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Pipeline Inspection and
Condition Analysis Corporation

CCTV-LASER PROFILOMETRY OF XXXXX RAW HEADER "B"
DN1200 Concrete Raw Water Intake Pipeline
XXXX Water Treatment Plant
XXXXXXXXX

Prepared for
XXXXXXXx

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PICA Project:
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Executive Summary

The City of XXXX contracted PICA to conduct a combination CCTV-Laser profiling of the RAW HEADER "B". This is a DN1200 Concrete Raw Water Intake Pipeline with some segments dating back to the 1930's. Raw Header "B" is located within the valve chamber identified as VC-1 which is located upstream of the rapid mix facility and south of the XXXXX water treatment plant.

The City initiated a follow up condition assessment on Raw Header "B" after PICA completed an internal inspection report assessment on Raw Header "A" back on November 25th of 2022.

The City wished to determine the internal conditions of the vintage AWWA C300 Concrete Lock Joint piping segment are of the same from Header "A" back on Nov 25th / 2022.

The client estimated the target length of 220 m for the DN1200 mm diameter raw water intake line. Satellite measurements using Google Earth correlates to within a couple meters for the length along the ground. Total recorded length inside the pipeline using combined CCTV-Laser profilometry inspection was 221 m.

A custom build robotic transport equipped with three camera heads was selected for this project.

1. Camera 1: Forward view, Pan, Zoom Tilt 1080p camera,
2. Camera 2: a 3K resolution camera with 180° hemispherical forward view
3. Camera 3: and a rear-view camera for laser profilometry recording using a rigid six head laser.

Valve chamber VC-1 (VC7501) at the top of the hill provided a single point access for the robotic transport.

The tethered transport (IBAK T76.1 Robotic crawler and winch) system has a working length of 300 m and is steerable from outside the pipeline using the computer controller pad and umbilical cable.

Median diameter pipe bore, and eccentricity (out-of-roundness) measurements were performed during the project. The six head laser plotted 1080 points on the pipe wall surface, a minimum of every 5 mm along the axial length, as per ASTM F3080-21. The projected laser appears in the CCTV image from camera 3 as a red circle. Profilometry reports were processed and generated using RedZone software. Any ovality changes and deflections of the circle are measurable with an accuracy of +/- 0.5%. Features such as dents, ERW welds, girth welds and ovality are easily seen, recorded and measurable in real-time or off-line.

Results:

The pipeline appears to consist of a variety of pipe types, including, Spiral weld steel, an unknown concrete pipe type, several unverified concrete pipe types (AWWA C301 or C303), 1930's vintage Lock Joint Pipe and ERW epoxy lined steel pipe. There were no signs of any significant pipe eccentricity for any of the five types of pipes observed within this pipeline. There was one location of joint gap detected.

There was some evidence of transverse cracking in the internal concrete liner at or near several joint connections (pipe adapters between the different types of pipes). No evidence of internal spalling was detected in the concrete pipes. No dents or perforations were observed in the steel pipes. For purposes of reporting this pipeline has been sub-divided into three segments. Segment 1, 2 & 3.

Segment 1

The first segment spans 12.64 m between VC-1 and the beginning of the Lock Joint pipe.

Segment 2

The next segment represents a nominal lay-length of 202.66 m for the Lock Joint pipes, starting at 12.64 m and ending at 214.80 m. There appear to be a total of 56 pipe sticks with 55 of them having lay lengths of 3.657 m (12 foot) and one 1.169 m (4 foot) and a median internal diameter of $1216^{+/-5}$ mm.

Segment 3

The third segment, nearest the pump station, represents the span starting at the vertical bend near 200 m and extending beyond 218.7 m, (the farthest point reached by the laser), to the pump station. After the bend the pipe type is Lock Joint continued transitioning to ERW steel pipe with a median internal diameter of 1198 mm.

Adapter Fitting Joint Gape – Transition Area

A dresser adapter that transitions the spiral steel pipe to an unknown type of concrete pipe, was located 2.66 m-2.70 m, upstream of the valve chamber. What is unusual is that at this transition the gap between pipe ends is approximately 50 mm. The median internal diameter of the gape was measured 1244.7 mm by the laser profilometry (inside the gap) at the location 2.6 m upstream of valve chamber VC7501.

No other pipe gaps were detected in the remainder of the pipeline for segment 2 or segment 3.

Figure 1 – Both top and right images show the area of the joint gap spacing with measurements.

The Orpheus camera head, dual diode laser measuring determined the gap spacing along the circumferential of the dresser adapter is 50mm in width.

Segment 1 - 3D rendered pipe bore (Overview 1)

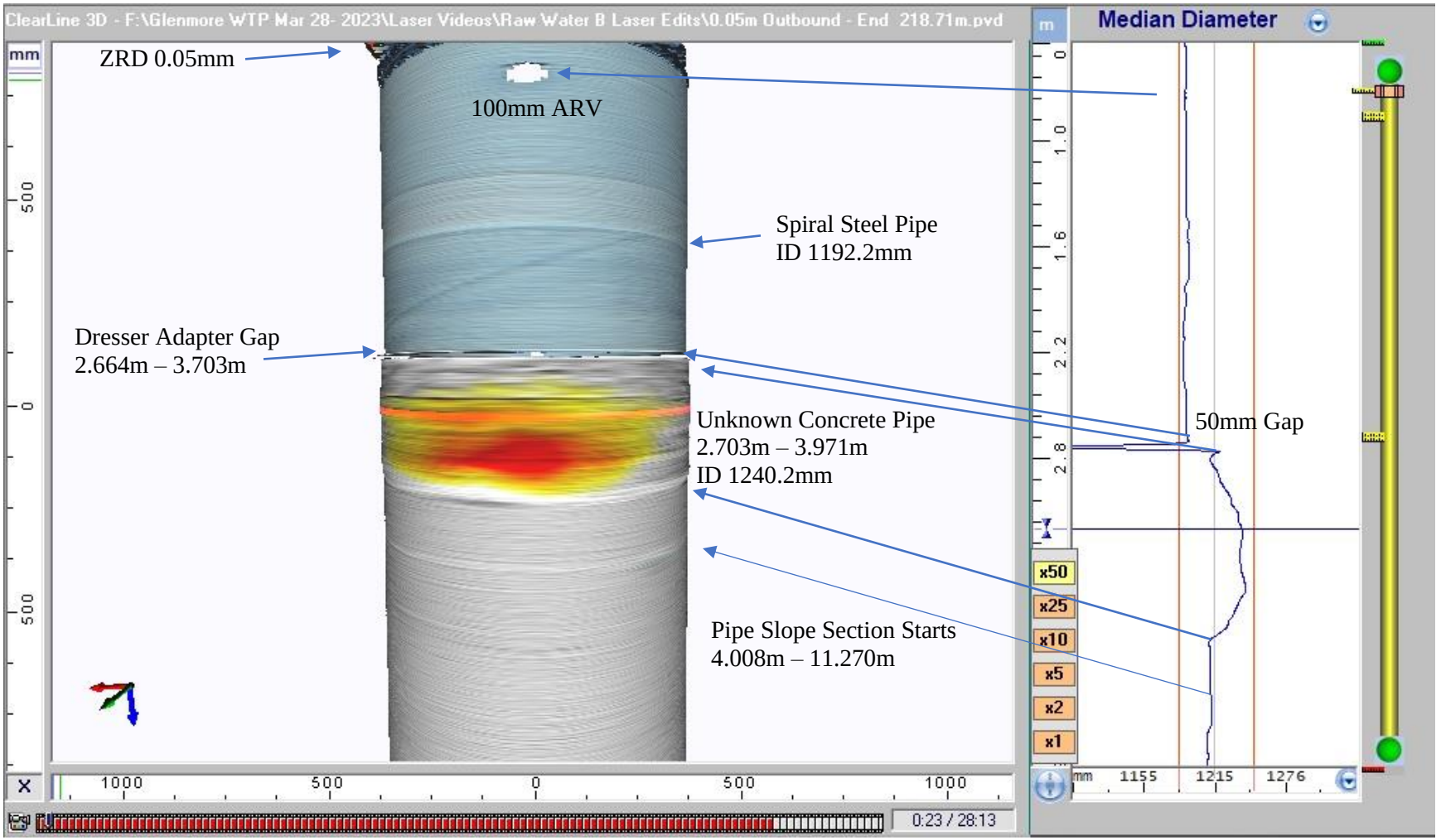

Figure 2 – Laser 3D perspective locations of pipe features

Segment 1 – 3D rendered pipe bore (Overview 2)

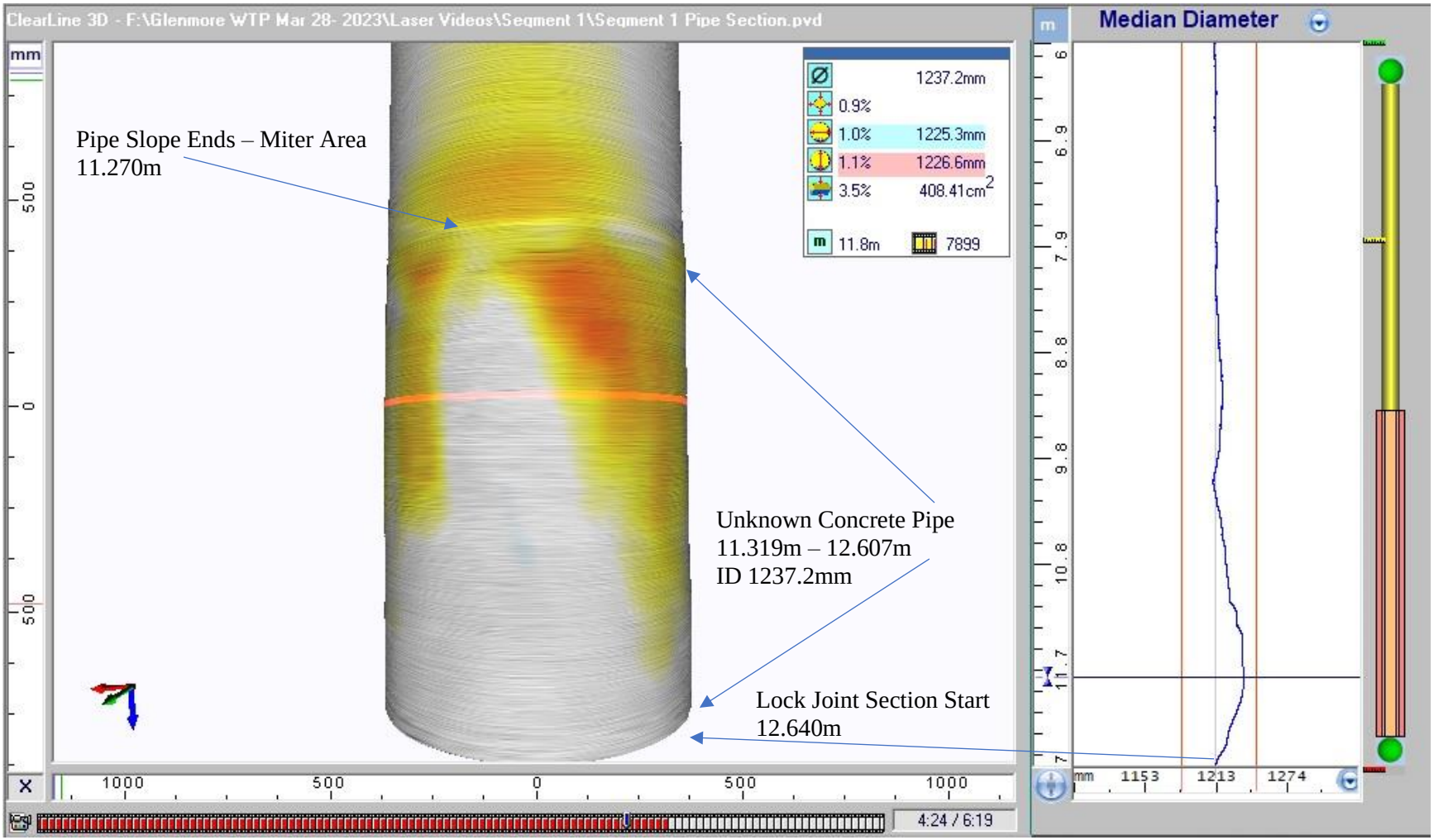

Figure 3– 3D perspective locations of pipe features

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Water Treatment Plant Requested Scope of Work

A CCTV and laser inspection was required by City of XXX from their DN1200 Raw Water main between the Pump Station and the Rapid Mix Facility on Raw Header "B". Asset: XXXXXX

The follow up CCTV visual inspection is to determine whether the internal pipe features mirror that of Raw Header "A". The City of XXXXXX Water Division (GWTP) is interested in knowing if the pipe shows any deterioration, deformations, cracks, fractures, and displacements of the lock joint piping.

A need for further CCTV investigation was initiated and PICA was contacted.

Discussion between PICA & the City concluded that a robotic transport with CCTV & Laser Profilometry would be the most cost-effective means of expediting an inspection while the pipe was drained and accessible during the March 2023 shutdown of this pipeline.

The piping is below ground and accessed inside valve chamber VC-1. The scope of work included:

- Background information and site assessment: Available drawings, reports, and other data reviewed.
- Internal Condition Detail:
    - Provide still images and CCTV recordings of condition of targeted "Pipe Joint Displacement" (Gap).
    - Identify if there are any secondary potential pipe displacements at joint locations.
    - Inspect, verify, and record internal condition of the pipe using both CCTV and laser profilometry technique attached to transport delivery system.
    - Graph imagery from the reports to include the pipe location showing distances, clock positioning and measurements.
    - If feasible, provide Pipe Tally information to help update missing asset records.

Client Information

- Client: XXXXXX
- Department: Water Utilities
- Province: XXXX
- Municipality: XXXXX
- Facility: XXXXX Water Treatment Plant
- Access Site: VC-1 Header Chamber Upstream of Rapid Mix Facility (SE of Building)
- GPS: Lat: 51.002464 Lon: -114.098654 (Source - Google Earth Pro)
- Access: Single point access inside Valve Chamber VC7501
    - (An estimated 0.9m long spool piece was removed to allow access)
- Nominal Pipe Size DN1200
- Standard Pipe lengths: To Be Confirmed (6ft, 12ft, 20ft or other pipe lengths)
- Pipe Types: Steel & Concrete conforming to C300, C301 or C303 & Lock Joint Pipe*
- Est Length: 220m

*Client believes 1930's vintage Lock Joint Pipe, AWWA C300, forms majority of this pipeline length.

Plan View of Inspection Area

The pipeline inspection is in the City of XXXXX, Southeast of the Water Treatment Plant (GWTP). The line inspected is a DN1200 concrete raw water header intake pipeline. The pipeline access for inspection was the Valve Chamber VC-1 upstream of the rapid mix facility. A short (0.89m long) coupling spool was removed upstream of the valve to provide access. The robotic transport (crawler) was inserted through Valve Chamber VC7501 and driven to the bottom of the hill near the pump station at the Reservoir, then driven back up the hill with the aid of a spool winch motor. See Figure 1 below.

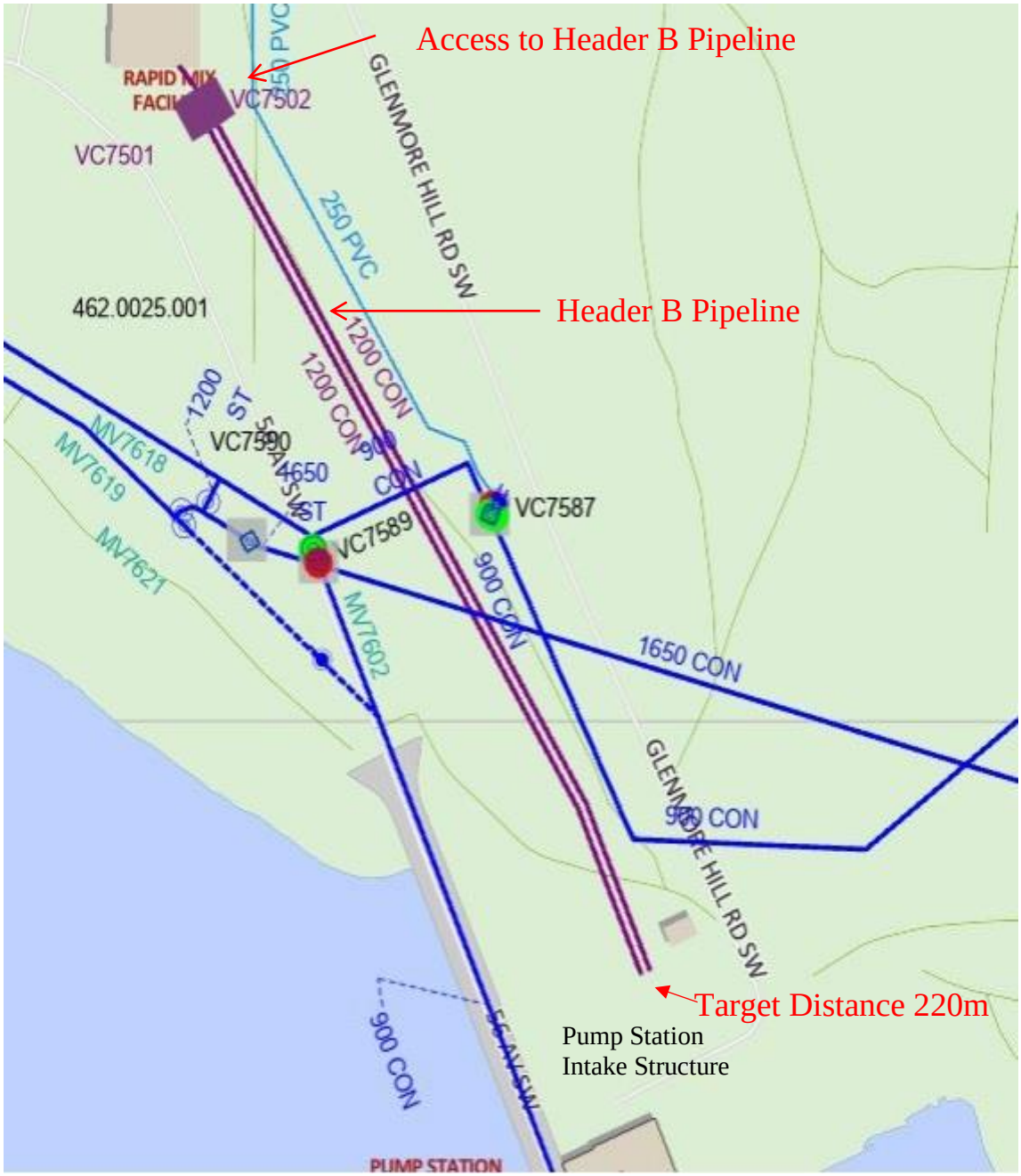

Figure 1 - Water Treatment Plant (GWTP) Header B

Plan & Profile of RoW for Header A Pipeline

The following satellite view shown in Figure 2, measured an approximate 25m elevation change from the pump station to VC7501.

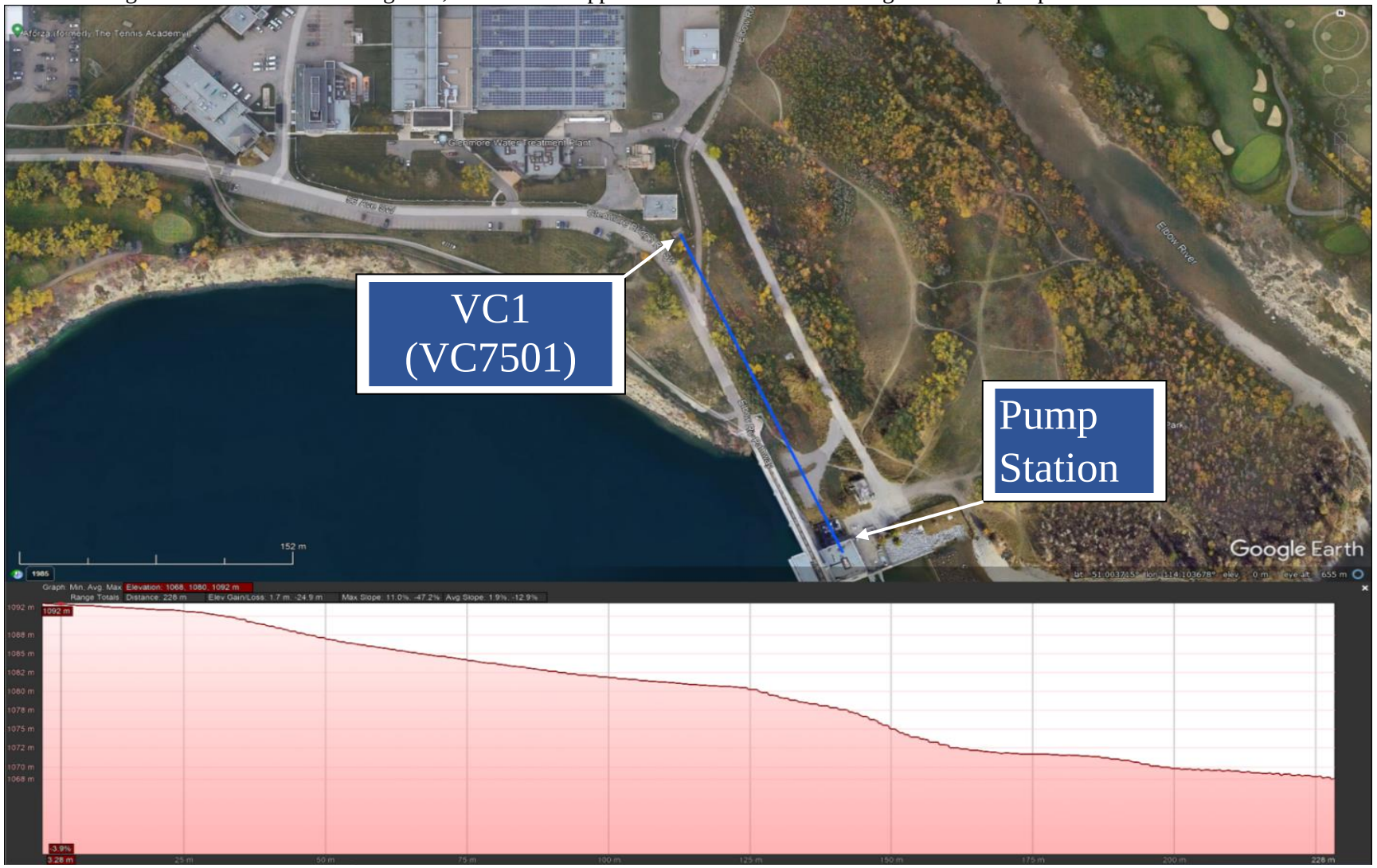

Figure 2 - Satellite View DN1200 x 220m LJP "B" Raw Water Header Pipeline (P&P)

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Raw Water Intake Piping Information:

Table 1 below summarizes the available information compiled to date from City records, site information and CCTV/Laser survey.

Table 1

Client:	XXXXX	
Client Work P.O No.	XXXXXX	
Work Area:	Water Treatment Plant	XXXXX
Main Asset ID:	XXXXXXX	
Asset Name:	XXXXX Raw Header B	
Pipeline Product:	River (RAW) Water	
Pipe Material: Type 1	Spiral Weld Steel,	
Pipe Material: Type 2	Undocumented Concrete pipe type	
Pipe Material: Type 3	AWWA C301 or C303	
Pipe Material: Type 4	Concrete Lock Joint Pipe (LJP) AWWA C300	
Pipe Material: Type 5	ERW Seam Weld Steel,	
Pipe Size:	1200 mm	
Pipe Nominal Wall Thickness:	Unknown – Incomplete Records	
OD Straight Pipe:	Unknown – Incomplete Records	
ID Straight Pipe:	Various – Spiral Weld Steel 1163mm, C303 1210mm, LJP 1207mm	
Pipe Lengths	Various – Incomplete Records, however the LJP (Segment #2), appears to be 54, 12ft Lay-Lengths and one 6ft lay-length	
Lining:	Various – Epoxy lining for steel pipes, CML for remaining pipes	
OD Bend Fittings:	Unknown – Incomplete Records	
ID Bend Fittings:	Various	
Nominal Wall Thickness Bend Fittings:	Unknown – Incomplete Records	
Length:	220 m (estimated by City)	
Surveyed Length	221 m	
Pipe Tally	**Pipe Type**	**Quantity**
Segment 1	Steel Spiral Weld	2
	Unknown Concrete Type	2
	Unverified AWWA (C301 or C303)	1
Segment 2	AWWA C300 Lock Joint 12-foot lay lengths	52
	AWWA C300 Lock Joint 4-foot lay length	1
Segment 3	Unverified AWWA (C301 or C303)	2
	Steel Seam Weld	3+
Bends:	4 Minor Deflections (3 vertical and 1 horizontal)	
Vertical Angle	Approximately 17-degrees for the 2 vertical deflections	
Horizontal Angle	Est. 5-degrees for the 1 section horizontal field bends 159 m – 161 m	
Branch Outlets	Injection tube at crown blocked further passage past 221 m	
At Crown	(2) small dia. at each end of the pipeline & 1 large near pump station	
At Invert	(1) 100 mm estimated dia. (6:00 o'clock)	
Lateral	(2) 500 mm estimated dia. Beyond 221 m (9:00 & 12:00 o'clock)	
Year Constructed:	1930's – estimated for original construction using Lock Joint Pipe	

Valve Chamber VC7501 Profile View

Figure 3 below shows the mark-up Zero Reference Datum (ZRD) for the CCTV/Laser survey access on the city supplied profile drawing of valve chamber VC7502.

Due to time and space constraints the winch spool was located inside the chamber which resulted in the 6-head laser starting at a position approximately 0.05 m inside the first steel spiral weld pipe.

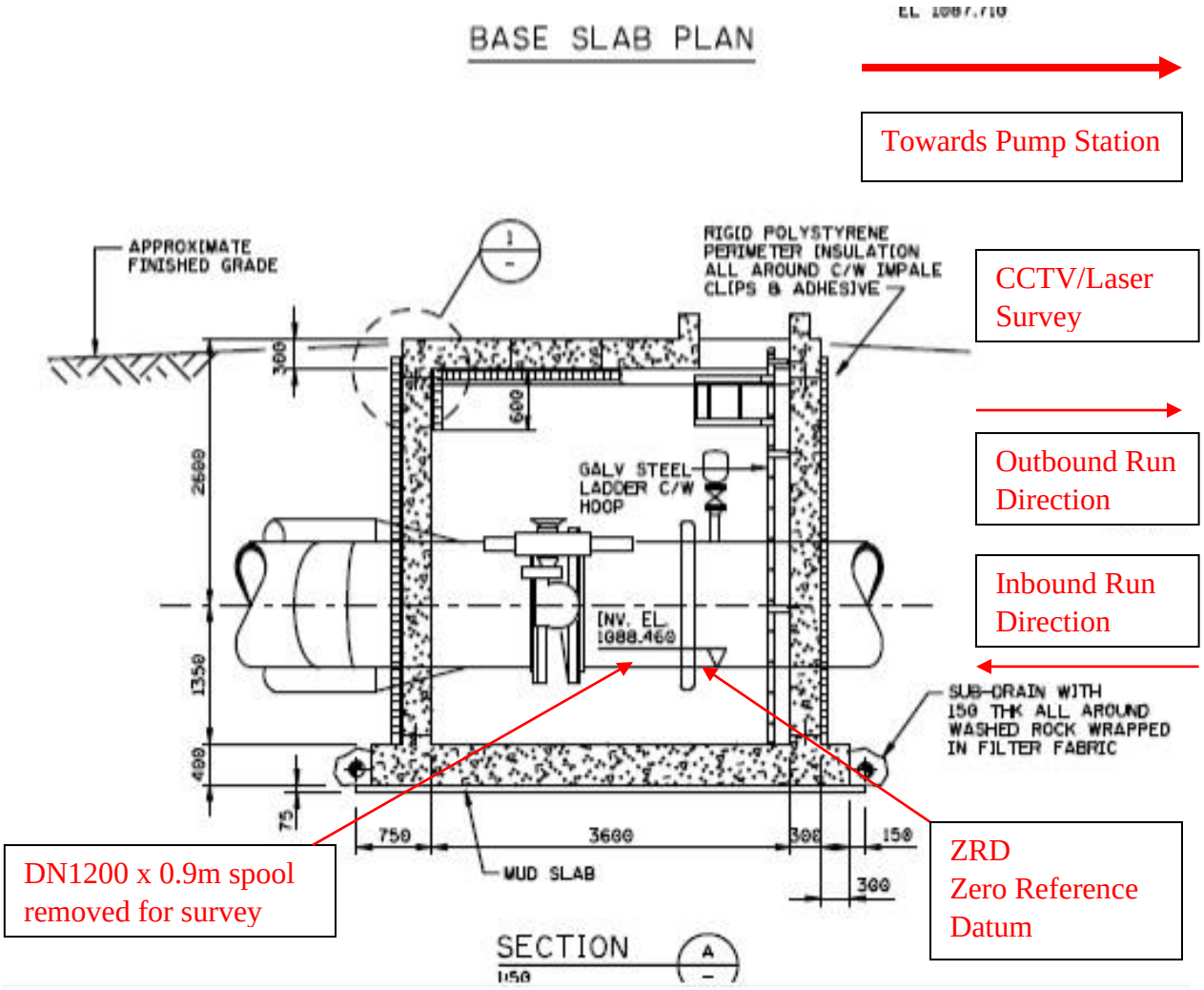


Figure 3 - Base slab plan provided by the city engineer representatives.

Pipeline Access at Valve Chamber VC 7501(VC-1)

The City WTP operations personnel removed a short spool piece inside Valve Chamber VC-1 to provide an access point for PICA to insert the robotic equipment inside Header "B". PICA used the vault access point to complete a primary[1] CCTV survey in the upstream direction (Outbound run towards the pump station) and then complete the primary Laser survey in the downstream direction back towards the valve chamber VC7501 during the return run direction (Inbound run back to valve chamber).

PICA was able to successfully navigate the transitional piping located at both the upstream & downstream ends and all the Lock joint pipes. An adapter fitting used to join different pipe types such as spiral weld steel pipe, concrete pipe (AWWA C301 or C303 pipe) and the 1930's vintage, Lock Joint Pipe (AWWA C300) and Epoxy lined Steel Seam weld pipe.

The Target inspection length was approximately 220m. PICA was able to obtain both the CCTV and Laser Profilometry data for 100% of the Lock Joint pipes and all but the first 0.05 m of the first steel pipe.

The restricted access inside the valve chamber created some challenges for positional location of the winch/spool assembly. However, to minimize requirements of winch cable rigging, the winch was subsequently located with bracing inside the valve chamber. The leader section of the umbilical cable to the transport meant that the transport needed to start the inspection with the transport robot 1.78m inside the first pipe which is the newer spiral weld steel pipe and was not part of the inspection scope of work.

A photo of the robotic transport being lowered by gantry crane and winch into valve chamber VC7501 is shown below in Figure 4. The winch is being lowered into the chamber as shown in Figure 5.

Figure 4 - VC7501 PICA lowering down robotic crawler equipment.

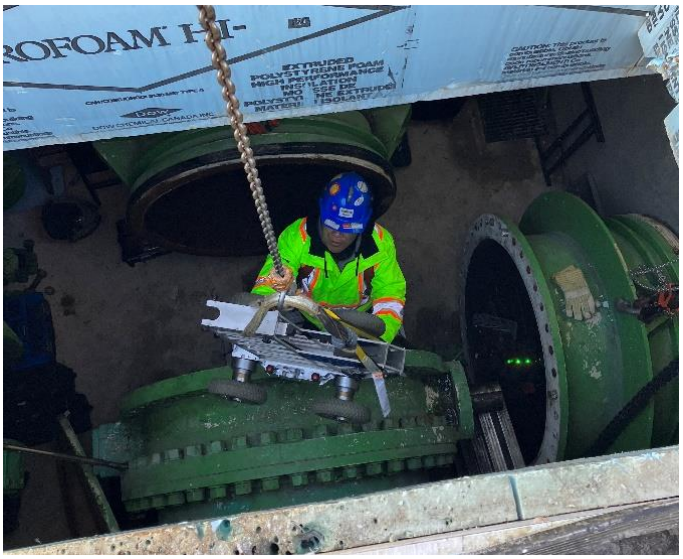


Figure 5 - PICA technician in vault receiving CCTV components and electric winch.

[1] All three cameras began recording at the started of the inspection and recorded for both outbound & inbound runs.

PICA Robotic Transport with CCTV and laser system setup

The photo below shows the assembled equipment inside the spiral weld steel pipe that starts inside the valve chamber (VC7502). The open end of this first pipe was used as a "Zero Reference Datum" (ZRD).

NOTE: Reported distances are counter to the normal water flow direction.

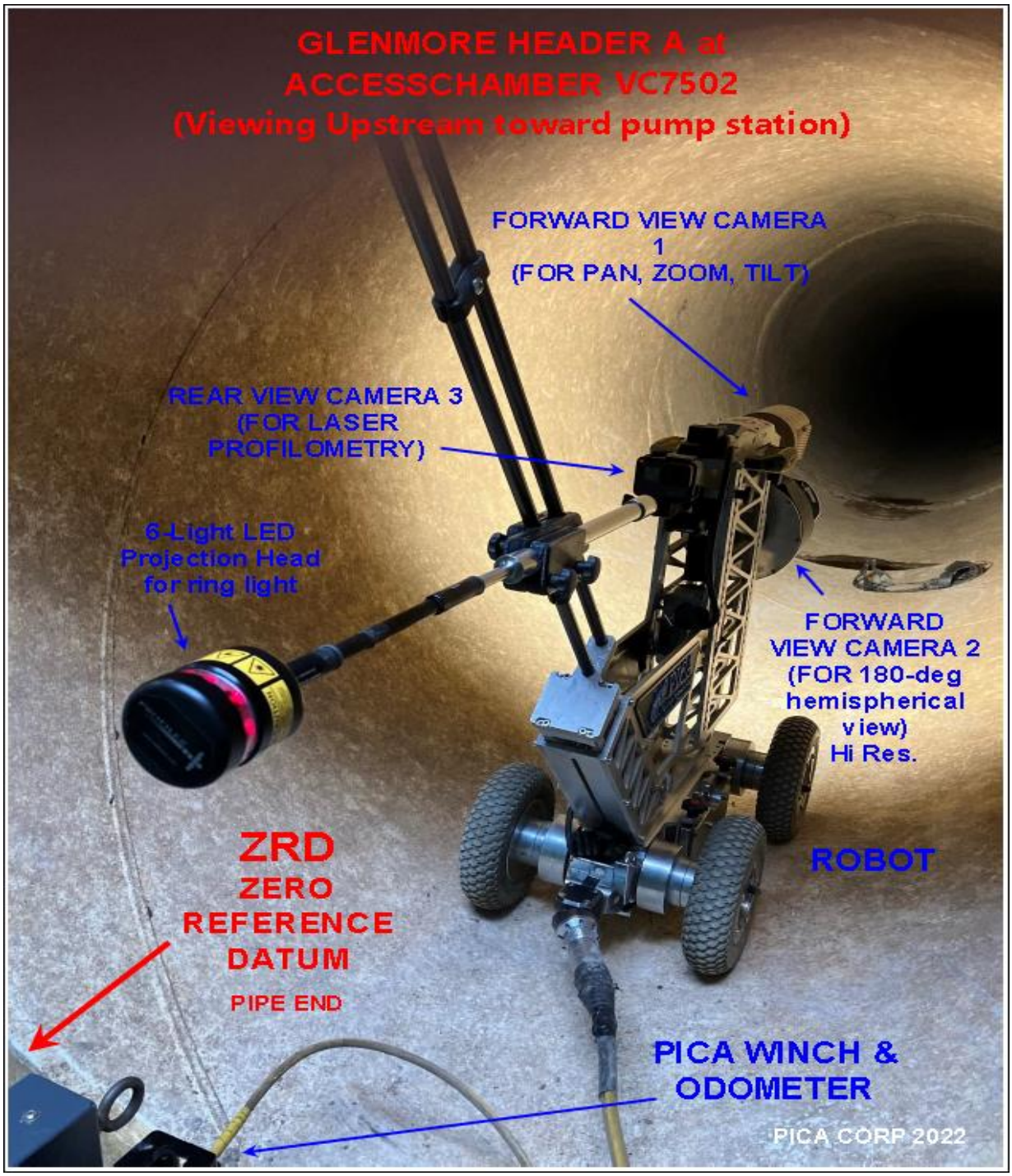


Figure 6 - PICA Robotic Crawler with CCTV and laser system setup

Results

Reporting Approach

For purposes of reporting this pipeline has been sub-divided into three pipeline segments. The two horizontal line segments at the near and far end of the pipeline is labeled as Segment 1 and Segment 3 respectively. These segments include the newer transitional pipes and adapters used to connect the Lock Joint piping to the valve chamber VC7501 at the top of the hill and the pump station at the bottom of the hill. The middle section, Segment 2, is comprised entirely of the vintage 1930's AWWA C300 Concrete Lock Joint Pipe and spans the approximate 17° slope section of this pipeline. Clock positions are referenced from VC7501 and looking upstream towards the pump station.

General Results

The pipeline appears to consist of a variety of pipe types, including, Spiral weld steel, an unknown concrete pipe type, several unverified concrete pipe types (AWWA C301 or C303), 1930's vintage C300 Lock Joint Pipe and ERW epoxy lined steel ERW pipe. There were no signs of any significant pipe eccentricity for any of the five types of pipes observed within this pipeline. There was one location of joint gap detected.

Signs of Stress

There was evidence of minor to moderate transverse cracking in the internal concrete liner near several joint connections (pipe adapters between the different types of pipes). There was also minor internal spalling of the grout at some joint locations. No dents or perforations were observed in the steel pipes.

Segment 1

This horizontal line segment spans 12.64 m between VC7501 and the first Lock Joint pipe.

Starting at the valve chamber, the first pipe appears to be Spiral Weld Steel Pipe, 2.66 m long with a measured median internal diameter of $1190^{+/-5}$ mm.

The second pipe (unknown concrete pipe type) extends from 2.7 m to 3.97 m and has a larger median internal diameter of $1240^{+/-20}$ mm. The cement mortar liner in this pipe appears to have been manually applied based on its non-uniformity.

The third pipe is sloped, which the client indicated may be either an AWWA C301 or C303 pipe, extends from 4.0 m to 11.27 m and has a measured nominal internal diameter of $1210^{+/-5}$ mm and length of 7.2 m (23 ft).

The fourth pipe (unknown concrete pipe type) extends from 11.31 m to 12.60 m and has a larger median internal diameter of $1233^{+/-20}$ mm. The cement mortar liner in this pipe appears to have been manually applied based on its non-uniformity.

Segment 2

The Lock Joint pipe has a measured nominal internal diameter of $1217^{+/-5}$ mm. It starts at approximately 12.640m and extends past the bottom vertical bend near 200 m and ends within the Segment 3 section near the pump station at 214.94m. Segment 2 represents a nominal lay-length of approximately 202.2 m for the 1930's vintage Concrete Lock Joint pipes. The Laser colormaps appear to detect a total of 57 pipe sticks with 56 of them having lay lengths of 3.657 m (12 foot) and one 1.169 m (4 foot) and a median internal diameter of $1217^{+/-5}$ mm. The standard length for 1930's vintage Concrete Lock Joint pipes is 12 feet long. Archived reference information is shown in **Error! Reference source not found.**.

Segment 3

The third segment is the horizontal piping and represents the span starting at the vertical bend near 200 m and extending beyond 221 m, (the farthest point reached by the laser), to the pump station. After the bend the pipe type appears to be Lock Joint with a median internal diameter of $1215^{+/-5}$ mm transitioning through a reducer to ERW steel pipe with an internal epoxy coating and a median internal diameter of $1195^{+/-5}$ mm.

Detailed Results: Pipe Joint Gap Images:

Only one location of the joint gap was detected and located within Segment 1.

Segment 1

Joint Gap Summary

A small gap was observed at the transitioning area from spiral steel pipe to concrete. There was no evidence of any abnormalities localized at or near the small gap spacing. These can be seen in the images 10 through 13. It is unknown what style, make or manufacturer was selected for this connection location. It does appear to be some form of external coupling sleeve. It is unknown whether it is a restrained or unrestrained style of coupling. It is unknown whether over the years since it was first installed whether the gap length has changed.

Comparing the drawings provided by the City for Raw Header "A" to Raw Header "B" transition gap area are not uniformed in length spacing. The construction drawings provided by the City indicate a 150mm spacing at the transition coupling from spiral welded steel pipe to concrete.

Prior to beginning the CCTV & laser survey, a measuring tape verified the gap start was located 2.62 m upstream of the pipe end opening, in valve chamber VC7501.

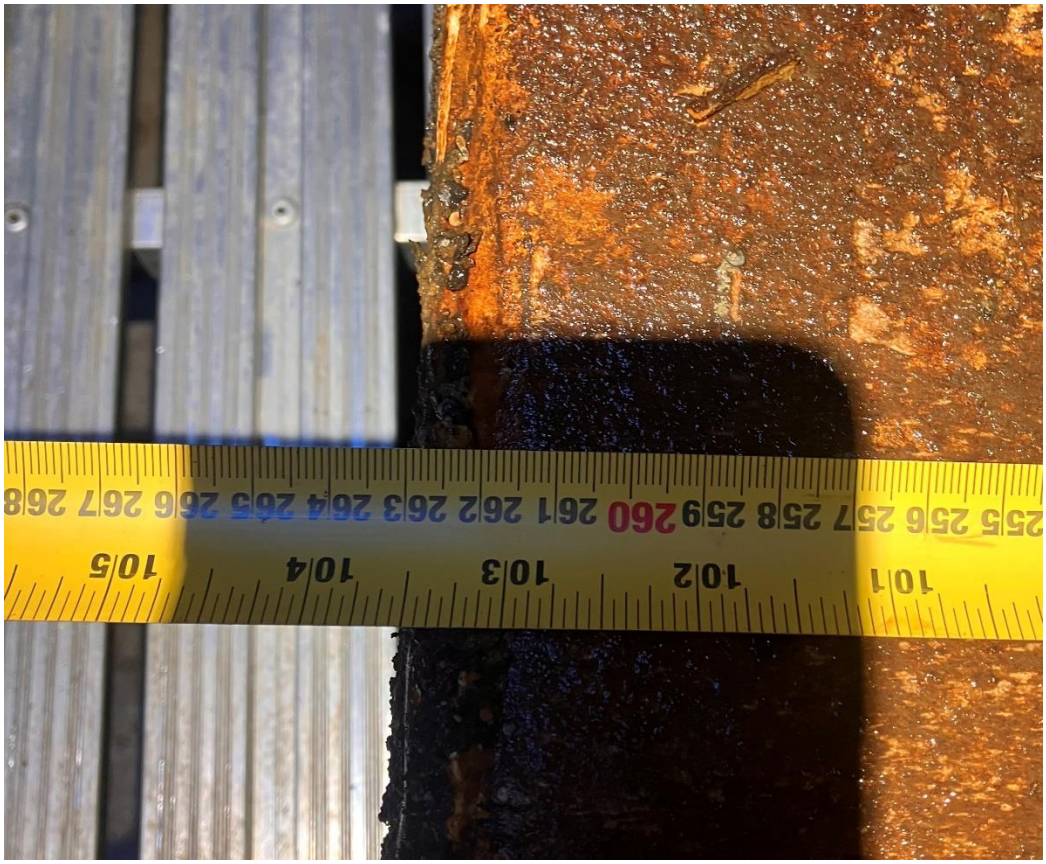


Figure 10 – Confirmation of the joint gap spacing begins at 103.5-inches (2.62m)

Figure 11 – Confirmation of the joint gap spacing within the video begins at 2.62m

Width measurements of this joint gap, at various locations around the circumference, ranged between 40 mm to 60 mm. The 6:00 position appeared to have the largest gap measurement where signs of minor erosion of the cement mortar liner of the adjacent concrete pipe (unconfirmed concrete pipe type) were observed. The median diameter bore within the first gap was measured at 1244 mm.

The median diameter bore of the first spiral weld steel pipe is $1190^{+/-5}$ mm.

Figure 12 – Laser Diode Measurement of Gap at the 1:00 position - 40 mm

Figure 13 – Laser Diode Measurement of Gap at the 9:00 position -50 mm

Transition to Lock Joint Pipe

The second unknown concrete pipe has a bore measurement ranging between 1230 mm - 1235 mm at this location. There does not appear to be any signs of significant stress at the transition

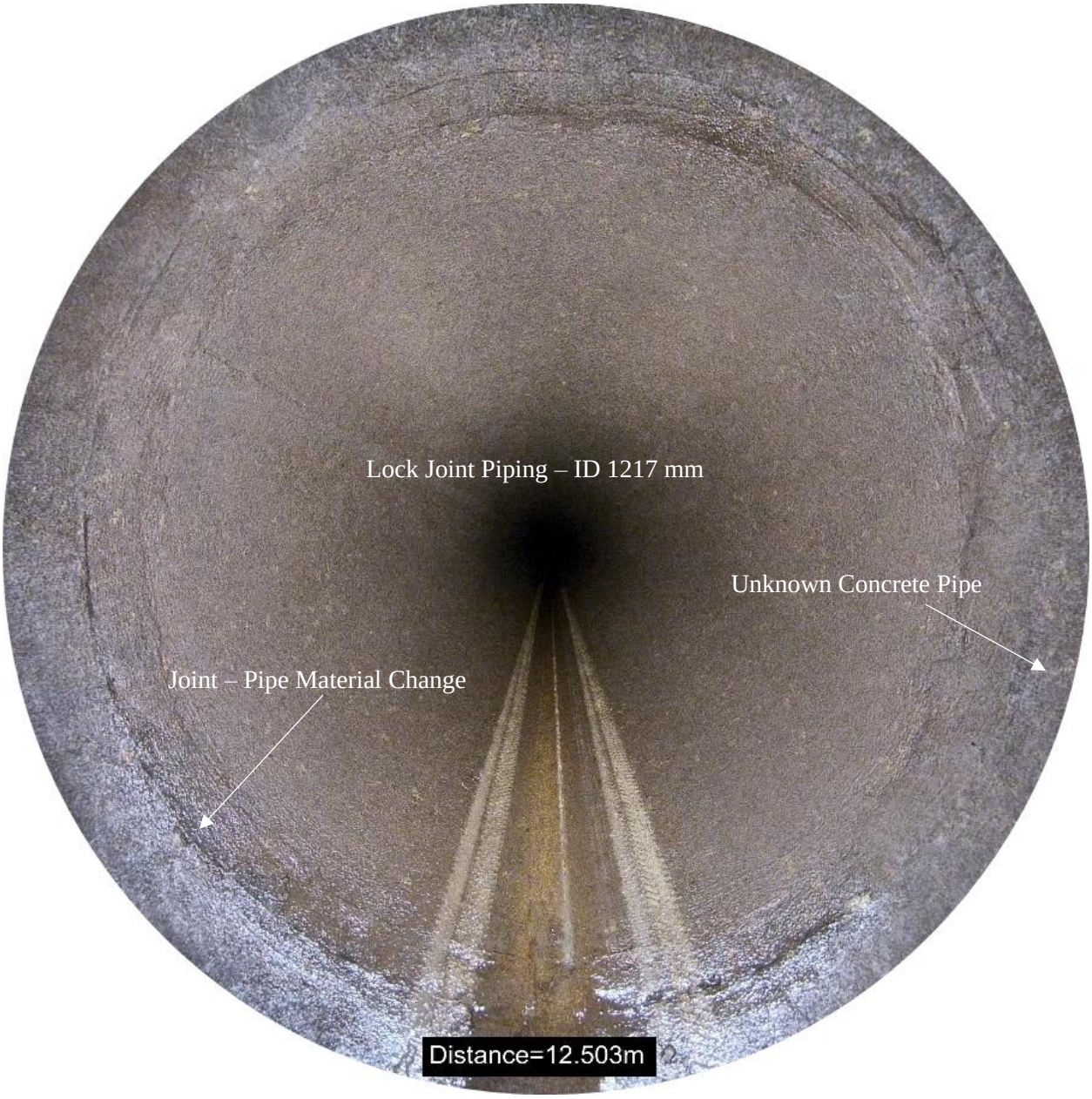


Figure 15 – Transition area from Unknown Concrete Pipe to Lock Joint Pipe

Summary Segment 1 CCTV/Laser Profilometry Color Map with Joint Gap.

The combined CCTV/Laser Ring image is processed to create the color map profilometry displayed in the right side

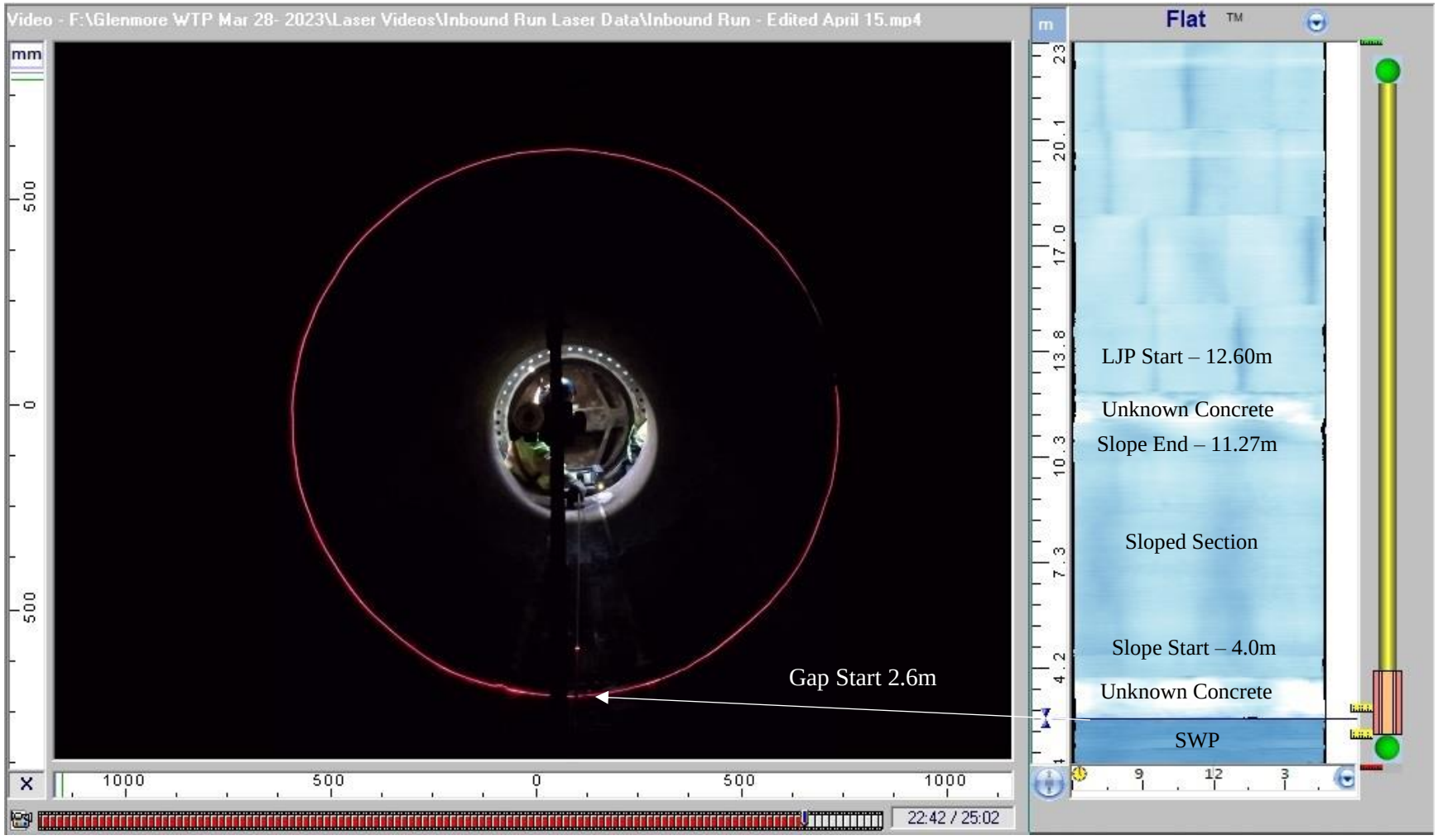


Figure 16 – Laser Diode Measurement of Gap at the 9:00 position -50 mm

Segment 2 – Random Frame captures from 3k CCTV 180-degree

The following images on Segment 2 section of the Lock Joint Piping will show various minor cracking of the grouting at joint locations with distances. The PACP survey report was provided to the City from PICA that also outlines the internal pipe wall and joint conditions on RAW Header "B" with codes and images.

Figure 17 – Sample observation of minor grout cracking at joint

Figure 18 – General observation of the grout cracking at the pipe joint with minor spalling

Figure 25 – Suspect area of discoloration run-off on the pipe wall at 9:00 located at 218.7m towards the pump station. The wet saturation staining on the pipe wall is greater in appearance that may indicate potential pinholes.

Closeup Observation of Indications on Seam Weld Pipe

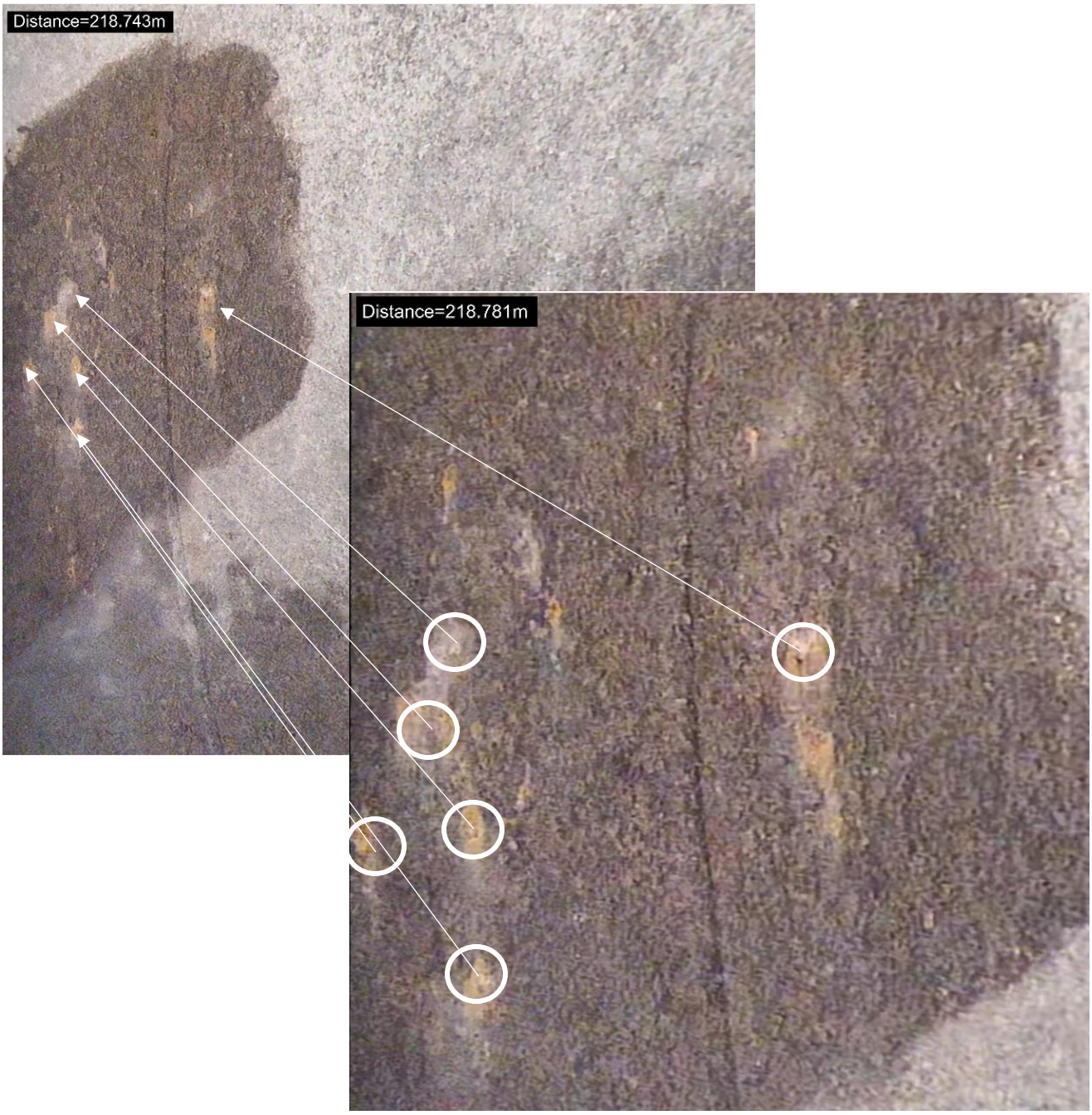


Figure 26 – (6) potential pinholes are observed with discoloration circular stains that weep downwards as a run-off pattern. This could be an indication area of ground water penetrating through the seam weld steel pipe.

Segment 3 – Pump Station Leg - Pipe Features

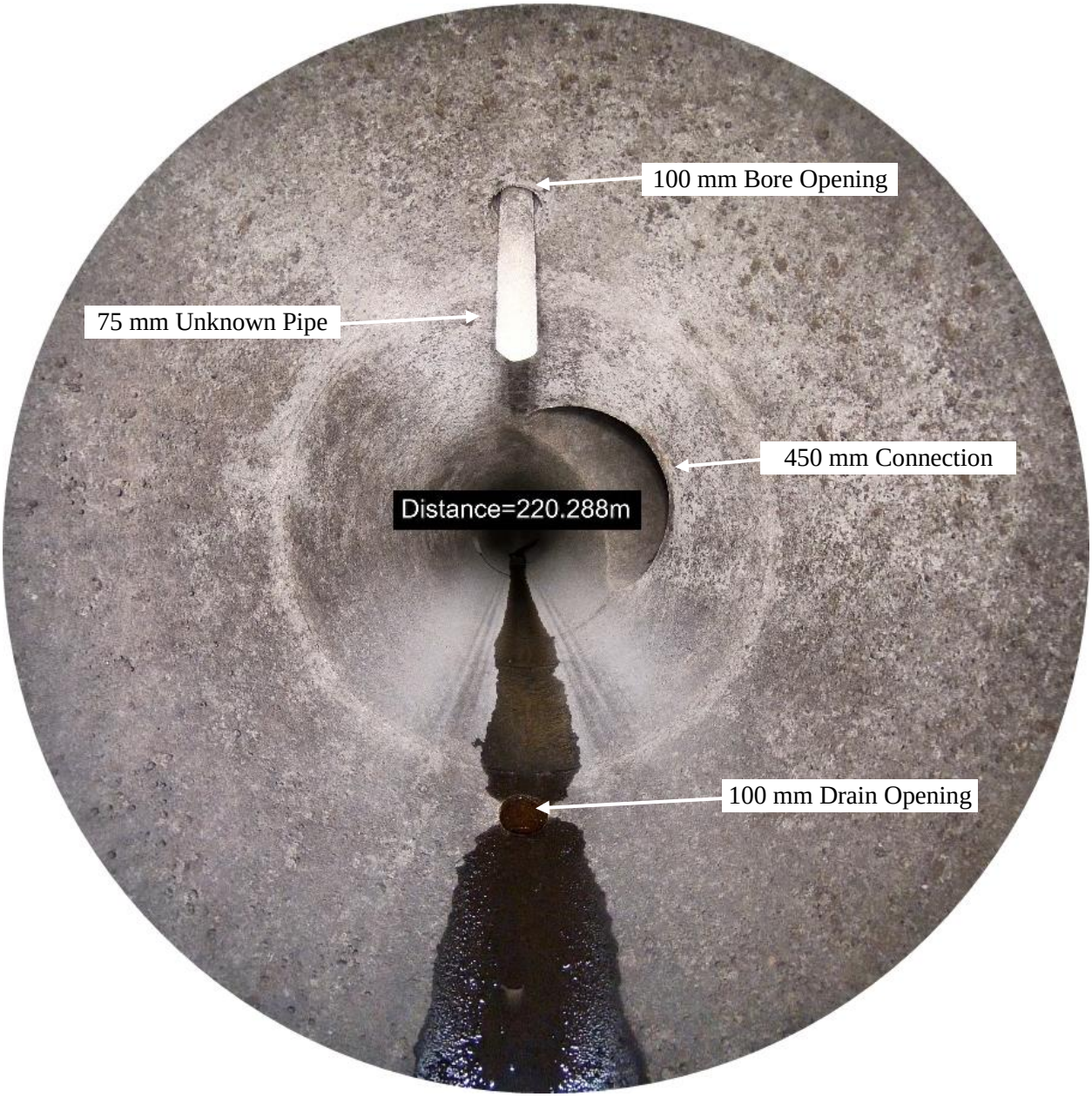


Figure 27 – The following pipe feature sizes are beyond the extent of the CCTV survey at 221.1m. The drain location along with bore opening at the crown is best calculated located at 225m. The 450 mm connection at the 3:00 position would then be located at 230m.

CCTV Summary:

Survey was conducted in the upstream (down hill) direction heading S.E towards the pump station.
Crawler odometer offset / start distance – 3.6 m from flange face of the valve spool end removed.
Forward view CCTV survey distance started at 3.6 m. and ended at 221.1 m: (Total length surveyed, 217.5 m.)

CCTV Observations:

Segment #1

General Observations in Segment #1

Adapter / Dresser Coupling Area - Gap

- (2.66 m to 2.70 m) Only one area on segment 1 with a gap. Dual diode laser measurements from camera 3 were conducted on the circumference at the dresser coupling those transitions from spiral steel pipe to concrete. The gap measurements fluctuated between 40 mm to 60 mm. Minor erosion was observed on the unknown concrete pipe at the 6:00 position.

Slope Section

- (4m to 11.2m) A short steep incline slope section of the concrete pipe was notable heading downstream adjacent and attached to a miter bend.

Unknow Concrete Sections

- Two unknown concrete sections (2.7m / 11.3m) were observed with a measured length of 1.2m each. The concrete profile measurement of the bore from the laser analysis shows the bore diameter ranging from 1234 mm to 1241 mm. The unknown concrete sections show 16 mm of erosion.

Segment #2

General Observations in Lock Joint Piping (Segment #2)

- Overall, the inside surface condition of the lock joint pipes appears to be in excellent condition.
- (118 m) Short section of Lock Joint pipe – length of pipe is 1.169m
- (159m to 163m) Observed minor field bend in horizontal plane. Light scale and sediment are more present on the pipe walls approaching the bottom of the hill heading to the pump station. The segment joints on the raw water system are difficult to visually locate due to the light scale on the pipe walls. The laser profilometry however did find the pipe joints throughout Segment #2 and detected 56 – 3.657 m (12 ft lay-length) pipes & 1- 1.169 m (4 ft lay-length) pipe.

Segment #3

General Observations in Segment #3

- Vertical bend reported near 200 m
- Adapter Coupling to possible AWWA C301 or C303 concrete pipe with bore of 1241 mm
- Transition to epoxy lined ERW Seam weld steel pipe with bore of 1196 mm
- Note: Lock Joint pipe extends into the segment 3 section and ends at 214m

Laser Profilometry Findings Summary:

Camera 3 is positioned as a rear facing camera to record the light projection ring created by the 6-head laser. Using special processing software to triangulate the respective distances between the recorded light ring in the CCTV images and the camera position it is possible to generate dimensions of the pipe bore and any ovality deviations along the pipe length.

The Laser profiler scanned a total distance from the spool piece removed at the Glenmore Raw Header "B" to the extent of the pipe near the pump station (218.7 m).

Minor bends / elbows are not measured with accuracy since the action of the transport and laser when passing through bends created oblong distortion inconsistent with the pipe true cross-sectional diameter.

- Total laser inspection data length reported: 218.7 m.
- Ovality average (out of roundness) from total the distance of the line inspected: 1.2% - 2.0%.
- Minor deflections were not observed. The out-of-roundness of the aging pipe is excellent.
- Median diameter (True Diameter) average per total distance inspected: 215 mm.

The Laser projection ring on the pipe wall at start of the profilometry inspection near spool piece removed from Glenmore Raw Header B inside the Valve Chamber VC-1 (aka VC7501) as shown in Figure .

Figure 28 - Laser projection ring on the pipe wall at 0.714 m from Zero Reference Datum (ZRD) VC7501

Laser projection ring on the pipe wall at Joint Gap location

The laser report format outputs (Flat Profile, Median Diameter, Ovality, etc.), are summarized in **Error! Reference source not found.**.

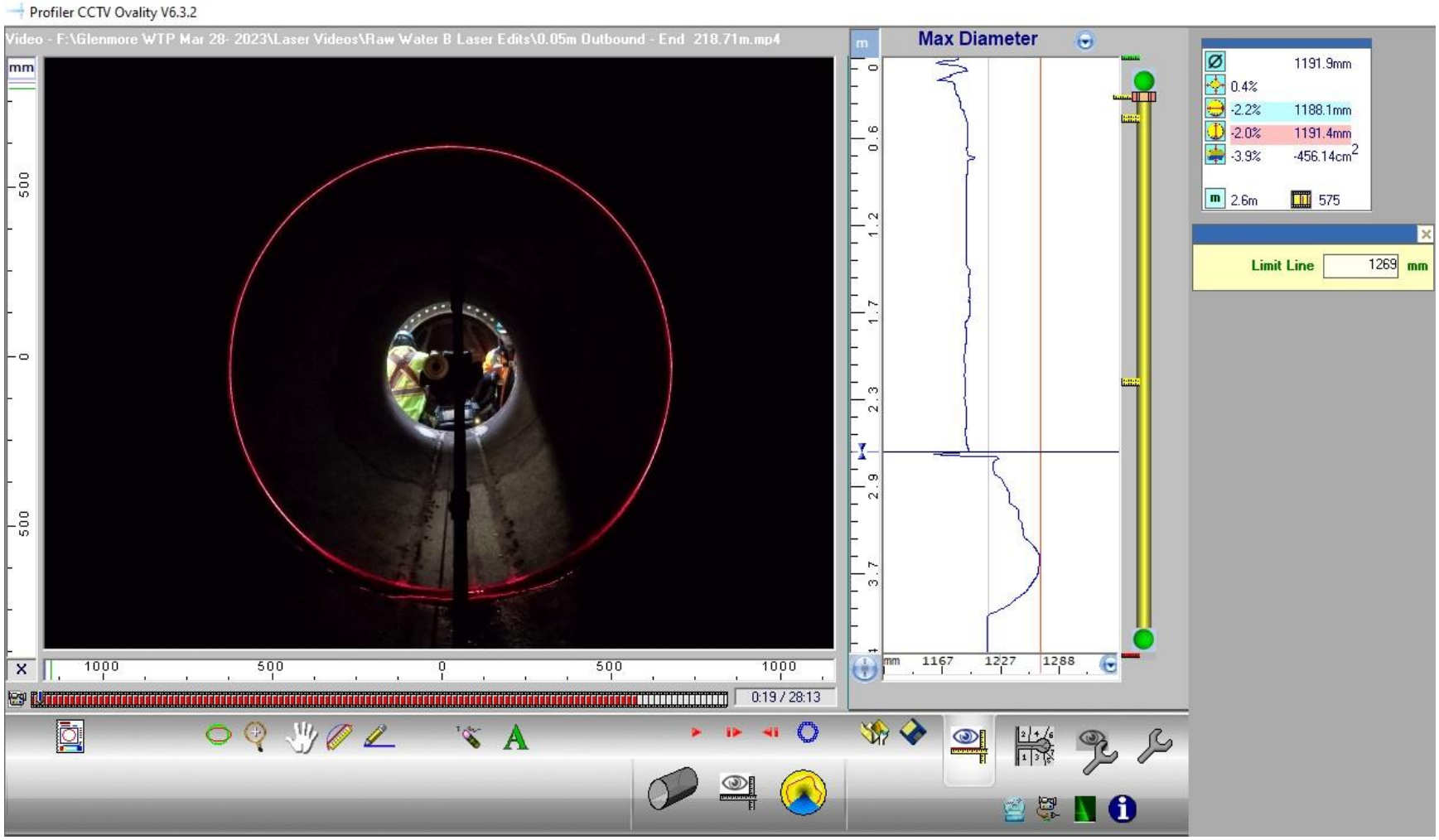
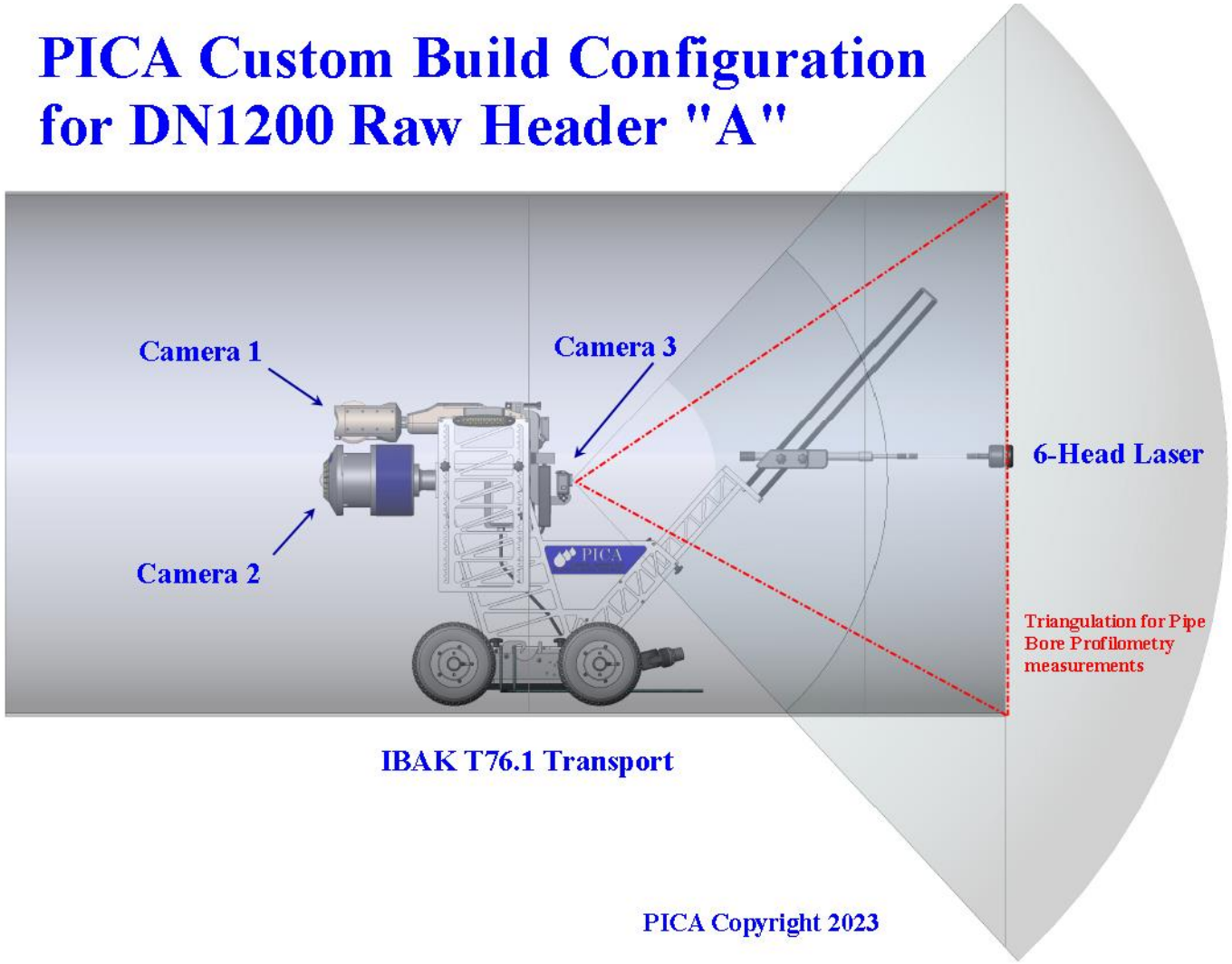


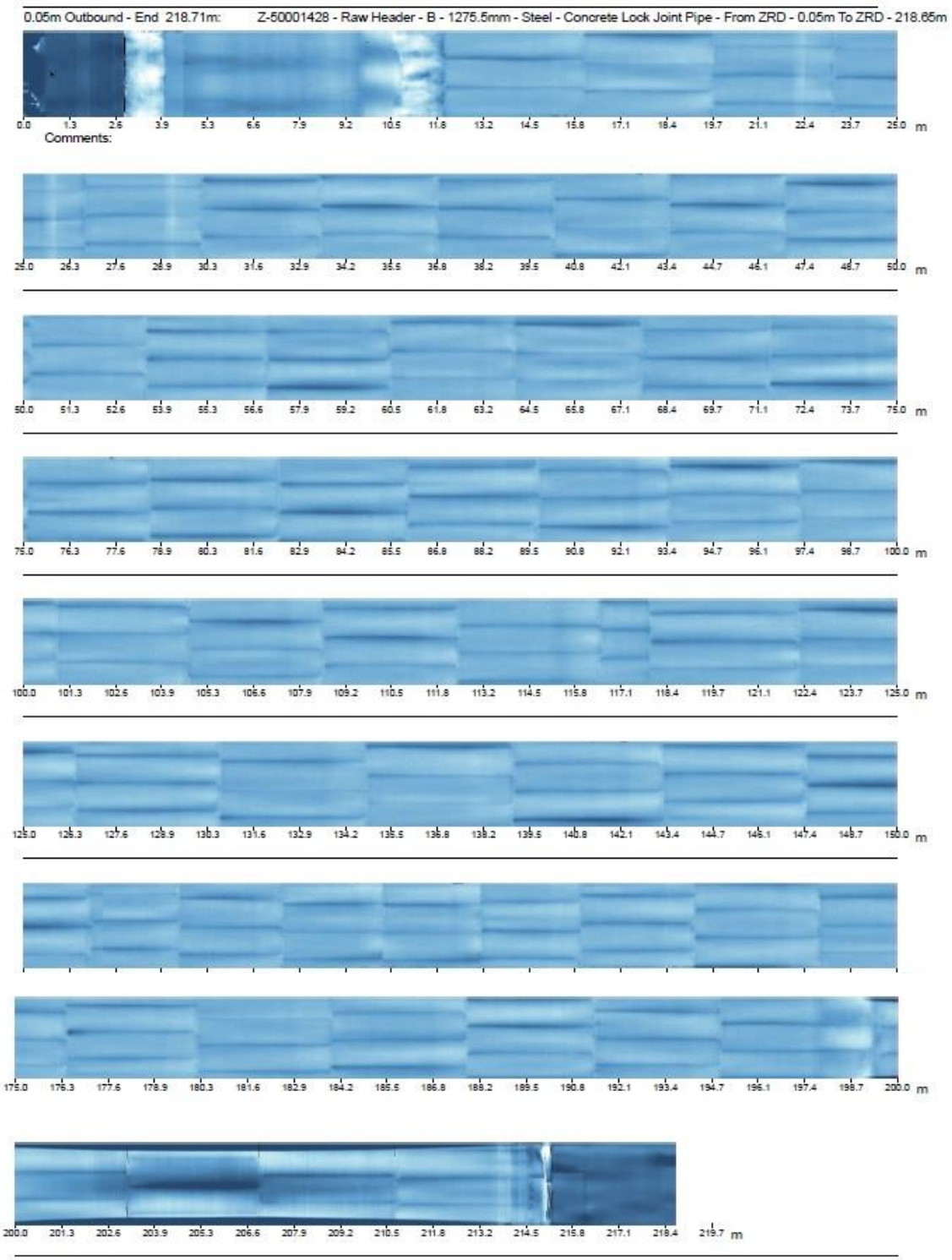
Figure 29 – Sample of Laser Software viewing area at a Gap in Segment 1

Appendix 1: Inspection Equipment List:

- PICA Custom Build (DN1200) Configuration
- IBAK T76.1 Robotic Transport
- IBAK Winch Spooler Assembly
- 300 m of Umbilical cable
- Camera 1 - IBAK Orpheus 2 PTZ Inspection Camera Head
- Camera 2 - 3k 180-degree Hemispherical (3K Imagery)
- Camera 3 - Modified GPH5 Black /
- RedZone 6 Head Laser
- Redzone Laser Software Version 6.3.2

Error! Reference source not found. below, shows custom build of the robotic crawler (Transport System), with the custom telescoping Tower mast and rear extension. These custom components allow for axial and height variations of the additional laser and CCTV equipment so that it can be correctly positioned for a variety of pipe bore diameters ranging from DN 1000 to DN1800. A diagram of the complete assembly build configuration is shown in **Error! Reference source not found.**.




0.05m Outbound - End 218.71m:
Z-50001428 - Raw Header - B - 1275.5mm - Steel - Concrete Lock Joint Pipe - From ZRD - 0.05m To ZRD - 218.65m
0.0 1.3 2.6 3.9 5.3 6.6 7.9 9.2 10.5 11.8 13.2 14.5 15.8 17.1 18.4 19.7 21.1 22.4 23.7 25.0 m
Comments:
25.0 26.3 27.6 28.9 30.3 31.6 32.9 34.2 35.5 36.8 38.2 39.5 40.8 42.1 43.4 44.7 46.1 47.4 48.7 50.0 m
50.0 51.3 52.6 53.9 55.3 56.6 57.9 59.2 60.5 61.8 63.2 64.5 65.8 67.1 68.4 69.7 71.1 72.4 73.7 75.0 m
75.0 76.3 77.6 78.9 80.3 81.6 82.9 84.2 85.5 86.8 88.2 89.5 90.8 92.1 93.4 94.7 96.1 97.4 98.7 100.0 m
100.0 101.3 102.6 103.9 105.3 106.6 107.9 109.2 110.5 111.8 113.2 114.5 115.8 117.1 118.4 119.7 121.1 122.4 123.7 125.0 m
125.0 126.3 127.6 128.9 130.3 131.6 132.9 134.2 135.5 136.8 138.2 139.5 140.8 142.1 143.4 144.7 146.1 147.4 148.7 150.0 m
175.0 176.3 177.6 178.9 180.3 181.6 182.9 184.2 185.5 186.8 188.2 189.5 190.8 192.1 193.4 194.7 196.1 197.4 198.7 200.0 m
200.0 201.3 202.6 203.9 205.3 206.6 207.9 209.2 210.5 211.8 213.2 214.5 215.8 217.1 218.4 219.7 m

Sample Flat Profile Report – Initial Gap Location

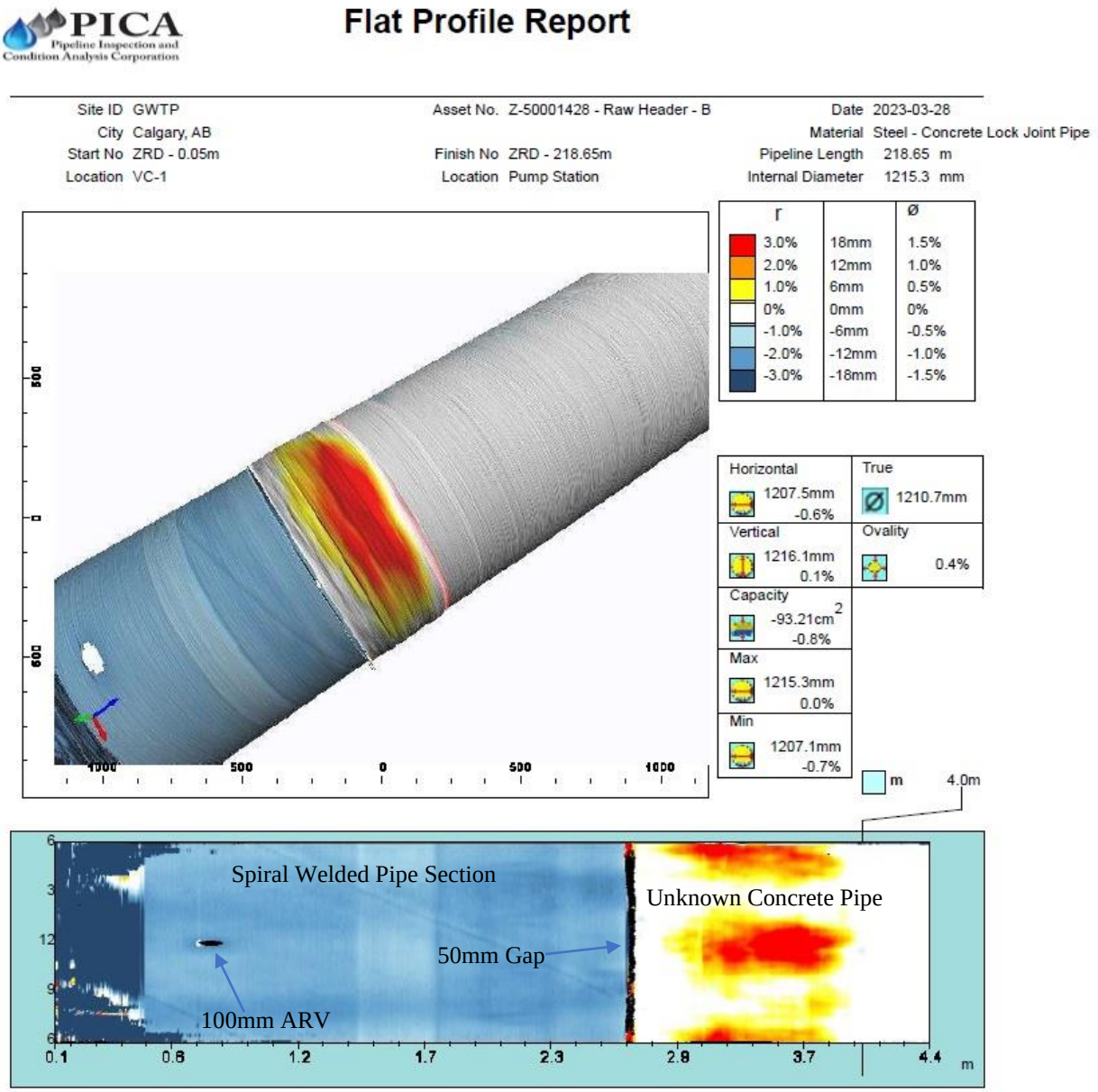


Figure 36 – Several pipe features are noted in the flat profile within the first 4m from VC-7501 opening.

Sample Ovality Profile Report at 215.2m – Reducer / Coupling Adapter Area

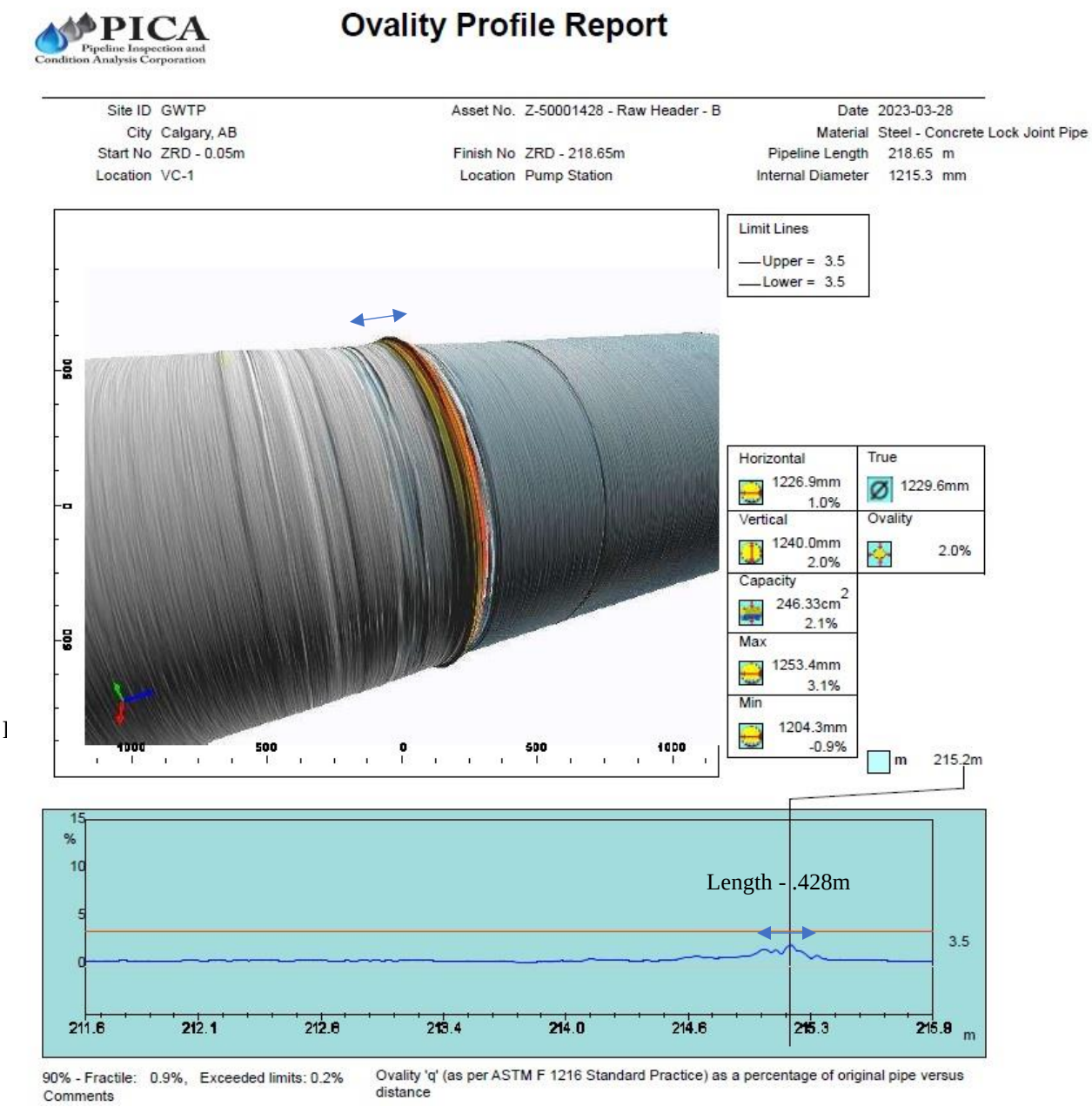


Figure 37 – The reducer / adapter length section that transition from concrete to steel is measured at .428m.