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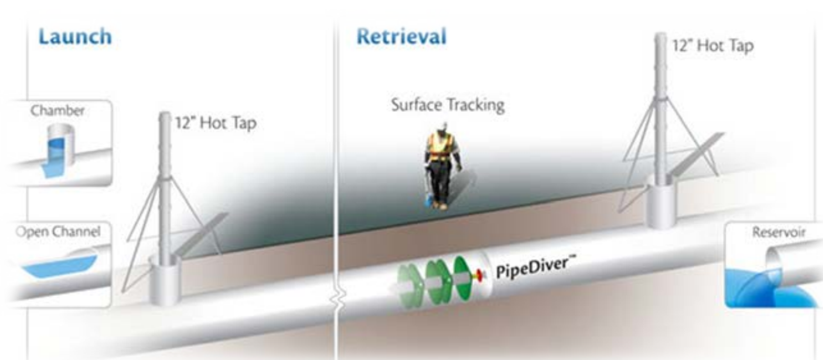
Mountain House Raw Water Pipeline – Condition Assessment Results and Recommendations

Final



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1. Introduction

The purpose of this technical memo (TM) is to summarize the results of the internal condition assessment inspection conducted on the Mountain House Raw Water Pipeline (MHRWP) in May 2020. See the Pure Technologies report, "PipeDiver Electromagnetic Inspection of the Mountain House Raw Water Pipeline", dated August 2020, for further information regarding the project background, pipeline inspection planning, pipeline inspection field work, and inspection results.

2. Project Background

From May 11 to May 14, 2020, Pure Technologies conducted an internal visual and electromagnetic inspection of the MHRWP, which is owned and operated by Byron-Bethany Irrigation District (BBID). The evaluation was performed using the PipeDiver tool, a non-destructive electromagnetic inspection technology. The purpose of the electromagnetic inspection was to identify and locate pipe segments with broken bar wraps or indications of wall loss in the cylinder. The tool also performed a visual inspection to determine the condition of the pipe lining and detect any sediment or debris. The inspection covered 518 pipe segments over 3.7 miles, which represents the complete MHRWP except short (less than 200 foot) segments on either end of the pipeline.

The MHRWP is a 30" diameter, AWWA C303 bar-wrapped steel pipeline with cement-mortar coating and lining. Pipe manufacturer drawings include both AWWA C303 pipe and AWWA C200 pipe, supplied in 40-foot lengths with a variety of joint types and cylinder thicknesses. However, BBID did not have any records of the original pipe lay plans that would indicate the location of the specific pipe segment details (i.e. material type, cylinder thickness, etc.). Therefore, there is some uncertainty as to the pipeline cylinder thickness at any specific location.

The pipeline was commissioned in 2002 to deliver raw water from the intake channel of the California Aqueduct to the Mountain House Water Treatment Plant (WTP), which in turn supplies the community of Mountain House, CA. The pipeline is operated in a cyclic manner, where the WTP fills their treated water tank during the day and turns off the pipeline at night. The pipeline was originally installed with sacrificial anodes providing cathodic corrosion protection, which was later upgraded to an impressed current system, which has operated semi-continuously.

3. Pipeline Inspection Results and Discussion

The inspection was successfully completed on schedule using two separate non-destructive condition assessment tools supplied by Pure Technologies. The inspection tools were run through the pipeline a total of three (3) separate times, with the first and third runs detecting cylinder wall thickness loss and recording video, and the second run detecting breaks in the bar wraps. Although turbidity during the inspection was low to moderate (8-9 NTU), video quality was mediocre. Modifications made to the video system after the first run resulted in better video quality for the third run. It appears the tool dislodged a significant amount of organic matter from the pipeline walls as it traveled through the pipeline, decreasing the video quality. The inspection tool frequently had difficulty passing the butterfly line valves in the pipeline, which often required valve operation along with flow modulation to pass the tool. No other obstacles were encountered that impeded the inspection tool. The inspection followed the planned hourly schedule closely. The inspection tool took roughly 4.5 hours to travel the length of the pipeline at a flow of about 6 CFS (1.3 ft/s). For the inspection tool extraction, dewatering the pipeline section from approximately Station 184+00 to Station 200+00 took about 2 hours using the blow-off (drain) at Station 197+25.

Generally, the pipeline was found to be in good condition. Based on the collected data, Pure Technologies concluded that, of the 518 inspected pipe segments:

1. Zero (0) pipe segments contained broken bar wraps.
2. Four (4) instances of localized cylinder wall loss were detected in four (4) different pipe segments, or 0.8% of all pipe segments.
   - The area of localized cylinder wall loss ranged from 11 to 18 square inches.
   - The cylinder wall loss anomalies had an estimated depth of 30 percent to 40 percent of the nominal cylinder wall thickness.
3. One (1) pipe segment exhibited a localized electromagnetic anomaly that is not indicative of cylinder wall loss. This anomaly could either be caused by an undocumented feature or a change in pipe property.

A summary of the pipeline inspection results and findings are summarized in Table 1.

Table 1: Detailed Anomaly Results

Cylinder Anomaly Station	Cylinder Anomaly Circumferential Position (degrees – looking downstream)	Circumferential location of anomaly	Cylinder anomaly area (square inches)	Estimated Depth of Cylinder Wall Loss (% of nominal thickness)	Internal Visual Findings	Notes
65+29	290	9 o'clock (midpoint side of pipe)	13	30	N/A	1
77+92	165	6 o'clock (bottom of pipe)	11	30	Spalling	-
80+71	210	6 o'clock (bottom of pipe)	18	40	Cracking	-
180+04	205	6 -7 o'clock (bottom of pipe)	-	-	Joint of interest	2
187+81	10	12 o'clock (top of pipe)	11	30	Joint of interest	1

Notes:
1. Localized cylinder anomaly is reported with less certainty due to its proximity to a cylinder weld.
2. Localized cylinder anomaly not consistent with pipe segment wall loss.

3.1 Discussion of Anomalies

Of the 5 detected anomalies, 4 are indicative of pipe wall loss. In addition to interior or exterior corrosion, these wall loss anomalies may be a result of manufacturing defects or damage during construction. Note that “variations in manufacturing processes may not impact the structural performance of the pipe segment but can significantly affect the electromagnetic properties”.[1] Based on conversations with BBID staff, it appears the single unknown anomaly at Station 180+04 may be due to a repair performed during construction, which consisted of a repair plate welded to the pipe cylinder. There is no record of this repair in the project drawings. Although the inspection does not provide a definitive explanation of this anomaly, Pure seems confident that it is not related to any wall loss, so this location should not be of concern to BBID.

The Station 65+29 anomaly occurs in a region of contaminated soil that was removed during construction. As no deterioration was found from the visual pipe inspection, this appears to suggest that the anomaly on the pipe cylinder at the 9 o’clock position may be a result of external corrosion activity. Because there are no breaks in the bar wrap, this anomaly does not invite any undue concern. However, this location should be monitored for leaks in the future.

The pipeline sections at Station 77+92 or Station 80+71 both show some deterioration of the pipe lining, along with pipe wall loss anomalies located at the bottom of the pipe. The Station 80+71 anomaly had the most significant wall loss by size reported from this inspection, and so it is recommended that this anomaly be prioritized for a subsequent validation inspection in the field.

The final anomaly at Station 187+81 is near the end of the inspection reach. This anomaly is of special concern because of its circumferential position at the top of the pipe, where air can accumulate because of an air pocket. This pipe segment is at a high elevation relative to the rest of the pipeline, increasing the likelihood of an air pocket forming when the pipeline is cycled off and depressurized. Excess air exposure over an extended period will increase the rate of oxygen-related corrosion. Thus, this location is also a high priority recommended for a subsequent field validation.

A caveat to the cylinder wall loss results is the uncertainty regarding the design cylinder thickness. The pipe manufacturer detail drawings include 4 different classes of AWWA C303 pipe and 2 classes of AWWA C200 pipe, with cylinder thicknesses ranging from 0.11 inches to 0.31 inches; however as indicated before there is no way to confirm where these different pipe classes were installed. Due to this uncertainty, Pure assumed “Reported cylinder wall loss anomalies were quantified based on a nominal cylinder wall thickness of 0.1094 inches (based on available calibration information)”.[2] Thus, the estimated depth of cylinder wall loss should be interpreted more as an indicator of wall loss, and less as an actual measurement of wall loss.

[1] “PipeDiver Electromagnetic Inspection of the Mountain House Raw Water Pipeline”. Pure, 2020.
[2] “PipeDiver Electromagnetic Inspection of the Mountain House Raw Water Pipeline”. Pure, 2020.

4. Recommendations and Conclusion

The results of this inspection reveal the success of the proactive maintenance that BBID has been performing on the MHRWP for the last 20 years. Considering the aggressive soils, cyclical operation, high operating pressures, and turbid water handled by the pipeline, less than 1% of pipe segments were found to have any anomaly. The following section will discuss recommendations for the continued monitoring and maintenance of this vital pipeline, which will allow the pipeline to continue conveying water well into the future.

4.1 Pipe Repair Recommendations

Hazen contacted a representative at Northwest Pipe (NWP), previously known as Ameron Pipe (original pipe manufacturer), for recommendations regarding repair options of the AWWA C303 pipe in the MHP based on the pipeline inspection results. They confirmed that the level of pipe wall thickness loss reported in the Pure Technologies inspection results was not a cause for concern in their opinion. Based on their experience, repairs of bar-wrapped pipe often do more harm than good when not necessitated by active leaks. NWP recommends maintaining the cathodic protection system and monitoring the suspect areas for any future leaks. In case of a leak, the best repairs are either replacing the entire pipe segment or welding in a short pipe spool with butt straps, provided the rest of the existing pipe segment is in good condition. AWWA C303 pipe most often fails at joints, so NWP recommends that any verification digs inspect the joints as well.

To ensure continuous cathodic protection of the pipeline against corrosion, Hazen recommends that the rectifier for the impressed current system have a simple SCADA alarm installed, so that BBID will be notified if the rectifier is disabled for any reason. Anecdotally, it appears that the rectifier is vulnerable to power surges and outages, and without an operation alarm, the only way to confirm the rectifier is working is to have the box checked by hand.

4.2 Spare Pipe Recommendations

Overall, the MHRWP is in good condition. However, regardless of pipeline condition, the pipeline is the only source of water for the Mountain House Community and due to the long lead times required for large diameter pipe, Hazen recommends that BBID have several spare pipe segments (ideally 100 ft of pipe) on hand in case of an emergency break. These spare pipe segments should be stored near the project in an enclosed warehouse, protected from all inclement weather and be available for emergency repairs in the event of a pipe failure. Full 40’ lengths are not needed; 10’-20’ pipe lengths are recommended for these spare pipe segments.

In addition, AWWA C303 is neither required nor recommended for these emergency spools; welded steel pipe per AWWA C200 is preferred. However, it will be important that the overall pipe wall thickness of the new steel cylinder pipe (i.e. spare pipe sections) is designed in accordance per AWWA M11 to ensure the resulting pipe wall strength meets the design parameter requirements (operating pressure, surge pressure, etc.) of the existing pipe at the repair location. Because the pipe wall thickness varies throughout the length of the pipeline, Hazen recommends designing the spare pipe steel cylinder thickness based on the highest operating system condition.

The effects of long-term storage must also be taken into consideration when choosing the pipe lining and coating system. NWP recommends polyurethane coating and lining per AWWA C222 for long term storage. However, if pipe is ordered with the intent of installation within 6 months, standard cement-mortar coating and lining per AWWA C205 is also an option but not recommended for long-term storage. Based on discussions with NWP, it is important that the spare pipes be covered and stored away inside a warehouse facility/building fully protected from direct sunlight in a cool, dry location, elevated from the ground with tight endcaps following any additional manufacturer's recommendations for long term storage. Ideally, the pipes can be stored in the original packaging from transportation. In addition to pipe spools, it is recommended spare butt-straps also be purchased and available on site to make necessary repairs.

Finally, all emergency repairs of the steel pipeline will need to be completed in accordance with the American National Standards Institute for structural welding of steel pipe (AWS D1.1/D1.1M – Structural Welding Code - Steel). Per this industry standard, all pipe welding for installation of replacement pipe sections requires certified welding inspectors, welders, and documentation (welding procedure specifications and welding procedure qualifications, etc.). Hazen recommends identifying and creating a contact list of qualified welding inspectors and welders in the area in the event of an emergency.

4.3 Validation of Inspection Results

Based on the discussion of the five (5) anomalies, Hazen recommends that the following two anomalies be prioritized for validation excavations and pipe wall measurements using non-destructive tools such as an ultrasonic gage:

1. Station 187+81: The position of the anomaly at the top of the pipe suggest that this anomaly may be due to an oxygen-related corrosion event.
2. Station 80+71: This location is recommended because the results show this anomaly as the deepest and largest in size.
3. If results from the above anomalies warrant further validation excavations, they are recommended with the following priority:
    a. Station 65+29
    b. Station 77+92
    c. Station 180+04

4.3.1 Ultrasonic Thickness Measurements

Hazen recommends BBID retain services of local subconsultant (i.e. V&A) to perform the external inspection for the two areas identified above for validation excavations. The subconsultant should be scoped to complete a thorough examination which includes physical mapping and ultrasonic thickness measurements of an appropriate representative area (2 feet by 2 feet) to confirm the location of the anomaly and quantify the remaining pipe wall thickness at that particular segment.

Validation excavations should be performed with the utmost care. Best safety practice includes depressurizing the pipeline during excavation, but this is at the discretion of BBID. Once the pipeline is exposed at the location of the anomaly, ultrasonic thickness testing can be performed by the subconsultant. If the anomaly is near a pipe joint, it is recommended that the joint be inspected as well. Refer to original design drawings for backfilling and restoration.

4.3.2 Coordination with Pure Technologies

If validation excavations and measurements are performed on any pipe segments from the MHRWP, the results can be applied to the data from this inspection to calibrate and refine the estimations of cylinder wall loss. It is recommended that Pure be contacted before the validation excavation, to ensure that the proper data is gathered.