GeoSpray™ GeoPolymer Mortar System and Concrete Cloth for Structural Rehabilitation/Repair of Sewer and Storm Infrastructure

Presented by David Keaffaber, P.E.
Midwest Region Manager

Milliken™ | Milliken Infrastructure Solutions, LLC

Milliken & Company

45 Facilities Around the World

Milliken Infrastructure Solutions

Providing Material Systems for Repair & Rehabilitation

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Milliken
RenewWrap™
FRP Strengthening System

Fiber Reinforced Polymers For Concrete Repair & Strengthening

ICC ES

Milliken®
Concrete Cloth™

2012 R&D 100 50th ANNIVERSARY

Concrete Impregnated Fabric



Licensed from
CONCRETE CANVAS®

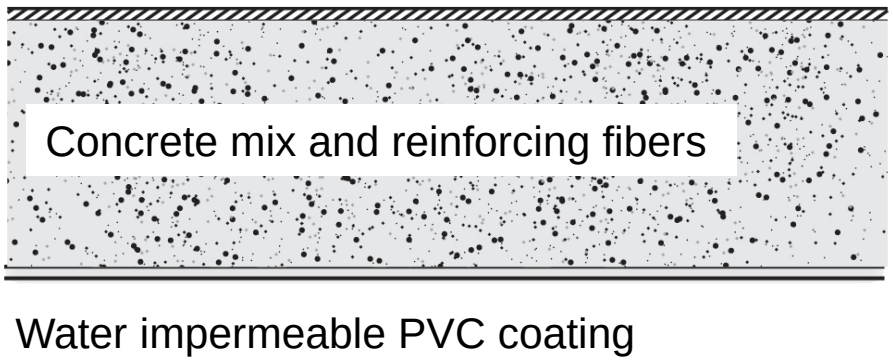
What is Concrete Cloth™?

A flexible cement-impregnated fabric that hardens when hydrated to form a thin, durable concrete layer.

Concrete Cloth™ ("CC") consists of:

- Dry concrete mix
- Reinforcing fiber matrix
- Fabric top surface
- PVC bottom coating

CC Section View



Thicknesses and Roll sizes available

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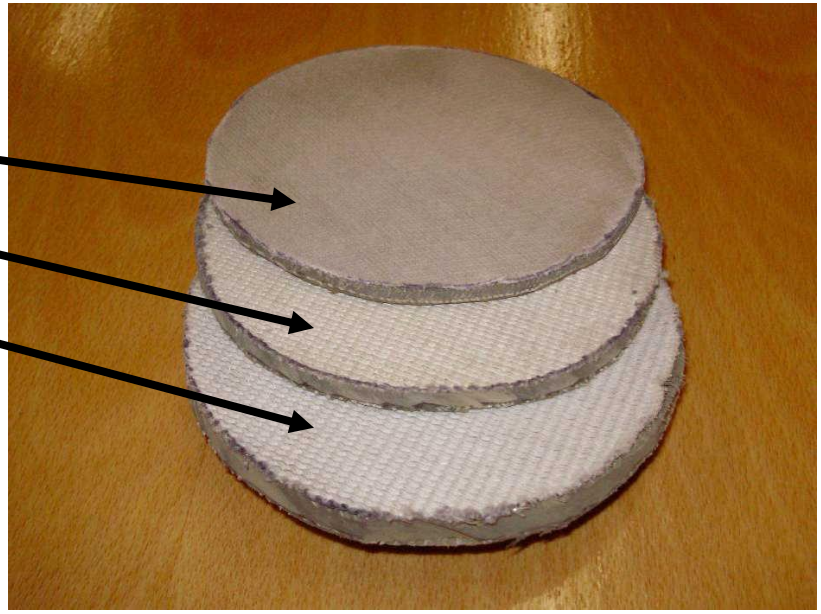
3 thicknesses available are:

CC5 (5mm)

CC8 (8mm)

CC13 (13mm)



CC	Thickness in(mm)	Roll Width ft(m)	Weight Unset lb/sf(kg/sm)	Batch Roll Length ft(m)	Batch Roll Area sf(sqm)	Batch Roll Weight Unset lbs(kg)	Bulk Roll Length ft(m)	Bulk Roll Size sf(sqm)	Bulk Roll Weight Unset lbs(kg)
CC5	0.2 (5)	3.5 (1.1)	1.4 (7)	30 (9.1)	105 (10)	147 (68)	615 (187)	2152 (200)	3013 (1404)
CC8	0.3 (8)	3.6 (1.1)	2.5 (12)	15 (4.6)	54 (5)	135 (60)	373 (114)	1346 (125)	3358 (1499)
CC13	0.5 (13)	3.6 (1.1)	3.9 (19)	n/a	n/a	n/a	239 (73)	862 (80)	3354 (1521)

Concrete Cloth™ comes in two roll varieties:

Portable Batched Rolls

Bulk Roll

Why Choose Concrete Cloth?
Asset Owner Benefits for Ditch Lining

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If your location is:

- Remote, or
- Difficult to access with standard concrete equipment.

If you have limited time:

- Simple, installs quickly, and
- You don't have to go back to the site to remove forms.

If you have limited labor or equipment:

- A small crew can do the job, and
- You don't need specialized equipment.

If you cannot stop the water flow:

- It even cures under water.

Deteriorating Metal Culvert

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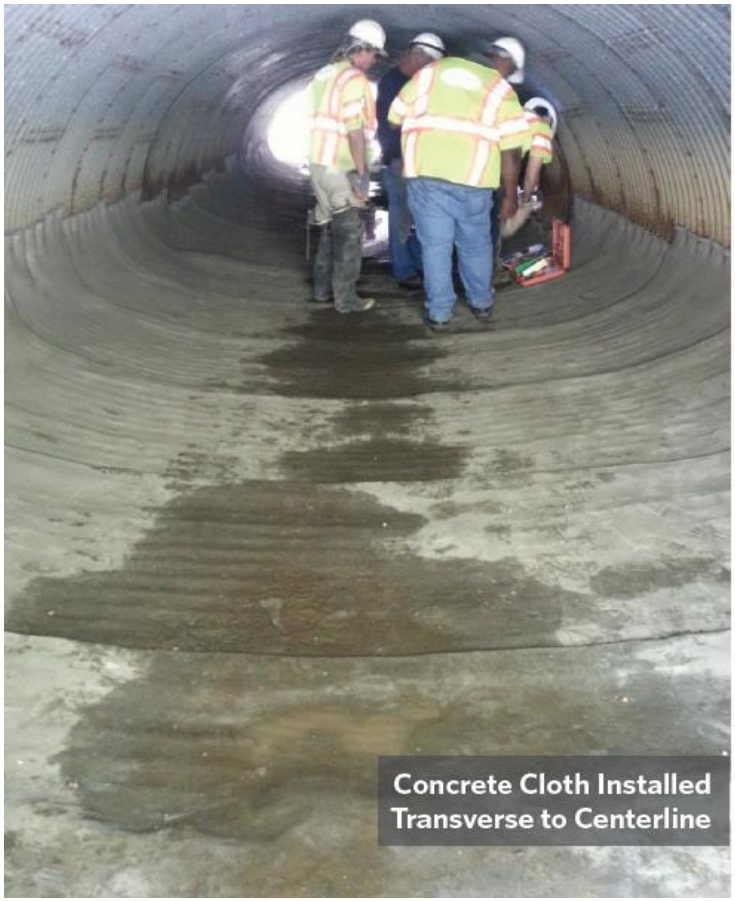
Minor Invert deterioration

Milliken®
Concrete Cloth™

Concrete Impregnated Fabric



Concrete Cloth Case Study
Culvert Outlet Repair – Michigan

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MDOT Michigan Department of Transportation

Project Details

Date: September, 2013

Owner: Michigan Department of Transportation

Application: M10 Median Culvert Outlet Washout Repair

Water blew out a 36 inch diameter culvert. Repair included a Concrete Cloth outlet/channel lining/spillway lining down to the nearby stream

Concrete Cloth Case Study

Culvert Outlet Repair – Michigan

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Collapsed 36” CMP Culvert with Outlet Scour

Concrete Cloth Case Study

Culvert Outlet Repair – Michigan

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Outlet channel before and after re-grading

Concrete Cloth Case Study
Culvert Outlet Repair – Michigan

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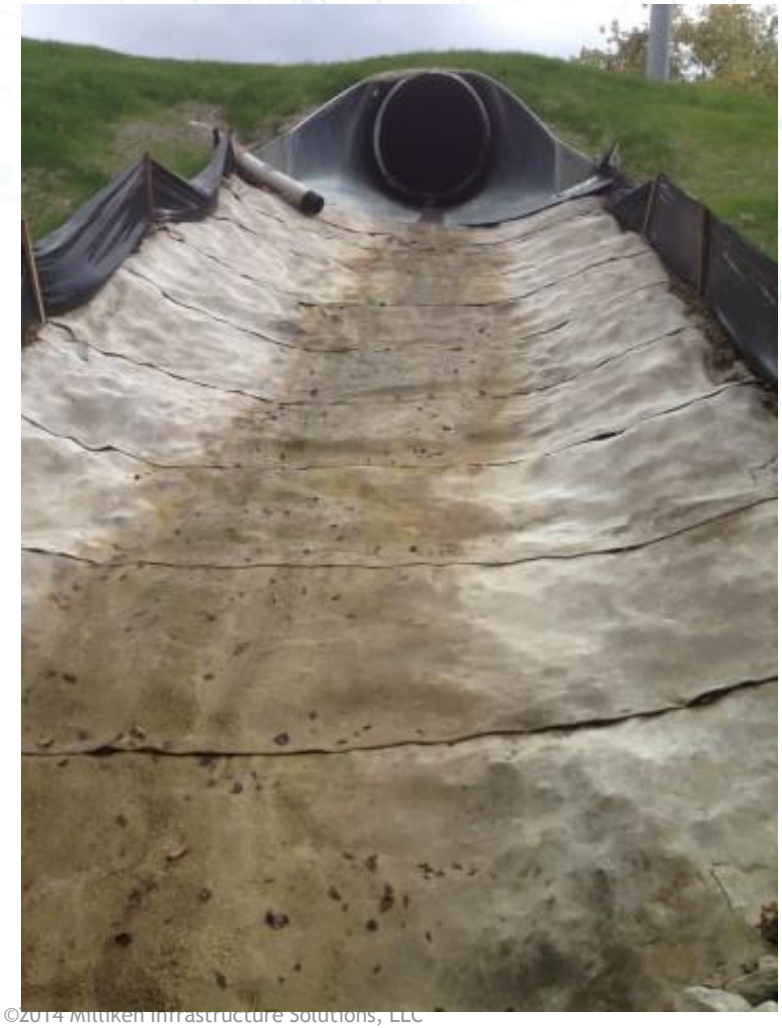
Completed Concrete Cloth Installation



Concrete Cloth Case Study
Culvert Outlet Repair – Michigan

Milliken | Milliken Infrastructure Solutions, LLC

After placement of RipRap in the stream outlet

Concrete Cloth Case Study
Culvert Outlet Repair – Michigan

Milliken | Milliken Infrastructure Solutions, LLC

MDOT Michigan Department of Transportation

Project Details

Date: August, 2013

Owner: Michigan Department of Transportation

Application: M33/72 Approach Drain Repair

Bridge approach drain was eroding exposing the pipe and the downstream outlet to scour. Repair included a Concrete Cloth outlet/channel lining lining down to the nearby stream

Concrete Cloth Case Study

Pavement Drain & Outlet Repair – Newaygo, Michigan

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Eroding Drain Inlet and Outlet

Completed Concrete Cloth Installation

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Ohio State Route 579 Bridge
Toledo, OH

Slope Foundation Protection Erosion Control

Installation Completed
September, 2015

Eroding Bridge Abutment Slope

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Slope Preparation

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Bridge Abutment Slope Protection

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Bridge Abutment Slope Protection

Milliken | Milliken Infrastructure Solutions, LLC

Project Details

- Date: July 18, 2013
- Location: Blair County, Pennsylvania
- Application: Roadside Drainage Ditch

  - Due to steep grades, the Pennsylvania DOT installed a number of cross culverts years ago in order to capture storm water runoff and outlet it on the downslope side of the roadway. On one stretch, the DOT wanted to improve erosion protection.

Roadside Ditch Protection

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Failing Metal Culvert

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Invert deterioration from corrosion and abrasion

Milliken Geopolymers

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Milliken Infrastructure Solutions, LLC

Pipe Rehabilitation Technology

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Structural Rehabilitation of Pipes
Centrifugal Casting

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Centrifugal Casting Concrete Pipe (CCCP) / Spin Casting of Geopolymer (SCGP) using GeoSpray

- Rapidly distributes material within the pipe's internal circumference
- Forms a strong, low permeability, cement lining
- Depending upon design & thickness, creates a "pipe within a pipe" and does not rely on the integrity of the host structure
- While not generally required, it is compatible with most common reinforcement technologies

Structural Rehabilitation
Application Sled

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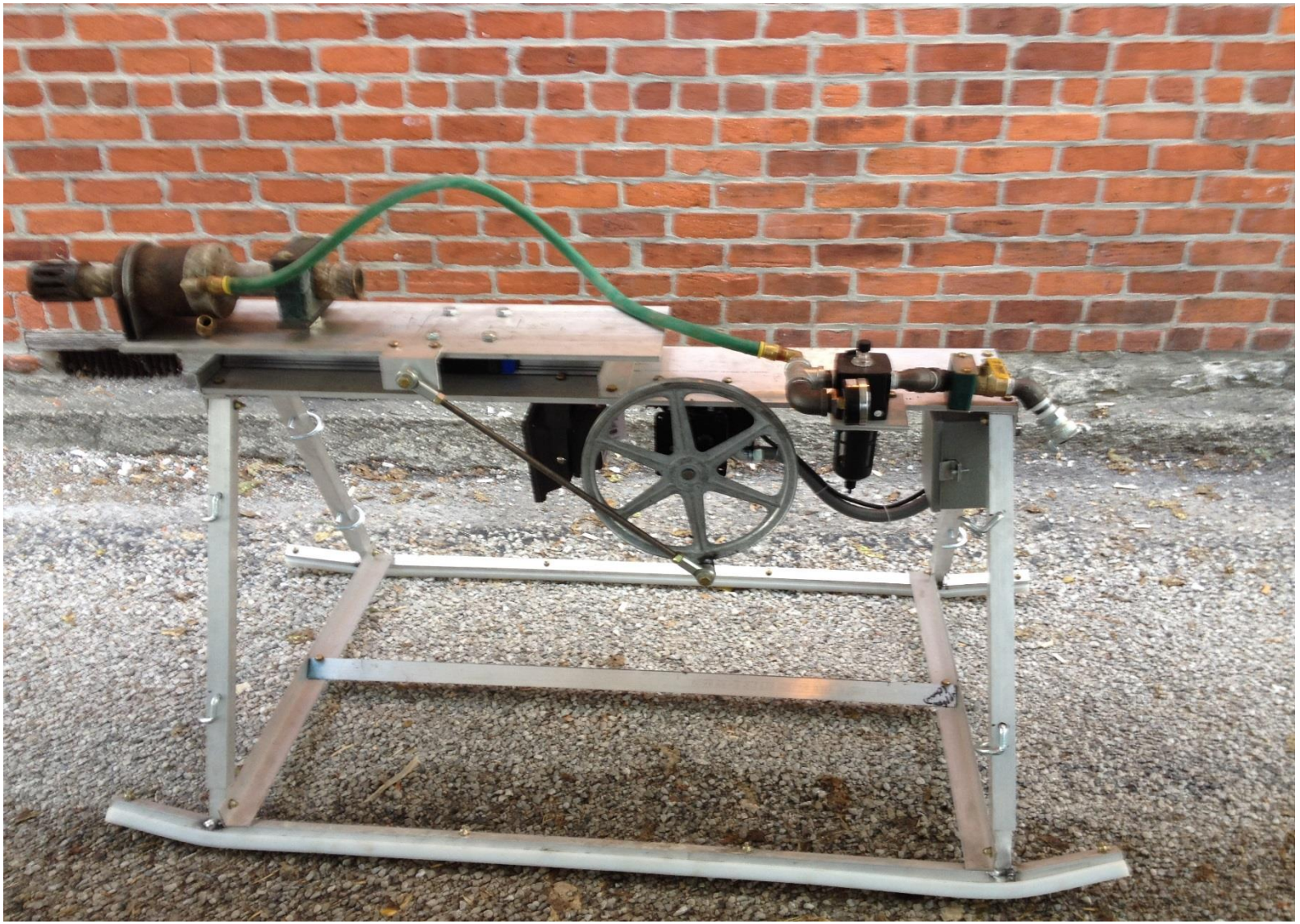

Structural Rehabilitation
Application Process

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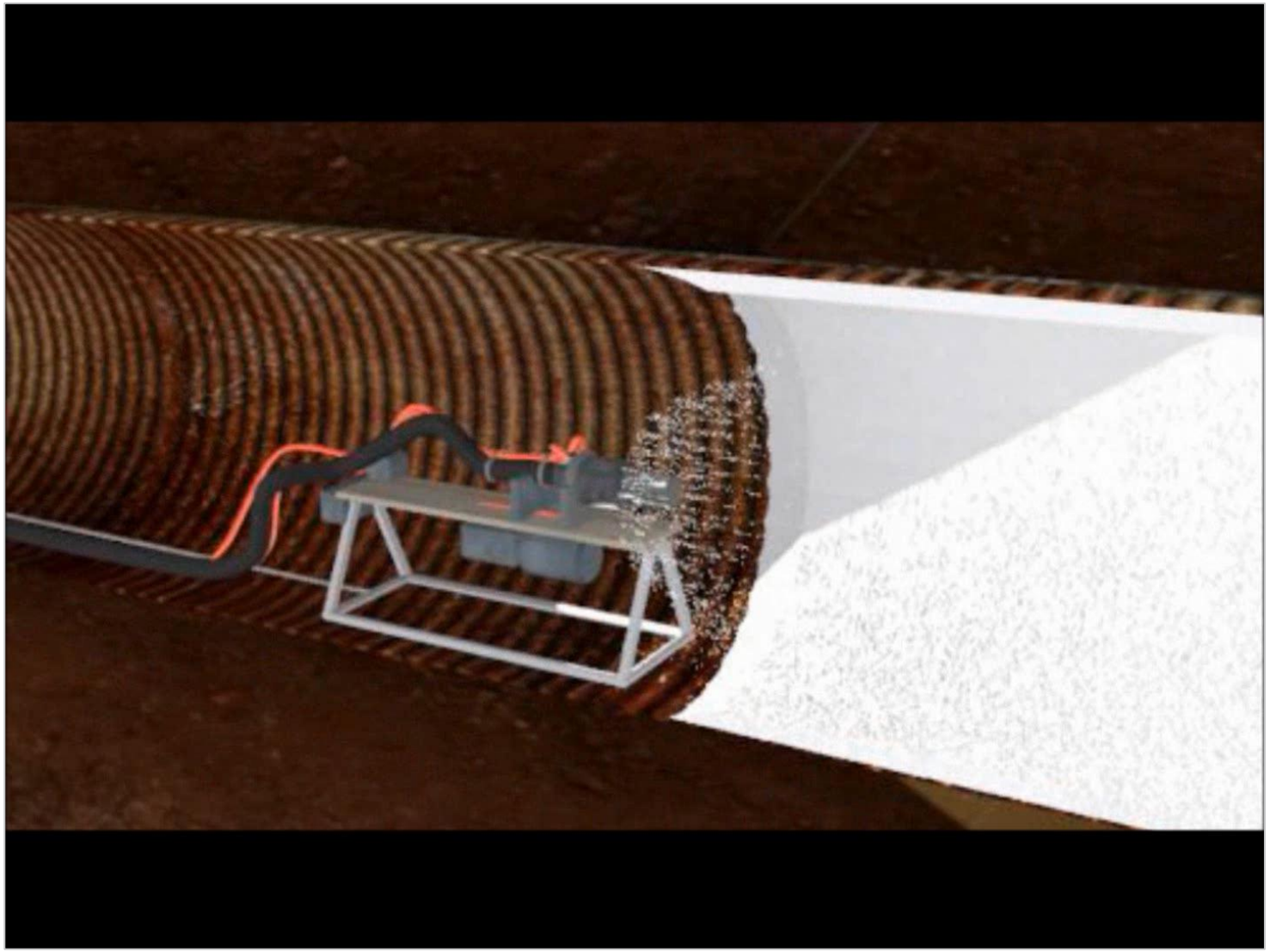

What is a GeoPolymer?

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- Not a Plastic
  - Not HDPE/PVC/Epoxy

- Looks and feels like cement
  - Workability
  - Material Properties
  - Service Life

- Chemical structure like natural stone
  - Monolithic
  - Durable
  - Corrosion Resistant

GeoPolymer Chemistry Primer
Typical GeoPolymer Chemistry

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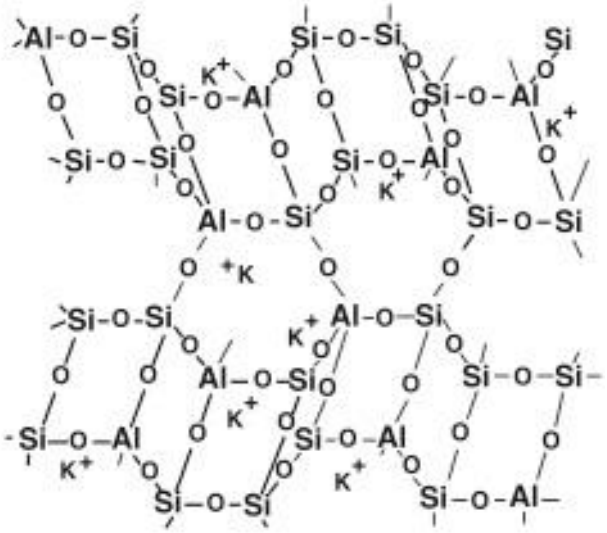
Geopolymers or alkali cements consist predominantly alumino-silicates or polymer Si-O-Al bonds and are similar in chemical make-up to natural Zeolites. Traditional starting materials for geopolymers cements are fumed silica, fly ash & metal slag.

- Geopolymers can be produced from commercially available industrial waste streams, creating a highly environmentally friendly product.
- The chemical reactions of geopolymer create only a fraction of the CO_2 emissions of standard cementitious materials.
- Geopolymers have excellent chemical and thermal resistance and can essentially be considered engineered stone.



Typical Geopolymer Structure

Source - J. Davidovits - Geopolymer Chemistry and Applications, 3rd ed.

GeoSpray Advantages
Generations of Cast Mortars

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GeoSpray offers significant physical, environmental, chemical, and economic advantages over traditional materials.

	Portland Cement	GeoSpray™
Specific Strength	Variable	Excellent
Early Strength	Variable	Excellent
Acid Resistance	Poor	Very Good
Self-Adhesion	Low	High
% Recycled Content	<10%	>50%
CO_2 Emissions	High	Low
Single Pass Thickness	X	2X-3X
Total Installed Cost	$$	$
	Old Tech	Emergent Tech

Milliken Products
GeoSpray Physical Properties

Milliken Infrastructure Solutions, LLC

Milliken®
GeoSpray™
Geopolymer Mortar

Flexural and Tensile Strength are 2-3x better

Test Method	Duration	GeoSpray	Conventional Repair Mortar
Compressive Strength ASTM C-39/C-39M-09a/C-109	1 Day 28 Days	Min. 2,500 psi / 17 MPa Min. 8,000 psi / 55 MPa	5000 psi / 34 MPa
Flexural Strength ASTM C-78	7 Day 28 Days	1200 psi / 8.3 MPa (C-78) 1300 psi / 9 MPa (C-78)	500 psi / 3.4 MPa
Modulus of Elasticity ASTM C-469 – 02	1 Day 28 Days	3,000,000 psi / 20700 MPa 6,500,000 psi / 46500 MPa	3,000,000 psi / 20700 MPa
Bond Strength to Concrete ASTM C-882/C-882M-05	1 Day 28 Days	Min 1,300 psi / 9 MPa Min. 2,500psi / 11 MPa	N/A
Set Time ASTM C-807 – 08 Initial Cure Time	Initial Set Final Set	60 - 75 Minutes 90 - 110 Minutes	120 Minutes 300 minutes
Freeze Thaw Durability ASTM C-666	300 Cycles	100% Zero loss	80% to 90% 10% to 20% degradation
Sulfate Resistance (% expansion) ASTM C-1012-04	6 Weeks	0.011 % Expansion	0.038% to 0.044% Expansion
Shrinkage ASTM C-1090	28 Days	0.07%	0.35% to 0.50%
Tensile Strength ASTM C-496	28 Days	Min. 750 psi / 5.2 MPa	400 psi / 2.7 MPa
Abrasion Resistance ASTM C-1138	6 Cycles @ 28 Day Maturity	0.67% Loss	5.60% Loss
Chloride Ion Penetration by Ponding ASTM C-1543	90 days ponding	0.014 % wt Cl at 55-65 mm	N/A

GeoSpray Advantages
Environmental Benefits

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- GeoSpray is produced from commercially available industrial waste streams, creating a highly environmentally friendly product, Greater than >50% post-industrial recycled.

- These materials are introduced and serve as “alternative cementitious” binders as well as “contributing fillers”, such that every particle within GeoSpray is providing some cross-linking characteristic.

- The production method & chemical reaction of GeoSpray create only a fraction of the CO_2 emissions of other cementitious materials.

GeoSpray Advantages
Self Bonding

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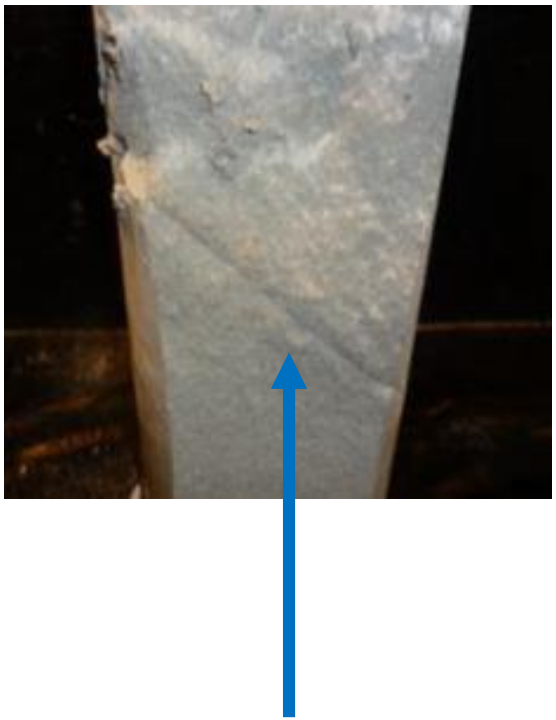
Experimental Parameters:

- On the first day a series of 2” by 4” cylinders were cast half full and cured with on an approximately 45 angle.
- On subsequent days (1, 7, 14 and 28) the top half of the cylinders were cast and filled creating a 45 angled joint in the center of the cylinders
- Compressive strength tests were conducted 28 days after the top half of the cylinders were cast.



Joint in Tested Sample

GeoSpray Advantages
Self Bonding

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Results:

- Samples cast of GeoSpray (both halves) when tested under compression did not break at the joint.
- The chemical nature of GeoSpray allows for chemical bonding across the interface even with pours 28 days apart resulting in a monolithic structure.
- Samples cast of competitive cement mortars always broke along the angled joint essentially creating 2 separate layers.

This unique property of geopolymers allows project flexibility in variable weather conditions as the covalent bonds prevent cold joint shear failure

GeoSpray Advantages
Corrosion Resistance

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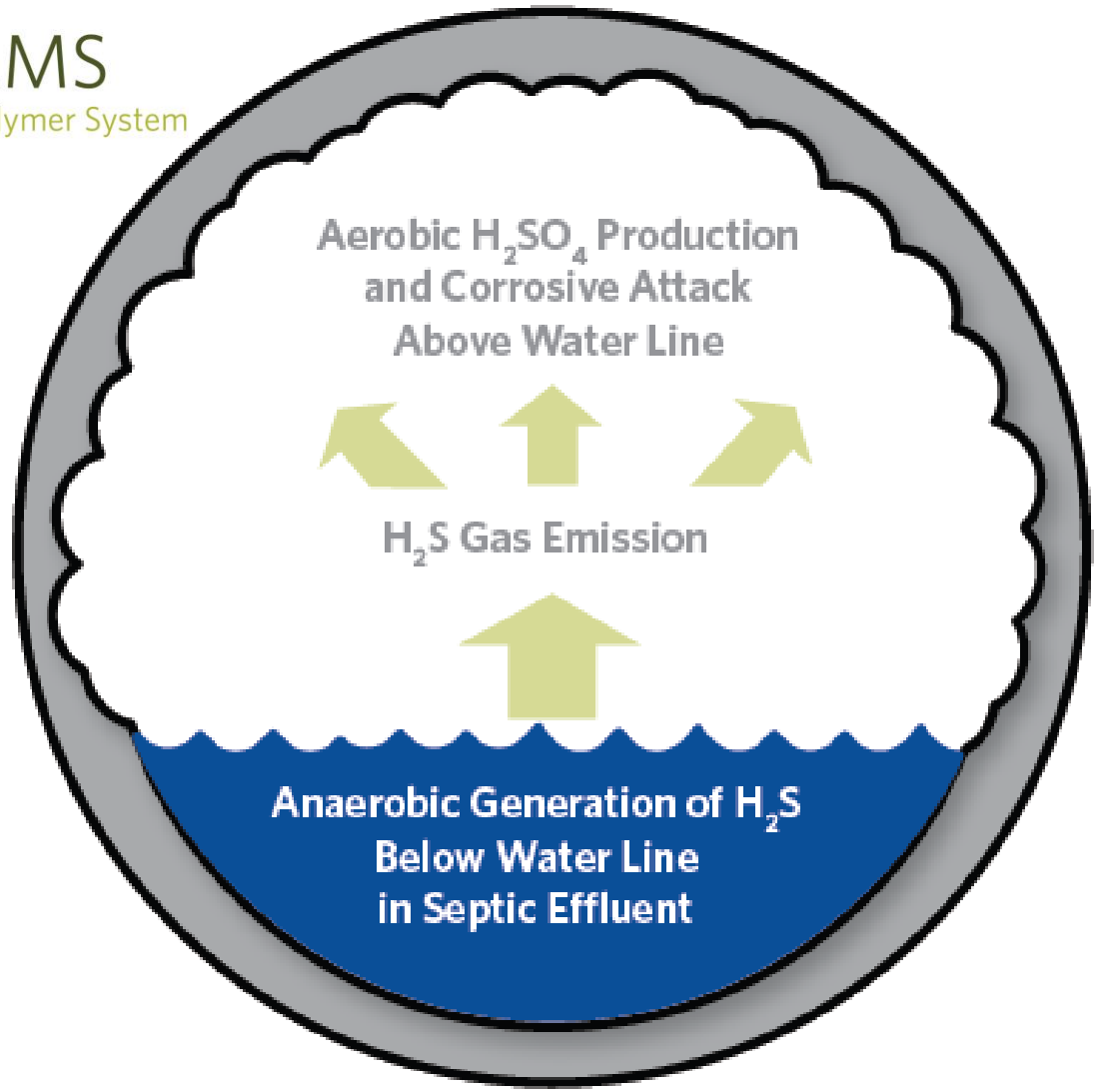
Milliken
GeoSpray™ AMS
Corrosion Resistant Geopolymer System



Microbial-Induced-Corrosion (MIC) Mechanism

GeoSpray Advantages
Corrosion Resistance

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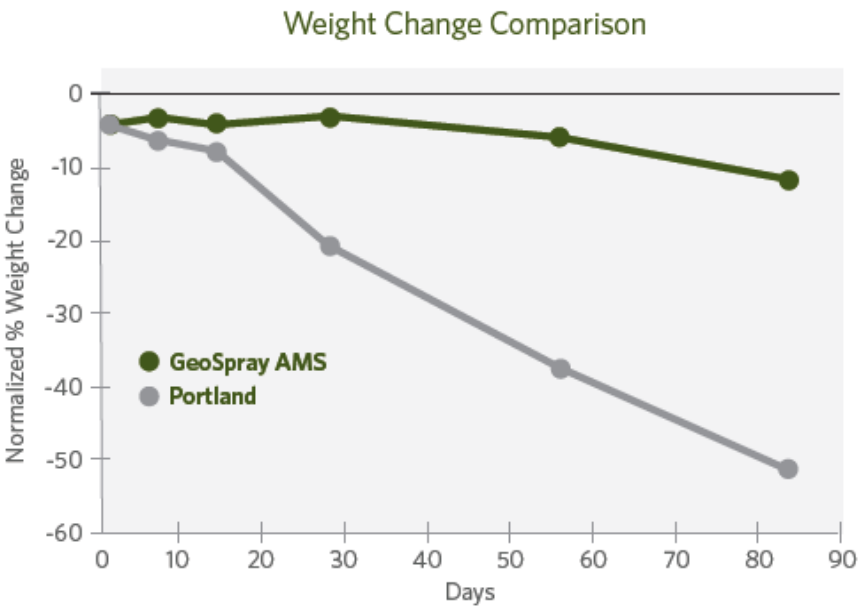

- When samples were further exposed to higher levels of sulfuric acid (7% H_2SO_4) GeoSpray AMS samples showed some signs of surface level corrosion after 84 days.
- GeoSpray AMS samples performed significantly better than standard portland cement samples which lost greater than 50% of their original weight.

GeoPolymer Advantage
Manning's n

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Centrifugally spun cement-mortar lining is noted to have a Manning coefficient of 0.009 or 0.010 on pipes in service 20 years or more

Table 12.1.1 Typical Coefficients of Pipe Friction for Design[a]

Material	Hazen–Williams C	Manning n[b]
New pipe or lining		
Smooth glass or plastic[c]	150	0.009
Centrifugally spun cement-mortar lining[d]	145	0.009
Cement-mortar lining troweled in place	140	0.009
Old pipe or lining [in moderate service (20 years or more), nonagressive water][e]		
Smooth glass or plastic	135	0.010
Centrifugally spun cement-mortar lining[f]	130	0.010
Cement mortar troweled in place	125	0.010

ACPA has a conservative design value of 0.012 for concrete pipe

Table 1: Values of Manning's *n*

Pipe Material	Values of Manning's *n*	
	Laboratory Values	ACPA Recommended Design Values
Concrete Pipe	0.010	Storm Sewer - 0.012 Sanitary Sewer - 0.012-0.013
Corrugated HDPE (lined)	0.009-0.015	Storm Sewer - 0.012-0.024
PVC solid wall	0.009	Storm & Sanitary Sewer - 0.011-0.013
Corrugated Metal Pipe	0.022-0.028	Storm Sewer - 0.029-0.034
Spiral Rib Metal Pipe	0.012-0.013	Storm Sewer - 0.016-0.018

- When lining corrugated metal pipe Manning's n values will likely be reduced to a range of 0.016 to 0.018 as the lining fills in some of the corrugation.
- Option to adjust the desired roughness of the surface by hand finishing techniques

Source: Mays, Larry; Water Resources Engineering, 2nd Edition; John Wiley & Sons, Inc; 2011; pg. 473.

Improving Manning's n

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Hand trowelled finish reduces roughness to the finish of smooth concrete pipe.

Slip Lining Drawbacks

- Open Area Reduction
- Requires work beyond inlet/outlet
- Requires Extra ROW or temporary access permits
- Wetland impact requiring ACOE permits
- Temporary haul road construction and removal
- Increases culvert new design standard requirement for aquatic organism

GeoSpray CCCP Advantages
Effective and Efficient

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- Lower total system cost than alternative methods
  - Installation + ongoing operating costs
- Point of failure repair
- Less risk exposure from weather
- Less disruptive to the community
  - Less cost associated with road closures, non-productive labor, traffic delays, impact to local business, etc.
- More quickly implemented
  - Less cure/set-up time

Equipment Footprint

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All required equipment is housed in a single 24 ft box truck, with a hopper and materials storage. All repair equipment fits down a standard 24 inch diameter manhole.

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GeoSpray Advantages
Application Flexibility

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Shape
- Non-round, elliptical, egg shaped
- Manholes, wet-wells, junction boxes

Length
- Short lines, culverts, point repair
- Longer sewer and storm segments

Diameter
- From 36 inches to 180 inch
- Varying diameter in a single run

Ovality
- Ovality greater than 10%
- Box culverts and structures

GeoSpray Advantages
Application Flexibility

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Angles
- Bends, curves, and change in elevation

Laterals
- Monolithically tied to structure

Host pipe material
- Brick, Rock, Concrete
- Corrugated Metal or Cast Iron

Host pipe condition
- Slightly to fully deteriorated

GeoSpray Applications
Manholes – ASTM F 2551-09

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Designation: F 2551 – 09

Standard Practice for Installing a Protective Cementitious Liner System in Sanitary Sewer Manholes[1]

This standard is issued under the fixed designation F 2551; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

A sanitary sewer manhole may be repaired or rehabilitated by applying a prepackaged cementitious liner to the interior surface after it has been properly prepared and cleaned. Sanitary sewer manholes can be damaged by dynamic loading, abrasion, erosion, and corrosion.

An ASTM Standard exists for coating of manhole with cementitious/geopolymer systems that describes the quality control and general process requirements.

GeoSpray Applications
Manholes

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Manhole Being Coated

GeoSpray Applications
Manholes

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Before

After

Trenchless Technologies
Simple Cost Estimations

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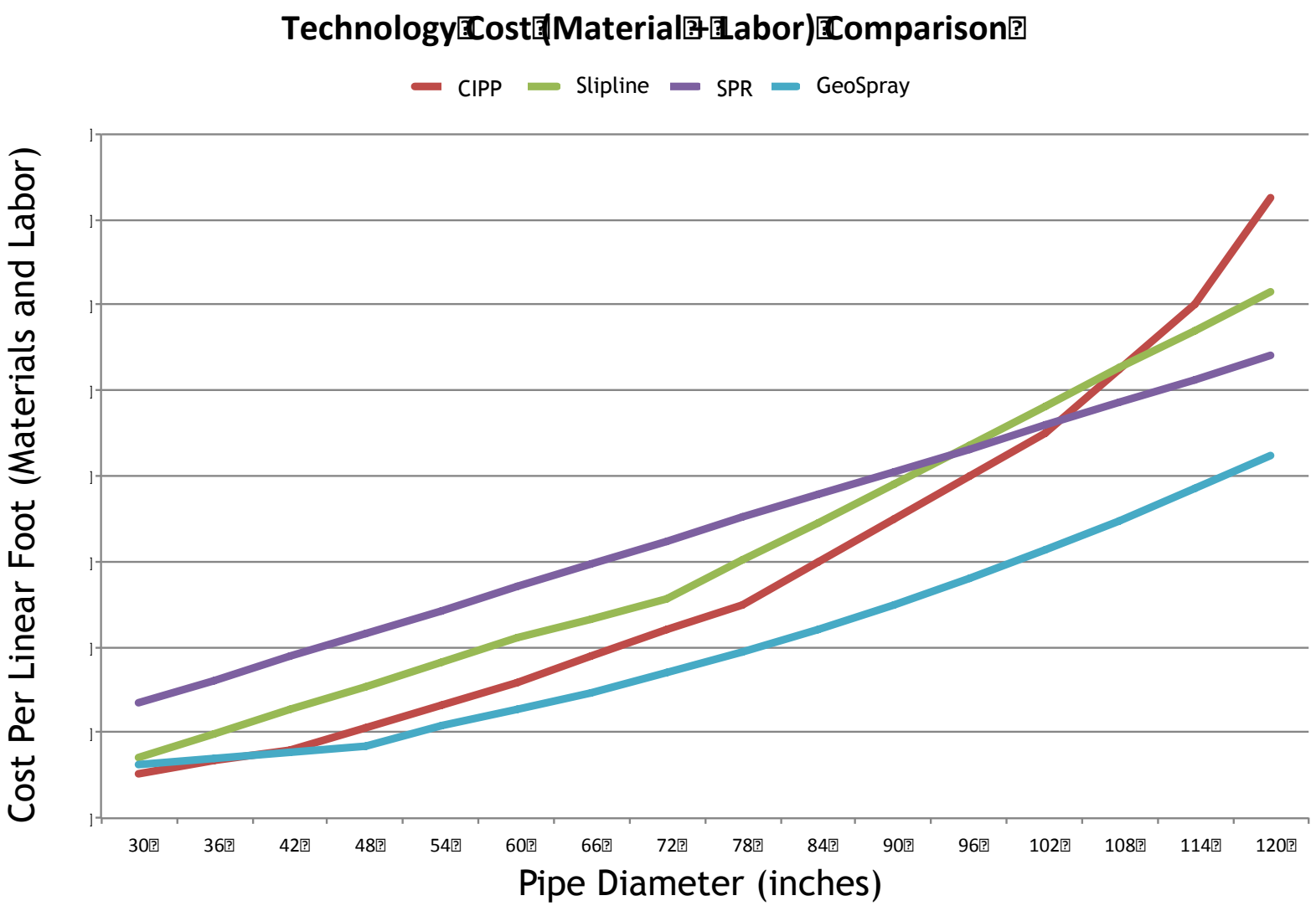

GeoSpray DOT Approvals
November - 2015

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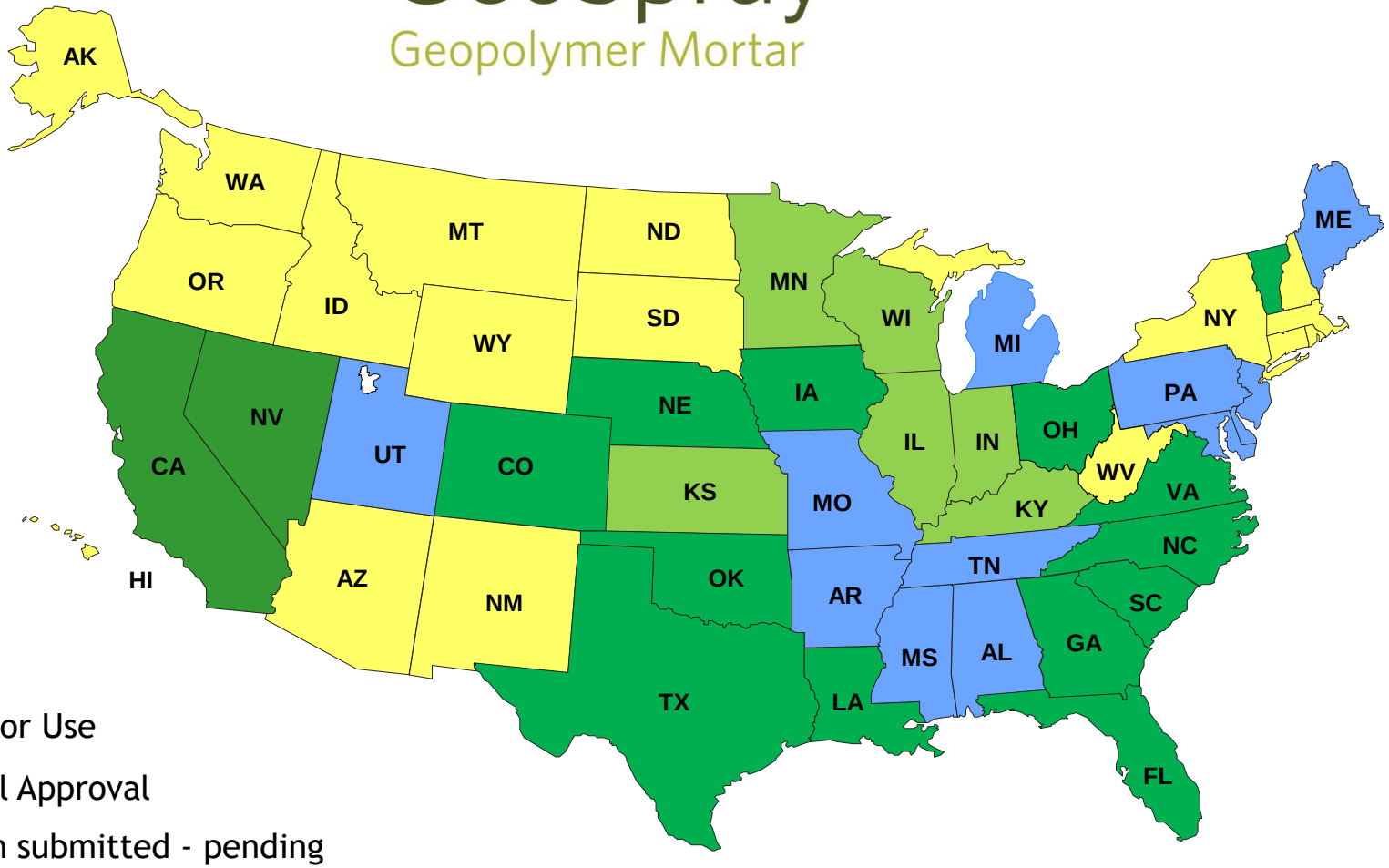
Milliken®
GeoSpray™
Geopolymer Mortar



- Approved for Use
- Conditional Approval
- Application submitted - pending
- Approved for field testing

GeoPolymer Case Studies

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City of Fort Worth - Texas

Five Multi-cell 84” CMP Culverts

Installation Completed
2013

GeoSpray Case Study
Side By Side Culverts – Fort Worth, TX - USA

Milliken | Milliken Infrastructure Solutions, LLC

The active creek bed was dewater and flow through the culverts were diverted. The pipes were then cleaned and pressure washed in preparation for lining.

The deteriorated condition of the pipes caused significant safety concerns due the heavy industrial traffic that is common on this road. Flooding of the road was also a common occurrence.

GeoSpray Case Study
Side By Side Culverts – Fort Worth, TX - USA

Milliken | Milliken Infrastructure Solutions, LLC

GeoSpray was used not only to rehabilitate the pipes, but also to rehab the head wall.

Carefully calculated and monitored application of the material provided improved flow characteristics and stopped flooding that had been common place.

The contractor was able to guarantee a fully structural rehabilitation of the existing infrastructure, and the asset owner renewed the culverts without public disruption.

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SR 446-Indiana DOT Bloomington, Indiana

Culvert Rehabilitation Case Study

Installation Completed
September 2015

GeoSpray Case Study
SR 446 – Bloomington, Indiana

Milliken | Milliken Infrastructure Solutions, LLC

Project Details:

- The Indiana DOT was looking for a site to demonstrate the lining capability of a geopolymer cement mortar. SR 446 provided a pipe that allowed for good access and viewing.

- Corroded & deteriorating CMP Culvert
  - 275 linear feet of 84 inch diameter
  - Bolted multiplate corrugated metal pipe

- Contractor – Temple and Temple

GeoSpray Case Study
SR 446 – Bloomington, Indiana

Milliken | Milliken Infrastructure Solutions, LLC

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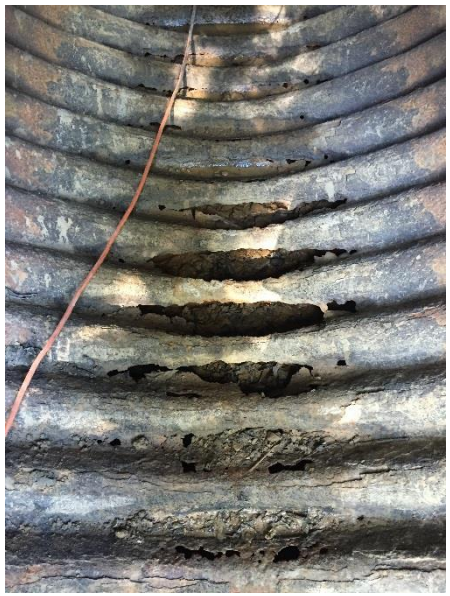
GeoSpray Case Study
SR 446 – Bloomington, Indiana

Milliken | Milliken Infrastructure Solutions, LLC

Additional Key Job Requirements:

- The culvert was originally specified to be rehabilitated with cured in place pipe (CIPP).
- SR 446 culvert under 30+ of fill.
- Sections of invert have corroded completely through with significant sections of ground water infiltration.



GeoSpray Case Study
SR 446 – Bloomington, Indiana

Milliken | Milliken Infrastructure Solutions, LLC

Small working footprint allowed for very limited disruption to traffic with no lane closures.

GeoSpray Case Study
SR 446 – Bloomington, Indiana

Milliken | Milliken Infrastructure Solutions, LLC

Invert was repaired by hand spraying GeoSpray mortar into the invert voids.

GeoSpray Case Study
SR 446 – Bloomington, Indiana

Milliken | Milliken Infrastructure Solutions, LLC

A 1.5 inch structural GeoSpray liner was applied in 2 passes.

GeoSpray Case Study
SR 446 – Bloomington, Indiana

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The entire rehabilitation was completed in seven days with little to no disruption of the private and commercial neighbors.

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River Road
Weldon, North Carolina

Culvert Case Study

Installation Completed
November 2013

GeoSpray Case Study
River Road – Weldon, North Carolina - USA

Milliken | Milliken Infrastructure Solutions, LLC

Project Details:

- NCDOT was looking for a challenging first application site for GeoSpray in North Carolina, and they found it on River Rd in Weldon NC.

- Corroded & deteriorating CMP Culvert
  - 85 linear feet of 108 inch diameter
  - 70,000 lbs of GeoSpray applied

- Contractor – IWPC – IPR Great Lakes

IWPC
AN IPR COMPANY

GeoSpray Case Study
River Road – Weldon, North Carolina - USA

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Additional Key Job Requirements:

- The north face of the culvert had already been repaired with metal bracing to prevent on-going erosion and potential damage to near by housing.
- River Rd is the only access road to an industrial waste treatment plant and 2 local farms.
- During many parts of the year the culvert is completely submerged causing significant areas of corrosion and water infiltration.

GeoSpray Case Study
River Road – Weldon, North Carolina - USA

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The 108 inch CMP culvert was missing significant material in the invert and was in need of repairs.

An 8 inch hydraulic by-pass was used to divert flow and allow traffic over the single lane road during the entire rehabilitation.

GeoSpray Case Study
River Road – Weldon, North Carolina - USA

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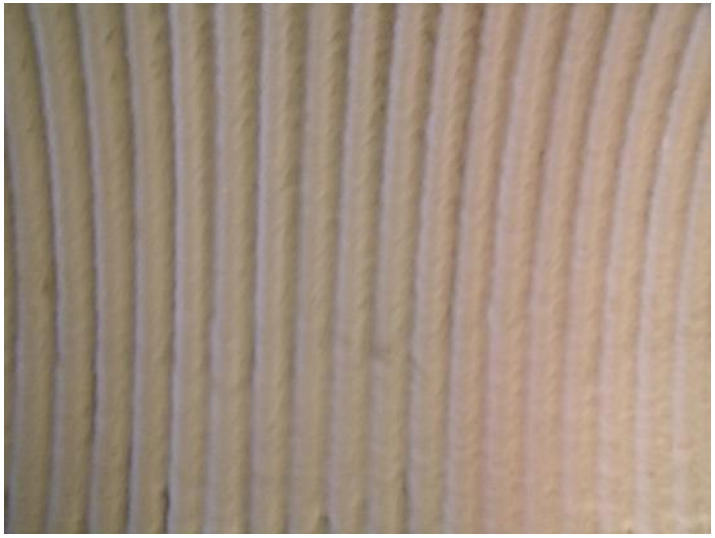
A 2.5 inch structural GeoSpray liner was applied in 4 passes.

The entire rehabilitation was completed in seven days with little to no disruption of the private and commercial neighbors.



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Rock Springs, Wyoming

Arched Culvert Case Study

Installation Completed
May 2014

GeoSpray Case Study
Rock Springs, Wyoming - USA

Milliken | Milliken Infrastructure Solutions, LLC

Project Details:

- Rock Springs, Wyoming

- Arched Storm Culvert
- 700 Linear Feet of CMP
- 48 Inch High
- 72 Inch Wide
- 126,000 lbs of GeoSpray Applied

- Contractor – IPR South Central

GeoSpray Case Study
Rock Springs, Wyoming - USA

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The initial culvert was in very poor shape with most of the invert corroded and lost with soil voids as deep as 2 ft below the pipe

Significant damage also existed in the crown with some sections caved in.

GeoSpray Case Study
Rock Springs, Wyoming - USA

Milliken | Milliken Infrastructure Solutions, LLC

Prior to repair the pipes required bracing for safe operation.

The finished culvert created a new structural system, integrated with the junction boxes

GeoSpray Case Study
Rock Springs, Wyoming - USA

Milliken | Milliken Infrastructure Solutions, LLC

The project was completed in under 1 week with no disruption to traffic along the roadway

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Fort Worth, Texas

Non-Round Storm Sewer Case Study

Installation Complete
June 2013

GeoSpray Case Study
Arched Storm Water – Fort Worth, TX - USA

Milliken | Milliken Infrastructure Solutions, LLC

Project Details:

- Work Order issued by the City of Fort Worth, Texas for trenchless repair existing RCP Storm Water

- Deteriorated RCP
  - 634 linear ft of 80” x 84” arched
  - 296 linear ft of 102” x 84” arched

- Contractor – IWPC – IPR Great Lakes

- Engineering called for rebar to be placed in the square bottoms of the pipes, and carbon fiber to provide additional support to the arched roof.

GeoSpray Case Study
Arched Storm Water – Fort Worth, TX - USA

Milliken | Milliken Infrastructure Solutions, LLC

Original arched storm water pipe with severely damaged invert.

The first step was to install a rebar cage along the bottom corners of the pipe to support a rounded bottom.

GeoSpray Case Study
Arched Storm Water – Fort Worth, TX - USA

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The completed rebar support system with initial repairs completed to the invert.

The lower corners of the pipe were then rounded with a hand sprayed application of GeoSpray.

GeoSpray Case Study
Arched Storm Water – Fort Worth, TX - USA

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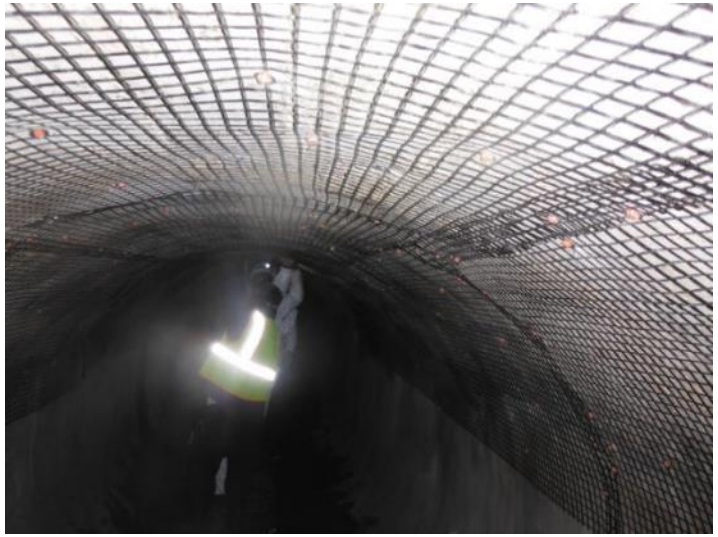
After the first pass of GeoSpray was completed on the pipe, a carbon fiber grid was applied to the top section to help with additional structural support.



A final pass of GeoSpray was applied finishing the application process.

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Garden State Parkway

Arched CMP Culverts

Completed
October 2014

GeoSpray Case Study
Garden State Parkway – NJ, USA

Milliken | Milliken Infrastructure Solutions, LLC

Project Details:

7 Arched CMP culverts running under the Garden State Parkway (owned by the New Jersey Turnpike Authority) were inspected and determined to be corroding. The dimensions of the structures were as follows:

1. 315 Linear Ft of 160” x 101” pipe
2. 315 Linear Ft of 60” x 40” pipe (3 Culverts)
3. 375 Linear Ft of 60” x 42” pipe (2 Culverts)
4. 150 Linear Ft of 112” x 75” pipe

A majority of the pipes were filled with significant amounts of silt and debris. Several sections had completely collapsed.

- Contractor – Inland Pipe Rehab

GeoSpray Case Study
Garden State Parkway – NJ, USA

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Most of the culverts were at least 40% filled with silt, so the pipes were thoroughly cleaned of the material and then pressure washed and inspected.

Because the inverts of the pipes were severely corroded, they were rebuilt and then prepared for GeoSpray material application.

GeoSpray Case Study
Garden State Parkway – NJ, USA

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Once cleaned, a first pass of material was applied by shotcrete methods to the corners of the pipe to insure that enough material was placed in those area as required by the engineering design.

Then the material was applied by spin casting the entire pipe to cover the crown and invert. The by-pass pipe was run through the pipe to avoid disruption of the highway and it was adjusted from side to side as the pipe was rehabbed.

GeoSpray Case Study
Garden State Parkway – NJ, USA

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Any laterals were plugged and sprayed passed, this create a structure that “feathers” in the material past the opening of laterals.

No post cutting of laterals was necessary, saving time and expense.

Each of the smaller pipes had 1.5 inches of thickness applied, while 2.1 inches was required for the largest pipe based on independent engineering. The invert was smoothed around the by-pass pipe to insure a complete structural repair.

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Kentucky Highway 9 Sanitation District 1 Newport, Kentucky

Sanitary Sewer Case Study

Installation Completed

December 2014

GeoSpray Case Study
KY 9 – Newport, Kentucky - USA

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Existing 60” x 40” brick sewer.

GeoSpray Case Study
KY 9 – Newport, Kentucky - USA

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Existing 60” x 40” brick sewer.

GeoSpray Case Study
KY 9 – Newport, Kentucky - USA

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A 1.5 inch structural GeoSpray liner was applied in 2 passes.

GeoSpray Case Study
KY 9 – Newport, Kentucky - USA

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Structural rehabilitation with a 1.5 inch GeoSpray mortar lining.

GeoSpray Case Study
KY 9 – Newport, Kentucky - USA

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Structural rehabilitation with a 1.5 inch GeoSpray mortar lining.

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US Highway 59
Houston, Texas

Sanitary Sewer RCP Repair Case Study

Installation Completed
August 2011

GeoSpray Case Study
Sanitary Sewer RCP – Houston, TX - USA

Milliken | Milliken Infrastructure Solutions, LLC

Project Details:

- City of Houston, Texas
- Deteriorated RCP
  - 700 linear feet of 72” RCP
  - Under heavily traveled US Highway 59 in northeast Houston
  - Severe infiltration at multiple joints
  - Evidence of significant ground settlement
  - 42 feet of cover above the pipe
- Contractor – IPR South Central

GeoSpray Case Study
Sanitary Sewer RCP – Houston, TX - USA

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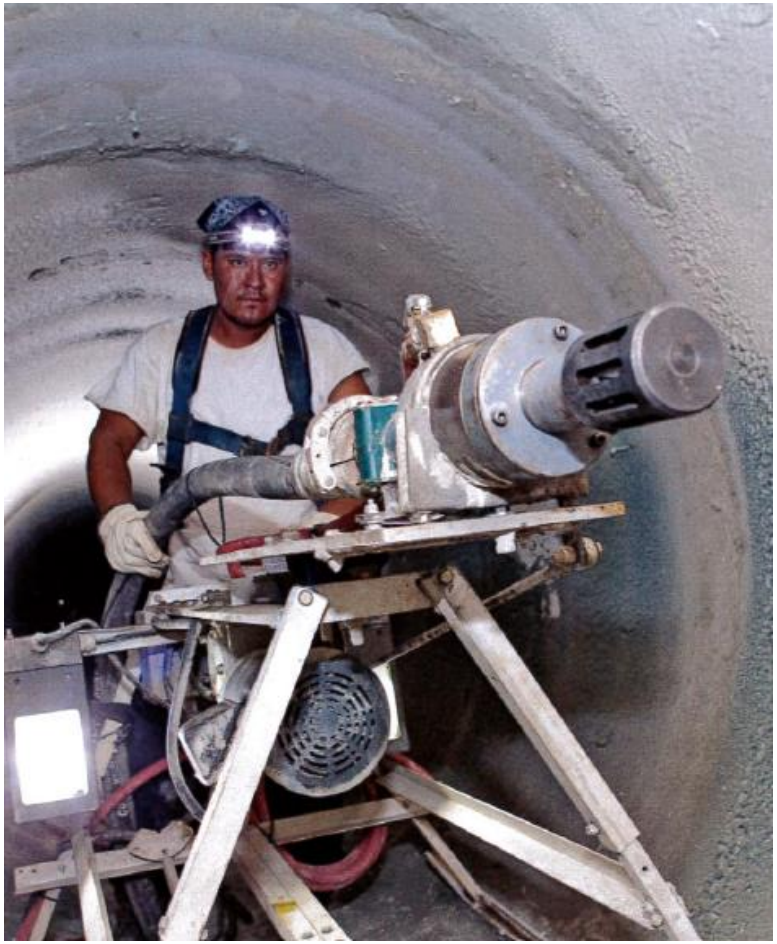
Additional Key Job Requirements:

- The rehabilitation was originally designed as a CIPP repair. Access holes and cleaning had been completed. Bypass was in place and running.

- Due to high temperatures (>100ºF during the summer months) the city deemed the risk of over-the-hole wet out along with early resin set-up as a significant risk.

- The city needed a solution as they did not expect the pipe to last through the Fall – when the risks associated with the CIPP installation would be inline with expectations.



GeoSpray Case Study
Sanitary Sewer RCP – Houston, TX - USA

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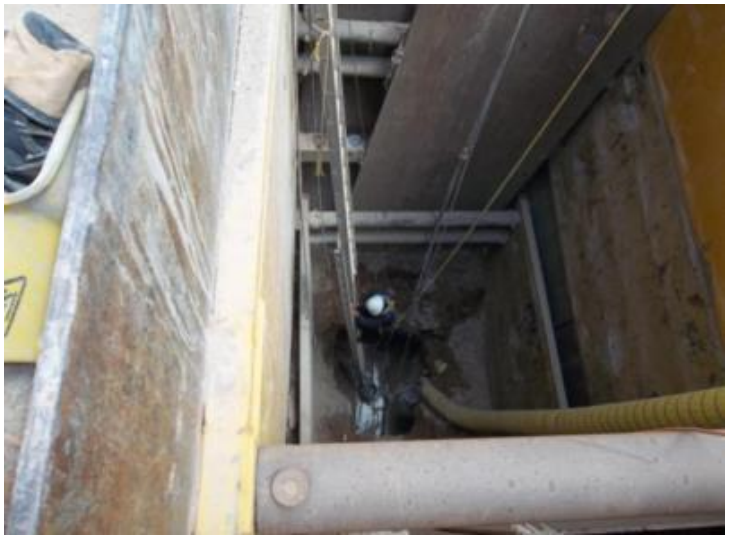
Access port that was created for the CIPP installation was used for the entry into the pipe.



Sever corrosion had occurred within the pipe and at the joints. The pipe was pressure washed and loose material was removed. Water infiltration was stopped at the joints with a hand application of GeoPlug material.

GeoSpray Case Study
Sanitary Sewer RCP – Houston, TX - USA

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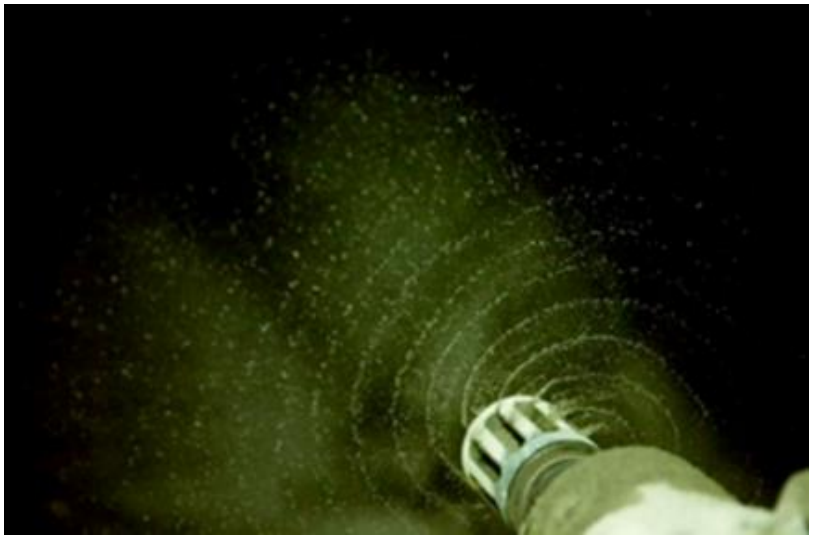
Once the pipe was cleaned and infiltration stopped, the application sled was positioned within the pipe.

The GeoSpray mortar was centrifugally cast from the spray nozzle onto the existing pipe wall to create a whole new pipe structure.

After the GeoSpray was applied, a finish coat of AMS Post Treatment was applied to impart additional corrosion resistance



GeoSpray Case Study
Sanitary Sewer RCP – Houston, TX - USA

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“The completed work is a benefit to the community”

David Tajadod – Managing Engineer – City of Houston

See Underground Construction – July 2012 for a complete article – ucononline.com

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EPA/Battelle Demonstration Houston, Texas

Sanitary Sewer RCP Repair – Case Study

Installation Completed
April 2013

GeoSpray Case Study
Sanitary Sewer RCP – Houston, TX - USA

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Project Details:

- City of Houston, Texas
- US EPA's Aging Water Infrastructure Program, conducted a field demonstration along with Battelle Memorial Institute.
- Deteriorated RCP
  - 165 linear feet of 60" RCP
  - 25 feet of cover
  - Directly beneath an open stormwater channel
  - Terminated in local treatment plant
- Contractor – IPR South Central

Final report of demonstration was presented at No Dig 2014 by John Matthews of Battelle.

GeoSpray Case Study
Sanitary Sewer RCP – Houston, TX - USA

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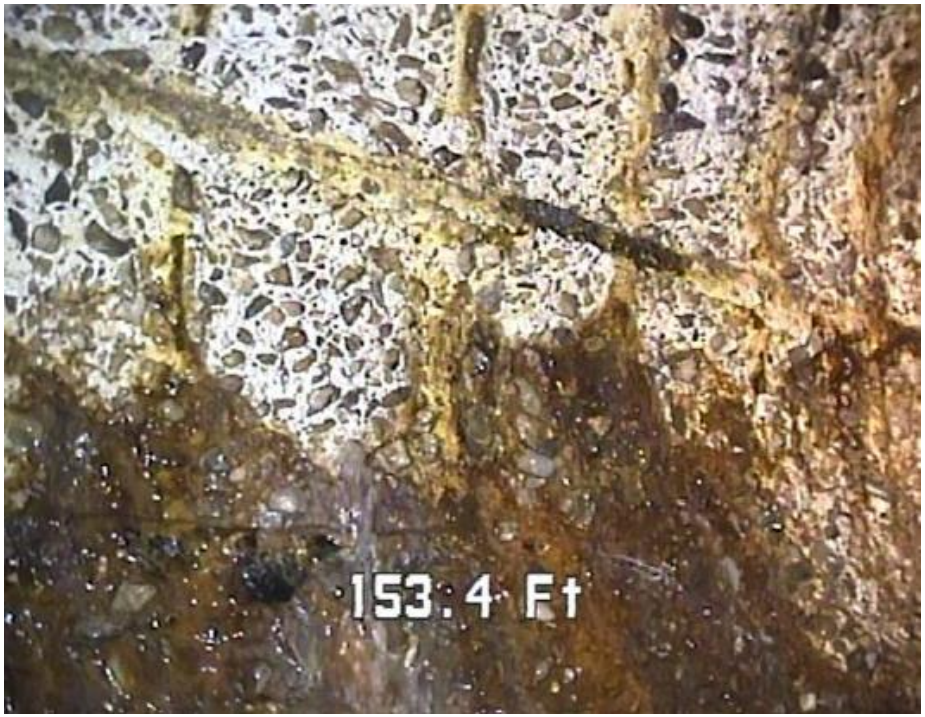
The RCP was severely deteriorated with exposed corroded rebar and several infiltration locations gushing water that needed to be repaired and controlled before lining the existing structure.



GeoSpray Case Study
Sanitary Sewer RCP – Houston, TX - USA

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Active infiltration was a concern that had to be repaired prior to lining.

Large sections of the invert of the pipe had also been corroded.

GeoSpray Case Study
Sanitary Sewer RCP – Houston, TX - USA

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Initial repairs were made and a thin first past of GeoSpray was applied prior to the final thickness

The 2.5” coating of GeoSpray was applied to the existing structure to create a new pipe inside the old. A final AMS Post Treatment was applied to provide additional corrosion resistance.

GeoSpray Case Study
Sanitary Sewer RCP – Houston, TX - USA

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"The independent evaluation of the technology showed it is a technically viable structural alternative to traditional repair and replace methods."

Ariamalar Selvakumar, Ph.D., P.E. – US EPA

John Matthews, Ph.D. & Wendy Condit – Battelle Memorial Institute

Thank You

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