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SprayWall® Pipe Liner	Work Plan ☐ Construction ☐ Evaluation ☒ Final ☐	8. Project No. 9. Project No. 10. Project No.

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14. Supplementary Notes

15. Abstract

Purpose and Need

North Dakota's state highway system has small and large centerline pipes constructed with deep fills above the pipe. When these pipes become deteriorated they need to be replaced or repaired to maintain hydraulic and structural capacity. The cost of excavating the material above the pipe and the time required to replace the pipe are a driving force for an alternative option. An option to repair the pipe without any excavation or any disruption to the traveling public is needed.

Objective

The objective of this research project is to evaluate the performance of SprayWall® polyurethane lining for use as a minimally intrusive option for repair of deteriorating pipe. The SprayWall® lining will re-establish the structural integrity and prevent infiltration by sealing the perforations.

Scope

This project will rehabilitate a 90" structural plate pipe on project SOIA-5-094(084)023. The contractor must ensure that the manufacturer's representatives are on site during the preparation of the pipe and installation of the SprayWall® System. The contractor will prepare the pipe and apply the SprayWall® polyurethane lining according to the manufacturer's recommendations. The contractor will apply SprayWall®® on the north 134 linear feet of the 674 linear feet pipe.

Summary

The Spraywall liner has very little defects at this time. Most of the cracks occur on the edge of the liner on the end section of the pipe. The crack along the side of the pipe end section is the most severe crack. After that crack was repaired another crack developed parallel next to the original crack.
The Spraywall liner is performing well at this point. The small cracks that were found don't appear to be a major concern. Materials and Research will continue to monitor the performance of the Spraywall pipe liner.

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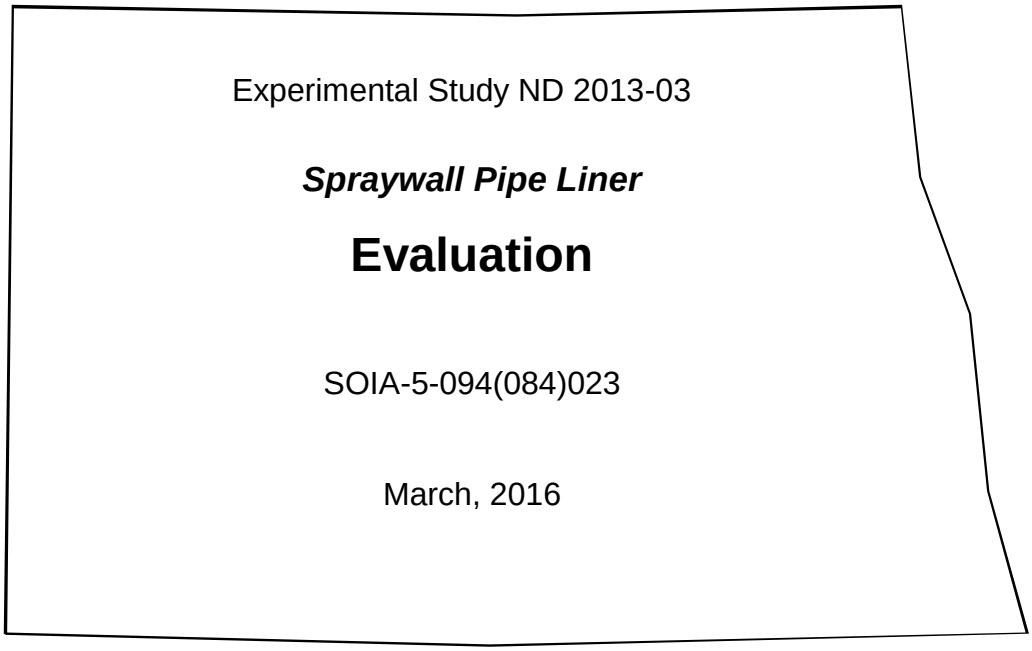
NORTH DAKOTA

DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH DIVISION



Experimental Study ND 2013-03

Spraywall Pipe Liner

Evaluation

SOIA-5-094(084)023

March, 2016

Prepared by

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Experimental Study ND 2013-03

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Written by
Kyle Evert

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

EXPERIMENTAL PROJECT REPORT

EXPERIMENTAL PROJECT

EXPERIMENTAL PROJECT NO.: 1 ND 2013 - 03
CONSTRUCTION PROJ NO: SOIA-5-094(084)023
LOCATION: ND 11 - Billings County, ND

EVALUATION FUNDING (48): 1 HP&R; 2 X CONSTRUCTION; 3 DEMONSTRATION; 4 IMPLEMENTATION
NEEP NO. (49):
PROPRIETARY FEATURE? (51): X Yes; No

SHORT TITLE

TITLE (52): Spraywall Pipe Liner

THIS FORM

DATE (140): MO. March -- YR. 2016
REPORTING: 1 INITIAL 2 X ANNUAL 3 FINAL

RCS HHO-30-19

KEY WORDS

KEY WORD 1 (145): Pipe Liner
KEY WORD 2 (167): Pipe
KEY WORD 3 (189): Steel Plate
KEY WORD 4 (211):
UNIQUE WORD (233):
PROPRIETARY FEATURE NAME (255): Spraywall

CHRONOLOGY

Date Work Plan Approved	Date Feature Constructed:	Evaluation Scheduled Until:	Evaluation Extended Until:	Date Evaluation Terminated:
277 2013	281 September 2013	285 2014	289	293

QUANTITY AND COST

QUANTITY OF UNITS (ROUNDED TO WHOLE NUMBERS) (297):

UNITS:
1 LIN. FT; 2 SY; 3 SY-IN; 4 CY; 5 TON; 6 LBS; 7 EACH; 8 X LUMP SUM

UNIT COST (*Dollars, Cents*) (306):

AVAILABLE EVALUATION REPORTS (315)

CONSTRUCTION	PERFORMANCE	FINAL
	X	

EVALUATION

CONSTRUCTION PROBLEMS (318): 1 NONE; 2 X SLIGHT; 3 MODERATE

PERFORMANCE (319): 1 EXCELLENT; 2 GOOD; 3 X SATISFACTORY; 4 MARGINAL

APPLICATION (320)

1 ADOPTED AS PRIMARY STD.; 2 PERMITTED ALTERNATIVE; 3 ADOPTED CONDITIONALLY; 4 X PENDING; 5 REJECTED; 6 NOT CONSTRUCTED

(Explain in remarks if 3, 4, 5, or 6 is checked)

REMARKS (321)

The Spraywall liner is performing well at this point. The small cracks that were found don't appear to be a major concern. Materials and Research will continue to monitor the performance of the Spraywall pipe liner.

Form FHWA 1461

Disclaimer

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Work Plan
Spraywall Pipe Liner
ND 2013-03

Purpose and Need

North Dakota's state highway system has pipes with large fills above the pipe. When these pipes become deteriorated these pipes need to be replaced or repaired to maintain hydraulic and structural capacity. The cost of excavating the material above the pipe and the time required to replace the pipe are a driving force for an alternative option. Repairing the pipe without any excavation or any disruption to the traveling public is needed.

Sprayroq® Protective Lining Systems produces a product called SprayWall® (Spraywall). Spraywall is a self-priming polyurethane lining that re-establish structural integrity, provides infiltration control and chemical resistance for concrete, steel, masonry, fiberglass and other surfaces. This product provides a structural repair and is applied using a spray system within the pipe alleviating any excavation or disruption to the traveling public.

Objective

The objective of this research project is to evaluate the performance of Spraywall polyurethane lining by installing the pipe lining system on a deteriorating 90" Structural Steel Plate pipe that has numerous rust perforations. The Spraywall lining will re-establish the structural integrity and prevent infiltration by sealing the perforations.

Scope

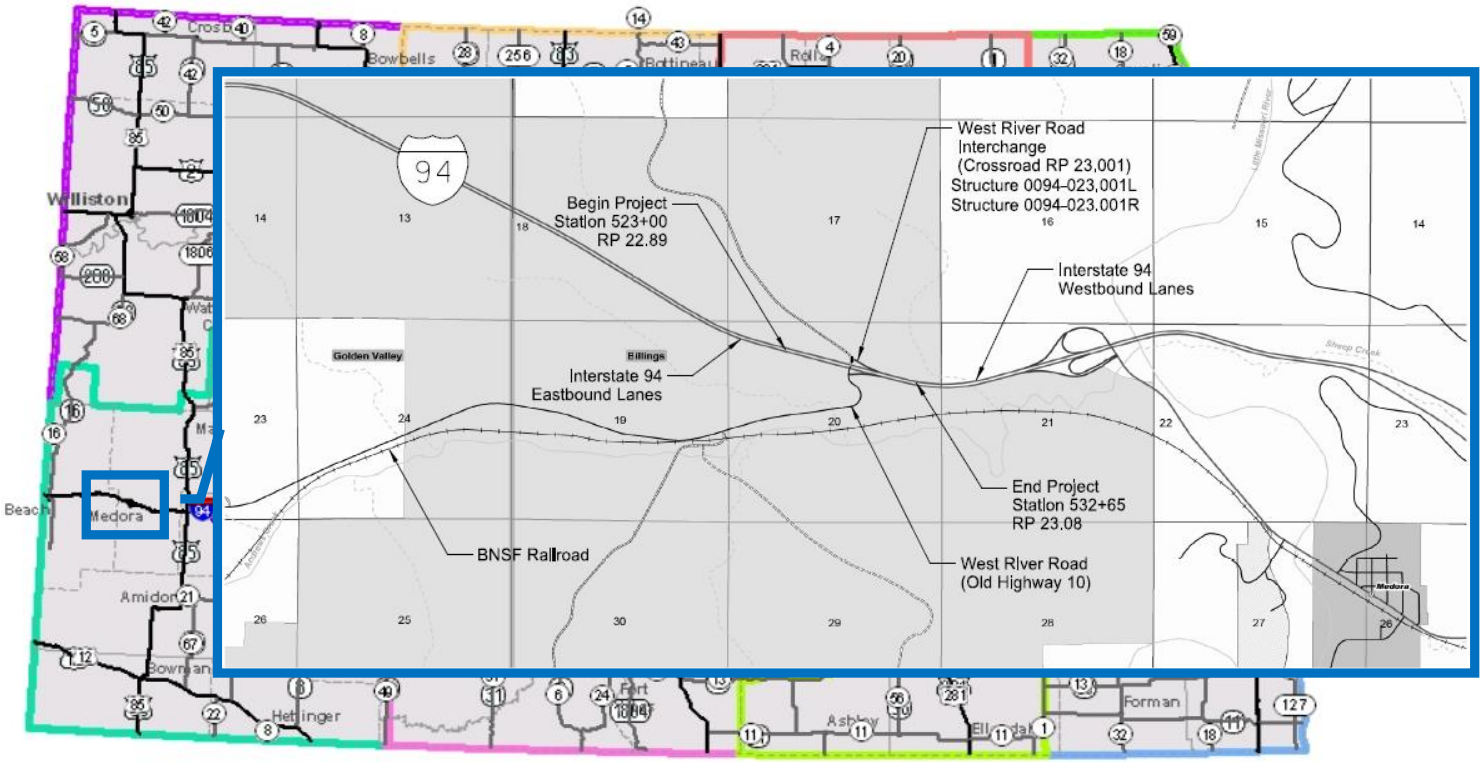
This project will rehabilitate a 90" structural plate pipe on project SOIA-5-094(084)023. The contractor must ensure that the manufacturer's representatives are on site during the preparation of the pipe and installation of the Spraywall System. The contractor will prepare the pipe and apply the Spraywall polyurethane lining according to the manufacturer's recommendations. The contractor will apply Spraywall® on the north 134 linear feet of the 674 linear feet pipe. The first 124 linear feet of Structural Steel Plate pipe has a smaller gage steel resulting in an earlier appearance of the rust

perforations. An additional 10' of liner was added to evaluate the performance of Spraywall on the transition of different gages of steel. The photos below display the deterioration of the pipe.

Photo - Deterioration of 90" Structural Steel pipe

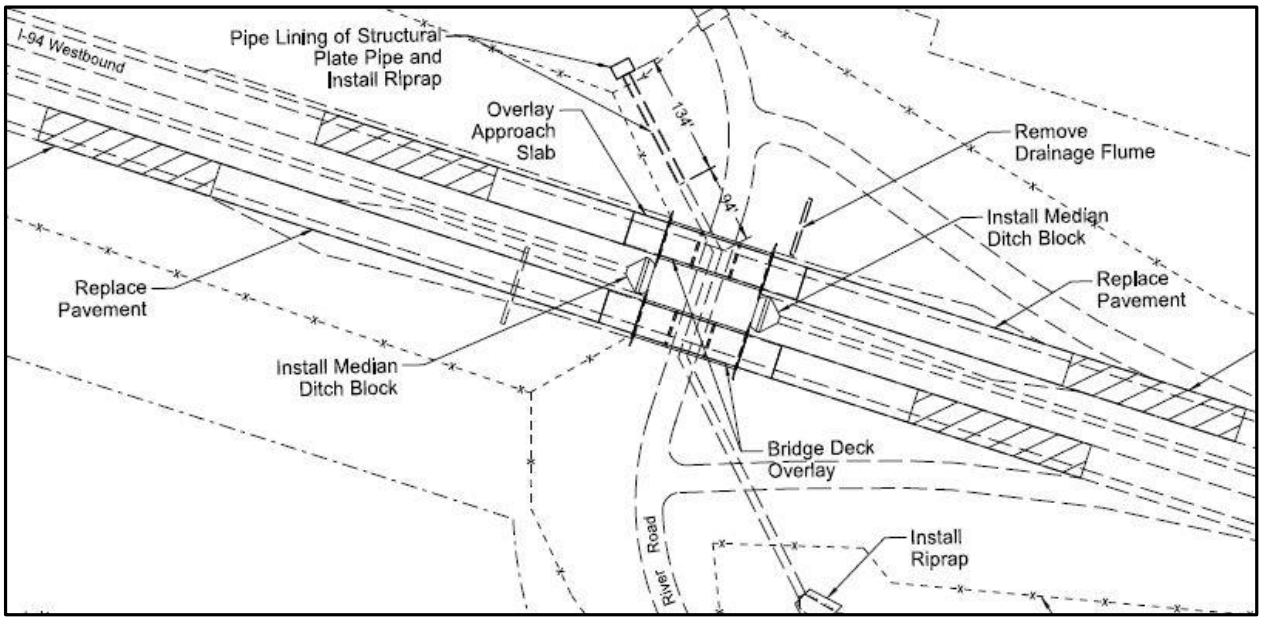
Location

The location of the pipe is on the Interstate 94 West River Interchange near Medora, at approximately reference point 23. The north 124 LF of the pipe will be lined with the Spraywall.



Design

The Spraywall liner shall be applied to the pipe according to the manufacturer's recommendations. The coating shall be designed to restore the structural integrity of the pipe. The original plans called for the 124' of Structural Plate Pipe to be replaced and riprap to be installed. The design provided by the manufacturer is to line 134' of the pipe with 500 mils of the Spraywall liner, providing a 50 year design life to the rehabilitated portion of the pipe.



Original scope of work for pipe.

Evaluation

The evaluation for this project will consist of annual observations and photo documentation of the performance of the Spraywall liner. The performance of the liner will be measured by distresses reflection through liner, infiltration of the liner and deflection of the liner.

Prior to the application of the liner the condition of the pipe will be documented by Materials and Research. Locations of corrosion and structural distress of pipe will be recorded for future inspection comparisons. The pipe will be evaluated annually and monitored for five years. Annual reports will document the results of the evaluations.

Construction

The installation of the Spraywall liner was performed by Subsurface Incorporation based out of Moorhead, Minnesota. Subsurface was represented by Ken Moulds and the crew consisted of one supervisor and four labors. The preparation work and Spraywall installation began on September 9, 2013 and ended September 24, 2013.

Pipe Preparation

Prior to the installation of the Spraywall liner the preparation work needed to be completed. The preparation work included dewatering the pipe, removing the corrosion, sealing deteriorated holes caused corrosion, and heating the pipe to optimal temperature for the Spraywall installation. This work took the Subsurface crew approximately 15 hours to complete. Photos of the pipe depict the conditions prior to any preparation work was completed can be seen in Photos 1 and 2.

Photo 1 – Deterioration and corrosion of steel pipe.

Photo 2 – Deterioration and corrosion of steel pipe

n the project a rain event passed though area. When Subsurface arrived at the project location three to four inches of water still remained in the bottom of the pipe. The water was pumped through the pipe downstream to the end of the pipe. The remaining water in the bottom of the pipe corrugations were vacuumed to leave the pipe dry.

Next the Subsurface crew began to remove the pipe corrosion and sealing up the deteriorated holes caused from corrosion. The corroded locations within the pipe were removed using a grinder attached with a cup wire brush as seen in Photo 3.

Photo 3 – Grinder and deteriorated location after corrosion has been removed.

After the corrosion was removed the locations with holes in the steel were filled with Speed Crete Blue Line, a rapid setting cement based mortar produced by The

Euclid Chemical Company. The mortar is to provide a clean dry substrate for the Spraywall. Example of this can be seen in Photo 4. The larger locations where the corrosion created a hole are filled with the mortar. The smaller locations where the

Photo 4 – Deteriorated holes filled with mortar.

corrosion has not deteriorated completely through the steel where not filled with mortar, they provide adequate substrate for the Spraywall.

After the deteriorated locations were removed and the holes were filled with mortar the pipe was pressure washed to remove any debris. Heated air was than pumped into the pipe to warm and dry the pipe overnight prior to the installation of the Spraywall. The pipe was heated to approximately 75 degrees Fahrenheit. Photo 5 displays the pipe before and after the pipe preparation was completed.

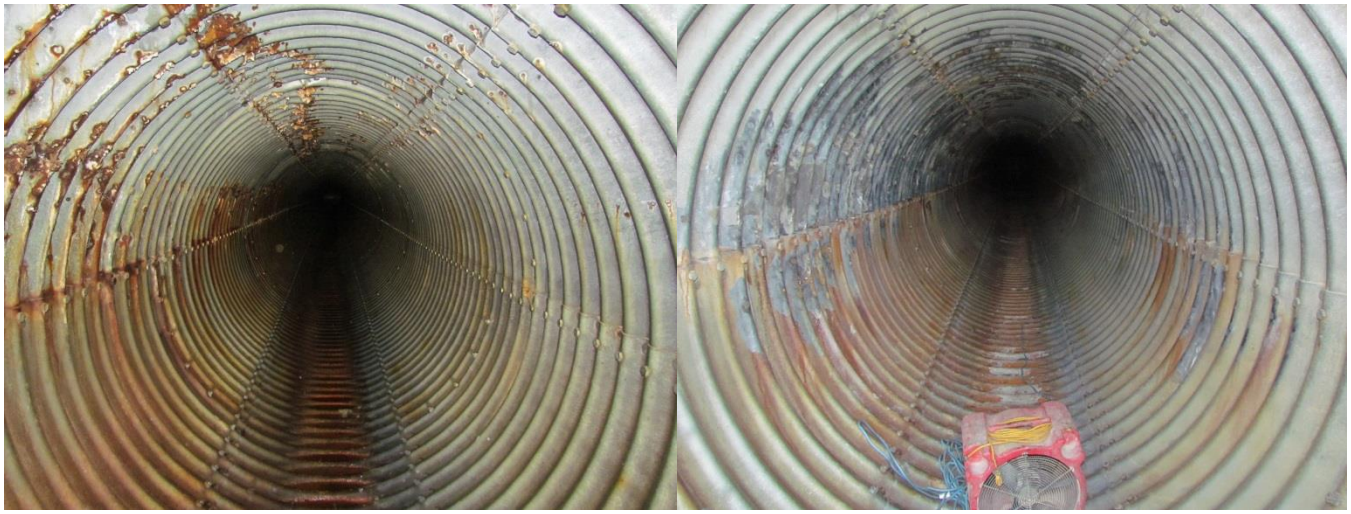


Photo 5 – Before and after pipe preparation

Spraywall Equipment

Spraywall is a two-part polyurethane, components A and B. Components A and B are located in an enclosed trailer with a specialized pump for pumping and metering the components to a spray gun/nozzle. The hose used to transfer the components from the pump to the spray nozzle is heated to control the temperature of the components as they travel to the nozzle. The components are delivered and stored in steel barrels. The barrels can be heated to ease the flow of the components through the pump. The components are sensitive to temperature and pressure. These specialized instruments help control the pressure and temperature for a smooth application of the product.

Photo 6 – Pump and spray nozzle used for Spraywall application.

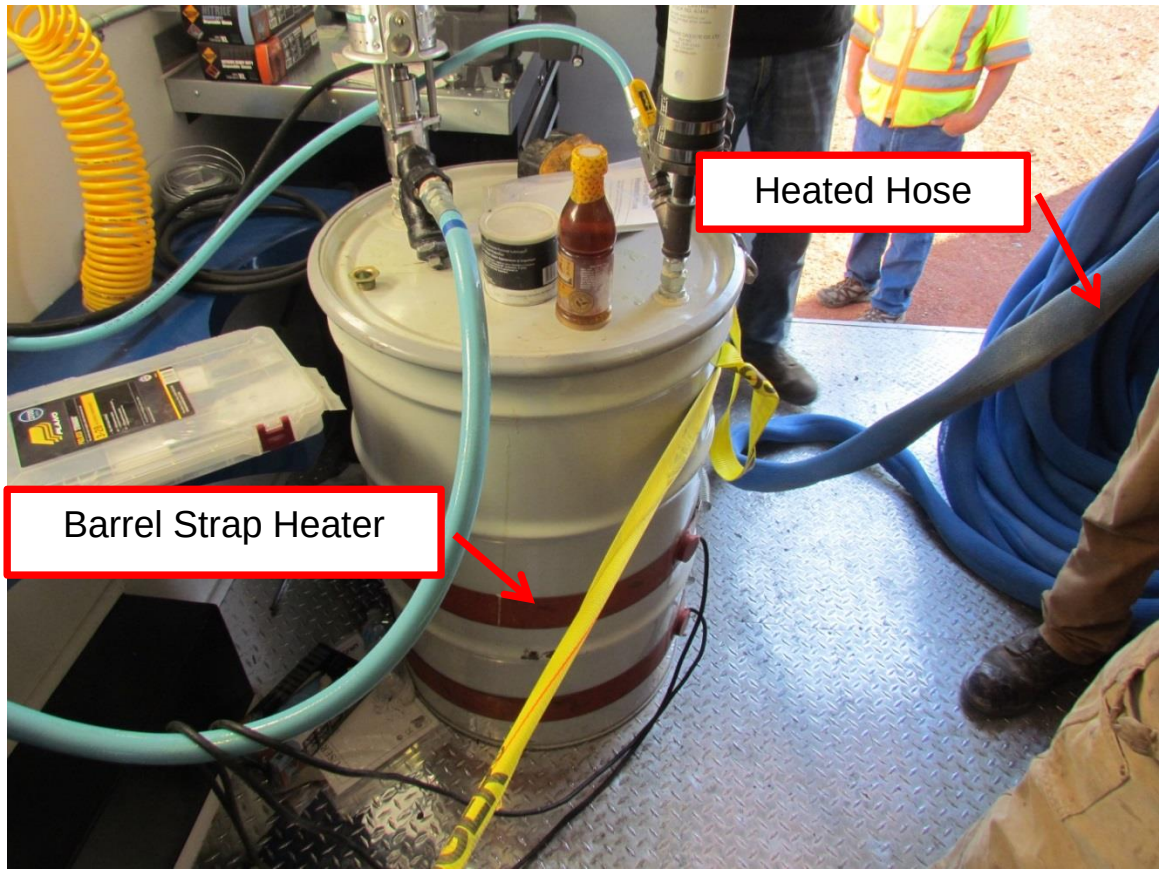


Photo 7 – Temperature controls used with the Spraywall application.

Contactors wishing to use Spayroq products must become Sprayroq Certified Partners (SCP). To achieve SCP, personal must complete training how to use Sprayroq products. The heat and the fumes produced from the application of the Spraywall required full body suits. Within the suit, breathable air is provided to the applicator from the enclosed trailer.

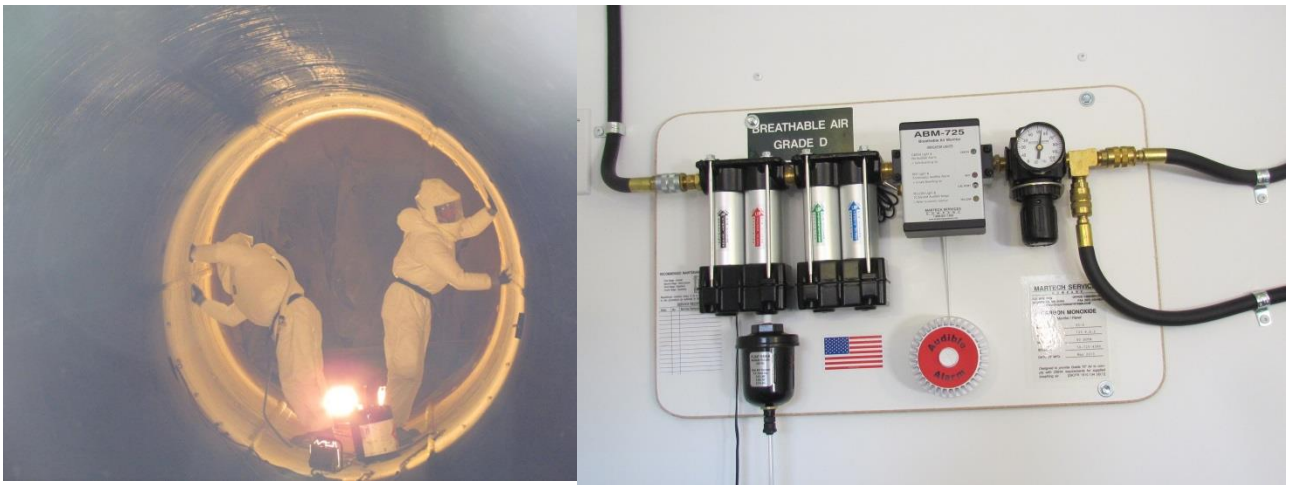


Photo 8 – Full body suit and breathable air regulator.

The Spraywall application began on September 11, 2013. Prior to any application of Spraywall to the pipe a test panel was applied with Spraywall to adjust the equipment and spray passes to achieve the correct thickness. The test panels have a wax release agent to allow the Spraywall material to be removed.

Photo 9 – Spraywall test panel and thickness measurement.

After the test panels have been completed the contractor began application of Spraywall to the pipe. The contractor would mark the pipe every 12.5' with a marker. This was used to aid the contractor in knowing how much material was being used, with the amount of passes used to cover the area. Photo 10 displays the contractor applying the Spraywall liner onto the pipe.

Photo 10 – Application of Spraywall.

The contactor was unable to complete the installation within one day. This required the contractor to quit and begin the process the following day after the Spraywall liner has cured. To begin the installation the following day the Spraywall liner is overlapped over the existing Spraywall liner. The Spraywall liner being overlapped is scuffed for proper adhesion with wire brush attached to a grinder as shown in Photo 11.

Photo 11 – Spraywall Liner scuffed for overlap preparation.

The application process was repeated daily until the pipe liner was complete on September 24, 2013. The installation of the liner required more time then what was originally planned by the contractor due to installation problems later described in this report.

Quality Control/Quality Assurance

The contractor used two methods for quality control. One method is to monitor the volume used to cover a measured area. The other method used by the contractor is to drill a hole into the liner before the product has cured and measure the depth using a caliper. After the depth of the hole has been measured, it is easily repaired with the Spraywall applicator near the area measured.

The quality assurance performed by the NDDOT also used the process of drilling a hole into the liner and measuring the depth with a caliper. This was done after the entire Spraywall installation was complete and cured. The holes were repaired using

the Sprayroq epoxy SR 6100. Eleven test locations were randomly chosen throughout the pipe and these measurements can be seen Appendix A.

Depth Checks	Mils
Average	652
Standard Deviation	226
Max	1133
Min	316

Spraywall Installation Issues

The application to the pipe did not go as smoothly as anticipated. The contractor had difficulty with the following:

- Getting proper coverage around sharp angles within the pipe, such as the bolts and panel seams.
- The Spraywall components were setting up within the hose and spray nozzle.

The coverage around the bolts and seams appeared very thin where there was a sharp angle on the substrate. Examples of these areas of concern can be seen in Photo 12.

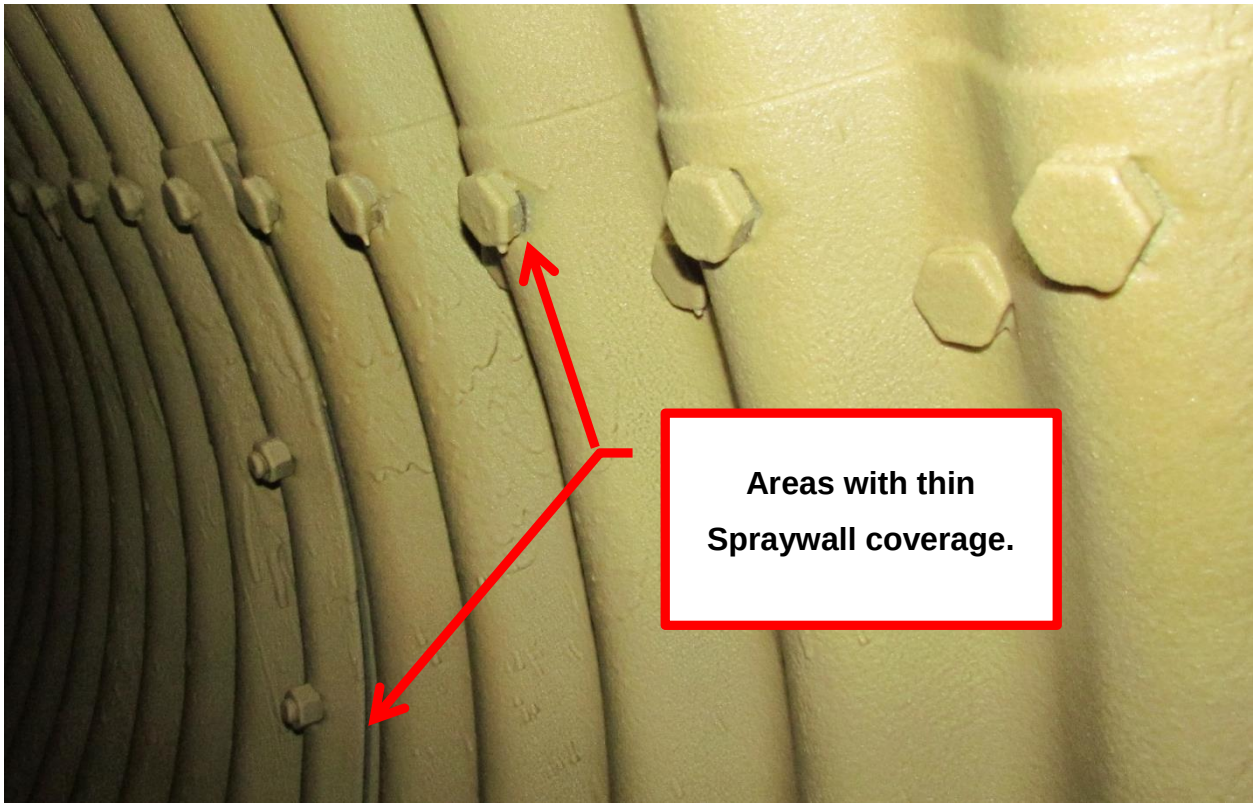


Photo 12 – Examples of locations with thin Spraywall coverage.

The contactor's original concern is that they were using too much Spraywall material around the bolts and plate seams. The contractor used the quick set mortar and SR 6100, an epoxy from Sprayroq, in attempt to smooth out the sharp angles of the bolts and plate seams.

Photo 13 – Quick set mortar and SR 6100 smoothing out sharp angles.

This method of smoothing out the sharp angles may remedy the sharp angles but it is very time consuming to complete the task. This method was abandoned and the Spraywall representative was approached for guidance on this problem. The Spraywall representative contacted other Sprayroq Certified Partners and it was determined that the contractor needed to adjust the technique used to spray the sharp angles. The contractor improved on the Spraywall application around the sharp angles after help was received by the Spraywall representatives.

The locations that appeared to have thin coverage of Spraywall were fixed using the SR 6100. In some of these locations a depth check was performed and the thickness of the Spraywall meet the design thickness of 500 mills in the majority of locations tested. The depth checks measurements can be seen in Appendix A.

The other issue the contractor had with the Spraywall installation was the components were setting up and plugging the hose and/or spray nozzle. It was determined supplier the reason for the components setting up was the distance the material was being pumped from the trailer to the pipe. This distance required a higher pressure to pump the material the needed distance and the material is sensitive to the change in pressure. The pipe is located at the bottom of a steep fore slope making it

difficult to position the Spraywall trailer next to the pipe.

The components setting up within the hose and/or nozzle was very time consuming. The contractor would have to remove the material form hose and/or spray nozzle and prep the existing Spraywall material that has cured during the time required to repair the hose and/or nozzle.

The issues with proper coverage around sharp angles and the Spraywall components setting up in the hose and/or spray nozzle caused additional time the contractor did not anticipate.

Evaluation

The Spraywall liner was inspected on July 24, 2014, May 26, 2015 and August 28, 2015. From these evaluations five cracks were found in the liner. Four of the cracks are found on the edge of the end section of the pipe. The other crack is on the floor 50’ in from the end of the edge section. Four of the cracks were repaired by Subsurface prior to the May 26, 2015 evaluation. The repairs were made using Sprayroq epoxy SR 6100 product.

The crack on the bottom edge of the end section (refer to Photo 14) appears to have been created by installation of the adjacent rip rap. There is a chip on the edge of the liner and two cracks propagating at an approximate 45 degree angle from the chip.

The crack on the side of the end section was the most severe crack (refer to Photo 16). The crack was repaired prior to May 26, 2015 and another crack appeared parallel next to the original crack. Subsurface then repaired the new crack prior to the August 28, 2015 evaluation. Along the edge of the end section where these cracks developed there is delamination between the end section and the Spraywall liner (refer to Photo 17). The gap between the end section and Spraywall liner were filled with Sprayroq epoxy SR 6100.

There was only one crack that was not on the outside edge Spraywall liner. This crack is on the floor of the pipe, 50’ in from the end of the pipe. The crack is on a joint for the structural plate pipe (refer to Photo 18).

There are no other visible defects on the Spraywall liner.

Photo 14 – A crack on the bottom edge of the end section. It appears the installation of riprap caused the damage.

Photo 15 – A crack at the top edge of the end section before and after the repair.

Photo 16 - A crack at the side edge of the end section before and after the repair. After the repair was complete, another crack formed parallel next the repaired crack. The new crack was repaired Subsurface.

Photo 17 – Delamination between edge of end section and Spraywall liner.

Photo 18 – Crack on the bottom of pipe 50' in from end of pipe.

Summary

The Spraywall liner has very little defects at this time. Most of the cracks occur on the edge of the liner on the end section of the pipe. The crack along the side of the pipe end section is the most severe crack. After that crack was repaired another crack developed parallel next to the original crack.

All but one crack has been repaired by Subsurface using Sprayroq epoxy SR 6100. The only crack that was not repaired was the crack within the pipe on the floor.

The Spraywall liner is performing well at this point. The small cracks that were found don't appear to be a major concern. Materials and Research will continue to monitor the performance of the Spraywall pipe liner.

Appendix A: Quality Assurance Depth Checks

Spraywall Pipe Liner Depth Checks	
Location	**Depth(Mils)**
1	580
2	773
3	654
4	893
5	631
6	588
7	316
8	428
9	698
10	480
11	1133
Average	652
Standard Deviation	226
Max	1133
Min	316