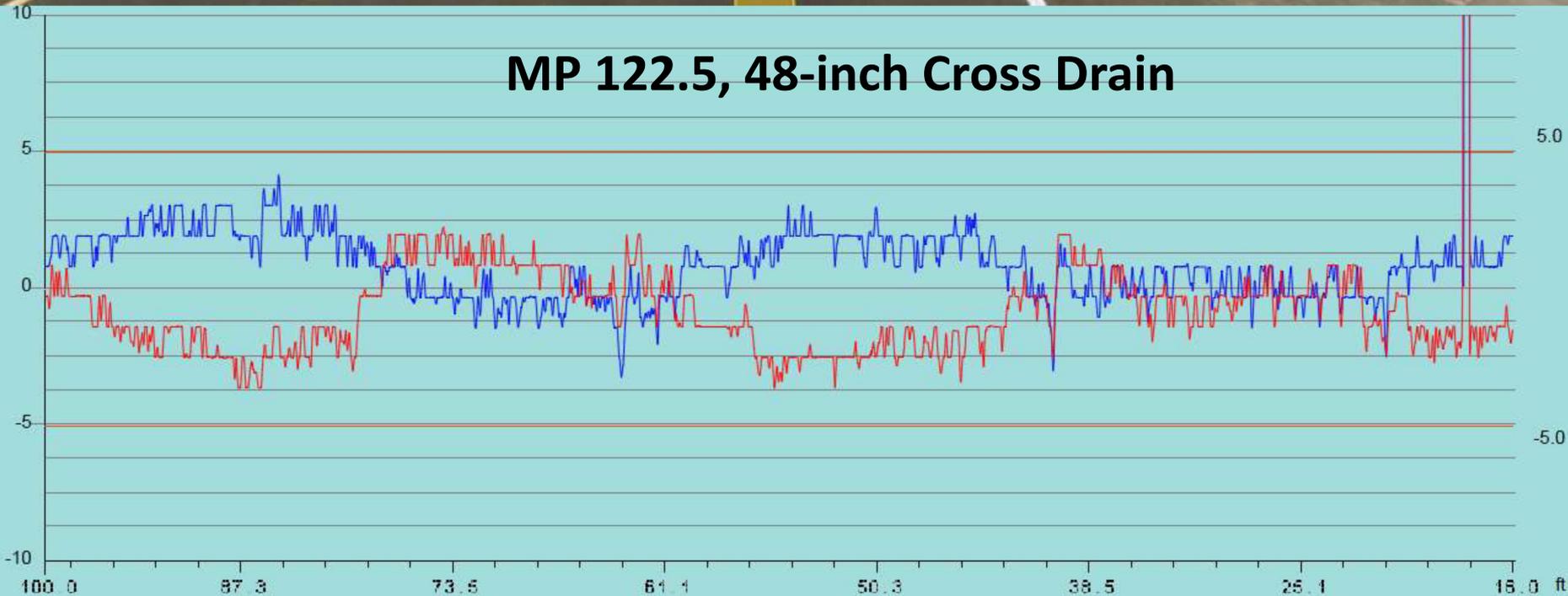




74 ft

33 ft

MP 122.5, 48-inch Cross Drain



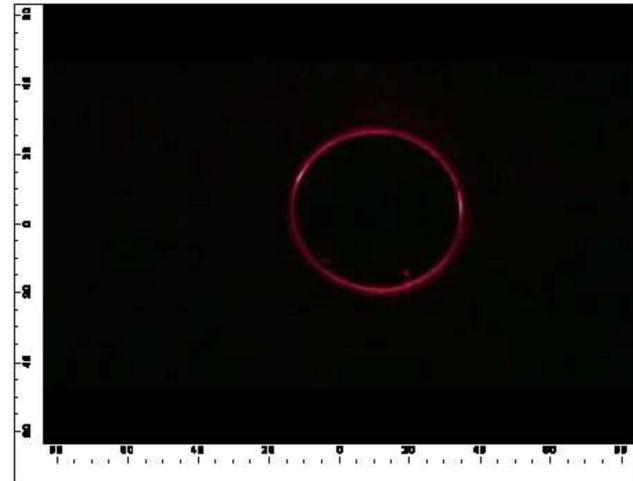
XY Deflection Observations Report

MP 122.5, I-25, DuroMaxx Installation, Fountain, Colorado

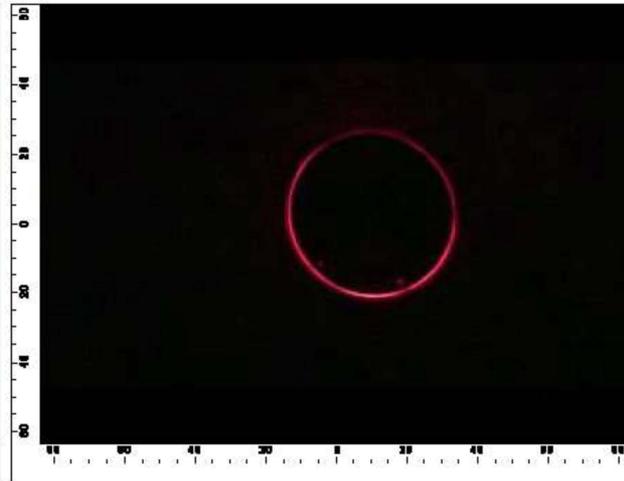
Site ID
City Fountain, Colorado
Start No Outlet
Location MP 122.5

Asset No. I-25, MP 122.5
Finish No Inlet
Location MP 122.5

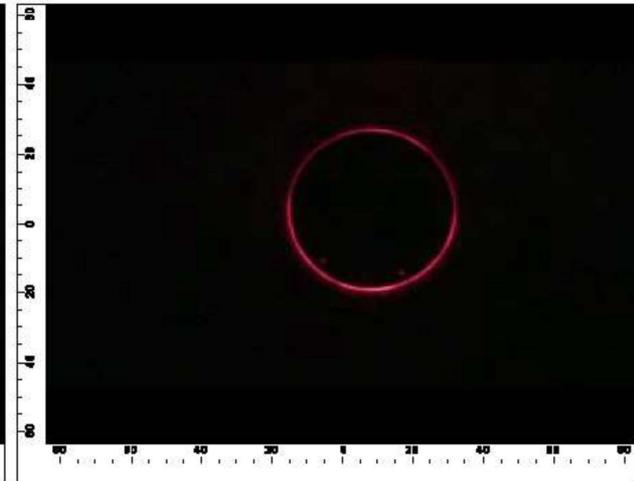
Date 9/30/2013
Material DuroMaxx
Pipeline Length 102 ft
Internal Diameter (Expected) 46.92 in



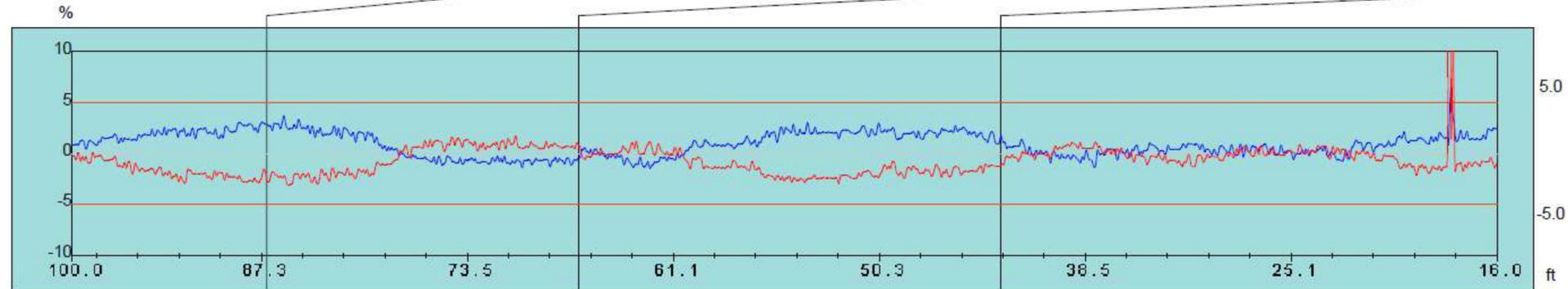
Joint at approx 88 ft.



Joint at approx. 66 ft.



Joint at approx. 44 ft.



XY Deflection Observations Report

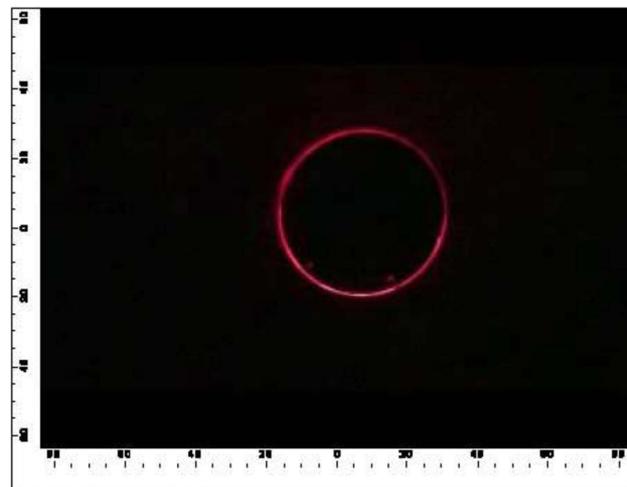
MP 122.5, I-25, DuroMaxx Installation, Fountain, Colorado

Site ID
City Fountain, Colorado
Start No Outlet
Location MP 122.5

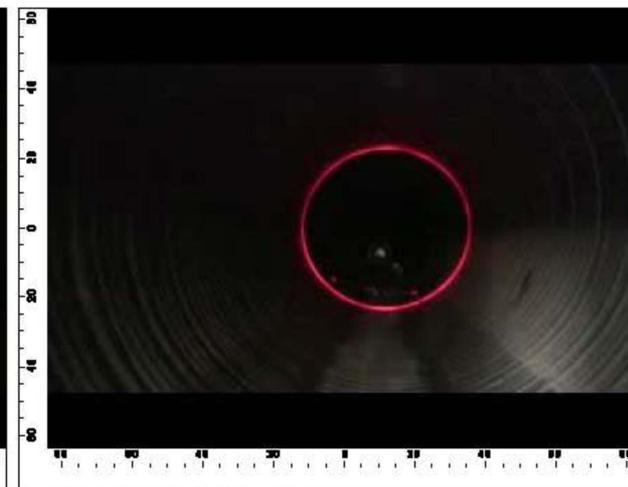
Asset No. I-25, MP 122.5

Finish No Inlet
Location MP 122.5

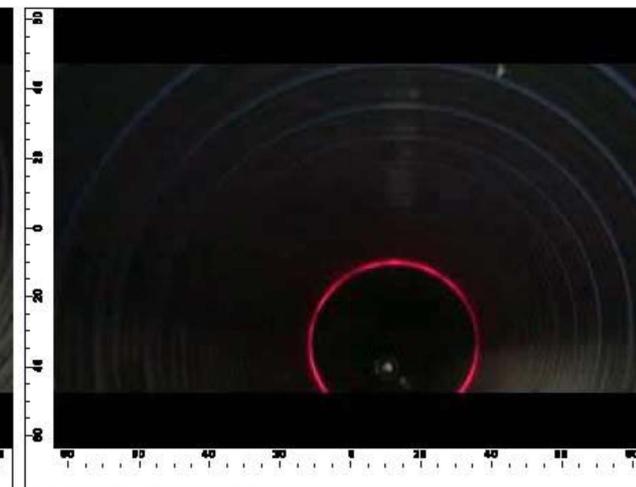
Date 9/30/2013
Material DuroMaxx
Pipeline Length 102 ft
Internal Diameter (Expected) 46.92 in



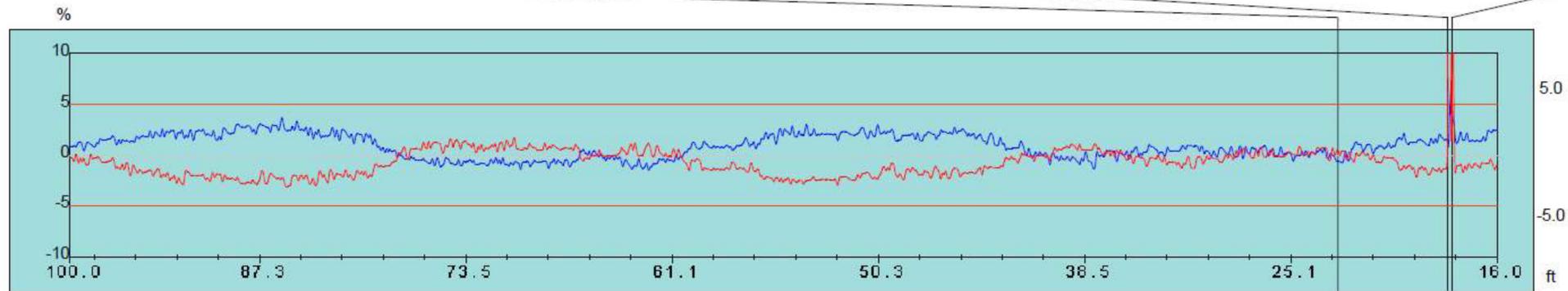
Joint at approx. 22 ft.



Spike due to outside light noise.



Camera tilted near outlet



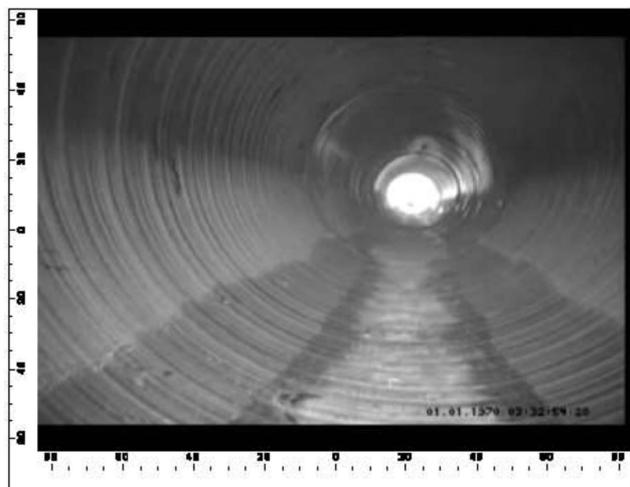
XY Deflection Observations Report

MP 122.5, I-25, DuroMaxx Installation, Fountain, Colorado

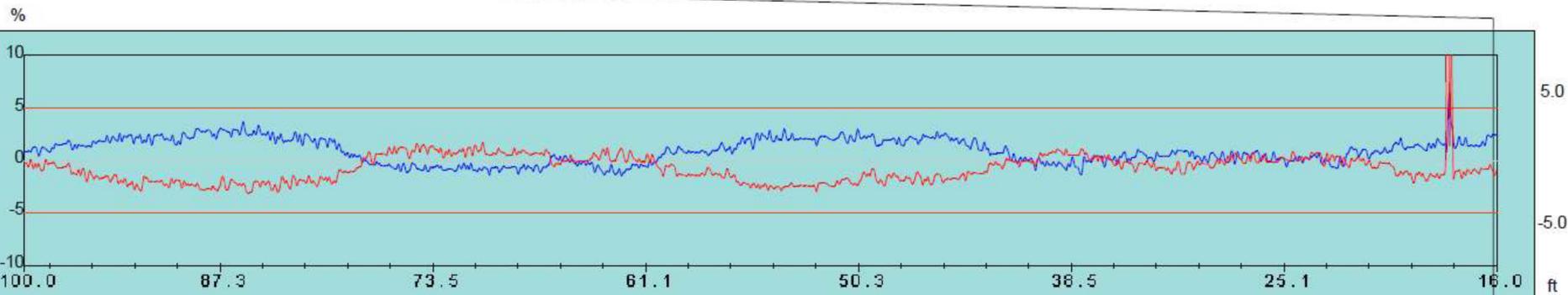
Site ID
City Fountain, Colorado
Start No Outlet
Location MP 122.5

Asset No. I-25, MP 122.5
Finish No Inlet
Location MP 122.5

Date 9/30/2013
Material DuroMaxx
Pipeline Length 102 ft
Internal Diameter (Expected) 46.92 in



View of pipe from outlet



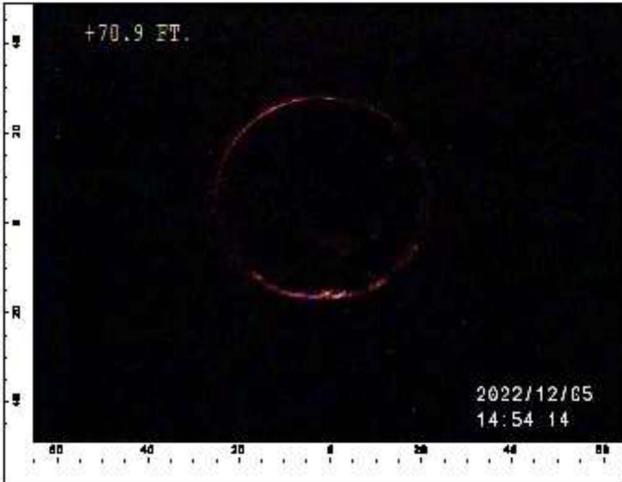
XY Diameter Observations Report

Pipe Deflected Approximately 4.6%

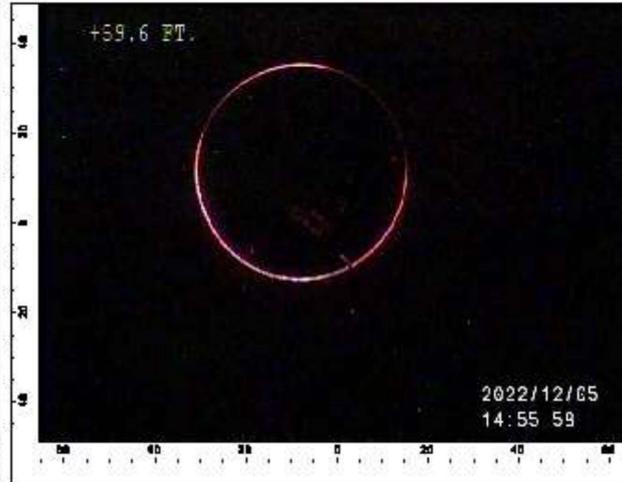
Site ID
City Fountain
Start No Outlet
Location

Asset No. MP 122.5
Finish No Inlet
Location

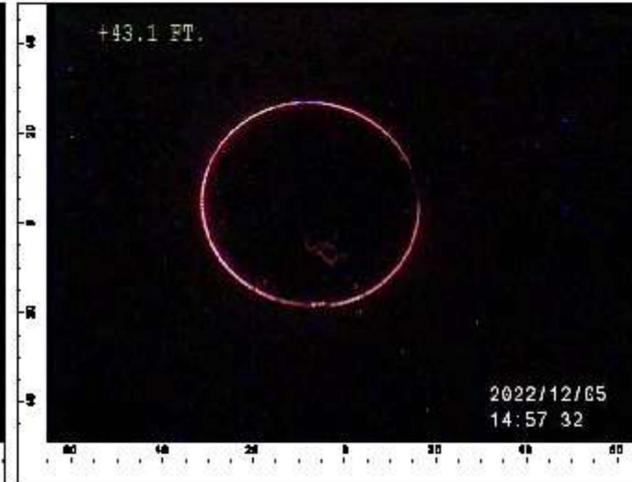
Date 12/15/2016
Material DuroMaxx
Pipeline Length 96.3 ft
Internal Diameter 47.13 in



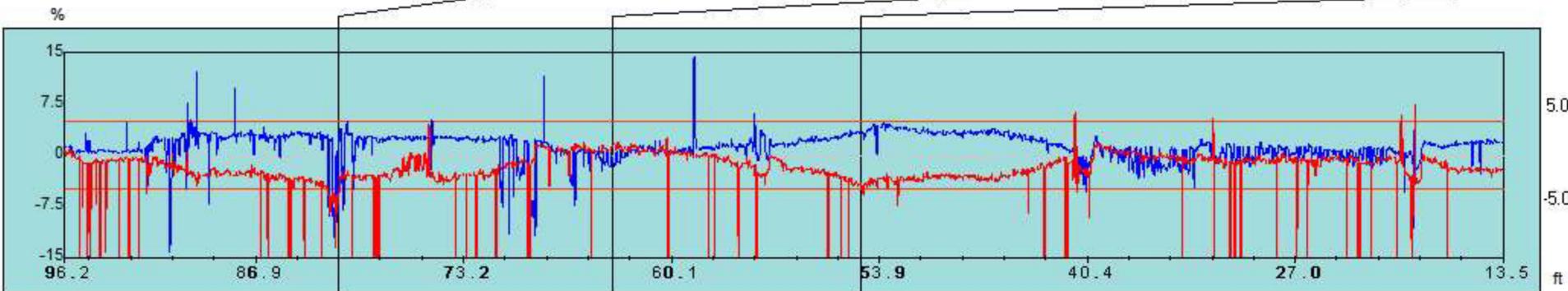
Tractor Bouncing causing scatter in data.



Pipe compressed horizontally

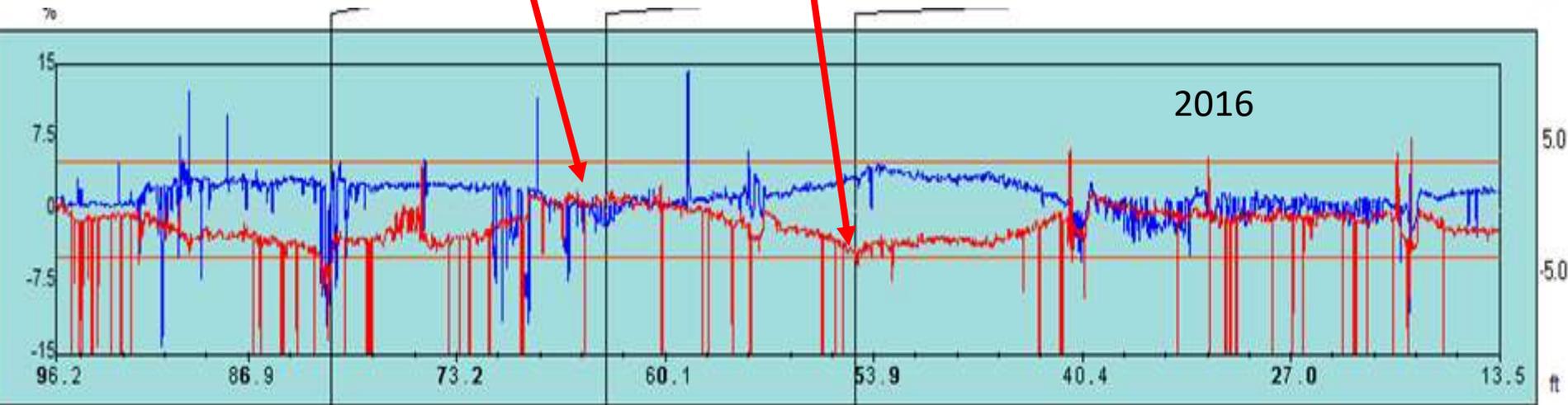
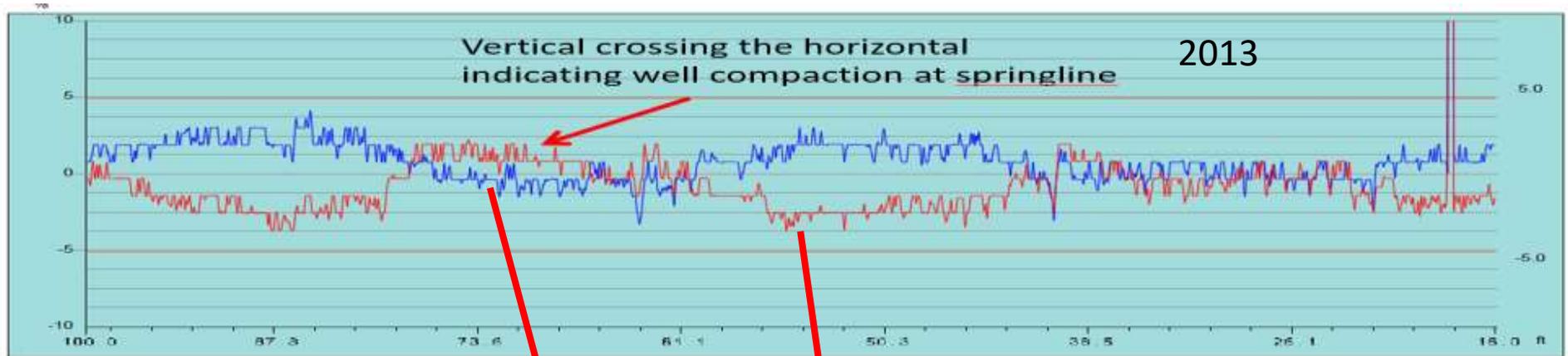


Pipe deflected approximately 4.6%.



90% - Fractile: (X) 3.2% : (Y) 0.5%, Exceeded limits: 6.1%

Performance Summary MP 122.5



Minor puncture was noted near the outlet end during the 2016 inspection that was not documented during the 2013 inspection. Deflection is still under 5%, but it appears that additional deflection has occurred in the center of the structure since the 2013 inspection.

MP 122, I-25, 48-Inch DuroMaxx









Project Name: I-25, Fountain, Colorado

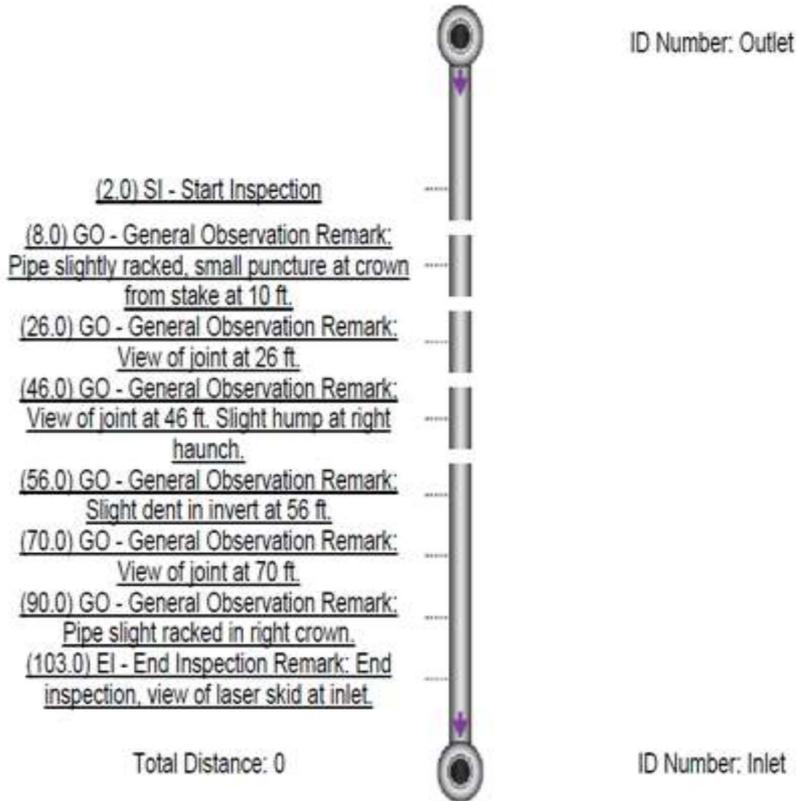
Date: Pipe ID: MP 122
 Asset Location: Start ID: Outlet
 Distance: 0 End ID: Inlet
 Run Number: Direction: Upstrm
 Pipe Size: 48-inch Pipe Type: DuroMaxx



Project Name: MP 122 Fountain Colorado

Date: 12/5/2016 Pipe ID:
 Asset Location: Start ID: Outlet
 Length Surveyed: 98.2 End ID: Inlet
 Run Number: Direction: Upstream
 Pipe Size: 48-inch Pipe Type: DuraMaxx

Severity
Light
Moderate
Average
Heavy
Severe



Project Name: I-25, Fountain, Colorado

Date:
 Asset Location:
 Distance: 0
 Run Number:
 Pipe Size: 48-inch

Pipe ID: MP 122
 Start ID: Outlet
 End ID: Inlet
 Direction: Upstrm
 Pipe Type: DuroMaxx



Project Name: MP 122 Fountain Colorado

Date: 12/5/2016	Pipe ID:
Asset Location:	Start ID: Outlet
Length Surveyed: 98.2	End ID: Inlet
Run Number:	Direction: Upstream
Pipe Size: 48-inch	Pipe Type: DuraMaxx

Distance	Fault Observation	Time	Picture
2.0	Start Inspection	43 00:00:00	
8.0	General Observation Remarks: Pipe slightly racked, small puncture at crown from stake at 10 ft.	02:30 00:00:43	
26.0	General Observation Remarks: View of joint at 26 ft.	12:08 00:01:27	

Distance	Fault Observation	Picture
0.0	Start Inspection	
1.6	General Observation Remarks: Noticeable deflection 2 O'clock	
14.3	General Observation Remarks: View down barrel	
22.7	Joint	
39.0	General Observation Remarks: Pipe crown slightly wavey	

Distance	Fault Observation	Time	Picture
46.0	General Observation Remarks: View of joint at 46 ft. Slight hump at right haunch.	14:40 00:02:17	
56.0	General Observation Remarks: Slight dent in invert at 56 ft.	16:11 00:02:33	
70.0	General Observation Remarks: View of joint at 70 ft.	17:18 00:03:03	

Distance	Fault Observation	Picture
44.8	Joint Remarks: Joint	
66.1	Joint Remarks: Joint	
69.0	General Observation Remarks: View down barrel, dent and deflection visible	
73.5	Dent Remarks: Visible dent at 10 and 11 O'clock	
80.0	Deflection	
88.0	Joint	

Distance	Fault Observation	Time	Picture
90.0	General Observation Remarks: Pipe slight racked in right crown.	18:41 00:03:48	
103.0	End Inspection Remarks: End inspection, view of laser skid at inlet.	21:21 00:04:14	

Created with the  report generator

Distance	Fault Observation	Picture
98.2	End Inspection	

Created with the  report generator [Back](#)

XY Diameter Summary Report

Pipe under 5% deflection in horizontal and vertical deflection plot

Site ID
City Fountain Colorado
Start No Outlet
Location MP 122

Asset No. I-25, MP 122.0
Finish No Inlet
Location MP 122

Date 9/30/2013
Material DuroMaxx
Pipeline Length 103 ft
Internal Diameter (Expected) 47.01 in

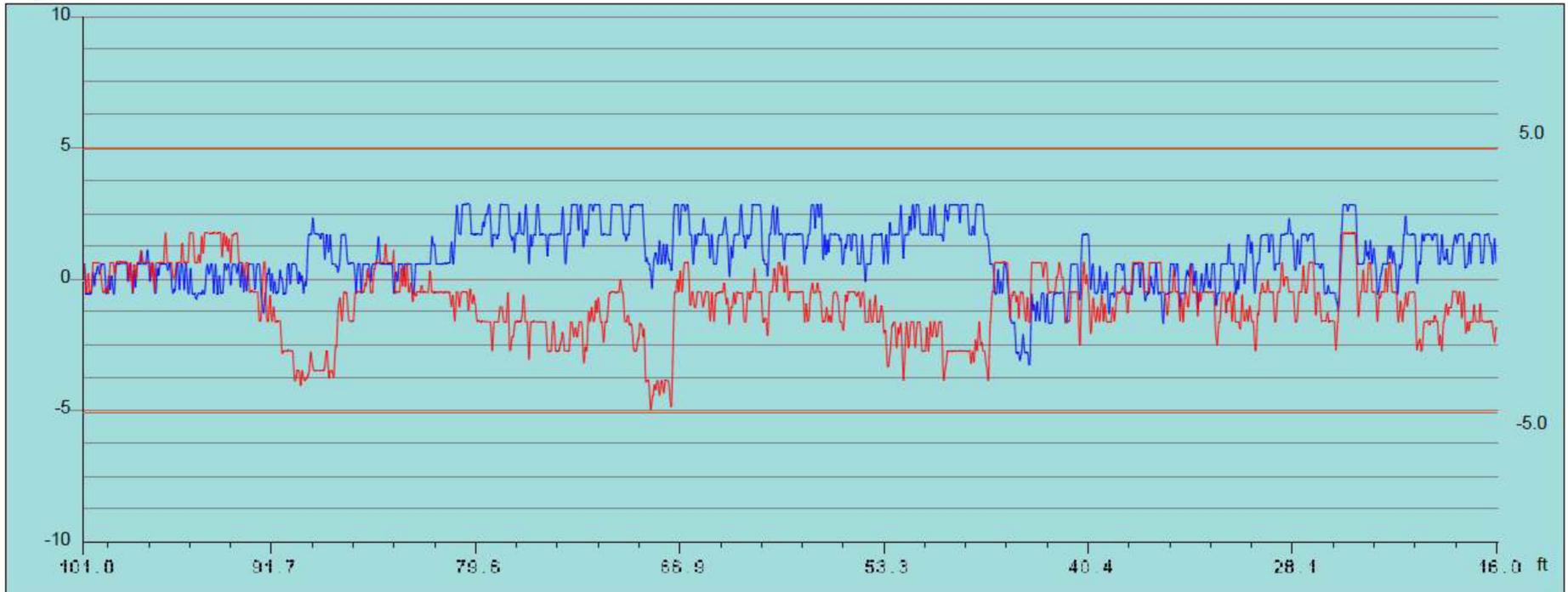
Comments

I-25, MP 122.0, 48-inch, DuroMaxx Cross Drain

Limit Lines

Upper limit = 5
Lower Limit = -5

% 90% - Fractile: (X) 2.7% : (Y) 0.7%, Exceeded limits: 0.0%



XY Deflection Summary Report

Pipe under 5% (Deflection based off Median I.D. per frame of video)

Site ID
City Fountain Colorado
Start No Outlet
Location MP 122

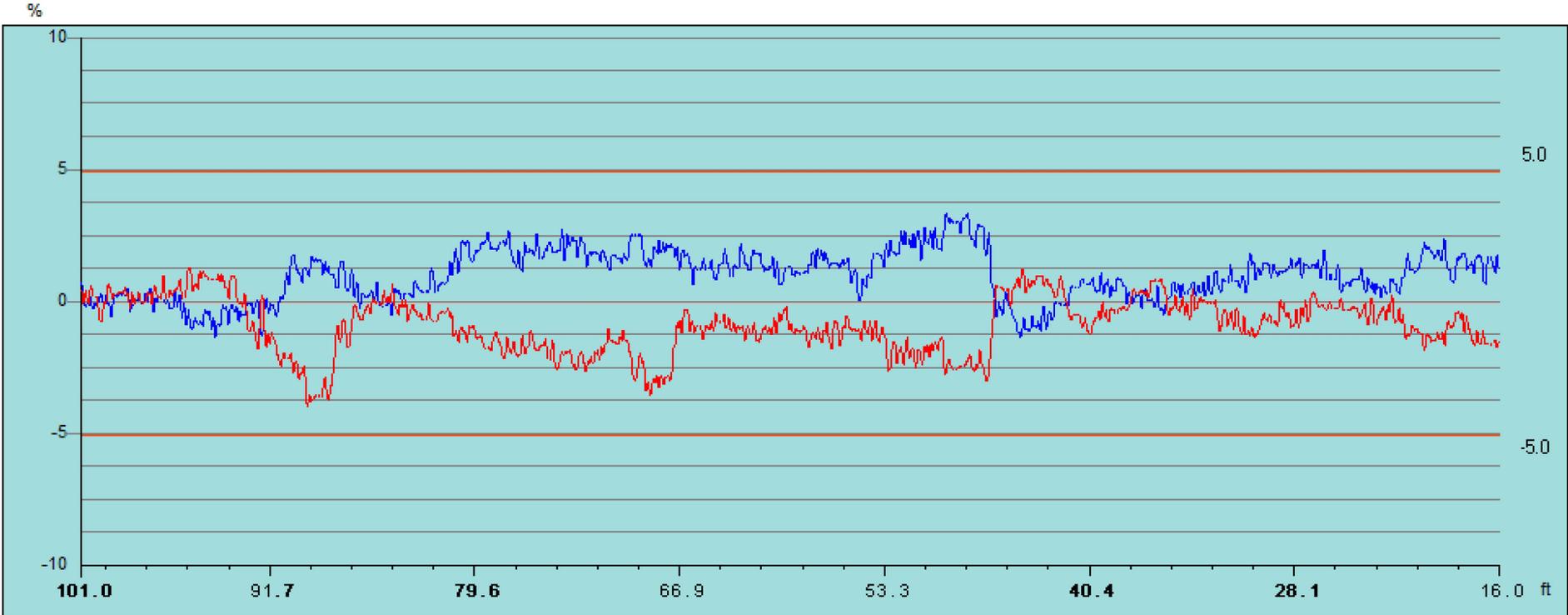
Asset No. I-25, MP 122.0
Finish No Inlet
Location MP 122

Date 9/30/2013
Material DuroMaxx
Pipeline Length 103 ft
Internal Diameter (Expected) 47.01 in

Comments

I-25, MP 122.0, 48-inch, DuroMaxx Cross Drain

Limit Lines
Upper limit = 5
Lower Limit= -5



Ovality Summary Report

Ovality slightly over 5% at 90 ft. Spike due to camera tilting at joint.

Site ID
City Fountain Colorado
Start No Outlet
Location MP 122

Asset No. I-25, MP 122.0
Finish No Inlet
Location MP 122

Date 9/30/2013
Material DuroMaxx
Pipeline Length 103 ft
Internal Diameter (Expected) 47.01 in

Comments

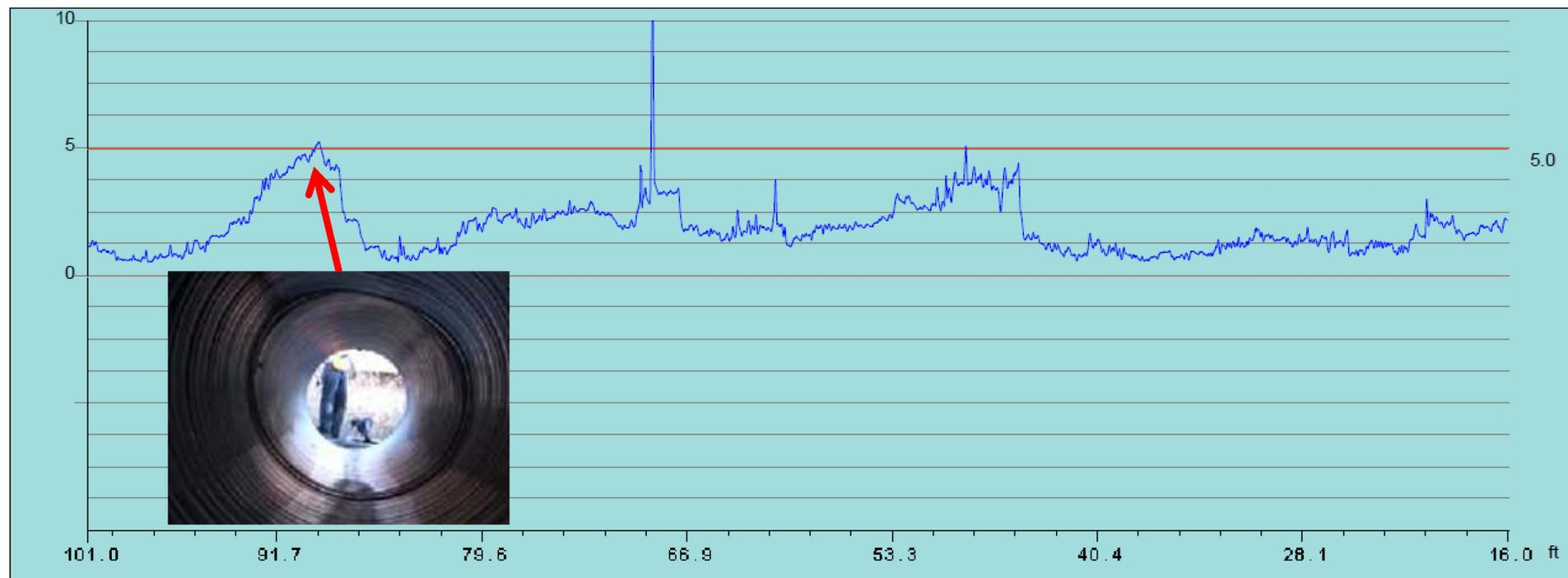
I-25, MP 122.0, 48-inch, DuroMaxx Cross Drain

Limit Lines

Upper limit = 5
Lower Limit = 5

% 90% - Fractile: 3.5%, Exceeded limits: 0.8%

Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance



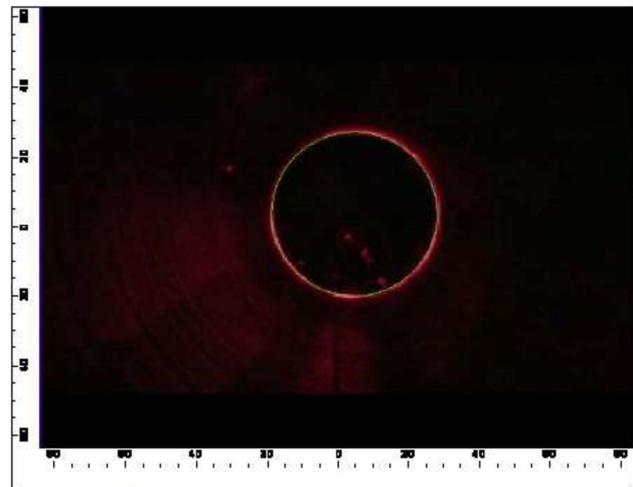
XY Diameter Observations Report

MP 122, I-25, DuroMaxx Installation, Fountain, Colorado

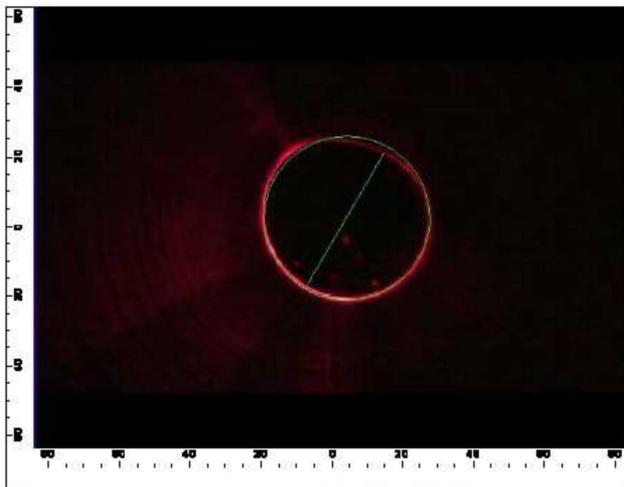
Site ID
 City Fountain Colorado
 Start No Outlet
 Location MP 122

Asset No. I-25, MP 122.0
 Finish No Inlet
 Location MP 122

Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 103 ft
 Internal Diameter (Expected) 47.01 in



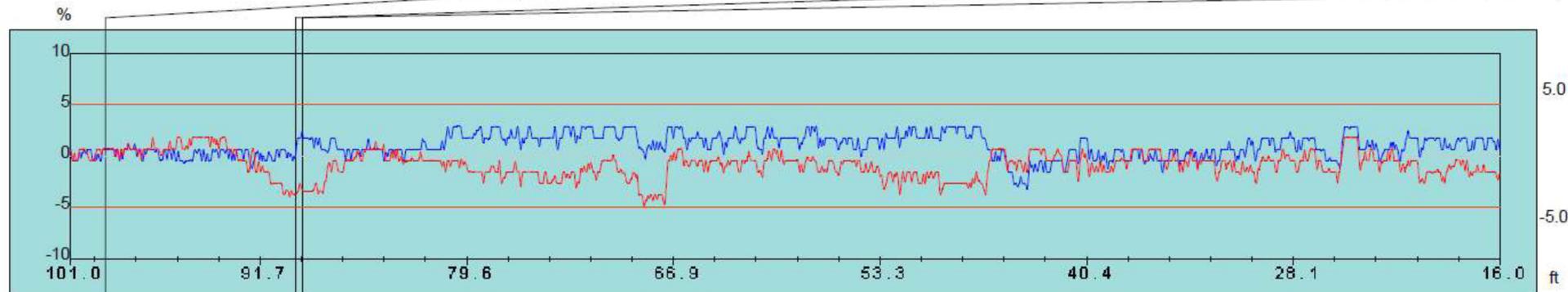
Pipe round near inlet end of structure.



Pipe compressed at 2 O'clock at approximately 90 ft. Pipe deflected approximately 5.3%.



View of compressed area at 90 ft.



90% - Fractile: (X) 2.7% : (Y) 0.7%, Exceeded limits: 0.0%

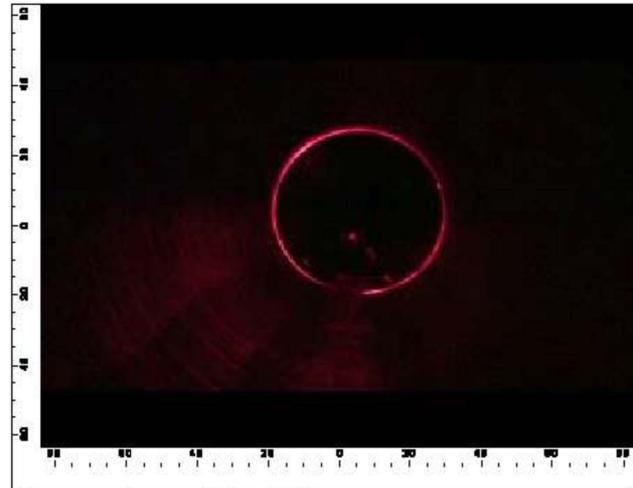
XY Diameter Observations Report

MP 122, I-25, DuroMaxx Installation, Fountain, Colorado

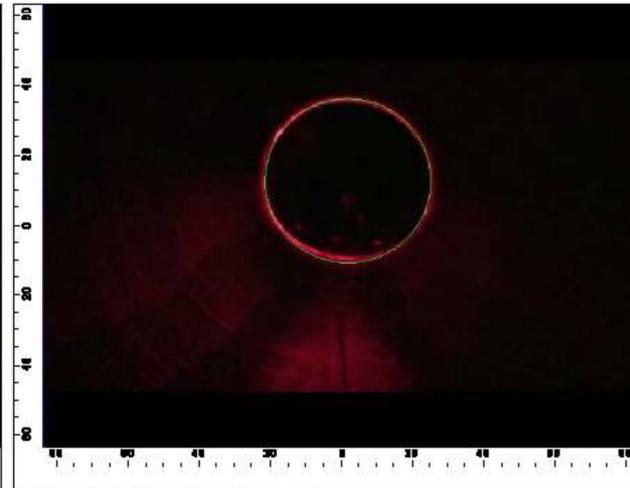
Site ID
 City Fountain Colorado
 Start No Outlet
 Location MP 122

Asset No. I-25, MP 122.0
 Finish No Inlet
 Location MP 122

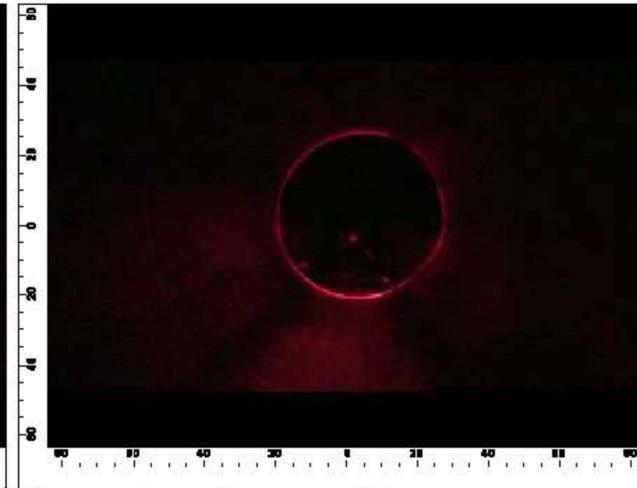
Date 9/30/2013
 Material DuroMaxx
 Pipeline Length 103 ft
 Internal Diameter (Expected) 47.01 in



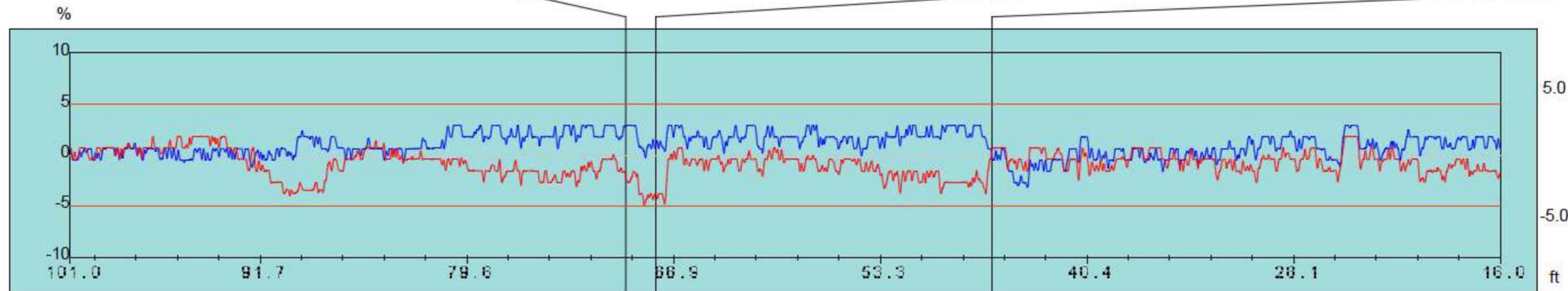
Laser passing over joint at 70 ft.



View of slightly raised invert at joint.



Laser passing over joint at approx. 46 ft.



90% - Fractile: (X) 2.7% : (Y) 0.7%, Exceeded limits: 0.0%

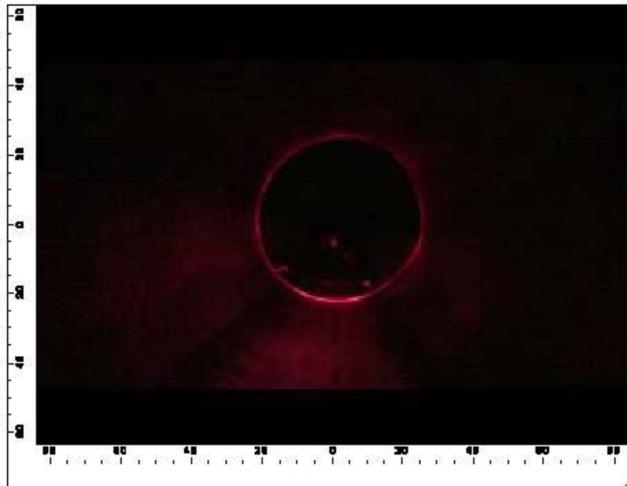
XY Diameter Observations Report

MP 122, I-25, DuroMaxx Installation, Fountain, Colorado

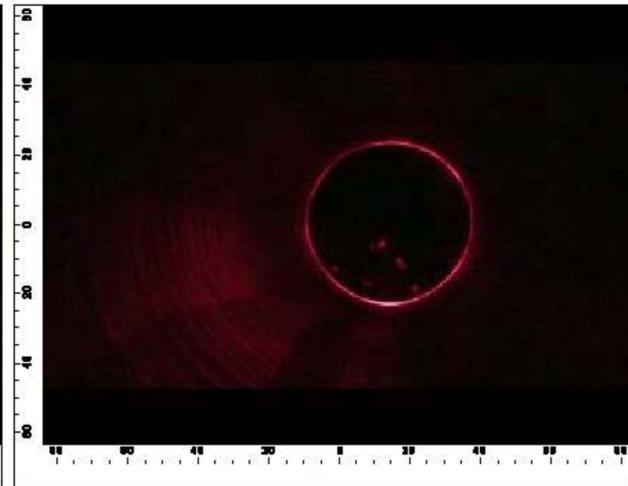
Site ID
City Fountain Colorado
Start No Outlet
Location MP 122

Asset No. I-25, MP 122.0
Finish No Inlet
Location MP 122

Date 9/30/2013
Material DuroMaxx
Pipeline Length 103 ft
Internal Diameter (Expected) 47.01 in



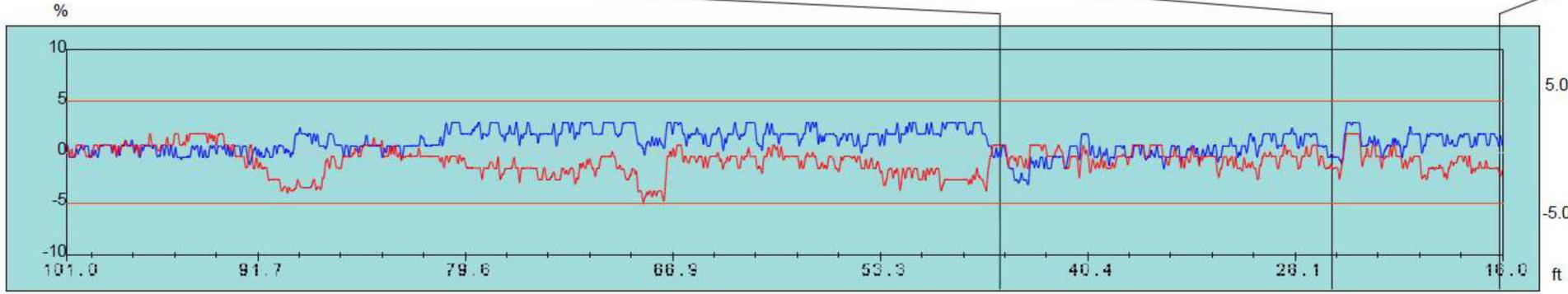
Slight compression in lower right haunch near joint.



Laser passing over joint at 26 ft.



View from outlet end, pipe slight racked near outlet end not caught by laser.



90% - Fractile: (X) 2.7% : (Y) 0.7%, Exceeded limits: 0.0%

Ovality Observations Report

Pipe Deflected Approximately 5.8% at 87 ft.

Site ID
 City Fountain Colorado
 Start No Outlet
 Location

Asset No. MP 122
 Finish No Inlet
 Location

Date 12/15/2016
 Material DuroMaxx
 Pipeline Length 100 ft
 Internal Diameter 47.43 in



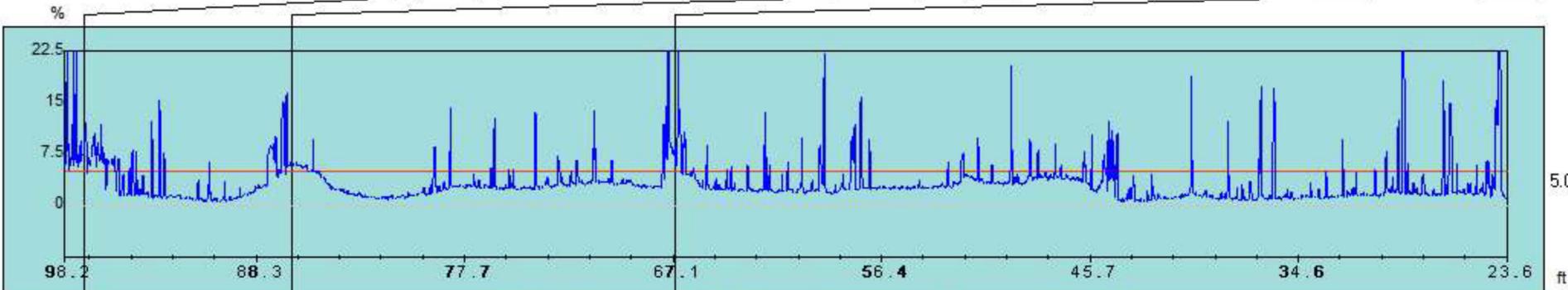
Noise in data due to outside light.



Pipe deflected approximately 5.8%.



Low laser light in invert causing spike in data.



Ovality 'q' (as per ASTM F 1216 Standard Practice) as a percentage of original pipe versus distance

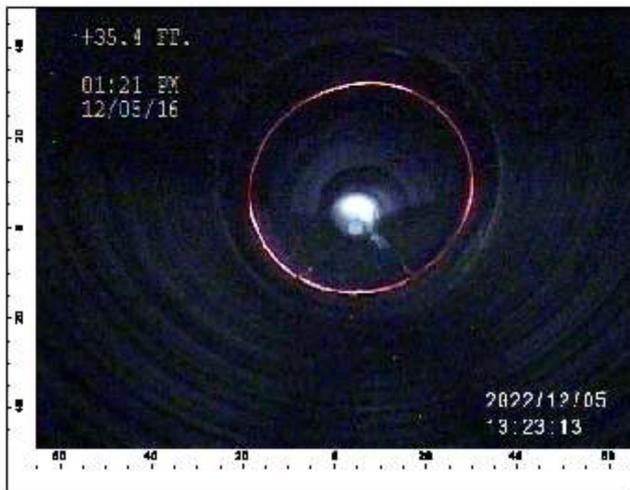
90% - Fractile: 6.2%, Exceeded limits: 14.8%

Ovality Observations Report

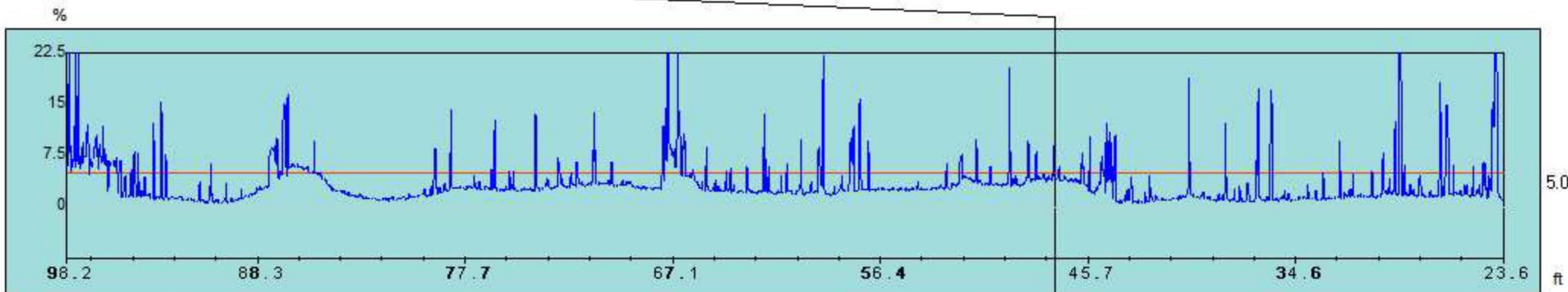
Site ID
City Fountain Colorado
Start No Outlet
Location

Asset No. MP 122
Finish No Inlet
Location

Date 12/15/2016
Material DuroMaxx
Pipeline Length 100 ft
Internal Diameter 47.43 in



Pipe slightly racked.



90% - Fractile: 6.2%, Exceeded limits: 14.8%

XY Diameter Observations Report

Pipe Deflected Approximately 5.8%

Site ID
City Fountain Colorado
Start No Outlet
Location

Asset No. MP 122
Finish No Inlet
Location

Date 12/15/2016
Material DuroMaxx
Pipeline Length 100 ft
Internal Diameter 47.43 in



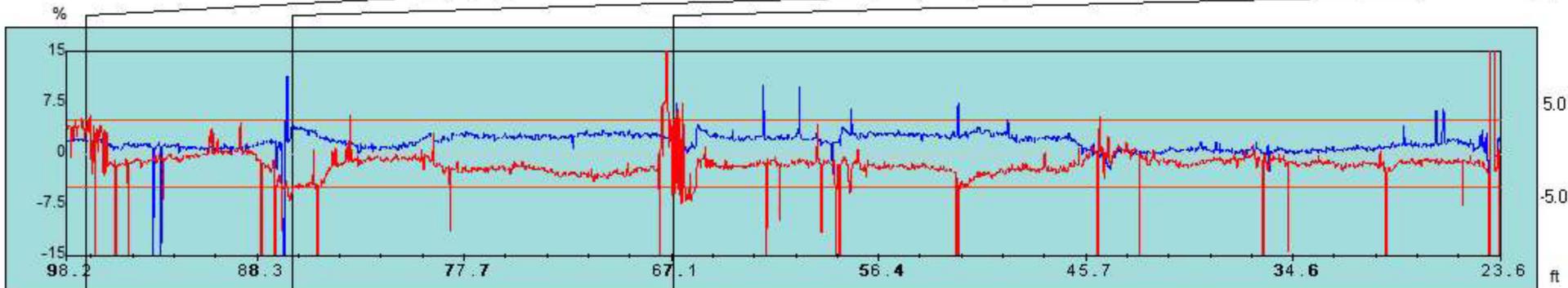
Noise in data due to outside light.



Pipe deflected approximately 5.8%.



Low laser light in invert causing spike in data.



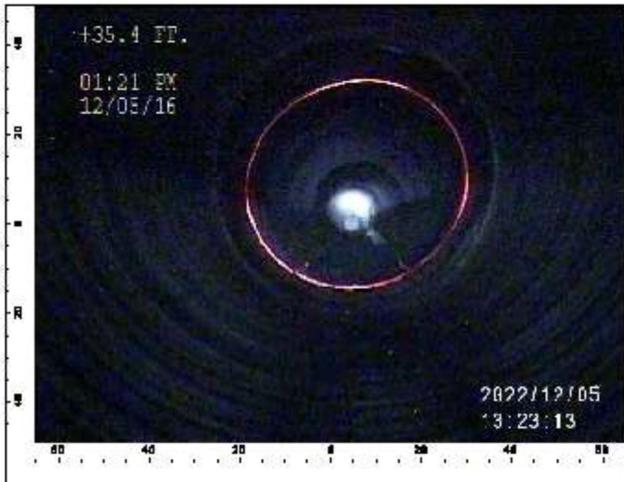
90% - Fractile: (X) 2.9% : (Y) 0.0%, Exceeded limits: 5.5%

XY Diameter Observations Report

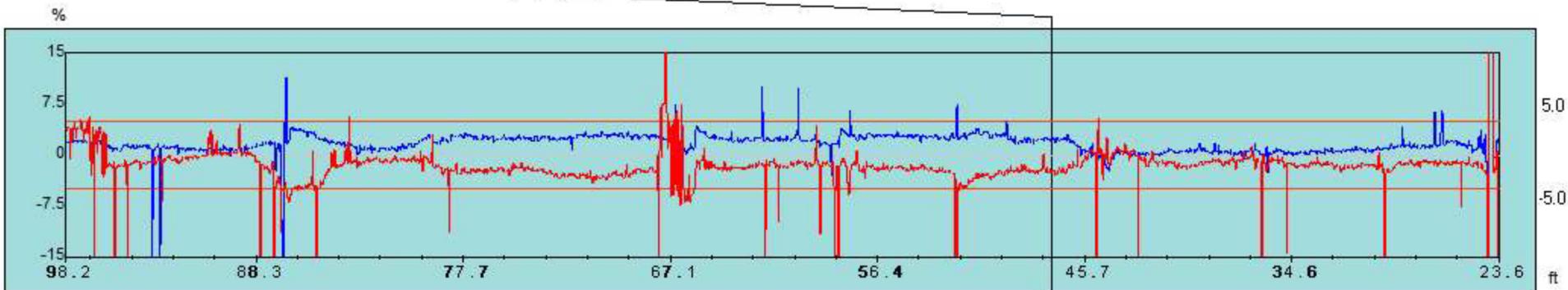
Site ID
City Fountain Colorado
Start No Outlet
Location

Asset No. MP 122
Finish No Inlet
Location

Date 12/15/2016
Material DuroMaxx
Pipeline Length 100 ft
Internal Diameter 47.43 in



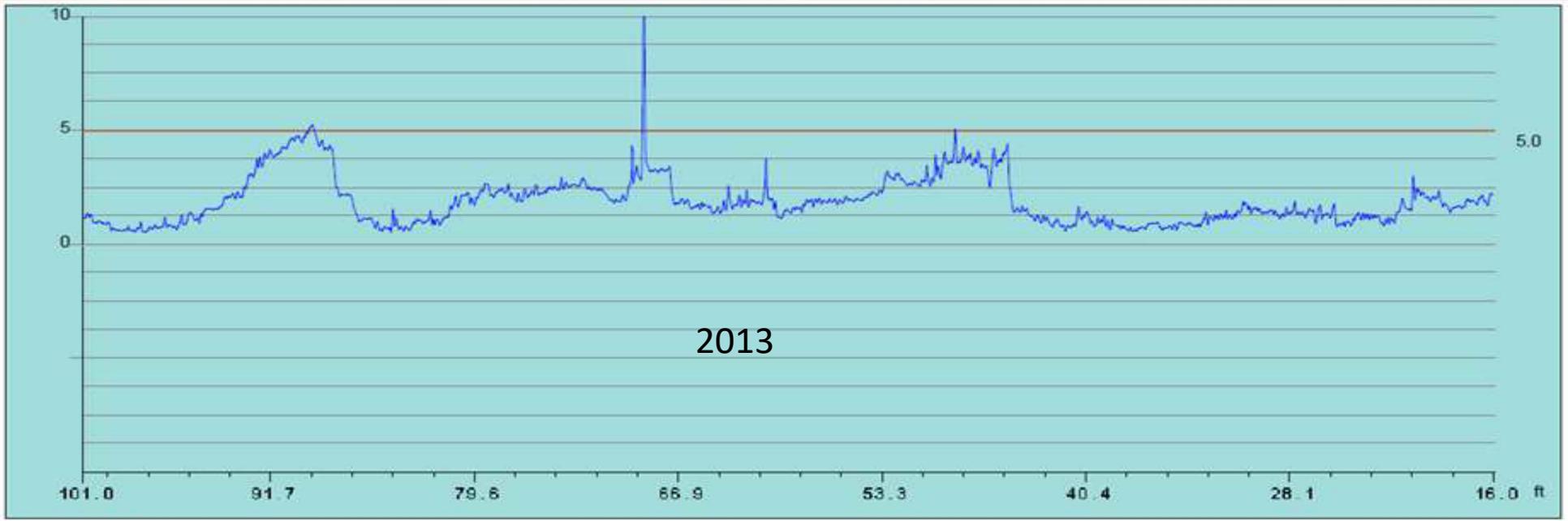
Pipe slightly racked. Deflected approximately 4.3%.



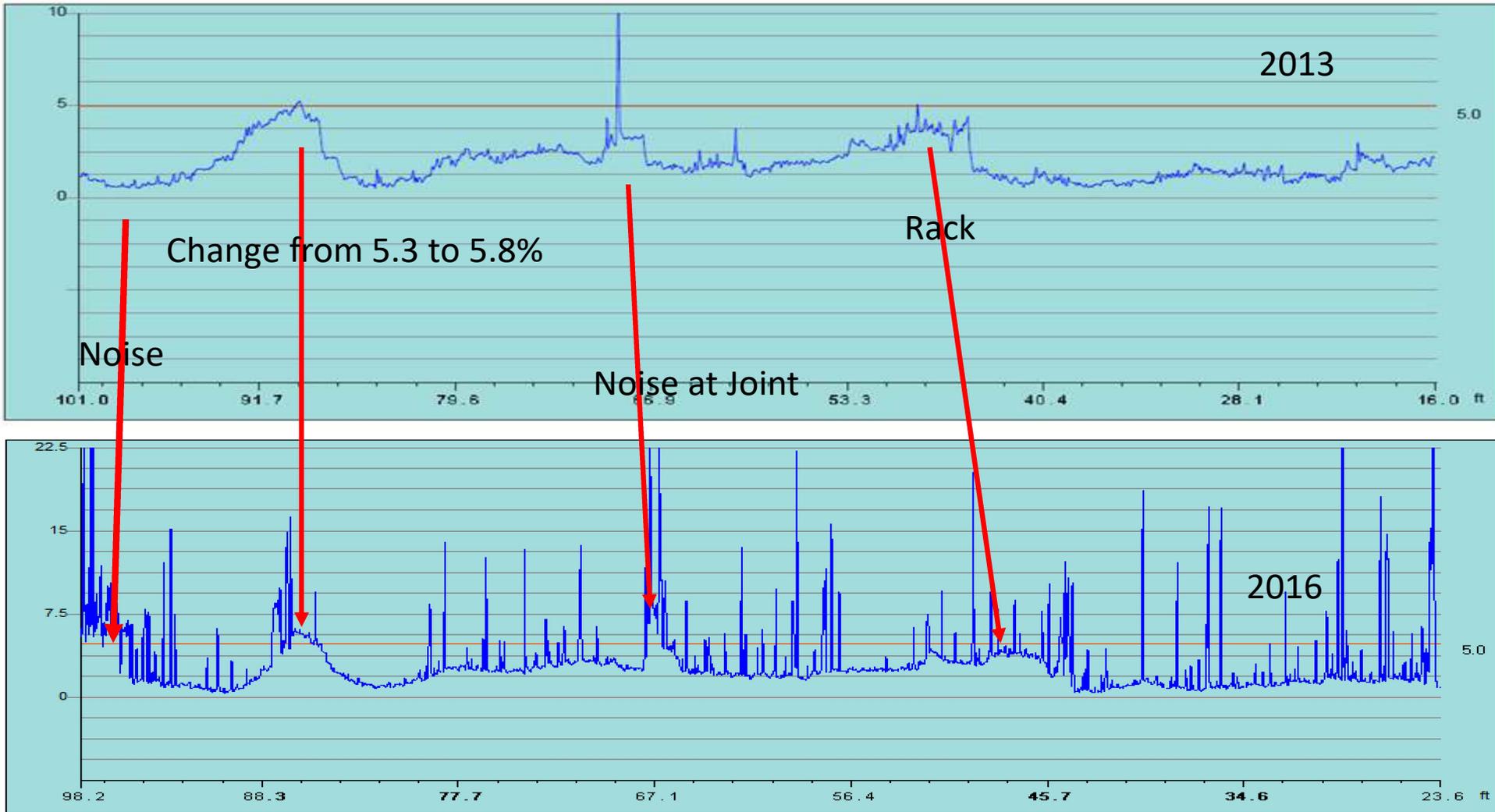


79 ft

34 ft



Performance Summary MP 122



Racking, Deflection, Minor punctures have been documented near the outlet end of the structure. Uneven flowline/hump and wall waviness have been documented mid pipe. Dent, deflection and racking has been documented towards the inlet end. Increased has occurred towards the inlet end of the structure that is not under pavement. Crown and possible invert curvature has occurred.

Conclusion: Punctures through the wall of the pipes observed during the 2013 inspection have not impacted the performance of the structures. Most of the punctures were due to the shallow cover and damage due to wooden stakes driven through the crown of the pipe during placement of straw wattles. Severe damage was observed in the inlet ends of two of the three pipes at MP 123 due to vehicle damage. Only a slight increase in deflection was observed in three of the five structures. Four of the structures are at or below 5%, and the other is at 5.8% with some signs of crown flattening and potential inverse curvature. This is outside the pavement area and in areas of shallow cover. In summary no significant changes have been observed since the 2013 inspection other than the damage due to vehicle damage. Settlement within the pavement reported in one of the locations does not appear to be due to issues with the underlying pipe structures.



APPENDIX III – DENVER COLORADO

HDPE PERFORMANCE INSPECTION

HDPE STORM DRAIN, I-25 AND QUINCY AVENUE

LEO JOHN FLECKENSTEIN

DECEMBER 5, 2016

Denver Colorado
HDPE Performance Inspection
HDPE Storm Drain, I-25 and Quincy Avenue
December 5, 2016
(Draft Report December 16, 2016)

By
Leo John Fleckenstein

Hydrau-Tech, Inc,
And
Colorado DOT



WALL H2-Z (a)

PROPOSED ROW

SEE ROADWAY PLANS FOR DITCH DETAIL

NB I-25

SB I-25

QUINCY AVE

MATCH LINE STA 378+00 NB I-25

Line Inspected

372V2

CO

EXISTING ROW SOUNDWALL 2-24

REMOVE EXISTING STORM DRAIN

CONCRETE LINED DITCH PER PSP072 LENGTH = 20' FROM CONCRETE APRON AROUND 374C2 TO EXISTING DITCH D=1.0', W=3.0', Z=3:1

LINE 22-374-C

LINE 22-375-A

LINE 22-374-A

LINE 21-362-E

ABANDON EXISTING STORM LINE
CONNECT LRT UNDERDRAIN TO 376C1

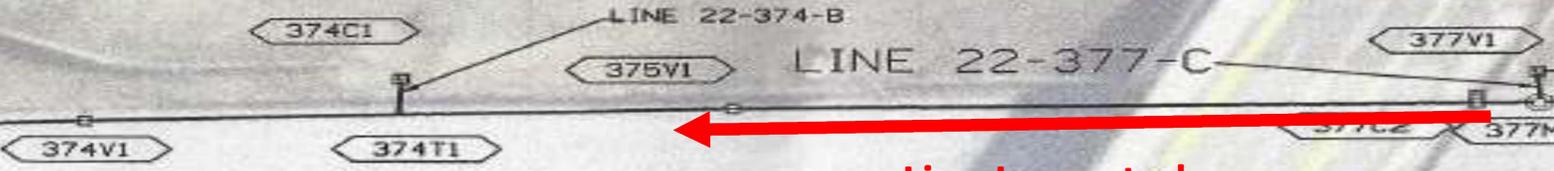
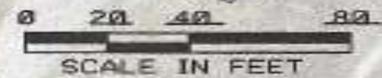
SEE ROADWAY PLANS FOR DITCH DETAIL

EXISTING ROW
PROPOSED ROW

PSP076 CASE B
MH4978

EXISTING OUTLET STRUCTURE FOR POND 7

WALL L2-S
CONNECT TO EXISTING 30" LINE



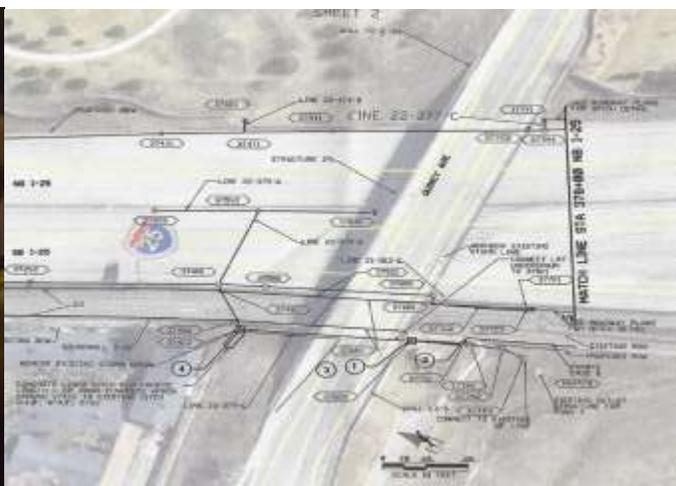
4

3

1

2

Project Summary and Conclusions: A section of I-25 near the Quincy overpass was coned off on December 5, 2016 to conduct a performance inspection of the HDPE storm drains in the area. Several factors limited the amount of pipe that could be inspected including difficulties in removing the bolts attaching the grates on the drop inlets, and removing the grates themselves. Heavy loads of sediment was also in the invert of the pipes. The inspection was limited to approximately 182 ft of estimated 36-inch HDPE. The pipe was inspected with Cues robotic pipeline inspection system. The pipe appeared to be sagging in areas. The overall shape of the structure appeared to be round and the joints appeared to be performing as anticipated. A laser profile could not be conducted due to the amount of debris in the system. Some of the adjacent pipes coming into the two drop inlets were glanced into and appeared to be performing satisfactory. It is recommend that the pipes be cleaned and fully inspected.





Inspection

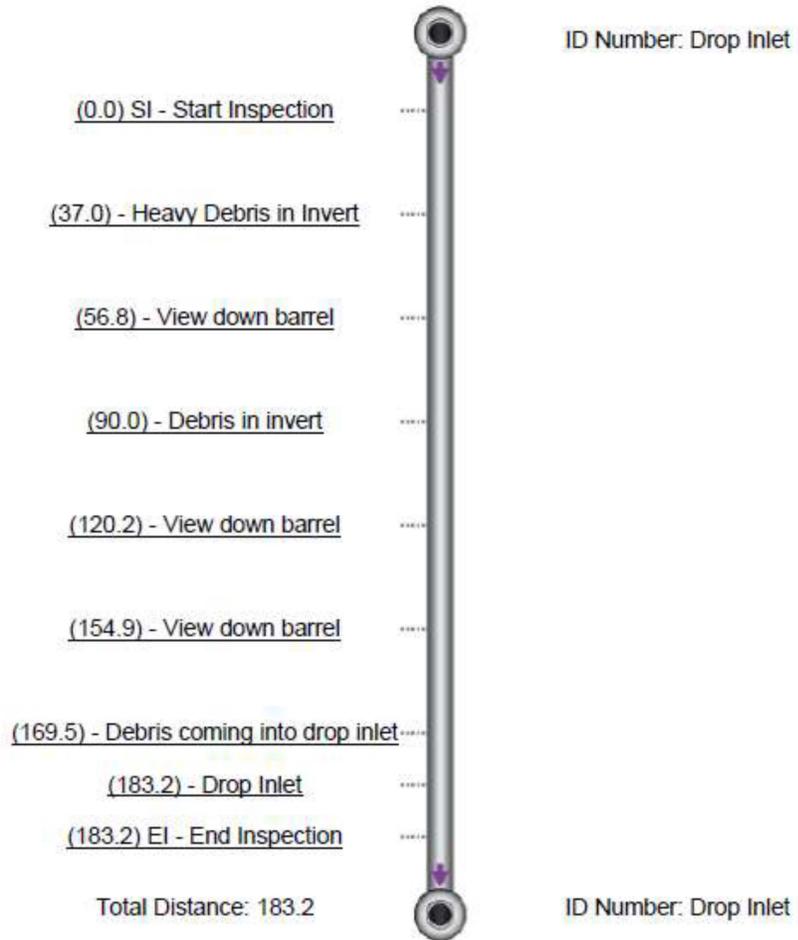
Project Name	I-25 Denver	Date	12/5/16
Direction	Downstream	Pipe Type	HDPE
Pipe Size	36	Pipe ID	
Start ID	Drop Inlet	Start Location	
End ID	Drop Inlet	Completed	Yes
Comments			

Inspection 2

Length Surveyed	183.2
------------------------	-------

Project Name: I-25 Denver	
Date: 12/5/2016	Pipe ID:
Asset Location:	Start ID: Drop Inlet
Length Surveyed: 183.2	End ID: Drop Inlet
Run Number:	Direction: Downstream
Pipe Size: 36	Pipe Type: HDPE

Severity
Light
Moderate
Average
Heavy
Severe



Project Name: I-25 Denver

Date: 12/5/2016	Pipe ID:
Asset Location:	Start ID: Drop Inlet
Length Surveyed: 183.2	End ID: Drop Inlet
Run Number:	Direction: Downstream
Pipe Size: 36	Pipe Type: HDPE

Distance	Fault Observation	Picture
0.0	Start Inspection	 A photograph showing the beginning of a pipe inspection. The camera is positioned at the start of the pipe, looking down the barrel. The pipe walls are visible, and there is some debris on the ground at the start.
37.0	Heavy Debris in Invert	 A photograph showing a large amount of heavy debris (possibly rocks or concrete) accumulated in the invert of the pipe. The debris is piled up in the center of the pipe. The distance marker '+37.0 FT.' is visible in the top left corner.
56.8	View down barrel	 A photograph showing a view down the barrel of the pipe. The pipe walls are visible, and the view is clear. The distance marker '+56.8 FT.' is visible in the top left corner.
90.0	Debris in invert	 A photograph showing debris in the invert of the pipe. The debris is piled up in the center of the pipe. The distance marker '+90.0 FT.' is visible in the top left corner.
120.2	View down barrel	 A photograph showing a view down the barrel of the pipe. The pipe walls are visible, and the view is clear. The distance marker '+120.0 FT.' is visible in the top left corner.

Distance	Fault Observation	Picture
154.9	View down barrel	 <p>A photograph showing a view down a dark, circular tunnel. The tunnel walls are dark and appear to be made of concrete or metal. The lighting is dim, with a bright spot at the end of the barrel. The text '+154.9 FT.' is visible in the top left corner, and the date and time '2022/12/08 00:45:34' are in the bottom right corner.</p>
169.5	Debris coming into drop inlet	 <p>A photograph showing a view down a dark, circular tunnel. The tunnel walls are dark and appear to be made of concrete or metal. The lighting is dim, with a bright spot at the end of the barrel. The text '+169.5 FT.' is visible in the top left corner, and the date and time '2022/12/08 00:45:45' are in the bottom right corner.</p>
183.2	Drop Inlet	 <p>A photograph showing a view down a dark, circular tunnel. The tunnel walls are dark and appear to be made of concrete or metal. The lighting is dim, with a bright spot at the end of the barrel. The text '+183.2 FT.' is visible in the top left corner, and the date and time '2022/12/08 00:46:25' are in the bottom right corner.</p>
183.2	End Inspection	 <p>A photograph showing a view down a dark, circular tunnel. The tunnel walls are dark and appear to be made of concrete or metal. The lighting is dim, with a bright spot at the end of the barrel. The text '+183.2 FT.' is visible in the top left corner, and the date and time '2022/12/08 00:47:25' are in the bottom right corner.</p>

APPENDIX IV - SOUTHEAST CORRIDOR
CONSTRUCTORS NONCONFORMANCE
REPORT AND EVALUATIONS

T-REX PROJECT, 2003



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin SECC Issued to: [] Carnazzo [] Wilson [x] Thoendel [] Mackin [] Ross [] Vetter

Commented [MC01]: Double-click on grey box to insert check mark

Referenced Contract Spec: N/A
Referenced Drawing Number: D102, D201
Location of Nonconformance: Drain Line 31-507-B
NB I-25 or I-225 Stationing: 506+92 & 507+67 (show nearest 500')

Description of NCR: Mandrel failed 24 feet North of structure 506V1 and 12 feet South of the same structure on Drain Line 31-507-B. MSE wall, concrete barrier, moment slab, and permanent asphalt have been constructed in this area of conflict.

Superintendent: Gary Palmer
Subcontractor: None
Supplier: None

Part II: Review by Construction QA Management

This NCR request has been reviewed by:
[] Terry Constable [] John Lee
[] Tim Nelson [] Pat McCready
[] Anthony Crockett [] Kevin Segrue
[x] Brian Bullen [] Other QA Management:
[] Glen Tonak

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO:
[] SECC Document Control (NCR File)
[] SECC QA Manager - Constable
SECC Design and Construction
[] Post Design - Klemz, Uyematsu, Field Design Coord
[] Highways - Doug Brannan
[] Structures - 1 Don Muns, 2/3 Rich Westerheid
[] Grading - 1 Tim Driver, 2/3 Scott Cromack
[] Paving - Dave Ross
[] Survey - Jim Bodi
[] ITS/Elec - Bruce Wilson
[] LRT - Tim Mackin, Wilson, Larson
[] Stations - JD Vetter, Mackin, Larson
[] MHT - Lloyd Maier, Luke Connelley
[] Segment 1 - Carnazzo, Sato
[] Segment 2/3 - Thoendel, Deml
[] Dynalectric - Vecchione, Wright

- SECC Construction Quality Assurance
[] Structures - Tim Nelson
[] Grading/Drainage - Anthony Crockett, Brian Bullen
[] Paving - Pat McCready
[] ITS - John Lee
[] LRT - Kevin Segrue
[] Procurement - Glen Tonak

- T-REX Oversight and Other
[] Oversight - Basner, Walker, Stevenson
[] Segment 1 - Jeff Clevenger, Danielle Smith
[] Segment 2/3 - Al Eastwood, David Wieder
[] LRT - Starling, Bacus, Reitter, (Shrestha if Systems)
[] ITS - Gonzales, Lipp
[] Design Oversight -
[] Utility Company (DW-McQuade, DWWW-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709	Date Issued: 9/12/03
Area: 3.1	Contractor: SECC
Discipline: Drainage	Subcontractor: None
Activity Number: 30001.20	Supplier: None

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

- NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

QA or PM Approved: Joe Jensen Date: 9/12/03
 Proposed Resolution: Evaluate remove/replace Drain Line 31-507-B at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be Implemented: Yes If Yes, Plans to be Reissued by: _____
 No

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: _____ Date: _____
 Post Design Services

Checked by: _____

Attachments: Yes
 No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company: Name of Utility Company Representative Date: Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

- Type of Resolution: Remove and Replace (skip to Part IX)
Repair/Rework to Contract Specification Compliance (skip to Part IX)
Repair/Rework to acceptable standards
Leave As Is (Use As Is) does not require QA reinspection

Description of Resolution:

Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by: Date: (Segment Oversight or Segment Design Oversight)

Part IX: SECC QA Disposition

- Action: Reinspected verifying Contract Specification Compliance
Reinspected and Accepted based on T-REX Technical Closure

Comments or Verification of Reinspection:

QA Manager: Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin SECC Issued to: Carnazzo, Thoendel, Ross, Wilson, Mackin, Vetter

Commented [MCO1]: Double-click on grey box to insert check mark

Referenced Contract Spec: N/A
Referenced Drawing Number: D102, D201
Location of Nonconformance: Drain Line 31-507-B
NB I-25 or I-225 Stationing: 506+92 & 507+67 (show nearest 500')

Description of NCR: Mandrel failed 24 feet North of structure 506V1 and 12 feet South of the same structure on Drain Line 31-507-B. MSE wall, concrete barrier, moment slab, and permanent asphalt have been constructed in this area of conflict.

Superintendent: Gary Palmer
Subcontractor: None
Supplier: None

Part II: Review by Construction QA Management

This NCR request has been reviewed by: Terry Constable, Tim Nelson, Anthony Crockett, Brian Bullen, Glen Tonak, John Lee, Pat McCready, Kevin Segrue, Other QA Management

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO: SECC Document Control (NCR File), SECC QA Manager - Constable
SECC Design and Construction: Post Design - Klemz, Uyematsu, Field Design Coord, Highways - Doug Brannan, Structures - 1 Don Muns, 2/3 Rich Westerheid, Grading - 1 Tim Driver, 2/3 Scott Cromack, Paving - Dave Ross, Survey - Jim Bodi, ITS/Elec - Bruce Wilson, LRT - Tim Mackin, Wilson, Larson, Stations - JD Vetter, Mackin, Larson, MHT - Lloyd Maier, Luke Connelley, Segment 1 - Carnazzo, Sato, Segment 2/3 - Thoendel, Deml, Dynalectric - Vecchione, Wright

- SECC Construction Quality Assurance: Structures - Tim Nelson, Grading/Drainage - Anthony Crockett, Brian Bullen, Paving - Pat McCready, ITS - John Lee, LRT - Kevin Segrue, Procurement - Glen Tonak

- T-REX Oversight and Other: Oversight - Basner, Walker, Stevenson, Segment 1 - Jeff Clevenger, Danielle Smith, Segment 2/3 - Al Eastwood, David Wieder, LRT - Starling, Bacus, Reitter, (Shrestha if Systems), ITS - Gonzales, Lipp, Design Oversight - Utility Company (DW-McQuade, DWWM-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709	Date Issued: 9/12/03
Area: 3.1	Contractor: SECC
Discipline: Drainage	Subcontractor: None
Activity Number: 30001.20	Supplier: None

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

Proposed Resolution: QA or PM Approved: Joe Jensen Date: 9/12/03
 Evaluate remove/replace Drain Line 31-507-B at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be implemented: Yes If Yes, Plans to be Reissued by: _____
 No

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: _____ Date: _____
 Post Design Services

Checked by: _____

Attachments: Yes
 No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company: Name of Utility Company Representative Date:
Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

- Type of Resolution: [] Remove and Replace (skip to Part IX)
[] Repair/Rework to Contract Specification Compliance (skip to Part IX)
[] Repair/Rework to acceptable standards
[] Leave As Is (Use As Is) does not require QA reinspection

Description of Resolution:

Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by: Date:
(Segment Oversight or Segment Design Oversight)

Part IX: SECC QA Disposition

- Action: [] Reinspected verifying Contract Specification Compliance
[] Reinspected and Accepted based on T-REX Technical Closure

Comments or Verification of Reinspection:

QA Manager: Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin SECC Issued to: [] Carnazzo [] Wilson [x] Thoendel [] Mackin [] Ross [] Vetter

Commented [MC01]: Double-click on grey box to insert check mark

Referenced Contract Spec: N/A

Referenced Drawing Number: D102, D201

Location of Nonconformance: Drain Line 31-507-B

NB I-25 or I-225 Stationing: 506+92 & 507+67 (show nearest 500')

Description of NCR: Mandrel failed 24 feet North of structure 506V1 and 12 feet South of the same structure on Drain Line 31-507-B. MSE wall, concrete barrier, moment slab, and permanent asphalt have been constructed in this area of conflict.

Superintendent: Gary Palmer
Subcontractor: None
Supplier: None

Part II: Review by Construction QA Management

This NCR request has been reviewed by:

- [] Terry Constable [] John Lee
[] Tim Nelson [] Pat McCready
[] Anthony Crockett [] Kevin Segrue
[x] Brian Bullen [] Other QA Management:
[] Glen Tonak

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO:
[] SECC Document Control (NCR File)
[] SECC QA Manager - Constable
SECC Design and Construction
[] Post Design - Klemz, Uyematsu, Field Design Coord
[] Highways - Doug Brannan
[] Structures - 1 Don Muns, 2/3 Rich Westerheid
[] Grading - 1 Tim Driver, 2/3 Scott Cromack
[] Paving - Dave Ross
[] Survey - Jim Bodi
[] ITS/Elec - Bruce Wilson
[] LRT - Tim Mackin, Wilson, Larson
[] Stations - JD Vetter, Mackin, Larson
[] MHT - Lloyd Maier, Luke Connelley
[] Segment 1 - Carnazzo, Sato
[] Segment 2/3 - Thoendel, Deml
[] Dynalectric - Vecchione, Wright

- SECC Construction Quality Assurance
[] Structures - Tim Nelson
[] Grading/Drainage - Anthony Crockett, Brian Bullen
[] Paving - Pat McCready
[] ITS - John Lee
[] LRT - Kevin Segrue
[] Procurement - Glen Tonak

- T-REX Oversight and Other
[] Oversight - Basner, Walker, Stevenson
[] Segment 1 - Jeff Clevenger, Danielle Smith
[] Segment 2/3 - Al Eastwood, David Wieder
[] LRT - Starling, Bacus, Reitter, (Shrestha if Systems)
[] ITS - Gonzales, Lipp
[] Design Oversight -
[] Utility Company (DW-McQuade, DWW-M-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709	Date Issued: 9/12/03
Area: 3.1	Contractor: SECC
Discipline: Drainage	Subcontractor: None
Activity Number: 30001.20	Supplier: None

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

QA or PM Approved: _____ Joe Jensen _____ Date: 9/12/03
 Proposed Resolution: Evaluate remove/replace Drain Line 31-507-B at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be implemented: Yes If Yes, Plans to be Reissued by: _____
 No

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: _____ Date: _____
 Post Design Services

Checked by: _____

Attachments: Yes
 No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company: Name of Utility Company Representative Date:
Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

- Type of Resolution: Remove and Replace (skip to Part IX)
Repair/Rework to Contract Specification Compliance (skip to Part IX)
Repair/Rework to acceptable standards
Leave As Is (Use As Is) does not require QA reinspection

Description of Resolution:

Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by: Date:
(Segment Oversight or Segment Design Oversight)

Part IX: SECC QA Disposition

- Action: Reinspected verifying Contract Specification Compliance
Reinspected and Accepted based on T-REX Technical Closure

Comments or Verification of Reinspection:

QA Manager: Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part I: Identify Field Design Change Request or RFI

Requested by: Josh Schlee
SECC

Phone: (303) 357-8456

- FDC (for work that has NOT been constructed)
 RFI

Reference Drawing Number: Various

Drawing Package Title: Drainage Plans (Profiles)

Response needed by: 6/30/03

RFC Date of Drawings: Various

Description of Problem: (attach plan mark up if needed) HDPE pipe problems encountered in the field with shallow cover (equipment running over installed pipe), and excavating around installed HDPE pipe. At some locations it may be necessary to remove previously installed HDPE and replace it with RCP.

Field Design Change Requested: Change all remaining HDPE to RCP. This will require coring some precast concrete structures to accommodate the larger O.D. associated with RCP. If the gap between the pipe and the structure is greater than 3", collaring around the RCP will be required; if less than 3", grouting between the structure and the RCP would be the method of installation. Design has mentioned that there is a slight decrease in pipe capacity when switching to RCP, and it may be necessary to increase the pipe diameter at a few locations, or stay with HDPE at those locations. We will need to evaluate these areas on a case-by-case basis; the majority of pipe left to install can be switched from HDPE to RCP without any major design problems.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Construction requests that design work be tracked for possible back charge.

Subcontractor: _____

Part II: Distribution

TO:

- SECC Document Control (FDC File)
- T-REX Document Control – Shelle Pope

SECC Construction Quality Assurance

- Structures – Tim Nelson
- Grading/Drainage – Brian Bullen, Anthony Crockett
- Paving – Pat McCready
- ITS – John Lee
- LRT – Kevin Segrue
- Procurement – Glen Tonak

SECC Construction

- Survey – Jim Bodi
- Paving – Dave Ross
- MHT – Lloyd Maier, Luke Connelley
- ITS/Elec – Bruce Wilson
- LRT – Mackin, Wilson, Larson
- Stations – Mackin, Larson, Vetter
- Segment 1 – Carnazzo, Sato
- Segment 2/3 – Thoendel, Deml
- Dynalectric – Vecchione, Wright

T-REX Oversight and Other

- Oversight – Basner, Stevenson
- Segment 1 – Jeff Clevenger, Danielle Smith
- Segment 2/3 – Al Eastwood, David Wieder
- LRT – Starling, Bacus, Reitter, (Shrestha if Systems)
- ITS – Gonzales, Lipp
- Design Oversight – John Griffith
- CCD Joe Barsoom

SECC Design Management

- Post Design Field Coordinators
- PDS Administration – Jeanette Bordner (FDC File)
- Design Management – Klemz, Wise, O'Malley
- Discipline Design Mgr – Roger Kilgore
- Design Coordinator for Construction – Laura Elliot
- Originator – Josh Schlee
- Steve Arent
- Scott Cromack, Jim Johnston, Jay Stepetin
- Lino Cruz, Jason Miner, Jeff Smith, Gabriel Gaytan



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
Area: Project Wide
Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
Discipline: Drainage
Contractor: SECC

Part III: Response

Response: The requested change is acceptable. Drainage Construction shall mark-up all drainage profiles to indicate the locations where HDPE pipe is to be changed to RCP. Drainage Design will revise Q_{full} values, and check that velocity and HGL criteria are satisfied. A separate FDC shall then be processed for each Area containing the revised drainage profiles.

If Drainage Design determines that it is necessary to upsize any particular pipe runs, or make any other significant changes, then separate FDC's may be processed to document those changes.

Revised Plans needed before
this change can be
Implemented: Yes
No

If Yes, Plans to be Reissued by: _____

Plans or Specs to be changed: Separate FDC's shall be processed for each Area containing the revised drainage profiles.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Design Work Charged to: Post-Design Services
Design Target

If PDS, Indicate WBS: _____
Hours: 200

Responded by: Don Clark

Date: 6/27/03

Checked by: _____

Attachments: Yes
No

Part IV: Utility FDCs

Response from Utility Company: _____
Name of Utility Company Representative

Date: _____

Attached utility company response or indicate location of response on FileNET.



SOUTHEAST CORRIDOR CONSTRUCTORS
FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
Area: Project Wide
Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
Discipline: Drainage
Contractor: SECC

Part V: Final Proposed FDC Resolution by SECC (if change does not meet contract requirements)

Related Contract References:

Final FDC Resolution:

Cost Implications:

- No Cost Change
Deductive Change - \$
Deductive Change TBD

Agreement of FDC Resolution and Cost Implications proposed by SECC:

SECC Signature:

Print or Type Name Signature Date

To be signed by Tom Howell, Doug Brannan, Ben Carnazzo, Barry Thoendel, Bruce Wilson, Dave Ross, Tim Mackin, or JD Vetter as appropriate.

Part VI: Field Design Change acceptance (if change does not meet contract requirements)

T-REX Signature:

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the use of the described field design change for the subject application only. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if the accepted field design change results in a cost reduction.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part I: Identify Field Design Change Request or RFI

Requested by: Josh Schlee
SECC

Phone: (303) 357-8456

- FDC (for work that has NOT been constructed)
 RFI

Reference Drawing Number: Various

Drawing Package Title: Drainage Plans (Profiles)

Response needed by: 6/30/03

RFC Date of Drawings: Various

Description of Problem: (attach plan mark up if needed) HDPE pipe problems encountered in the field with shallow cover (equipment running over installed pipe), and excavating around installed HDPE pipe. At some locations it may be necessary to remove previously installed HDPE and replace it with RCP.

Field Design Change Requested: Change all remaining HDPE to RCP. This will require coring some precast concrete structures to accommodate the larger O.D. associated with RCP. If the gap between the pipe and the structure is greater than 3", collaring around the RCP will be required; if less than 3", grouting between the structure and the RCP would be the method of installation. Design has mentioned that there is a slight decrease in pipe capacity when switching to RCP, and it may be necessary to increase the pipe diameter at a few locations, or stay with HDPE at those locations. We will need to evaluate these areas on a case-by-case basis; the majority of pipe left to install can be switched from HDPE to RCP without any major design problems.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Construction requests that design work be tracked for possible back charge.

Subcontractor: _____

Part II: Distribution

TO:

- SECC Document Control (FDC File)
- T-REX Document Control – Shelle Pope

SECC Construction Quality Assurance

- Structures – Tim Nelson
- Grading/Drainage – Brian Bullen, Anthony Crockett
- Paving – Pat McCready
- ITS – John Lee
- LRT – Kevin Segrue
- Procurement – Glen Tonak

SECC Construction

- Survey – Jim Bodi
- Paving – Dave Ross
- MHT – Lloyd Maier, Luke Connelley
- ITS/Elec – Bruce Wilson
- LRT – Mackin, Wilson, Larson
- Stations – Mackin, Larson, Vetter
- Segment 1 – Carnazzo, Sato
- Segment 2/3 – Thoendel, Deml
- Dynalectric – Vecchione, Wright

T-REX Oversight and Other

- Oversight – Basner, Stevenson
- Segment 1 – Jeff Clevenger, Danielle Smith
- Segment 2/3 – Al Eastwood, David Wieder
- LRT – Starling, Bacus, Reitter, (Shrestha if Systems)
- ITS – Gonzales, Lipp
- Design Oversight – John Griffith
- CCD Joe Barsoom

SECC Design Management

- Post Design Field Coordinators
- PDS Administration – Jeanette Bordner (FDC File)
- Design Management – Klemz, Wise, O'Malley
- Discipline Design Mgr – Roger Kilgore
- Design Coordinator for Construction – Laura Elliot
- Originator – Josh Schlee
- Steve Arent
- Scott Cromack, Jim Johnston, Jay Stepetin
- Lino Cruz, Jason Miner, Jeff Smith, Gabriel Gaytan



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part III: Response

Response: The requested change is acceptable. Drainage Construction shall mark-up all drainage profiles to indicate the locations where HDPE pipe is to be changed to RCP. Drainage Design will revise Q_{full} values, and check that velocity and HGL criteria are satisfied. A separate FDC shall then be processed for each Area containing the revised drainage profiles.

If Drainage Design determines that it is necessary to upsize any particular pipe runs, or make any other significant changes, then separate FDC's may be processed to document those changes.

Revised Plans needed before
 this change can be
 Implemented: Yes
 No

If Yes, Plans to be Reissued by: _____

Plans or Specs to be changed: Separate FDC's shall be processed for each Area containing the revised drainage profiles.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Design Work Charged to: Post-Design Services If PDS, Indicate WBS: _____
 Design Target Hours: 200

Responded by: Don Clark Date: 6/27/03

Checked by: _____

Attachments: Yes
 No

Part IV: Utility FDCs

Response from Utility Company: _____ Date: _____
 Name of Utility Company Representative

Attached utility company response or indicate location of response on FileNET.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part V: Final Proposed FDC Resolution by SECC (if change does not meet contract requirements)

Related Contract References:

Final FDC Resolution:

Cost Implications:

- No Cost Change
- Deductive Change - \$ _____
- Deductive Change TBD

Agreement of FDC Resolution and Cost Implications proposed by SECC:

SECC Signature:

Print or Type Name	Signature	Date
--------------------	-----------	------

To be signed by Tom Howell, Doug Brannan, Ben Carnazzo, Barry Thoendel, Bruce Wilson, Dave Ross, Tim Mackin, or JD Vetter as appropriate.

Part VI: Field Design Change acceptance (if change does not meet contract requirements)

T-REX Signature:

Print or Type Name	Signature	Date
--------------------	-----------	------

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the use of the described field design change for the subject application only. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if the accepted field design change results in a cost reduction.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part I: Identify Field Design Change Request or RFI

Requested by: Josh Schlee
SECC

Phone: (303) 357-8456

- FDC (for work that has NOT been constructed)
 RFI

Reference Drawing Number: Various

Drawing Package Title: Drainage Plans (Profiles)

Response needed by: 6/30/03

RFI Date of Drawings: Various

Description of Problem: (attach plan mark up if needed) HDPE pipe problems encountered in the field with shallow cover (equipment running over installed pipe), and excavating around installed HDPE pipe. At some locations it may be necessary to remove previously installed HDPE and replace it with RCP.

Field Design Change Requested: Change all remaining HDPE to RCP. This will require coring some precast concrete structures to accommodate the larger O.D. associated with RCP. If the gap between the pipe and the structure is greater than 3", collaring around the RCP will be required; if less than 3", grouting between the structure and the RCP would be the method of installation. Design has mentioned that there is a slight decrease in pipe capacity when switching to RCP, and it may be necessary to increase the pipe diameter at a few locations, or stay with HDPE at those locations. We will need to evaluate these areas on a case-by-case basis; the majority of pipe left to install can be switched from HDPE to RCP without any major design problems.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Construction requests that design work be tracked for possible back charge.

Subcontractor: _____

Part II: Distribution

TO:

- SECC Document Control (FDC File)
- T-REX Document Control – Shelle Pope

SECC Construction Quality Assurance

- Structures – Tim Nelson
- Grading/Drainage – Brian Bullen, Anthony Crockett
- Paving – Pat McCready
- ITS – John Lee
- LRT – Kevin Segrue
- Procurement – Glen Tonak

SECC Construction

- Survey – Jim Bodi
- Paving – Dave Ross
- MHT – Lloyd Maier, Luke Connelley
- ITS/Elec – Bruce Wilson
- LRT – Mackin, Wilson, Larson
- Stations – Mackin, Larson, Vetter
- Segment 1 – Carnazzo, Sato
- Segment 2/3 – Thoendel, Deml
- Dynalectric – Vecchione, Wright

T-REX Oversight and Other

- Oversight – Basner, Stevenson
- Segment 1 – Jeff Clevenger, Danielle Smith
- Segment 2/3 – Al Eastwood, David Wieder
- LRT – Starling, Bacus, Reitter, (Shrestha if Systems)
- ITS – Gonzales, Lipp
- Design Oversight – John Griffith
- CCD Joe Barsoom

SECC Design Management

- Post Design Field Coordinators
- PDS Administration – Jeanette Bordner (FDC File)
- Design Management – Klemz, Wise, O'Malley
- Discipline Design Mgr – Roger Kilgore
- Design Coordinator for Construction – Laura Elliot
- Originator – Josh Schlee
- Steve Arent
- Scott Cromack, Jim Johnston, Jay Stepetin
- Lino Cruz, Jason Miner, Jeff Smith, Gabriel Gaytan



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part III: Response

Response: The requested change is acceptable. Drainage Construction shall mark-up all drainage profiles to indicate the locations where HDPE pipe is to be changed to RCP. Drainage Design will revise Q_{full} values, and check that velocity and HGL criteria are satisfied. A separate FDC shall then be processed for each Area containing the revised drainage profiles.

If Drainage Design determines that it is necessary to upsize any particular pipe runs, or make any other significant changes, then separate FDC's may be processed to document those changes.

Revised Plans needed before
 this change can be
 Implemented: Yes
 No

If Yes, Plans to be Reissued by: _____

Plans or Specs to be changed: Separate FDC's shall be processed for each Area containing the revised drainage profiles.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Design Work Charged to: Post-Design Services If PDS, Indicate WBS: _____
 Design Target Hours: 200

Responded by: Don Clark Date: 6/27/03

Checked by: _____

Attachments: Yes
 No

Part IV: Utility FDCs

Response from Utility Company: _____ Date: _____

Name of Utility Company Representative

Attached utility company response or indicate location of response on FileNET.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part V: Final Proposed FDC Resolution by SECC (if change does not meet contract requirements)

Related Contract References:

Final FDC Resolution:

Cost Implications:

- No Cost Change
- Deductive Change - \$ _____
- Deductive Change TBD

Agreement of FDC Resolution and Cost Implications proposed by SECC:

SECC Signature:

Print or Type Name	Signature	Date
--------------------	-----------	------

To be signed by Tom Howell, Doug Brannan, Ben Carnazzo, Barry Thoendel, Bruce Wilson, Dave Ross, Tim Mackin, or JD Vetter as appropriate.

Part VI: Field Design Change acceptance (if change does not meet contract requirements)

T-REX Signature:

Print or Type Name	Signature	Date
--------------------	-----------	------

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the use of the described field design change for the subject application only. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if the accepted field design change results in a cost reduction.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part I: Identify Field Design Change Request or RFI

Requested by: Josh Schlee
SECC

Phone: (303) 357-8456

- FDC (for work that has NOT been constructed)
 RFI

Reference Drawing Number: Various

Drawing Package Title: Drainage Plans (Profiles)

Response needed by: 6/30/03

RFI Date of Drawings: Various

Description of Problem: (attach plan mark up if needed) HDPE pipe problems encountered in the field with shallow cover (equipment running over installed pipe), and excavating around installed HDPE pipe. At some locations it may be necessary to remove previously installed HDPE and replace it with RCP.

Field Design Change Requested: Change all remaining HDPE to RCP. This will require coring some precast concrete structures to accommodate the larger O.D. associated with RCP. If the gap between the pipe and the structure is greater than 3", collaring around the RCP will be required; if less than 3", grouting between the structure and the RCP would be the method of installation. Design has mentioned that there is a slight decrease in pipe capacity when switching to RCP, and it may be necessary to increase the pipe diameter at a few locations, or stay with HDPE at those locations. We will need to evaluate these areas on a case-by-case basis; the majority of pipe left to install can be switched from HDPE to RCP without any major design problems.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Construction requests that design work be tracked for possible back charge.

Subcontractor: _____

Part II: Distribution

TO:

- SECC Document Control (FDC File)
- T-REX Document Control – Shelle Pope

SECC Construction Quality Assurance

- Structures – Tim Nelson
- Grading/Drainage – Brian Bullen, Anthony Crockett
- Paving – Pat McCready
- ITS – John Lee
- LRT – Kevin Segrue
- Procurement – Glen Tonak

SECC Construction

- Survey – Jim Bodi
- Paving – Dave Ross
- MHT – Lloyd Maier, Luke Connelley
- ITS/Elec – Bruce Wilson
- LRT – Mackin, Wilson, Larson
- Stations – Mackin, Larson, Vetter
- Segment 1 – Carnazzo, Sato
- Segment 2/3 – Thoendel, Deml
- Dynalectric – Vecchione, Wright

T-REX Oversight and Other

- Oversight – Basner, Stevenson
- Segment 1 – Jeff Clevenger, Danielle Smith
- Segment 2/3 – Al Eastwood, David Wieder
- LRT – Starling, Bacus, Reitter, (Shrestha if Systems)
- ITS – Gonzales, Lipp
- Design Oversight – John Griffith
- CCD Joe Barsoom

SECC Design Management

- Post Design Field Coordinators
- PDS Administration – Jeanette Bordner (FDC File)
- Design Management – Klemz, Wise, O'Malley
- Discipline Design Mgr – Roger Kilgore
- Design Coordinator for Construction – Laura Elliot
- Originator – Josh Schlee
- Steve Arent
- Scott Cromack, Jim Johnston, Jay Stepetin
- Lino Cruz, Jason Miner, Jeff Smith, Gabriel Gaytan



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
Area: Project Wide
Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
Discipline: Drainage
Contractor: SECC

Part III: Response

Response: The requested change is acceptable. Drainage Construction shall mark-up all drainage profiles to indicate the locations where HDPE pipe is to be changed to RCP. Drainage Design will revise Q_{full} values, and check that velocity and HGL criteria are satisfied. A separate FDC shall then be processed for each Area containing the revised drainage profiles.

If Drainage Design determines that it is necessary to upsize any particular pipe runs, or make any other significant changes, then separate FDC's may be processed to document those changes.

Revised Plans needed before this change can be Implemented: Yes
No

If Yes, Plans to be Reissued by: _____

Plans or Specs to be changed: Separate FDC's shall be processed for each Area containing the revised drainage profiles.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Design Work Charged to: Post-Design Services
Design Target If PDS, Indicate WBS: _____
Hours: 200

Responded by: Don Clark Date: 6/27/03

Checked by: _____

Attachments: Yes
No

Part IV: Utility FDCs

Response from Utility Company: _____ Date: _____
Name of Utility Company Representative

Attached utility company response or indicate location of response on FileNET.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
Area: Project Wide
Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
Discipline: Drainage
Contractor: SECC

Part V: Final Proposed FDC Resolution by SECC (if change does not meet contract requirements)

Related Contract References:

Final FDC Resolution:

Cost Implications:

- No Cost Change
- Deductive Change - \$ _____
- Deductive Change TBD

Agreement of FDC Resolution and Cost Implications proposed by SECC:

SECC Signature:

Print or Type Name	Signature	Date
--------------------	-----------	------

To be signed by Tom Howell, Doug Brannan, Ben Carnazzo, Barry Thoendel, Bruce Wilson, Dave Ross, Tim Mackin, or JD Vetter as appropriate.

Part VI: Field Design Change acceptance (if change does not meet contract requirements)

T-REX Signature:

Print or Type Name	Signature	Date
--------------------	-----------	------

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the use of the described field design change for the subject application only. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if the accepted field design change results in a cost reduction.



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30251.20 Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin SECC Issued to: [] Carnazzo [] Wilson [x] Thoendel [] Mackin [] Ross [] Vetter

Commented [MCO1]: Double-click on grey box to insert check mark

Referenced Contract Spec: N/A

Referenced Drawing Number: D113, D209

Location of Nonconformance: Drain Line 31-613-C

NB I-25 or I-225 Stationing: 631+00 (show nearest 500)

Description of NCR: Mandrill failed 28 feet South of structure 613S1 and 20 feet North of structure 614S1 on Drain Line 31-613-C. Concrete barrier and permanent asphalt have been constructed in this area of conflict.

Superintendent: Gary Palmer

Subcontractor: None

Supplier: None

Part II: Review by Construction QA Management

This NCR request has been reviewed by:

- [] Terry Constable [] John Lee
[] Tim Nelson [] Pat McCready
[] Anthony Crockett [] Kevin Segrue
[x] Brian Bullen [] Other QA Management:
[] Glen Tonak

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO:
[] SECC Document Control (NCR File)
[] SECC QA Manager - Constable
SECC Design and Construction
[] Post Design - Klemz, Uyematsu, Field Design Coord
[] Highways - Doug Brannan
[] Structures - 1 Don Muns, 2/3 Rich Westerheid
[] Grading - 1 Tim Driver, 2/3 Scott Cromack
[] Paving - Dave Ross
[] Survey - Jim Bodi
[] ITS/Elec - Bruce Wilson
[] LRT - Tim Mackin, Wilson, Larson
[] Stations - JD Vetter, Mackin, Larson
[] MHT - Lloyd Maier, Luke Connelley
[] Segment 1 - Carnazzo, Sato
[] Segment 2/3 - Thoendel, Demi
[] Dynalectric - Vecchione, Wright

- SECC Construction Quality Assurance
[] Structures - Tim Nelson
[] Grading/Drainage - Anthony Crockett, Brian Bullen
[] Paving - Pat McCready
[] ITS - John Lee
[] LRT - Kevin Segrue
[] Procurement - Glen Tonak

- T-REX Oversight and Other
[] Oversight - Basner, Walker, Stevenson
[] Segment 1 - Jeff Clevenger, Danielle Smith
[] Segment 2/3 - Al Eastwood, David Wieder
[] LRT - Starling, Bacus, Reitter, (Shrestha if Systems)
[] ITS - Gonzales, Lipp
[] Design Oversight -
[] Utility Company (DW-McQuade, DWWW-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711	Date Issued: 9/12/03
Area: 3.1	Contractor: SECC
Discipline: Drainage	Subcontractor: None
Activity Number: 30251.20	Supplier: None

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

QA or PM Approved: Joe Jensen Date: 9/12/03
 Proposed Resolution: Evaluate remove/replace Drain Line 31-613-C at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be implemented: Yes If Yes, Plans to be Reissued by: _____
 No

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: _____ Date: _____
 Post Design Services

Checked by: _____

Attachments: Yes
 No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30251.20 Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company: Name of Utility Company Representative Date:
Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

Type of Resolution: [] Remove and Replace (skip to Part IX)
[] Repair/Rework to Contract Specification Compliance (skip to Part IX)
[] Repair/Rework to acceptable standards
[] Leave As Is (Use As Is) does not require QA reinspection
Description of Resolution:
Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by: Date:
(Segment Oversight or Segment Design Oversight)

Part IX: SECC QA Disposition

Action: [] Reinspected verifying Contract Specification Compliance
[] Reinspected and Accepted based on T-REX Technical Closure
Comments or Verification of Reinspection:
QA Manager: Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30251.20 Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin SECC

Issued to: [] Carnazzo [] Wilson
[X] Thoendel [] Mackin
[] Ross [] Vetter

Commented [MC01]: Double-click on grey box to insert check mark

Referenced Contract Spec: N/A

Referenced Drawing Number: D113, D209

Location of Nonconformance: Drain Line 31-613-C

NB I-25 or I-225 Stationing: 631+00 (show nearest 500')

Description of NCR: Mandrill failed 28 feet South of structure 613S1 and 20 feet North of structure 614S1 on Drain Line 31-613-C. Concrete barrier and permanent asphalt have been constructed in this area of conflict.

Superintendent: Gary Palmer

Subcontractor: None

Supplier: None

Part II: Review by Construction QA Management

This NCR request has been reviewed by:

- [] Terry Constable [] John Lee
[] Tim Nelson [] Pat McCready
[] Anthony Crockett [] Kevin Segrue
[X] Brian Bullen [] Other QA Management:
[] Glen Tonak

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO:
[X] SECC Document Control (NCR File)
[X] SECC QA Manager - Constable
SECC Design and Construction
[X] Post Design - Klemz, Uyematsu, Field Design Coord
[] Highways - Doug Brannan
[] Structures - 1 Don Muns, 2/3 Rich Westerheid
[X] Grading - 1 Tim Driver, 2/3 Scott Cromack
[] Paving - Dave Ross
[] Survey - Jim Bodi
[] ITS/Elec - Bruce Wilson
[] LRT - Tim Mackin, Wilson, Larson
[] Stations - JD Vetter, Mackin, Larson
[] MHT - Lloyd Maier, Luke Connelley
[] Segment 1 - Carnazzo, Sato
[X] Segment 2/3 - Thoendel, Deml
[] Dynalectric - Vecchione, Wright

- SECC Construction Quality Assurance
[] Structures - Tim Nelson
[X] Grading/Drainage - Anthony Crockett, Brian Bullen
[] Paving - Pat McCready
[] ITS - John Lee
[] LRT - Kevin Segrue
[] Procurement - Glen Tonak

- T-REX Oversight and Other
[X] Oversight - Basner, Walker, Stevenson
[] Segment 1 - Jeff Clevenger, Danielle Smith
[X] Segment 2/3 - Al Eastwood, David Wieder
[] LRT - Starling, Bacus, Reitter, (Shrestha if Systems)
[] ITS - Gonzales, Lipp
[] Design Oversight -
[] Utility Company (DW-McQuade, DWWM-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711	Date Issued: 9/12/03
Area: 3.1	Contractor: SECC
Discipline: Drainage	Subcontractor: None
Activity Number: 30251.20	Supplier: None

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

QA or PM Approved: Joe Jensen Date: 9/12/03
 Proposed Resolution: Evaluate remove/replace Drain Line 31-613-C at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be Implemented: Yes No If Yes, Plans to be Reissued by: _____

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: Post Design Services Date: _____

Checked by: _____

Attachments: Yes No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30251.20 Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company: Name of Utility Company Representative Date:
Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

- Type of Resolution: [] Remove and Replace (skip to Part IX)
[] Repair/Rework to Contract Specification Compliance (skip to Part IX)
[] Repair/Rework to acceptable standards
[] Leave As Is (Use As Is) does not require QA reinspection

Description of Resolution:

Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by: Date:
(Segment Oversight or Segment Design Oversight)

Part IX: SECC QA Disposition

- Action: [] Reinspected verifying Contract Specification Compliance
[] Reinspected and Accepted based on T-REX Technical Closure

Comments or Verification of Reinspection:

QA Manager: Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin SECC Issued to: [] Carnazzo [] Wilson [x] Thoendel [] Mackin [] Ross [] Vetter

Commented [MC01]: Double-click on grey box to insert check mark

Referenced Contract Spec: N/A
Referenced Drawing Number: D102, D201
Location of Nonconformance: Drain Line 31-507-B
NB I-25 or I-225 Stationing: 506+92 & 507+67 (show nearest 500')

Description of NCR: Mandrel failed 24 feet North of structure 506V1 and 12 feet South of the same structure on Drain Line 31-507-B. MSE wall, concrete barrier, moment slab, and permanent asphalt have been constructed in this area of conflict.

Superintendent: Gary Palmer
Subcontractor: None
Supplier: None

Part II: Review by Construction QA Management

This NCR request has been reviewed by:
[] Terry Constable [] John Lee
[] Tim Nelson [] Pat McCready
[] Anthony Crockett [] Kevin Segrue
[x] Brian Bullen [] Other QA Management:
[] Glen Tonak

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO:
[] SECC Document Control (NCR File)
[] SECC QA Manager - Constable
SECC Design and Construction
[] Post Design - Klemz, Uyematsu, Field Design Coord
[] Highways - Doug Brannan
[] Structures - 1 Don Muns, 2/3 Rich Westerheid
[] Grading - 1 Tim Driver, 2/3 Scott Cromack
[] Paving - Dave Ross
[] Survey - Jim Bodi
[] ITS/Elec - Bruce Wilson
[] LRT - Tim Mackin, Wilson, Larson
[] Stations - JD Vetter, Mackin, Larson
[] MHT - Lloyd Maier, Luke Connelley
[] Segment 1 - Carnazzo, Sato
[] Segment 2/3 - Thoendel, Deml
[] Dynaletric - Vecchione, Wright

- SECC Construction Quality Assurance
[] Structures - Tim Nelson
[] Grading/Drainage - Anthony Crockett, Brian Bullen
[] Paving - Pat McCready
[] ITS - John Lee
[] LRT - Kevin Segrue
[] Procurement - Glen Tonak
T-REX Oversight and Other
[] Oversight - Basner, Walker, Stevenson
[] Segment 1 - Jeff Clevenger, Danielle Smith
[] Segment 2/3 - Al Eastwood, David Wieder
[] LRT - Starling, Bacus, Reitter, (Shrestha if Systems)
[] ITS - Gonzales, Lipp
[] Design Oversight -
[] Utility Company (DW-McQuade, DWW-M-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709	Date Issued: 9/12/03
Area: 3.1	Contractor: SECC
Discipline: Drainage	Subcontractor: None
Activity Number: 30001.20	Supplier: None

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

Proposed Resolution: QA or PM Approved: Joe Jensen Date: 9/12/03
 Evaluate remove/replace Drain Line 31-507-B at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be Implemented: Yes If Yes, Plans to be Reissued by: _____
 No

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: _____ Date: _____
 Post Design Services

Checked by: _____

Attachments: Yes
 No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company: Name of Utility Company Representative Date: Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

- Type of Resolution: Remove and Replace (skip to Part IX)
Repair/Rework to Contract Specification Compliance (skip to Part IX)
Repair/Rework to acceptable standards
Leave As Is (Use As Is) does not require QA reinspection

Description of Resolution:

Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by: Date: (Segment Oversight or Segment Design Oversight)

Part IX: SECC QA Disposition

- Action: Reinspected verifying Contract Specification Compliance
Reinspected and Accepted based on T-REX Technical Closure

Comments or Verification of Reinspection:

QA Manager: Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin SECC Issued to: [] Carnazzo [] Wilson [x] Thoendel [] Mackin [] Ross [] Vetter

Commented [MC01]: Double-click on grey box to insert check mark

Referenced Contract Spec: N/A
Referenced Drawing Number: D102, D201
Location of Nonconformance: Drain Line 31-507-B
NB I-25 or I-225 Stationing: 506+92 & 507+67 (show nearest 500')

Description of NCR: Mandrel failed 24 feet North of structure 506V1 and 12 feet South of the same structure on Drain Line 31-507-B. MSE wall, concrete barrier, moment slab, and permanent asphalt have been constructed in this area of conflict.

Superintendent: Gary Palmer
Subcontractor: None
Supplier: None

Part II: Review by Construction QA Management

This NCR request has been reviewed by:
[] Terry Constable [] John Lee
[] Tim Nelson [] Pat McCready
[] Anthony Crockett [] Kevin Segrue
[x] Brian Bullen [] Other QA Management:
[] Glen Tonak

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO:
[] SECC Document Control (NCR File)
[] SECC QA Manager - Constable
SECC Design and Construction
[] Post Design - Klemz, Uyematsu, Field Design Coord
[] Highways - Doug Brannan
[] Structures - 1 Don Muns, 2/3 Rich Westerheid
[] Grading - 1 Tim Driver, 2/3 Scott Cromack
[] Paving - Dave Ross
[] Survey - Jim Bodi
[] ITS/Elec - Bruce Wilson
[] LRT - Tim Mackin, Wilson, Larson
[] Stations - JD Vetter, Mackin, Larson
[] MHT - Lloyd Maier, Luke Connelley
[] Segment 1 - Carnazzo, Sato
[] Segment 2/3 - Thoendel, Deml
[] Dynalectric - Vecchione, Wright

- SECC Construction Quality Assurance
[] Structures - Tim Nelson
[] Grading/Drainage - Anthony Crockett, Brian Bullen
[] Paving - Pat McCready
[] ITS - John Lee
[] LRT - Kevin Segrue
[] Procurement - Glen Tonak

- T-REX Oversight and Other
[] Oversight - Basner, Walker, Stevenson
[] Segment 1 - Jeff Clevenger, Danielle Smith
[] Segment 2/3 - Al Eastwood, David Wieder
[] LRT - Starling, Bacus, Reitter, (Shrestha if Systems)
[] ITS - Gonzales, Lipp
[] Design Oversight -
[] Utility Company (DW-McQuade, DWW-M-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709	Date Issued: 9/12/03
Area: 3.1	Contractor: SECC
Discipline: Drainage	Subcontractor: None
Activity Number: 30001.20	Supplier: None

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

Proposed Resolution: QA or PM Approved: Joe Jensen Date: 9/12/03
 Evaluate remove/replace Drain Line 31-507-B at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be Implemented: Yes If Yes, Plans to be Reissued by: _____
 No

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: _____ Date: _____
 Post Design Services

Checked by: _____

Attachments: Yes
 No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company: Name of Utility Company Representative Date: Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

- Type of Resolution: Remove and Replace (skip to Part IX)
Repair/Rework to Contract Specification Compliance (skip to Part IX)
Repair/Rework to acceptable standards
Leave As Is (Use As Is) does not require QA reinspection

Description of Resolution:

Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by: Date: (Segment Oversight or Segment Design Oversight)

Part IX: SECC QA Disposition

- Action: Reinspected verifying Contract Specification Compliance
Reinspected and Accepted based on T-REX Technical Closure
Comments or Verification of Reinspection:

QA Manager: Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part I: Identify Field Design Change Request or RFI

Requested by: Josh Schlee
SECC

Phone: (303) 357-8456

- FDC (for work that has NOT been constructed)
 RFI

Reference Drawing Number: Various

Drawing Package Title: Drainage Plans (Profiles)

Response needed by: 6/30/03

RFC Date of Drawings: Various

Description of Problem: (attach plan mark up if needed) HDPE pipe problems encountered in the field with shallow cover (equipment running over installed pipe), and excavating around installed HDPE pipe. At some locations it may be necessary to remove previously installed HDPE and replace it with RCP.

Field Design Change Requested: Change all remaining HDPE to RCP. This will require coring some precast concrete structures to accommodate the larger O.D. associated with RCP. If the gap between the pipe and the structure is greater than 3", collaring around the RCP will be required; if less than 3", grouting between the structure and the RCP would be the method of installation. Design has mentioned that there is a slight decrease in pipe capacity when switching to RCP, and it may be necessary to increase the pipe diameter at a few locations, or stay with HDPE at those locations. We will need to evaluate these areas on a case-by-case basis; the majority of pipe left to install can be switched from HDPE to RCP without any major design problems.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Construction requests that design work be tracked for possible back charge.

Subcontractor: _____

Part II: Distribution

TO:

- SECC Document Control (FDC File)
- T-REX Document Control – Shelle Pope

SECC Construction Quality Assurance

- Structures – Tim Nelson
- Grading/Drainage – Brian Bullen, Anthony Crockett
- Paving – Pat McCready
- ITS – John Lee
- LRT – Kevin Segrue
- Procurement – Glen Tonak

SECC Construction

- Survey – Jim Bodi
- Paving – Dave Ross
- MHT – Lloyd Maier, Luke Connelley
- ITS/Elec – Bruce Wilson
- LRT – Mackin, Wilson, Larson
- Stations – Mackin, Larson, Vetter
- Segment 1 – Carnazzo, Sato
- Segment 2/3 – Thoendel, Deml
- Dynalectric – Vecchione, Wright

T-REX Oversight and Other

- Oversight – Basner, Stevenson
- Segment 1 – Jeff Clevenger, Danielle Smith
- Segment 2/3 – Al Eastwood, David Wieder
- LRT – Starling, Bacus, Reitter, (Shrestha if Systems)
- ITS – Gonzales, Lipp
- Design Oversight – John Griffith
- CCD Joe Barsoom

SECC Design Management

- Post Design Field Coordinators
- PDS Administration – Jeanette Bordner (FDC File)
- Design Management – Klemz, Wise, O'Malley
- Discipline Design Mgr – Roger Kilgore
- Design Coordinator for Construction – Laura Elliot
- Originator – Josh Schlee
- Steve Arent
- Scott Cromack, Jim Johnston, Jay Stepetin
- Lino Cruz, Jason Miner, Jeff Smith, Gabriel Gaytan



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
Area: Project Wide
Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
Discipline: Drainage
Contractor: SECC

Part III: Response

Response: The requested change is acceptable. Drainage Construction shall mark-up all drainage profiles to indicate the locations where HDPE pipe is to be changed to RCP. Drainage Design will revise Q_{full} values, and check that velocity and HGL criteria are satisfied. A separate FDC shall then be processed for each Area containing the revised drainage profiles.

If Drainage Design determines that it is necessary to upsize any particular pipe runs, or make any other significant changes, then separate FDC's may be processed to document those changes.

Revised Plans needed before
this change can be
Implemented: Yes
No

If Yes, Plans to be Reissued by: _____

Plans or Specs to be changed: Separate FDC's shall be processed for each Area containing the revised drainage profiles.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Design Work Charged to: Post-Design Services If PDS, Indicate WBS: _____
Design Target Hours: 200

Responded by: Don Clark Date: 6/27/03

Checked by: _____

Attachments: Yes
No

Part IV: Utility FDCs

Response from Utility Company: _____ Date: _____
Name of Utility Company Representative

Attached utility company response or indicate location of response on FileNET.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
Area: Project Wide
Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
Discipline: Drainage
Contractor: SECC

Part V: Final Proposed FDC Resolution by SECC (if change does not meet contract requirements)

Related Contract References:

Final FDC Resolution:

Cost Implications:

- No Cost Change
- Deductive Change - \$ _____
- Deductive Change TBD

Agreement of FDC Resolution and Cost Implications proposed by SECC:

SECC Signature:

Print or Type Name	Signature	Date
--------------------	-----------	------

To be signed by Tom Howell, Doug Brannan, Ben Carnazzo, Barry Thoendel, Bruce Wilson, Dave Ross, Tim Mackin, or JD Vetter as appropriate.

Part VI: Field Design Change acceptance (if change does not meet contract requirements)

T-REX Signature:

Print or Type Name	Signature	Date
--------------------	-----------	------

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the use of the described field design change for the subject application only. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if the accepted field design change results in a cost reduction.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part I: Identify Field Design Change Request or RFI

Requested by: Josh Schlee
SECC

Phone: (303) 357-8456

- FDC (for work that has NOT been constructed)
 RFI

Reference Drawing Number: Various

Drawing Package Title: Drainage Plans (Profiles)

Response needed by: 6/30/03

RFC Date of Drawings: Various

Description of Problem: (attach plan mark up if needed) HDPE pipe problems encountered in the field with shallow cover (equipment running over installed pipe), and excavating around installed HDPE pipe. At some locations it may be necessary to remove previously installed HDPE and replace it with RCP.

Field Design Change Requested: Change all remaining HDPE to RCP. This will require coring some precast concrete structures to accommodate the larger O.D. associated with RCP. If the gap between the pipe and the structure is greater than 3", collaring around the RCP will be required; if less than 3", grouting between the structure and the RCP would be the method of installation. Design has mentioned that there is a slight decrease in pipe capacity when switching to RCP, and it may be necessary to increase the pipe diameter at a few locations, or stay with HDPE at those locations. We will need to evaluate these areas on a case-by-case basis; the majority of pipe left to install can be switched from HDPE to RCP without any major design problems.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Construction requests that design work be tracked for possible back charge.

Subcontractor: _____

Part II: Distribution

TO:

- SECC Document Control (FDC File)
- T-REX Document Control – Shelle Pope

SECC Construction Quality Assurance

- ____ Structures – Tim Nelson
- Grading/Drainage – Brian Bullen, Anthony Crockett
- ____ Paving – Pat McCready
- ____ ITS – John Lee
- ____ LRT – Kevin Segrue
- Procurement – Glen Tonak

SECC Construction

- Survey – Jim Bodi
- ____ Paving – Dave Ross
- ____ MHT – Lloyd Maier, Luke Connelley
- ____ ITS/Elec – Bruce Wilson
- ____ LRT – Mackin, Wilson, Larson
- Stations – Mackin, Larson, Vetter
- Segment 1 – Carnazzo, Sato
- Segment 2/3 – Thoendel, Deml
- Dynalectric – Vecchione, Wright

T-REX Oversight and Other

- Oversight – Basner, Stevenson
- Segment 1 – Jeff Clevenger, Danielle Smith
- Segment 2/3 – Al Eastwood, David Wieder
- LRT – Starling, Bacus, Reitter, (Shrestha if Systems)
- ____ ITS – Gonzales, Lipp
- Design Oversight – John Griffith
- CCD Joe Barsoom

SECC Design Management

- Post Design Field Coordinators
- PDS Administration – Jeanette Bordner (FDC File)
- Design Management – Klemz, Wise, O'Malley
- Discipline Design Mgr – Roger Kilgore
- Design Coordinator for Construction – Laura Elliot
- Originator – Josh Schlee
- Steve Arent
- Scott Cromack, Jim Johnston, Jay Stepetin
- Lino Cruz, Jason Miner, Jeff Smith, Gabriel Gaytan



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
 Area: Project Wide
 Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
 Discipline: Drainage
 Contractor: SECC

Part III: Response

Response: The requested change is acceptable. Drainage Construction shall mark-up all drainage profiles to indicate the locations where HDPE pipe is to be changed to RCP. Drainage Design will revise Q_{full} values, and check that velocity and HGL criteria are satisfied. A separate FDC shall then be processed for each Area containing the revised drainage profiles.

If Drainage Design determines that it is necessary to upsize any particular pipe runs, or make any other significant changes, then separate FDC's may be processed to document those changes.

Revised Plans needed before
 this change can be
 Implemented: Yes
 No

If Yes, Plans to be Reissued by: _____

Plans or Specs to be changed: Separate FDC's shall be processed for each Area containing the revised drainage profiles.

Does this field design change meet the requirements of the Contract? Yes
 No If No, complete Parts V and VI

Design Work Charged to: Post-Design Services
 Design Target

If PDS, Indicate WBS: _____
 Hours: 200

Responded by: Don Clark

Date: 6/27/03

Checked by: _____

Attachments: Yes
 No

Part IV: Utility FDCs

Response from Utility Company: _____
 Name of Utility Company Representative

Date: _____

Attached utility company response or indicate location of response on FileNET.



SOUTHEAST CORRIDOR CONSTRUCTORS

FIELD DESIGN CHANGE/RFI MEMO

Field Memo Number: G273
Area: Project Wide
Package: Drainage Plans (Profiles)

Date of Request: 6/23/03
Discipline: Drainage
Contractor: SECC

Part V: Final Proposed FDC Resolution by SECC (if change does not meet contract requirements)

Related Contract References:

Final FDC Resolution:

Cost Implications:

- No Cost Change
Deductive Change - \$
Deductive Change TBD

Agreement of FDC Resolution and Cost Implications proposed by SECC:

SECC Signature:

Print or Type Name Signature Date

To be signed by Tom Howell, Doug Brannan, Ben Carnazzo, Barry Thoendel, Bruce Wilson, Dave Ross, Tim Mackin, or JD Vetter as appropriate.

Part VI: Field Design Change acceptance (if change does not meet contract requirements)

T-REX Signature:

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the use of the described field design change for the subject application only. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if the accepted field design change results in a cost reduction.



SOUTHEAST CORRIDOR CONSTRUCTORS
NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711
Area: 3.1
Discipline: Drainage
Activity Number: 30251.20

Date Issued: 9/12/03
Contractor: SECC
Subcontractor: None
Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin
SECC

Issued to: Carnazzo Wilson
 Thoendel Mackin
 Ross Vetter

Referenced Contract Spec: N/A

Referenced Drawing Number: D113, D209

Location of Nonconformance: Drain Line 31-613-C

NB I-25 or I-225 Stationing: 631+00 (show nearest 500')

Description of NCR: Mandrill failed 28 feet South of structure 613S1 and 20 feet North of structure 614S1 on Drain Line 31-613-C. Concrete barrier and permanent asphalt have been constructed in this area of conflict.

Superintendent: Gary Palmer
Subcontractor: None
Supplier: None

Commented [MC01]: Double-click on grey box to insert check mark

Part II: Review by Construction QA Management

This NCR request has been reviewed by:

Terry Constable John Lee
 Tim Nelson Pat McCready
 Anthony Crockett Kevin Segrue
 Brian Bullen Other QA Management:
 Glen Tonak

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO:**
- SECC Document Control (NCR File)
 - SECC QA Manager – Constable
- SECC Design and Construction**
- Post Design – Klemz, Uyematsu, Field Design Coord
 - Highways – Doug Brannan
 - Structures – 1 Don Muns, 2/3 Rich Westerheid
 - Grading – 1 Tim Driver, 2/3 Scott Cromack
 - Paving – Dave Ross
 - Survey – Jim Bodi
 - ITS/Elec – Bruce Wilson
 - LRT – Tim Mackin, Wilson, Larson
 - Stations – JD Vetter, Mackin, Larson
 - MHT – Lloyd Maier, Luke Connelley
 - Segment 1 – Carnazzo, Sato
 - Segment 2/3 – Thoendel, Deml
 - Dynalectric – Vecchione, Wright
- SECC Construction Quality Assurance**
- Structures – Tim Nelson
 - Grading/Drainage – Anthony Crockett, Brian Bullen
 - Paving – Pat McCready
 - ITS – John Lee
 - LRT – Kevin Segrue
 - Procurement – Glen Tonak
- T-REX Oversight and Other**
- Oversight – Basner, Walker, Stevenson
 - Segment 1 – Jeff Clevenger, Danielle Smith
 - Segment 2/3 – Al Eastwood, David Wieder
 - LRT – Starling, Bacus, Reitter, (Shrestha if Systems)
 - ITS – Gonzales, Lipp
 - Design Oversight –
 - Utility Company (DW-McQuade, DWWW-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number:	<u>711</u>	Date Issued:	<u>9/12/03</u>
Area:	<u>3.1</u>	Contractor:	<u>SECC</u>
Discipline:	<u>Drainage</u>	Subcontractor:	<u>None</u>
Activity Number:	<u>30251.20</u>	Supplier:	<u>None</u>

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

- NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

Proposed Resolution: QA or PM Approved: Joe Jensen Date: 9/12/03
 Evaluate remove/replace Drain Line 31-613-C at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be Implemented: Yes If Yes, Plans to be Reissued by: _____
 No

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: _____ Date: _____
 Post Design Services

Checked by: _____

Attachments: Yes
 No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30251.20 Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company: Name of Utility Company Representative Date:
Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

- Type of Resolution: [] Remove and Replace (skip to Part IX)
[] Repair/Rework to Contract Specification Compliance (skip to Part IX)
[] Repair/Rework to acceptable standards
[] Leave As Is (Use As Is) does not require QA reinspection

Description of Resolution:

Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by: Date:
(Segment Oversight or Segment Design Oversight)

Part IX: SECC QA Disposition

- Action: [] Reinspected verifying Contract Specification Compliance
[] Reinspected and Accepted based on T-REX Technical Closure

Comments or Verification of Reinspection:

QA Manager: Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30251.20 Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin SECC Issued to: [] Carnazzo [] Wilson [x] Thoendel [] Mackin [] Ross [] Vetter

Commented [MC01]: Double-click on grey box to insert check mark

Referenced Contract Spec: N/A
Referenced Drawing Number: D113, D209
Location of Nonconformance: Drain Line 31-613-C
NB I-25 or I-225 Stationing: 631+00 (show nearest 500')

Description of NCR: Mandrill failed 28 feet South of structure 613S1 and 20 feet North of structure 614S1 on Drain Line 31-613-C. Concrete barrier and permanent asphalt have been constructed in this area of conflict.

Superintendent: Gary Palmer
Subcontractor: None
Supplier: None

Part II: Review by Construction QA Management

This NCR request has been reviewed by:

- [] Terry Constable [] John Lee
[] Tim Nelson [] Pat McCready
[] Anthony Crockett [] Kevin Segrue
[x] Brian Bullen [] Other QA Management:
[] Glen Tonak

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO:
[x] SECC Document Control (NCR File)
[] SECC QA Manager - Constable
SECC Design and Construction
[] Post Design - Klemz, Uyematsu, Field Design Coord
[] Highways - Doug Brannan
[] Structures - 1 Don Muns, 2/3 Rich Westerheid
[] Grading - 1 Tim Driver, 2/3 Scott Cromack
[] Paving - Dave Ross
[] Survey - Jim Bodi
[] ITS/Elec - Bruce Wilson
[] LRT - Tim Mackin, Wilson, Larson
[] Stations - JD Vetter, Mackin, Larson
[] MHT - Lloyd Maier, Luke Connelley
[] Segment 1 - Carnazzo, Sato
[] Segment 2/3 - Thoendel, Deml
[] Dynalectric - Vecchione, Wright

- SECC Construction Quality Assurance
[] Structures - Tim Nelson
[] Grading/Drainage - Anthony Crockett, Brian Bullen
[] Paving - Pat McCready
[] ITS - John Lee
[] LRT - Kevin Segrue
[] Procurement - Glen Tonak

- T-REX Oversight and Other
[] Oversight - Basner, Walker, Stevenson
[] Segment 1 - Jeff Clevenger, Danielle Smith
[] Segment 2/3 - Al Eastwood, David Wieder
[] LRT - Starling, Bacus, Reitter, (Shrestha if Systems)
[] ITS - Gonzales, Lipp
[] Design Oversight -
[] Utility Company (DW-McQuade, DWW-M-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711	Date Issued: 9/12/03
Area: 3.1	Contractor: SECC
Discipline: Drainage	Subcontractor: None
Activity Number: 30251.20	Supplier: None

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

QA or PM Approved: Joe Jensen Date: 9/12/03
 Proposed Resolution: Evaluate remove/replace Drain Line 31-613-C at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be Implemented: Yes If Yes, Plans to be Reissued by: _____
 No

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: _____ Date: _____
 Post Design Services

Checked by: _____

Attachments: Yes
 No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 711 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30251.20 Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company: Name of Utility Company Representative Date:
Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

Type of Resolution: [] Remove and Replace (skip to Part IX)
[] Repair/Rework to Contract Specification Compliance (skip to Part IX)
[] Repair/Rework to acceptable standards
[] Leave As Is (Use As Is) does not require QA reinspection
Description of Resolution:
Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by: (Segment Oversight or Segment Design Oversight) Date:

Part IX: SECC QA Disposition

Action: [] Reinspected verifying Contract Specification Compliance
[] Reinspected and Accepted based on T-REX Technical Closure
Comments or Verification of Reinspection:
QA Manager: Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Staring, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 710 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin SECC Issued to: [] Carnazzo [] Wilson [x] Thoendel [] Mackin [] Ross [] Vetter
Referenced Contract Spec: N/A
Referenced Drawing Number: D105, D205
Location of Nonconformance: Drain Line 31-536-A
NB I-25 or I-225 Stationing: 536+00 (show nearest 500')
Description of NCR: Mandrel failed 40 feet South of structure 536V1 and 2 feet South of structure 539V1 and 15 feet North of existing structure 539E1 on Drain Line 31-536-A. Concrete barrier and permanent asphalt have been constructed in this area of conflict.
Superintendent: Gary Palmer
Subcontractor: N/A
Supplier: N/A

Commented [MC01]: Double-click on grey box to insert check mark

Part II: Review by Construction QA Management

This NCR request has been reviewed by:
[] Terry Constable [] John Lee
[] Tim Nelson [] Pat McCready
[] Anthony Crockett [] Kevin Segrue
[x] Brian Bullen [] Other QA Management:
[] Glen Tonak

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO:
[x] SECC Document Control (NCR File)
[] SECC QA Manager - Constable
SECC Design and Construction
[] Post Design - Klemz, Uyematsu, Field Design Coord
[] Highways - Doug Brannan
[] Structures - 1 Don Muns, 2/3 Rich Westerheid
[] Grading - 1 Tim Driver, 2/3 Scott Cromack
[] Paving - Dave Ross
[] Survey - Jim Bodi
[] ITS/Elec - Bruce Wilson
[] LRT - Tim Mackin, Wilson, Larson
[] Stations - JD Vetter, Mackin, Larson
[] MHT - Lloyd Maier, Luke Connelley
[] Segment 1 - Carnazzo, Sato
[] Segment 2/3 - Thoendel, Deml
[] Dynalectric - Vecchione, Wright

- SECC Construction Quality Assurance
[] Structures - Tim Nelson
[] Grading/Drainage - Anthony Crockett, Brian Bullen
[] Paving - Pat McCready
[] ITS - John Lee
[] LRT - Kevin Segrue
[] Procurement - Glen Tonak
T-REX Oversight and Other
[] Oversight - Basner, Walker, Stevenson
[] Segment 1 - Jeff Clevenger, Danielle Smith
[] Segment 2/3 - Al Eastwood, David Wieder
[] LRT - Starling, Bacus, Reitter, (Shrestha if Systems)
[] ITS - Gonzales, Lipp
[] Design Oversight -
[] Utility Company (DW-McQuade, DWWW-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 710	Date issued: 9/12/03
Area: 3.1	Contractor: SECC
Discipline: Drainage	Subcontractor: None
Activity Number: 30001.20	Supplier: None

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

QA or PM Approved: Joe Jensen Date: 9/12/03
 Proposed Resolution: Evaluate remove/replace Drain Line 31-536-A at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be Implemented: Yes If Yes, Plans to be Reissued by: _____
 No

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: Post Design Services Date: _____

Checked by: _____

Attachments: Yes
 No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 710 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company: Name of Utility Company Representative Date: Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

- Type of Resolution: Remove and Replace (skip to Part IX)
Repair/Rework to Contract Specification Compliance (skip to Part IX)
Repair/Rework to acceptable standards
Leave As Is (Use As Is) does not require QA reinspection

Description of Resolution:

Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by: Date: (Segment Oversight or Segment Design Oversight)

Part IX: SECC QA Disposition

- Action: Reinspected verifying Contract Specification Compliance
Reinspected and Accepted based on T-REX Technical Closure

Comments or Verification of Reinspection:

QA Manager: Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709 Date Issued: 9/12/03
Area: 3.1 Contractor: SECC
Discipline: Drainage Subcontractor: None
Activity Number: 30001.20 Supplier: None

Part I: Identify Nonconformance

Issued by: Jay Stepetin SECC Issued to: [] Carnazzo [] Wilson [x] Thoendel [] Mackin [] Ross [] Vetter

Commented [MC01]: Double-click on grey box to insert check mark

Referenced Contract Spec: N/A
Referenced Drawing Number: D102, D201
Location of Nonconformance: Drain Line 31-507-B
NB I-25 or I-225 Stationing: 506+92 & 507+67 (show nearest 500')

Description of NCR: Mandrel failed 24 feet North of structure 506V1 and 12 feet South of the same structure on Drain Line 31-507-B. MSE wall, concrete barrier, moment slab, and permanent asphalt have been constructed in this area of conflict.

Superintendent: Gary Palmer
Subcontractor: None
Supplier: None

Part II: Review by Construction QA Management

This NCR request has been reviewed by:
[] Terry Constable [] John Lee
[] Tim Nelson [] Pat McCready
[] Anthony Crockett [] Kevin Segrue
[x] Brian Bullen [] Other QA Management:
[] Glen Tonak

Part III: Distribution The NCR/NCE form will be distributed to the appropriate parties via e-mail after each step where action is required or a change in status has taken place. The person making the distribution at these occurrences must update the status column of the NCR Log.

- TO:
[x] SECC Document Control (NCR File)
[] SECC QA Manager - Constable
SECC Design and Construction
[] Post Design - Klemz, Uyematsu, Field Design Coord
[] Highways - Doug Brannan
[] Structures - 1 Don Muns, 2/3 Rich Westerheid
[] Grading - 1 Tim Driver, 2/3 Scott Cromack
[] Paving - Dave Ross
[] Survey - Jim Bodi
[] ITS/Elec - Bruce Wilson
[] LRT - Tim Mackin, Wilson, Larson
[] Stations - JD Vetter, Mackin, Larson
[] MHT - Lloyd Maier, Luke Connelley
[] Segment 1 - Carnazzo, Sato
[] Segment 2/3 - Thoendel, Deml
[] Dynalectric - Vecchione, Wright

- SECC Construction Quality Assurance
[] Structures - Tim Nelson
[] Grading/Drainage - Anthony Crockett, Brian Bullen
[] Paving - Pat McCready
[] ITS - John Lee
[] LRT - Kevin Segrue
[] Procurement - Glen Tonak

- T-REX Oversight and Other
[] Oversight - Basner, Walker, Stevenson
[] Segment 1 - Jeff Clevenger, Danielle Smith
[] Segment 2/3 - Al Eastwood, David Wieder
[] LRT - Starling, Bacus, Reitter, (Shrestha if Systems)
[] ITS - Gonzales, Lipp
[] Design Oversight -
[] Utility Company (DW-McQuade, DWWW-Gaines)



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709	Date Issued: 9/12/03
Area: 3.1	Contractor: SECC
Discipline: Drainage	Subcontractor: None
Activity Number: 30001.20	Supplier: None

Part IV: Identify Need for Nonconformance Evaluation

Note: NCE is not needed if the work is to be removed and replaced, or reworked to Contract Specification Compliance.

NCE Needed? May be requested but requires Project Manager approval
 Yes, by QA Discipline Manager approval
 No (skip to Part VII)

QA or PM Approved: Joe Jensen Date: 9/12/03
 Proposed Resolution: Evaluate remove/replace Drain Line 31-507-B at location of damaged pipe or NCE alternative.

Date Sent to Post Design: _____
 Response Requested by: _____

Part V: Post Design Response

Response:

Revised Plans needed before this change can be implemented: Yes If Yes, Plans to be Reissued by: _____
 No

Plans or Specs to be changed:

Design Work Charged to WBS: _____ Hours: _____

Responded by: _____ Date: _____
 Post Design Services

Checked by: _____

Attachments: Yes
 No



SOUTHEAST CORRIDOR CONSTRUCTORS

NONCONFORMANCE REPORT and EVALUATION (NCR/NCE)

NCR Number: 709
Area: 3.1
Discipline: Drainage
Activity Number: 30001.20

Date Issued: 9/12/03
Contractor: SECC
Subcontractor: None
Supplier: None

Part VI: Public Utility NCEs

Response from Utility Company:
Name of Utility Company Representative
Date:
Attached utility company response or indicate location of response on FileNET.

Part VII: Resolution of NCR

- Type of Resolution:
Remove and Replace (skip to Part IX)
Repair/Rework to Contract Specification Compliance (skip to Part IX)
Repair/Rework to acceptable standards
Leave As Is (Use As Is) does not require QA reinspection

Description of Resolution:

Expected Closure Date:

Part VIII: T-REX Technical Closure

Closure by:
Date:
(Segment Oversight or Segment Design Oversight)

Part IX: SECC QA Disposition

- Action:
Reinspected verifying Contract Specification Compliance
Reinspected and Accepted based on T-REX Technical Closure

Comments or Verification of Reinspection:

QA Manager:
Date:

Part X: Compliance with Contractual Requirements

Note: This disposition results in the work being in full contract compliance.

T-REX Signature: Submit Change Order: YES NO (circle one)

Print or Type Name Signature Date

To be signed by Jeff Clevenger, Al Eastwood, Del Walker, Jim Starling, Gary Gonzales, Pranaya Shrestha, or Jerry Nery as appropriate.

T-REX accepts the effected elements of the work described by this NCR. This acceptance does not change SECC's responsibilities for the Work pursuant to the Contract, nor does it create any additional liabilities for CDOT or RTD, nor does it change any rights SECC has under the Contract. SECC agrees to submit a Request for Change Order (RCO) if acceptance requires concessions pursuant to Section 10.1.2 of the Contract.

