The Haysboro Water Feedermain - Product Test

S-301 Epoxy Spray System
Warren Environmental Inc. and A & W Maintenance Inc.

Prepared by

THE CITY OF
CALGARY
WATER RESOURCES

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February 11, 2009

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Introduction

The Haysboro Feedermain project involves the rehabilitation or replacement of 180 m (600 ft) of 900 mm (36”) steel pipe. The feedermain is located in the drainage tunnel of the Glenmore dam. Construction inside the dam is difficult due to a number of factors, including the area’s confined space classification. If a cost effective alternative to replacement can be found it would mitigate a number of risk factors and provide a solution to keep the Haysboro Feedermain in service. As part of this evaluation process, Water Resources decided to put an innovative Structural Epoxy system through in-house product testing.

Product

S-301 Epoxy Spray System - Product Code 301-01
NSF-61 Certified
0% VOC

Companies - Manufacturing and Application

The product is manufactured and distributed by Warren Environmental Inc. Application is handled by their subsidiary, A & W Maintenance Inc.

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Test Set up

The test specimens were two 2 m (79”) lengths of steel pipe 200 mm (8”) in diameter with a wall thickness of 9.5 mm (3/8”). One pipe was bare metal with a cap welded on one end and a flange on the other end. The second pipe was coated with two flange ends. The interior of both pipes was lightly sand blasted and the exterior received no sand blasting.

The bare metal pipe was drilled with two clusters of holes spaced approximately 12” (320 mm) apart. One cluster was comprised of four 25 mm (1”) holes with edge distances of 10 mm (Figure 1) and the other was a group of eight random holes of 12 mm (1/2”) to 25 mm (1”) diameter (Figure 2).

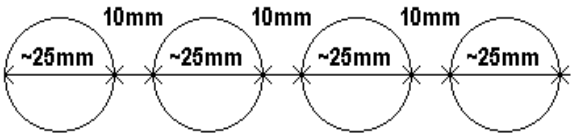

Figure 1 Layout of the first group of holes on the bare metal pipe.

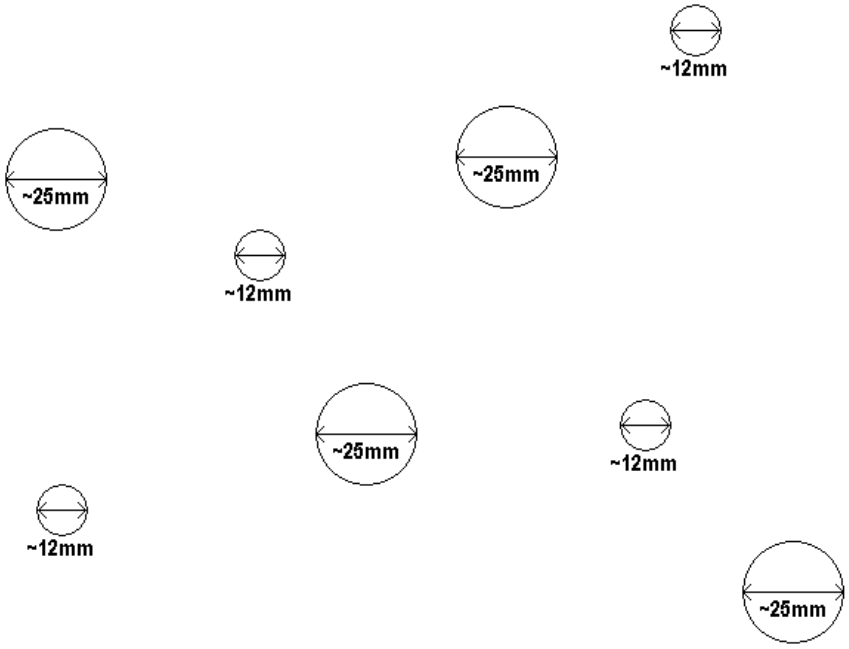

Figure 2 Approximate layout of the second group of holes on the bare metal pipe.

The coated pipe was drilled with eight random holes of approximately 12 mm (1/2”) diameter.

The drilled holes were threaded to hold bolts. The original intent was to place bolts in the holes until after the product was applied, then remove the bolts before testing (Figure 3 and Figure 4). On the recommendation of A & W Maintenance, duct tape was used to cover the holes instead.

Figure 3 Photo of second group of holes on the bare metal pipe.

Figure 4 Photo of the bare metal pipe, the second group of holes, and the end with the welded cap.

Application – December 16, 2008

The application occurred during very cold weather so the epoxy had to be heated before it could be applied (Figure 5).

The product was applied using a spinner head pulled through the pipe by hand (Figure 6). There was nothing to control the speed of the application; therefore the thickness of the application varied slightly.

One coat was applied to each pipe and then allowed to cure for a few hours (Figure 7).

Once the initial epoxy coat had set, the second coat was applied. The cap welded on the end of the bare metal pipe only allowed the epoxy to be applied from one direction (2 coats, 1 direction). The two flange ends on the coated metal pipe provided access from both ends. The second coat was applied from the opposite end to allow for better coverage (2 coats, opposite directions).

After a few hours, the duct tape was removed from the holes on the exterior. In an attempt to fill any voids, one thin layer was applied to the exterior of the holes followed by a second thicker layer (Figure 8, Figure 9, and Figure 10).

Figure 5 A & W Maintenance's machine set up.

Figure 6 Manual application of the epoxy.

Figure 7 First coat of epoxy inside the bare metal pipe.

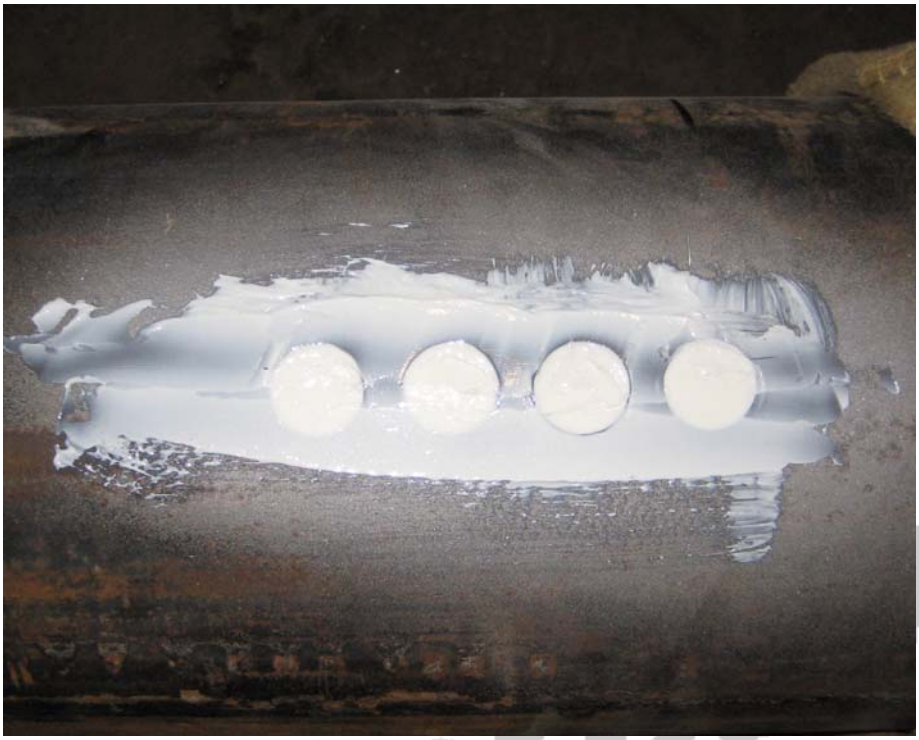

Figure 8 First layer of epoxy, bare metal pipe.

Figure 9 First layer of epoxy, coated pipe.

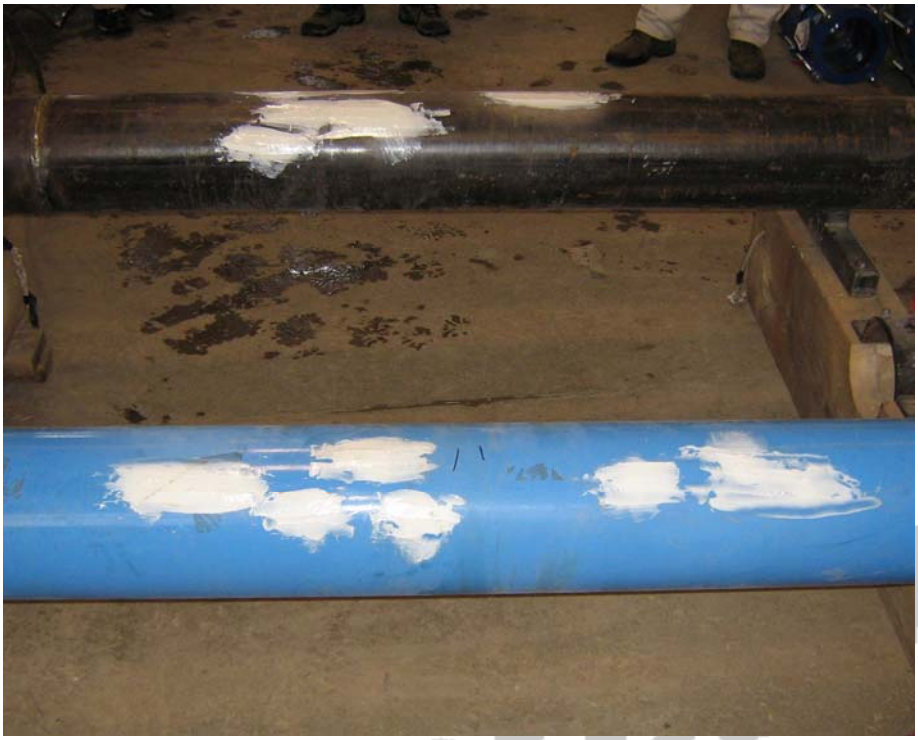

Figure 10 Second layer of epoxy, both pipes.

Testing – January, 2009

According to the specifications, the epoxy needs 48 hours to cure. Greg Swartz, A & W Maintenance, recommended that the epoxy cure for seven days before testing. Because of the Christmas holidays, the pipes were left for close to 3 weeks.

Water was used to pressure test the pipes.

Coated Metal Pipe

The pressure was initially brought to 100 psi (690 kPa) then increased in 50 psi (345 kPa) increments. After each increase, the pipe was left for 5 minutes during which time the exterior was checked for leaks. Since there were no leaks, the pressure was brought to 600 psi (4137 kPa) and left over night. The pressure did not remain at 600 psi (4137 kPa) due to slight weeping at the fittings. The fittings were tightened and the pressure brought back up to 500 psi (3447 kPa), using the same method as the day before. It was left overnight at 500 psi (3447 kPa). The next morning a small slow pinhole leak had appeared (Figure 11). The pipe was re-pressurized but the leakage remained relatively small with no crack propagation.

Further testing was performed on the pipe by welding two outlets onto the pipe surface to test the effect of welding on the epoxy. One outlet used a gas welding procedure and one used an arc welding procedure. A new hole was also drilled through the metal to the exterior surface of the epoxy (Figure 12). As well, a saddle was placed over the leaking

pinhole as a temporary repair (Figure 13). The pipe was then retested. The pressure was brought up to 250 psi (1724 kPa). Since no leaks appeared, the pressure was increased to 500 psi (3447 kPa) in 50 psi (345 kPa) increments. The 500 psi (3447 kPa) held overnight with no new leaks.

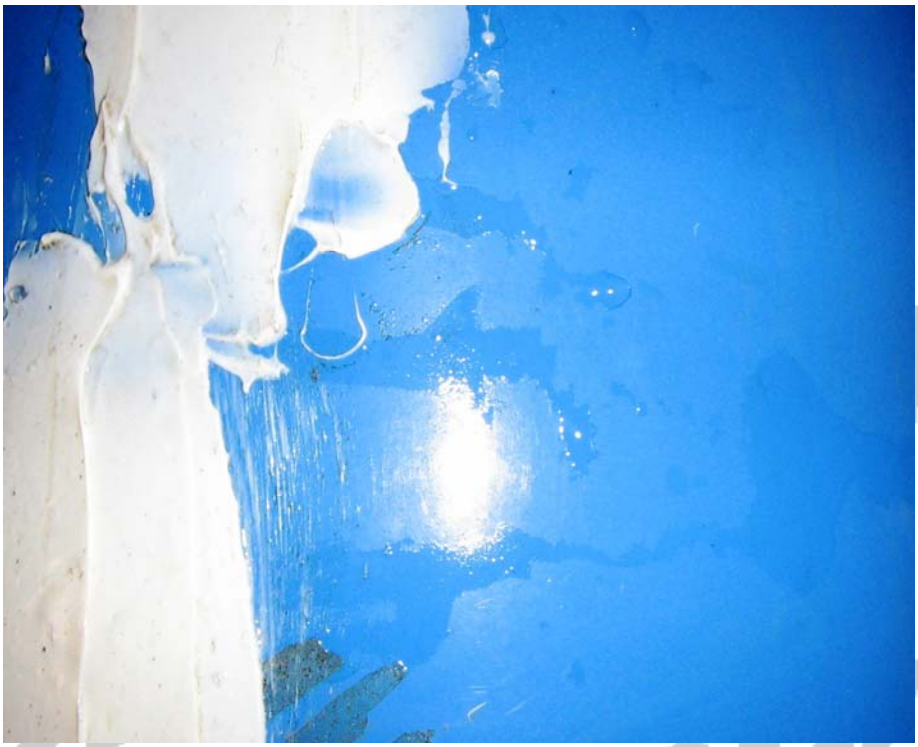

Figure 11 Slow leak from the coated metal pipe.

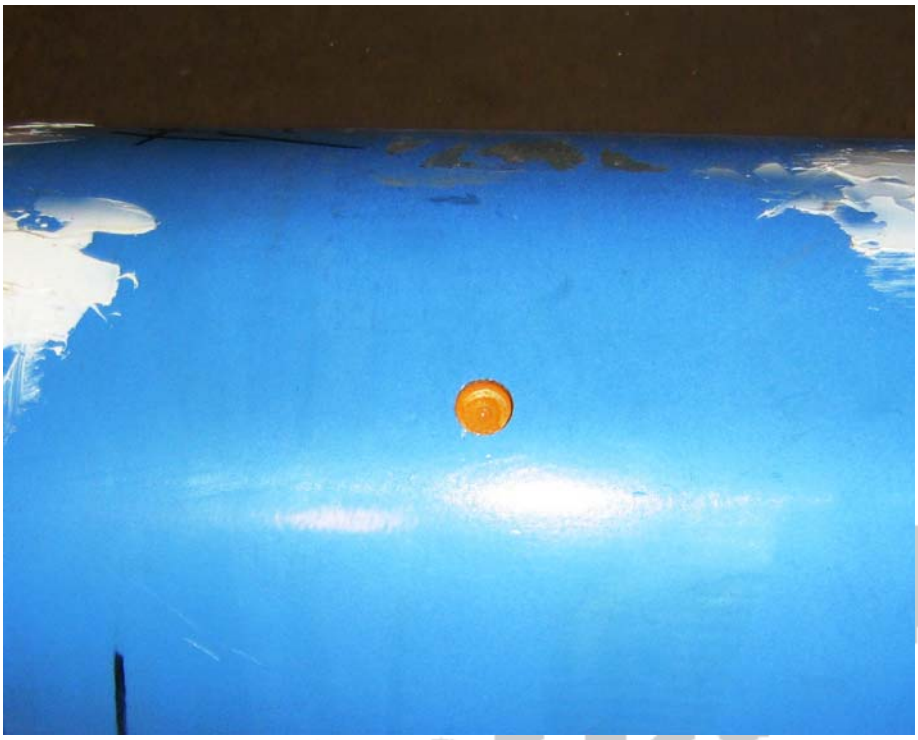

Figure 12 Hole drilled through the steel to the epoxy.

Figure 13 Coated pipe with the outlet welded on and the leak fitted with a saddle.

Bare metal Pipe

Using the same procedure as the coated metal pipe, the pressure was increased to 250 psi (1724 kPa) which held overnight (no leaks). It was then brought up to 500 psi (3447 kPa) which developed a slow leak when left overnight.

Test Results

After the test, both sections of pipe were cut open to examine the epoxy.

It was visible that the holes weren't completely filled with epoxy (Figure 14). Since the holes were not sealed, the leaks occurred where the water found a way through or around the epoxy. One test hole had a layer of epoxy so thin that changes in light could be seen through the epoxy, but it held the pressures and did not leak.

The welding showed no effect on the epoxy (Figure 15). There was no discoloration or melting and the epoxy stayed fused to the wall of the pipe.

Figure 14 Epoxy pushed into the holes.

Figure 15 Weld.

Conclusion

The two pipes held a pressure of 250 psi (1724 kPa). When the pressure was increased, small slow leaks developed overnight. The leaks were not catastrophic failures and occurred at pressures in excess of 500 psi (3447 kPa). When the pipes were re-pressurized, the leaks did not progress. In most locations, the pressure was held by a thin film of epoxy. The design pressure of the Haysboro Feedermain is 121 psi (835 kPa), well below 250 psi (1724 kPa).

Greg Swartz, A & W Maintenance, warned about the problem of unfilled holes. He tried to remedy it by applying the epoxy from both ends of the pipe for better coverage. This was only possible on the coated pipe due to the welded end cap on the bare pipe. In larger diameter pipes the application would be applied with a hand held sprayer by someone inside the pipe. Any large holes or indentations would be visible and could be filled with epoxy during the application to avoid inclusions or voids in the lining. The Haysboro Feedermain is considered large enough for a hand held application.

Since neither welding procedure showed an effect on the epoxy, any future repairs could be done externally without compromising the existing lining or water quality.

Based on the results of this test, the epoxy is recommended as a viable option for the Haysboro Feedermain assuming the cost estimate is reasonable.

It should be noted that the epoxy is NSF-61 certified for pipes sized 36” (900 mm) and larger. Certification for smaller diameter pipes is in progress.

Appendix A – Product Specifications

Certified Applicators of Non Toxic No Dig Restoration Systems

Warren Environmental, Inc.

CTS-301-NSF
Epoxy Spray System

DESCRIPTION: A two part, highly thixotropic epoxy system formulated for spraying with Warren Environmental, Inc.'s patented meter/mix spray equipment.

CHARACTERISTICS: Formulated with special additives and modifiers to enhance the water resistance, chemical resistance, and bond strength to a variety of substrates as well as its own internal strength. The high thixotropic index allows for up to a ¼" build-up on vertical surfaces without sag.

APPLICATION: Designed for use with Warren Environmental's patented meter, mix and spray equipment. The epoxy component utilizes a 2 parts base to 1 part activator mix ratio by volume. This product is sold and installed only by technicians specifically trained and licensed in our patented techniques.

ADVANTAGES:

- Long Open time for Efficient Topcoating
- Excellent Cure at Low Temperature
- Excellent Cure at High Humidity
- Zero Induction Time
- 0% VOC's
- 100% Solids
- Long Working Time Relative to Cure Time
- Ready-to-Use (No Thinning Required)
- Excellent Water and Chemical resistance with ambient cure
- Achieve high-build thicknesses without sag

CERTIFICATION:
NSF: Certified to Standard NSF-61

SPECIAL SAFETY AND HANDLING: There are no special safety or handling procedures beyond those published on the reverse and the Material Safety Data Sheets.

Typical Properties

Liquid Properties (Systems)

Viscosity	90,000-120,000 cps
Thixotropic Index	5.0-6.0
Specific Gravity	1.162
Flash Point (Closed Cup)	>235°F
Color	Varies
Geltime (200g@77°F)	27 minutes
Thin Film Set (@ 77°F)	2 hours
Thin Film Set (@ 40°F)	8 hours

Physical Properties
(1/8" Casting)

Tensile Strength (ASTM D638-86)	7000 psi
Flexural Strength (ASTM D790-86)	11,000 psi
Flexural Modulus @ 0.100" (ASTM D790-86)	500.000 psi
Compressive Strength (ASTM D695-85)	12,000 psi
Glass Transition Temperature (ASTM D3418-82)	151°F
Tensile Elongation @ Break	4.8%
Thin Film Set (@77°F)	2 hours
Shore D Hardness	83-85

Chemical Resistance
(28 Day Immersion)

Chemical	Weight Gain (%)
Toluene	0.99
Ethanol	4.68
10% Acetic Acid	3.85
70% Sulfuric Acid	0.13
50% Sodium Hydroxide	0.09
Distilled Water	1.11
Methanol	9.55
Xylene	0.69
Butyl Cellosolve	1.18
Methyl Ethyl Ketone	11.19
10% Lactic Acid	3.24
Bleach	0.93
1,1,1 Trichloroethane	0.43
10% Nitric Acid	2.05
30% Nitric Acid	4.17

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MISSION STATEMENT

Warren Environmental, Inc. will provide cost-effective coatings and methodologies that lead to permanent time-sensitive solutions meeting the structural rehabilitation needs of their customers. To this end, we pledge to use environmentally friendly materials, train and certify the people installing our products, and provide our customers a worry free experience.

STORAGE & USE

TWO-PART EPOXY COATINGS: are supplied in 50 gallon steel drums. The unmixed shelf-life is one (1) year from date of purchase when stored indoors in their sealed original containers at a room temperature between 60˚F and 80˚F. When using this material, it is important to prevent cross contamination of the unused components. To assure proper performance, it is mandatory that the components be correctly identified and the mix ratio cited on the front of this bulletin be strictly followed.

CURED IN-PLACE PIPLINING SYSTEMS: this patented system may be provided in several different methodologies depending upon the application and field conditions. Warren Environmental, Inc. requires that these materials be installed by our licensed applicators only. These people are trained by us to address the issues unique to each situation. For more information please contact us.

SAFETY AND HANDLING

Material inadvertently applied to the skin should be washed immediately with lanolin based soap and warm water. Refer to the Material Safety Data Sheet for additional information.

GENERAL SURFACE PREPARATION GUIDELINES

Surfaces to be coated or adhered to should be cleaned of oil, grease, rust, scale, loose dirt and other contaminants that may hinder the adhesion of the epoxy coating to the substrate. In many instances cleaning the area to be coated of tuberculation and debris via scarifiers, sand blasting, or water will be sufficient. In rare instances such as oil covered metal, it may be necessary to treat the area with a solvent based cleaner. It is important to remove all traces of the solvent including fumes prior to applying the epoxy coating to ensure that no pinhole defects develop as the product cures. Concrete should be cured a minimum of 28 days prior to applying coating materials. Please contact us with specific questions regarding your application.

WARRANTY

Warren Environmental, Inc. warrants only that the product meets that quality and technical standards published in its current literature. Warren Environmental, Inc. cannot be held responsible for circumstances outside of its control including, but not limited to: product application, product handling, product storage, or any other conditions outside of our control. If within one (1) year from date of purchase, any product is proven by accepted industry standard test methods to be defective Warren Environmental, Inc. will, at its sole option, either replace or refund the purchase price of the product. These remedies shall constitute the sole and exclusive remedy for any claim under this warranty. This warranty is in lieu of any other warranties, expressed, implied, or statutory and is strictly limited to its terms.

All values reported above are typical values, and are reported as a means of reference. Individual testing should be done to determine actual results, tested at specific conditions.