

**EPOXY LINER PILOT TEST WORK PLAN
JANNEY RUN PROJECT
SEPTEMBER 2013**

1.0 INTRODUCTION

On behalf of ExxonMobil Environmental Services (ExxonMobil), TetraTech and its engineering subcontractor, SPEC Consulting (SPEC), presents this Work Plan document entitled “Epoxy Liner Pilot Test Work Plan, Janney Run Project”, dated September 2013. This Work Plan outlines an alternative lining system to be applied to the Janney Run culvert as a remedy to eliminate the infiltration of Light Non-Aqueous Phase Liquid (LNAPL). The alternative lining system outlined in this work plan is the Warren Environmental 100% Solid Epoxy Liner System (Warren System), which is a spray-on coating that can be applied in humid and wet conditions. The Warren System will initially be installed in a pilot test program consisting of two sections of the culvert, both measuring fifty (50) linear feet (LF). The test sections feature both bare host pipe surfaces as well as a portion of the culvert that is currently lined with the Danby System. These pilot tests will be conducted between STA 9+15 to STA 9+65, and STA 2+10 to STA 2+60. The pilot test area is proposed to be monitored for approximately six (6) to eight (8) months. This period will allow the test area to endure one (1) winter cycle and one (1) spring cycle including an elevated water table.

2.0 PROJECT PREPARATION

2.1 ABOVE-GRADE SITE PREPARATION

Above-grade setup for the pilot test will consist of an application trailer, a storage trailer and miscellaneous ancillary equipment located within the fence line. A safety equipment/access trailer will be placed at Manhole #1 and ventilation equipment (Coppus air-powered fans, pneumatic air blowers and electric ventilation blowers) will be installed at Manhole #1 and Manhole #2, located at STA 3+45 and STA 12+27, respectively.

2.2 STORMWATER BYPASS SYSTEM

For the pilot test sections described in this work plan, water will be controlled within the culvert by the use of a temporary pump around system, which will consist of the following:

- A moveable bulkhead that is custom-fit to accommodate the bottom third of the culvert.
- Two (2) high volume electric trash pumps.

- Two (2) lay-flat hoses attached to the pumps.
- A wire box surrounding the pumps intended to prevent debris from the plugging of the pumps.
- Miscellaneous supports installed to allow the hoses to pass through the work area without interfering with the installation of the Warren System.

It is anticipated that this system will be capable of handling standard base flow within the culvert. However, if this method proves to be insufficient, above ground pumping by conventional means will be implemented. It should be noted that the existing bypass system located within the culvert will be removed as the Warren System is installed.

2.3 CULVERT PREPARATION

In areas where the floor of the culvert is distressed, smoothing and leveling of the surface will be completed. This will be accomplished by installing epoxy mastic with a pea stone aggregate. In some instances, the mastic may be reinforced with a #3 steel reinforcing bar (See “Distressed Floor Repair” on attached reference drawing “Janney Run – Warren System – Miscellaneous Details”).

2.4 PILOT TEST BOUNDARY PREPARATION

The pilot test work areas will begin and end with a saw-cut keyway. The keyway wall will be cut into the entire circumference of the host pipe and will be approximately 1/2 inch deep by 1/4 inch wide. This keyway is intended to maintain the integrity of the Warren System at the end of the application area as well as to provide a sound joint for mating liner sections during liner installation associated with the proposed full scale remediation project.

3.0 WARREN SYSTEM

The Warren System consists of a two-part compound spray-application system, the S-301 Epoxy Spray System and the M-301 Epoxy Trowel-On Mastic System. Joint repair and sealing of visible seeps are performed using Warren Grout 151. Each component is discussed below followed with the specific application procedures.

3.1 EPOXY SPRAY-APPLICATION SYSTEM

The spray-application system designed by Warren features a method of applying the S-301 Epoxy Spray System by:

- Providing separate containers for the two parts of the compound.
- Heating the contents of the containers to decrease the viscosity of the contents.
- Mixing the heated contents of the containers.
- Pumping the liquids from each container to a downstream mixing assembly for intermingling the two parts of the compound.



- Providing a heated hose between the mixing assembly and a downstream spray device for applying the mixed compound.

This system is designed to allow the entire interior surface of an underground pipe to be coated, even while wet, to seal liquid leaks.

3.2 S-301 EPOXY SPRAY SYSTEM

The S-301 Epoxy Spray System is a two-part epoxy system formulated for spraying with Warren's spray-application system. The spray system is highly thixotropic, meaning that it is viscous under normal conditions, but becomes less viscous over time when stressed (in this case, heated within the pump). The spray system is formulated to enhance water and chemical resistance as well as to improve bond strength to a variety of substrates in addition to maximizing its own internal strength. The high thixotropic index allows for increased build thicknesses without sag.

3.3 M-301 EPOXY TROWEL-ON MASTIC SYSTEM

The M-301 Epoxy Trowel-On Mastic System is a two-part, highly thixotropic epoxy system formulated specifically for trowel-on applications. The mastic system is formulated to enhance water and chemical resistance as well as bond strength to a variety of substrates. The high thixotropic index allows for build-ups of up to 1½ inches on vertical surfaces without sag.

3.4 WARREN GROUT 151

The Warren Injection Grout is a hydrophobic water cut-off grout based on an MDI (methylene-diphenyl-isocyanate) polyurethane. The resin is 100% solvent free and 100% solids. Upon contact with water, Warren Injection Grout reacts to form a foam while expanding its volume 30 to 40 times. The cured material is semi-flexible and of a constant volume. Since water is not a component of the foam structure, the cured material is essentially not affected by water or dryness and does not shrink or swell. Additional information on this product can be found on the Warren Injection Grout Product Data Sheet attached as Work Plan Item #3.

4.0 APPLICATION PROCEDURE

A&W Maintenance, Inc., (A&W) is the primary installer for the technology owned by Warren Environmental, Inc. (Warren). The Warren System is applied, using its two-part compound spray-application system and methodology, in a three step process consisting of surface preparation, joint repair and spray-on epoxy liner application. A testing and inspection program is implemented following installation for quality control.

4.1 SURFACE PREPARATION



All surfaces of the culvert are to be visually inspected prior to surface preparation. This requires all concrete, grout or brick that is damaged to be removed to a sound surface. All contaminants are also to be removed from the surface prior to epoxy lining as described below.

Concrete surfaces are prepared via high-pressure water blasting, or hydroblasting, with a bio degreasing agent. The method and equipment used for cleaning by hydroblasting will be done in sections equal to the length of lining and grouting. Cleaning and hydroblasting will be performed once per 50 foot section of the culvert. Wash water will be collected by weirs built on site and either discharged to Janney Run or taken off sit for treatment pending laboratory testing results. Weirs will be built using a combination of sand bags and stop logs. There will be two (2) weirs installed for the test area. The first weir will be constructed upstream of the 50 foot test sections and the second weir will be constructed downstream of the test sections. Hydroblasting is followed by a light acid etching, which will neutralize embedded salts and open the pores of the host pipe concrete, allowing for deep penetration of the epoxy.

The joint between the host pipe floor and the Danby System PVC wall/ceiling panel will require special preparation prior to installing the Warren System (See “Typical Culvert Section at Danby Liner” and “Danby/Warren Joint Detail” on attached reference drawing “Janney Run – Warren System – Miscellaneous Details”). Specifically:

- The lower section of the Danby panels will be thoroughly abraded using a GV5000 Makita disc grinder with a 24-grit abrasive disc, creating a suitable anchor profile that will receive the Warren epoxy.
- Lower sections of the Danby System curved corner strip that are to remain in place will be epoxied to the grout installed as part of the Danby System annulus filler.
- A bed of epoxy will be placed along the lower section of the Danby System along the exposed Danby annulus grout and partially onto the host pipe floor.
- An epoxy/e-glass composite will be set in a wet-out condition on the epoxy bed and will span from the host pipe floor to the bottom of the Danby wall panel. The composite will consist of four layers of e-glass and epoxy and is attached to the Danby wall panel using aluminum straps that are lagged through the Danby grout and into the host pipe wall.

4.2 CRACK / JOINT REPAIR

Tight cracks found in the Janney Run host pipe displaying signs of moisture without dripping may be sealed by the epoxy coating without special attention. However, tight cracks with minor seepage shall be opened using a handheld grinder and filled with a waterstop material consisting of hydraulic cement or moisture-tolerant epoxy grout, installed following the procedure below:

- Open crack to approximately 1/4 inch to 1/2 inch wide and 1/4 inch deep.
- Drill and pack the main water source with oakum.
- Apply epoxy joint repair material over the entire crack.



For cracks with major seepage, epoxy joint repair material shall not be applied. Water flowing through larger cracks shall be stopped by drilling a hole through the crack and injecting Warren Grout 151 through the hole, sealing the crack from behind the culvert.

Joints are visually inspected for active leaks, which are also repaired by applying Warren Grout 151. The joints are then cleaned and ground to a rough profile prior to being lined with Warren epoxy embedded with chopped fiberglass. Lining of the joints with this type of epoxy accommodates movement of existing expansion or cold joints. Expansion joints will be reinstated by following the procedure:

- Open expansion joint to approximately 1/4 inch to 1/2 inch using a handheld wet saw.
- Roughen the surface of the expansion joint with a GV5000 Makita grinder by approximately three (3) inches on both sides of the joint, using 20-24 grit abrasive discs.
- High pressure wash, acid etch and rinse the expansion joint.
- Stop infiltration through the expansion joint using Warren Grout 151.
- Fill expansion joint with Warren M-301 Epoxy Mastic System filled with 3/4 inch s-glass.
- Spray application of Warren S-301 Epoxy Spray System to provide waterproofing of the joint.

In critical areas, a vinyl water shield may be applied to prevent infiltration from the reopening of an expansion joint. The water shield is made up of a vinyl material with a thickness of ten (10) mils that is laminated to a felt material with a thickness of 1/8 inch. The shield will be set in a bed of flexible epoxy and can be bound to both sides of the expansion joint with the vinyl shield spanning the entire length of the expansion joint (See “Existing Joint Detail” on attached reference drawing “Janney Run – Warren System – Miscellaneous Details”).

5.0 QUALITY ASSURANCE / QUALITY CONTROL

A&W shall use an adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts. These workmen shall be completely familiar with the specified requirements and the methods needed for proper performance of the work detailed in this work plan. The job foreman shall have a minimum of seven years of experience, and the crew members shall have a minimum of five years of experience. The pump operator must be trained and certified by the pump manufacturer as being a factory trained operator with a certificate showing his level of training on high pressure pumps. A&W shall initiate and enforce quality control procedures consistent with applicable ASTM and NACE standards together with recommendations from Warren and SPEC. The following procedure shall be followed to ensure the quality of work provided:

- Inspections are conducted after the surface preparation to check for a neutral surface pH before lining using litmus paper.
- Cold joints are visually inspected for active leaks, which are to be repaired prior to lining.
- The spray-applied epoxy is checked for proper thickness during the spray application using a wet film gauge.
- Once cured, and within 48 hours, an ultrasonic tester is used to test the thickness of the cured system. There are to be twenty (20) ultrasonic tests per fifty (50) linear feet of culvert.



- Spark testing is used to check for any pinholes or vapor voids in the cured liner.
- Adhesion is to be checked using a pull tester, using a minimum pull test value of 400 psi. Ten (10) pull tests will be performed per 100 linear feet of culvert.

6.0 CONCLUSION

The Warren System outlined within this Work Plan, while differing in technology from the previously-approved Danby System, is considered to be an industry-tested alternative for the lining of existing subgrade storm water systems. Pending the results of the proposed Pilot Test, it is anticipated that the Warren System will be used for the full-scale implementation of remediation efforts within the Janney Run culvert.

ATTACHMENTS

Work Plan Item #1:	Sequencing of Work and Project Schedule
Work Plan Item #2:	Technical Requirements and Specifications for Structural Epoxy Lining System
Work Plan Item #3:	Warren Injection Grout 151 Product Data Sheet
Work Plan Item #4:	Material Safety Data Sheet
Work Plan Item #5:	Warren System Miscellaneous Details



WORK PLAN ITEM #1 – SEQUENCING OF WORK AND PROJECT SCHEDULE

The project activities are projected to be performed in the following sequence of events:

DAY 1 – Day 1 will consist of the following activity:

1. Kickoff meeting

DAYS 2-3 – Days 2-3 will consist of the following activities:

1. Site orientation
2. Site-specific safety meeting
3. Equipment delivery
4. Work site preparation
5. Spray trailer and storage trailer setup
6. Bypass system setup
7. Air make up system setup
8. Tunnel lighting setup

DAYS 3-4 – Days 3-4 will consist of the following activities:

1. Work will take place in two locations simultaneously:
 - a. STA 2+10 to 2+60: This location, spanning fifty (50) linear feet (LF), is upstream of Manhole #1. The surface consists of bare concrete walls, ceiling and floor.
 - b. STA 9+15 to 9+65: This location, spanning 50 LF, will feature ten (10) LF of unlined culvert where the Danby System was installed, but later removed and forty (40) LF of culvert where the Danby System is installed on the walls and ceiling, but has been removed from the floor.
2. Key way installation
3. Surface preparation
4. Joint repair
5. Danby liner area preparation on step at the floor-to-wall interface

DAYS 4-5 – Days 4-5 will consist of the following activities:

1. Apply epoxy lining in a single coat to both sections simultaneously
2. Allow liner to cure for 48 hours

DAY 6 – Day 6 will consist of the following activity:

1. Curing of epoxy liner

DAY 7 – Day 7 will consist of the following activities:

1. Testing and Inspection
 - a. Visual inspection
 - b. Spark tests
 - c. Elcometer adhesion testing (pull test)
2. Cut a three (3) foot by five (5) foot section sample from wall for visual inspection

NARRATIVE – DAY 1:

The first day on site will involve a kickoff meeting to discuss project details.

NARRATIVE – DAY 2-3:

The first day on site will involve setup and preparation activities. To familiarize the crew with the site, the crew will attend a site orientation. A site-specific safety meeting held after orientation will prepare the crew for any dangers found on site. Equipment will be delivered, the spray trailer and storage trailer will be set up and the work site will be prepared to begin work the following day. Once the work areas are set up, the stormwater bypass system and the air make up system will be prepared and tunnel lighting will be set up.

NARRATIVE – DAYS 3-4:

The work for this project will be done in two areas, both spanning 50 LF. The first area will be located between STA 2+10 and STA 2+60 upstream of Manhole #1. The second area will be located between STA 9+15 to 9+65, featuring 10 LF of bare concrete surfaces on the floor, walls and ceiling, where the Danby System was installed, but later removed and 40 LF of previously installed the Danby System on the walls and ceiling, but has been removed from the floor. Work in this area will demonstrate how the Warren System will be able to tie into and adhere to the Danby System surfaces. The work areas will begin and end with a saw-cut keyway. Once the keyway is cut into the walls, all surfaces will be prepared for lining and analyzed for any leaks. Any cracks or joints that show signs of infiltration will be repaired consistent with the procedures outlined in the work plan. The step area where the Danby System is installed will also be prepared for coating.

NARRATIVE DAYS 4-5:

Epoxy lining will be applied to all surfaces of the project areas simultaneously in a single coating. The epoxy must be allowed to cure for 48 hours after application.

NARRATIVE DAY 6:

During day 6 of the project, the epoxy liner will still be in the process of curing.

NARRATIVE DAY 7:

Testing and Inspection of the epoxy surfaces will take place on the seventh day of the project. Testing and inspection methods will include visual testing, spark tests and Elcometer adhesion testing (otherwise known as pull testing). Testing and inspection will be performed as detailed in the work plan. At the Owner's request, Warren will cut a sample area of 3 feet by 5 feet of the applied epoxy lining from the wall surface for visual inspection.

TECHNICAL REQUIREMENTS AND SPECIFICATIONS FOR STRUCTURAL EPOXY TUNNEL LINING SYSTEM

WARREN ENVIRONMENTAL SYSTEM S-301

By

WARREN ENVIRONMENTAL, INC.

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. This specification covers work, materials, equipment and tools including specially developed surface preparation and application equipment as required for installation and testing of the unique monolithic tunnel surfacing system – Warren Environmental System S-301, (hereafter referred to as “WES”) or approved equal.
- B. The use of specialized application equipment combined with rigorous surface preparation requirements shall be used to apply the WES products without the use of solvents. The surface preparation utilizes high- pressure (10,000 psi) water. Patented application equipment adds high heat and pressure to the monolithic surfacing system. This results in a high build and quick set of the completed system, creating a ceramic like finish.
- C. Product application requirements and procedures described include surface preparation, mixing, application, material handling and storage, qualification of applicator and application quality control.

1.02 REFERENCES

- A. ASTM D638 – Tensile Properties of Plastics
- B. ASTM D790 – Flexural Properties of Unreinforced and Reinforced Plastics.
- C. ASTM D695 – Compressive Properties of Rigid Plastics.
- D. ASTM D4414 – Wet Film Thickness by Notched Gages
- E. ASTM D4541 – Pull-off Strength of Coatings Using a Portable adhesion Tester
- F. ASTM D2584 – Volatile Matter Content. - Zero Volatile Organic Compound
- G. ASTM D2240 – Durometer Hardness, Type Shore D
- H. ASTM D543 – Water Vapor Transmission of Organic Coating Films. 1.549×10^{-6}
- I. ASTM D543 – Resistance of Plastics to Chemical Reagents to a pH of one
- J. ASTM – The published standards of the American Society for Testing and Materials, West Conshohocken, PA.
- K. NACE – The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
- L. ISO 9001 Certified Manufacturing Facility
- M. Dept of the Navy Certified Production Facility

1.03 SUBMITTALS

- A. All submittals shall be submitted in accordance to the applicable portions of these specifications.
- B. Qualification and Performance Responsibility of Applicator:
 - 1. The Applicator shall apply the system and be responsible for the complete performance of the system, including surface preparation, materials, application and quality control.
 - 2. Applicator shall provide documentation as follows:
 - a. A list of at least five past clients, including names and telephone numbers, to verify previous satisfactory performance on large diameter tunnel projects of similar or greater size and difficulty factor in the last 10years.
 - b. The monolithic surfacing manufacturer shall provide at least 5 previous installations of the product including installation dates, description of work performed, contact names and telephone numbers.

1.04 QUALITY ASSURANCE

- A. Applicator shall initiate and enforce quality control procedures consistent with applicable ASTM and NACE standards together with Warren Environmental, Inc. and the Engineer's recommendations.
- B. Applicator shall use an adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts. These workmen shall be completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section. The job foreman shall have a minimum of seven years experience, and the crew members shall have five years experience. The pump operator must be trained and signed off by the pump manufacturer as being a factory trained operator with a certificate showing his level of training on high pressure pumps.
- C. Applicator shall use approved specialty equipment adequate in size, capacity and number sufficient to accomplish the work of this Section in a timely manner.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Materials are to be kept dry, protected from weather and stored under cover and stored between 50 deg F and 90 deg F. Do not store near flame, heat or strong oxidants.
- B. Protective coating materials are to be handled according to their material safety data sheets.

PART 2 – PRODUCTS AND APPLICATION EQUIPMENT

2.01 MANUFACTURER AND EQUIPMENT SUPPLIER

- A. Warren Environmental, Inc., P.O. Box 1206, Carver, MA 02330 Telephone (508) 947-8539 or approved equal.

2.02 REPAIR MATERIALS

- A. Repair materials must be accepted and approved by the monolithic surfacing system manufacturer for compatibility with the specified monolithic surfacing system and shall only be used as determined necessary by the Engineer.

2.03 MONOLITHIC SURFACING SYSTEM

- A. Warren Environmental System S-301 – a unique non-toxic, 100% solids, solventless epoxy resin laminar system as applied via plural component heated spray equipment as manufactured by Warren Environmental, Inc., or approved equal and exhibiting the following characteristics or equal.

Product type	cycloaliphatic cured – epoxy resin
Color	White
Solids Content (vol %)	100
Mix Ratio, Laminating System	2:1
Compressive Strength	ASTM D695 13,627psi
Flatwise Tensile Strength	
Of Sandwich Constructions	ASTM C297 2,608psi
Tensile Strength	ASTM D638 6,000psi
Tensile Elongation	ASTM D638 4.5%
Flexural Strength	ASTM D790 11,000psi
Flexural Modulus	ASTM D790 500,000psi
Bond Strength – Concrete	ASTM D4541 Concrete Failure or 400 psi
Chemical Resistance to:	
Sulfuric Acid, 70%	ASTM D543 Immersion Service – no effect
Sodium Hydroxide, 20%	ASTM D543 Immersion Service – no effect

Surface Burning Characteristics of Building Materials	ASTM E84-Meets airline standards
Toxic Gas Generation by Materials on Combustion	BSS 7239-Class “A” rating
ISO 9001 Production Facility Dept. of the Navy	Certified and pass yearly inspection Certified Production Facility

- B. The monolithic surfacing system shall be continuously bonded to all brick, mortar, concrete, grout, pipe and other surfaces inside the tunnel.
- C. The finished system shall provide a minimum total thickness of 125 mils on new structures, and 250 mils to 350 mils on rehabilitation projects.
- D. When cured, the system shall form a continuous, tight-fitting, hard, impermeable surfacing that is suitable for sewer system service and chemically resistant to any chemicals, bacteria or vapors normally found in domestic sewage.
- E. The system shall effectively seal the interior surfaces of the tunnel and prevent any infiltration, exfiltration, penetration or leakage of groundwater

2.04 PROTECTIVE COATING APPLICATION EQUIPMENT

- A. Heated, plural component, specially designed equipment for use in the spray or spincast application of the specified system approved for use by the monolithic surfacing system manufacturer as designed and developed by Warren Environmental, Inc. or approved equal.

PART 3 – EXECUTION

3.01 PRE-COAT INSPECTION

- A. All structures to be coated shall be readily accessible to Applicator for inspection.
- B. Appropriate actions shall be taken to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety.
- C. Active flows shall be dammed, plugged or diverted as required to ensure that the flow is maintained below the surfaces to be coated.
- D. Installation of the protective coating shall not commence until the concrete substrate has properly cured a minimum cure of 28 days for new concrete.

3.02 SURFACE PREPARATION

- A. Applicator shall inspect all surfaces specified to receive the monolithic epoxy system prior to surface preparation. Applicator shall notify Owner of any noticeable disparity in the surfaces that may interfere with the proper preparation or application of the monolithic epoxy system.
- B. All concrete or brick that is not sound or has been damaged by chemical exposure shall be removed to a sound surface. All existing coatings, waxes, form release, efflorescence, sealers, salts, or other contaminants must be removed from the surface to be epoxy lined.

- C. Surface preparation method(s) shall be based upon the conditions of the substrate and the requirements of the epoxy surfacing system to be applied.
- D. Quick setting high strength concrete with latex or curing agent additives can not be used. Proper surface preparation procedures must be followed to ensure adequate bond strength to any surface to be coated. New cement must cure at least 30 days prior to coating.
- E. Existing coatings should be removed or thoroughly abraded to provide adequate surface profile for mechanical bond. Applicator is to maintain strict adherence to the monolithic surfacing system manufacturer's recommendations with regard to proper surface preparation and compatibility of restoration and structural liner material.
- F. Surfaces to receive protective coating shall be cleaned and abraded to produce a sound surface with adequate profile and porosity to provide a strong bond between the epoxy surfacing system and the substrate. The first procedure upon entering each structure will be to blast all specified surfaces by low pressure water cleaning. When all loose and /or contaminated debris has been removed, the surface shall be water blasted by the use of a hand held wand again. The wash water shall include a dilute solution of chlorine to diminish bacterial growth and to kill any bacteria residing on or in the surface. The surface will be tested at this point to ensure that the pH is within acceptable limits (not to exceed 8.5). These tests will be performed with litmus paper on various areas within the structure.
- G. Surfaces that require additional cleaning or profiling will be prepared by abrasive blast or water blasting at 4,000 to 10,000 psi in order to rough the surface sufficient to obtain and ensure adequate bonding of the system. A minimum surface profile of 8-10 mils must be achieved to assure proper adhesion. Detergent water cleaning and hot water blasting may be necessary to remove oils and grease from the concrete or brick. Whichever methods are used, they shall be performed in a manner that provides a uniform, sound clean surface that is not excessively damaged.
- H. Active water infiltration shall be stopped by using approved cementitious water plug or hydroactive grout that is compatible and suitable for topcoating with the specified epoxy surfacing system. Latex base products cannot be used, - NO exception.
- I. All surfaces shall be inspected during and after preparation and prior to application of the monolithic surfacing system. Any evidence of remaining contamination or residuals shall be removed by additional water or abrasive blast, or other approved method before proceeding with application of the monolithic surfacing system.

3.03 APPLICATION OF REPAIR MATERIALS

- A. Areas where structural steel has been exposed or removed shall be repaired in accordance with the Project Engineer's recommendations.
- B. Repair materials shall meet the specifications of this Section. The materials shall be trowel or spray applied utilizing proper equipment on to specified surfaces. The material thickness shall be specified by the Project Engineer according to Owner's requirements and manufacturer's recommendations.

The Engineer will measure the system-cured thickness from a specimen retrieved by the Applicator. Retrieval can be made by physically cutting through the surfacing (by drilling or coring) or a suitable non-destructive type of thickness measurement may also be used (ultrasonic positector).

- C. All lined surfaces will be tested with high-voltage holiday detection equipment. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the pinhole. All detected pinholes shall be marked and repaired by abrading the lined surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional system material can be hand applied to the repair area. All touch-up/repair procedures shall follow the monolithic surfacing system manufacturer's recommendations.
- D. Measurement of bond strength of the system to the substrate can be made at regular intervals and along different sections of the structure. Bond strength can be measured in accordance with ASTM D4541. Any areas detected to have inadequate bond strength (less than 400 psi or 80% substrate failure to concrete or brick) shall be evaluated by the Project Engineer. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Applicator in strict accordance with manufacturer's recommendations.
- E. A final visual inspection shall be made by the owner's representative. Any deficiencies in the finished system shall be marked and repaired according to the procedures set forth herein by Applicator.
- F. The system may be put back into operational service as soon as the final inspection has taken place.

3.06 CLEANING

- A. Trash and loose debris shall not be permitted to accumulate at the project site. All items shall be regularly removed and disposed of at an approved site in accordance with applicable regulatory agencies.

END OF SECTION

PREQUALIFICATION:

Prospective bidder must have a minimum experience of 10,000 feet of coating experience utilizing plural spray application technique in large diameter underground tunnel systems.

STATEMENT OF EXPERIENCE: The undersigned as bidder declares that he has successfully accomplished similar work in the following places:

1. Description of Project: _____
(Include type of project total value of contract, date of completion, etc.)
Owner & Contact Person: _____
(Names, addresses and telephone numbers)

Engineer & Contact Person: _____

2. Description of Project: _____
(Include type of project, total value of contract, date of completion, etc.)

Owner & Contact Person: _____
(Names, addresses and telephone numbers)

Engineer & Contact Person: _____

3. Description of Project: _____
(Included type of project, total value of contract, date of completion, etc.)

Owner & Contact Person: _____
(Names, addresses and telephone numbers)

Engineer & Contact Person: _____

4. Description of Project: _____
(Included type of project, total value of contract, date of completion, etc.)

Owner & Contact Person: _____
(Names, addresses and telephone numbers)

Engineer & Contact Person: _____

5. Description of Project: _____
(Included type of project, total value of contract, date of completion, etc.)

Owner & Contact Person: _____
(Names, addresses and telephone numbers)

Engineer & Contact Person: _____

Note: Bidders may attach supplementary information, if necessary, to indicate the experience, organization and equipment available to undertake the work in the event of an award of the contract.

The bidder shall list below the name/names of subcontractor, if other than the bidder, who shall perform work on the project:

A. _____

B. _____

The bidder shall submit a list of experience for above sub-contractor.

- C. Approved repair materials, shall be trowelled to provide a smooth surface with an average profile equivalent to coarse sandpaper to receive the protective coating. No bugholes or honeycomb surfaces should remain after the final trowel procedure of the repair epoxy mortar.
- D. The repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds may not be used unless approved by the monolithic surfacing system manufacturer for compatibility with the specified system.
- E. Application procedure of the repair materials, if not performed by the monolithic surfacing system applicator, should be observed by the Applicator's representative to ensure proper finishing for suitability to receive the specified epoxy liner.
- F. All surfaces shall be sufficiently smooth and even, to ensure good flow handling characteristics prior to the application of the structural epoxy liner.

3.04 APPLICATION OF MONOLITHIC SURFACING SYSTEM

- A. Application procedures shall conform to the recommendations of the monolithic surfacing system manufacturer, including material handling, mixing, environmental controls during application, safety, and equipment.
- B. The equipment shall be specially designated to accurately ratio and apply the specified materials and shall be regularly maintained and in proper working order.
- C. The specified materials must be applied by an approved installer of the monolithic surfacing system.
- D. The specified coating system must be capable of being applied in one coat of 125 mils or greater in order to eliminate the possibility of intercoat contamination resulting in delamination. All specified surfaces will be lined with the monolithic surfacing system to provide a minimum total thickness of 125 mils on new surfaces and 250 mils to 350 mils on rehabilitation work. The cured surfacing shall be monolithic with proper sealing connections to all unsurfaced areas and shall be placed and cured in one or two applications in conformance with the recommendations of the monolithic surfacing system manufacturer. Coating to be applied to insure a total system thickness of 125 mils up to 350 mils, depending on the surface requirements of the structure.

3.05 TESTING AND INSPECTION

- A. During application a wet film thickness gage meeting ASTM D4414 – Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.
- B. After the system has set hard to the touch it shall be inspected by the Engineer verifying the following:

MATERIAL SAFETY DATA SHEET

M301 A BASE 301-18 Base

Section 1. Identification

Product Name: **M301-18 Base**
Manufacturer's Name: **Warren Environmental, Inc.**
Address: 137 Pine Street
Middleboro, MA 02346
Telephone: **508-947-8539**
Fax: 508-947-3220
Emergency: 800-255-3924
(CHEM.TEL)

Section 2. Chemical Product

Product: M301-16 A Base
Product Classification: "Part A" of a Two Component Epoxy.

Section 3. Chemical Ingredients / Identification

Single or Mixture: **Mixture**
Chemical Identification: Resin

<u>Ingredient</u>	<u>CAS#</u>	<u>OSHA/PEL</u>	<u>ACGIH/TLV</u>	<u>% by Weight</u>
Diglycidylether of Bisphenol A	25068-38-6	Not applicable	Not applicable	85 – 95
Titanium dioxide	13463-67-7	8hr. TWA-10mg/m ³ , total	8hr. TWA-10mg/m ³ , total	1 – 2
Thickening Agent	67762-90-7	Not applicable	Not applicable	4 – 8

Section 4. Physical and Chemical Properties

- Boiling Point:-----Not applicable
- Vapor Pressure: -----<1 (mm Hg @ 25°C)
- Vapor Density: ----->1 (Air=1)
- Specific Gravity: -----1.18 @ 25°C (Water = 1.00)
- Melting Point:-----Not applicable
- Evaporation Rate: -----<1 (Butyl Acetate = 1)
- Volatiles by Weight-----<1%
- Solubility in Water: -----Not soluble
- Appearance (color):-----Off-White
- Appearance (form):-----Liquid
- Odor: -----Odorless

Section 5. First Aid Measures

Skin Contact:	Remove product from skin with dry cloth or paper towel, and wash exposed area with water and mild detergent.
Eye Contact:	Immediately flush with water for at least 15 minutes. Get medical attention.
Ingestion:	Wash out mouth with water provided person is conscious. Never give anything by mouth to an unconscious person. Call a physician immediately.
Potential Health Effect:	Skin Contact: May cause slight skin irritation, but no significant effect. Eye Contact: May cause slight eyes irritation Ingestion: No information is available

Section 6. Fire Fighting Measures

Flash Point (method used):	>325°F, based on flash points of components
Flammable Limits:	Lower: Not measured Upper: Not measured
Extinguishing Media:	Foam, dry chemical, carbon dioxide or fine water spray
Special Fire Fighting Procedure:	Firefighters/rescue personnel should wear positive pressure self-contained breathing apparatus and full protective equipment. Cool exposed containers with water to prevent pressure buildup. If large quantities of material are involved, evacuate area and fight fire from a safe distance,
Unusual Fire and Explosion Hazard:	Decomposition and combustion products may be toxic. Closed containers may violently rupture under fire condition.

Section 7. Accidental Release Measures

Spill response operations must be conducted in accordance with the provisions of OSHA 29 CFR 1910.120. Review the entire MSDS before proceeding with spill response.

Small Spills: Activate available exhaust ventilation equipment in the immediate spill area. Wipe up or absorb spilled material with paper towels or other absorbent material. Wash area with soapy water to remove residue. Collect absorbed material and water rinses in appropriate containers. Dispose of in accordance with current Federal, State, and local regulations.

Large Spills: Limit access to the immediate spill area. Shut off source of the release if this can be done without risk of injury. Activate available exhaust ventilation equipment in the spill area. Dike area to contain the spill and prevent releases to sewers, drains or other waterways. Collect spilled material for salvage/disposal. Apply absorbent material to soak up residue. Wash area with soapy water. Prevent runoff from entering waterways. Transfer absorbed material and water rinses to appropriate waste containers. Dispose of in accordance with current Federal, State, and local regulations.

Section 8. Handling and Storage

Personal Protection

- Wear chemical safety glasses or goggles. Have Eyewash equipment available.
- Wear impervious gloves
- Other protective clothing or equipment to be used as appropriate to prevent prolonged or repeated contact with skin.
- Use good personal hygiene practices. Wash hands before eating, drinking, smoking or using the restroom facilities.
- Promptly remove contaminated clothing and launder thoroughly before reuse.

Ventilation

- Provide effective mechanical exhaust ventilation to draw vapors, mists or fumes generated during processing away from the worker and prevent routine inhalation, especially during elevated temperature processing.
- Ventilation must be sufficient to maintain airborne levels of Section 2 ingredients below their PEL/TLV values.
- Use an appropriate, properly fitted respirator if exposures exceed PEL/TLV values.
- The type of protection selected (SCBA, air purifying) will depend upon the conditions of use. Observe OSHA regulations for respiratory protection (29 CFR 1910.134).

Precaution to be taken in handling and storing:

- Keep container closed when not in use.
- Vent the container properly to eliminate internal pressure.
- Store in a cool place (Qualitatively under 10 degrees C).
- Keep away from heat and flame.
- Do not lay the container on its side.
- Avoid contact with eyes and prolonged or repeated skin contact.
- Avoid contact with acidic, basic or oxidizing materials.
- Contact lens wearers take appropriate precaution.
- Keep out of reach of children.

Information about the emptied container:

- Do not re-use this container.
- Keep away from heat, sparks and flame.
- Do not puncture or cut this container.
- Do not weld on or near this container.

Section 9. Stability and Reactivity

Stability: ----- Stable under normal handling and storage conditions (But it will not vigorously polymerize, decompose, condense, or will not become self-reactive under conditions of shocks, pressure or temperature).

Incompatibility (Material to avoid): ----- Acidic, basic or oxidizing materials.

Hazardous Decomposition or By-Product: ----- Carbon monoxide, carbon dioxide, aldehydes, acids and other organic substances may be formed during combustion. The chemical nature and quantity of decomposition by-products will vary widely depending on the conditions of combustion.

Hazardous Polymerization: ----- Uncontrolled mixing with amines, anhydrides, mercaptans, and imidazoles may cause hazardous polymerization.

Conditions to avoid: ----- Contact with acidic, basic or oxidizing materials.
 Avoid storage in open containers, exposure to open flame or uncontrolled exposure to heat, uncontrolled mixing with curing agents or exposure to incompatible substances.

Section 10. Toxicological and Health Information

Skin Irritation: Contains materials that cause moderate skin irritation. Prolonged or repeated exposure to the liquid may exert a defatting or drying action on the skin, possibly resulting in dermatitis. This product may cause skin sensitization/allergic skin reactions that may be severe in certain individuals. Symptoms include rash, itching, hives, swelling.

Eye Irritation: Contains materials irritating to the eyes. Symptoms may include blurred vision, burning sensation and tearing.

Inhalation: Heating can generate vapors that may cause respiratory irritation, nausea and headaches. Inhalation hazard at room temperature is unlikely, due to the low volatility of this product.

Ingestion: Harmful if swallowed.

Acute Toxicity (LD50): ----- No information is available.

Acute Toxicity (LC50): ----- Not applicable.

Chronic Toxicity ----- Not applicable

Carcinogen: -----NTP: Not Listed IARC: not classifiable as carcinogens.
-----OSHA Regulated: Not Listed
Other Information -----None

Section 11. Ecological Information

Biodegradation: -----Not applicable.
Bioaccumulation:-----No information is available.
Aquatic Toxicity:-----No information is available.
Other Information: -----None

Section 12. Disposal Consideration

- Can be burned in a chemical incinerator equipped with an afterburner and scrubber.
- Do not dispose of the emptied container unlawfully.
- Observe all federal, state, and local laws.

Section 13. Transportation Information

UN No.----- None
IMO Classification and Class: ----- None
Packaging Group: ----- None
Proper Shipping Name: ----- None
Technical Shipping Name:----- None
Marine Pollutant: ----- None
Dot Reportable Quantity (RQ):
Hazard Substance (s) Name / (CAS No.), Contents and RQ -----Not applicable.

Section 14. Regulatory Information

Toxic Substances Control Act (TSCA) Status: Listed on the TSCA inventory

Superfund Amendments and reauthorization to of 1986 (SARA) Title III Section 313 Supplier Notification:

This regulation required submission of annual reports of toxic chemical(s) that appear in section 313 of the emergency planning and community Right-To-Know Act of 1986 and 40 CFR 372. This information must be included in all MSDS's that are copied and distributed for the materials.
The toxic chemical(s) contained in this product are: ****None****

Section 15. Other Information

For Industrial Use Only

This material safety data sheet is offered solely for your information, consideration and investigation. The data described in this MSDS consist of data on literature, our inquisitional data and analogical inference by data of similar chemical substance or product. Warren Environmental, Inc provides no warranties, either express or implied, and assumes no responsibility for the accuracy or completeness of the data contained herein.

WARREN INJECTION GROUT

EPOXY FORTIFIED POLYURETHANE WATER – CUT – OFF & SOIL STABILIZATION GROUT

RANGE OF APPLICATION

- Defective Concrete (Cracked or Honeycombed)
- Concrete Joints
- Limestone
- Brick Construction
- Pipe Intrusions
- Waste Water Tanks
- Drinking Water Reservoirs
- Sewers, Manholes, Utility Boxes, etc.
- Tunnels, Dams
- Also: Soil Stabilization

TYPE OF MATERIAL

Is a hydrophobic water cut-off grout and soil stabilization grout based on a MDI (methylene-diphenyl-isocyanate) polyurethane. The resin is 100% solvent free and 100% solids. The gel-time of the product is adjustable by the mandatory adding of a certain percentage of Accelerator.

Upon contact with water, Warren Injection Grout reacts to a foam while expanding its volume 30 to 40 times. The cured material is semi flexible and of a constant volume. Since water is not a component of the foam structure, the cured material is essentially not affected by water or dryness. The reacted material does not shrink or swell.

Depending on the amount of accelerator added and the pressure of injection, Warren Injection Grout reacts to a very dense, closed cell, semi rigid material or an open cell, more flexible product.

Warren Injection Grout is extremely well suited for the filling of large cavernous spaces and cracks in stone or concrete structures as well as for cutting off gushing water of high pressure and speed. Due to the low viscosity of the material, Warren Injection Grout offers superior penetration in hairline crack injection.

Warren Injection Grout is a product of the Warren Environmental resin line and to achieve best results a combination of several products may be recommended in some applications.

The product is also a non-shrink soil stabilization grout when used with very little accelerator. The moisture content of the soil must be sufficient to ensure reaction.

PROCESSING

Warren Injection Grout and the 15X Accelerator are supplied separately to allow adjustment of gel-time and to provide a long shelf life. It is mandatory to add Warren Injection Grout 15X Accelerator to ensure complete reaction as a designed. A higher percentage of Accelerator added will increase reactive speed and foam volume. Recommended mix ratios are between 5% and 10% of Accelerator added. In extreme situations, ratios may be as low as 1% or as high as 20%.

Examples: In applications of high pressure water-intrusions, the system will react aggressively on contact with water when catalyzed at 10% or more. A slightly catalyzed product at about 2% on the other hand assures good penetration results in very fine capillary crack injection and for soil stabilization purposes.

The accelerator system has been proven superior to solvent-loaded single component materials. The Warren Injection Grout system gives the applicator the choice to control gel-time and reactive properties.

Plan ahead: Observe temperature and humidity of the environment, since both determine the pot-life of the premixed batch. Do not mix more material than the amount that will be pumped within reasonable time. Rule: High temperatures and high humidity – less accelerator.

Since Warren Injection Grout reacts with the moisture in the structure, single component injection equipment is recommended. Warren Injection Grout does not need large amounts of water to react. Simultaneous injection of water is not necessary. If the area of application seems to be completely dry, pre-injection of water is recommended.

Caution: It is essential for all equipment to be dry. Avoid any moisture contact with the mixture to prevent premature reaction of the product. If reaction of the batch occurs while pumping, immediately shut down the machine and flush with a cleaner to avoid built up and clogging of the equipment.

MAINTENANCE OF EQUIPMENT

Remove all excess sealant and any smears. Tools and mixing equipment are best cleaned immediately after use.

Recommended: R70 Pump Flush is a solvent free, non-flammable and for shipping as non-hazardous classified cleaner, which conditions your pump and hoses. Circulate cleaner through pump for several minutes.

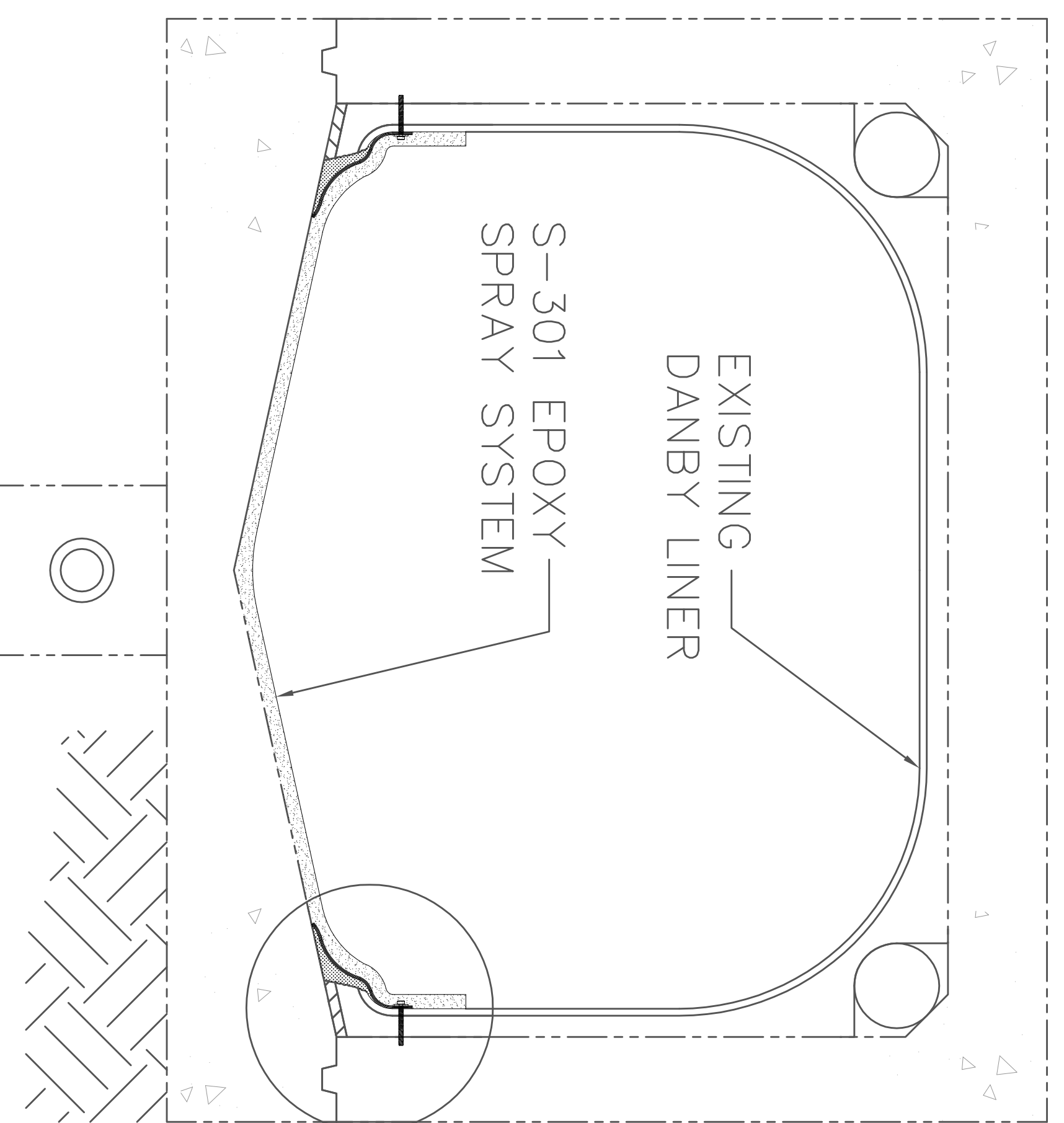
Xylol, Toluol, Acetone, M.E.K. and related solvents can be used for initial flushing. Solvents are hazardous, are aggressive towards plastic and rubber and might be in conflict with regulations on the jobsite. Caution! Some cleaners are combustible.

PRECAUTION

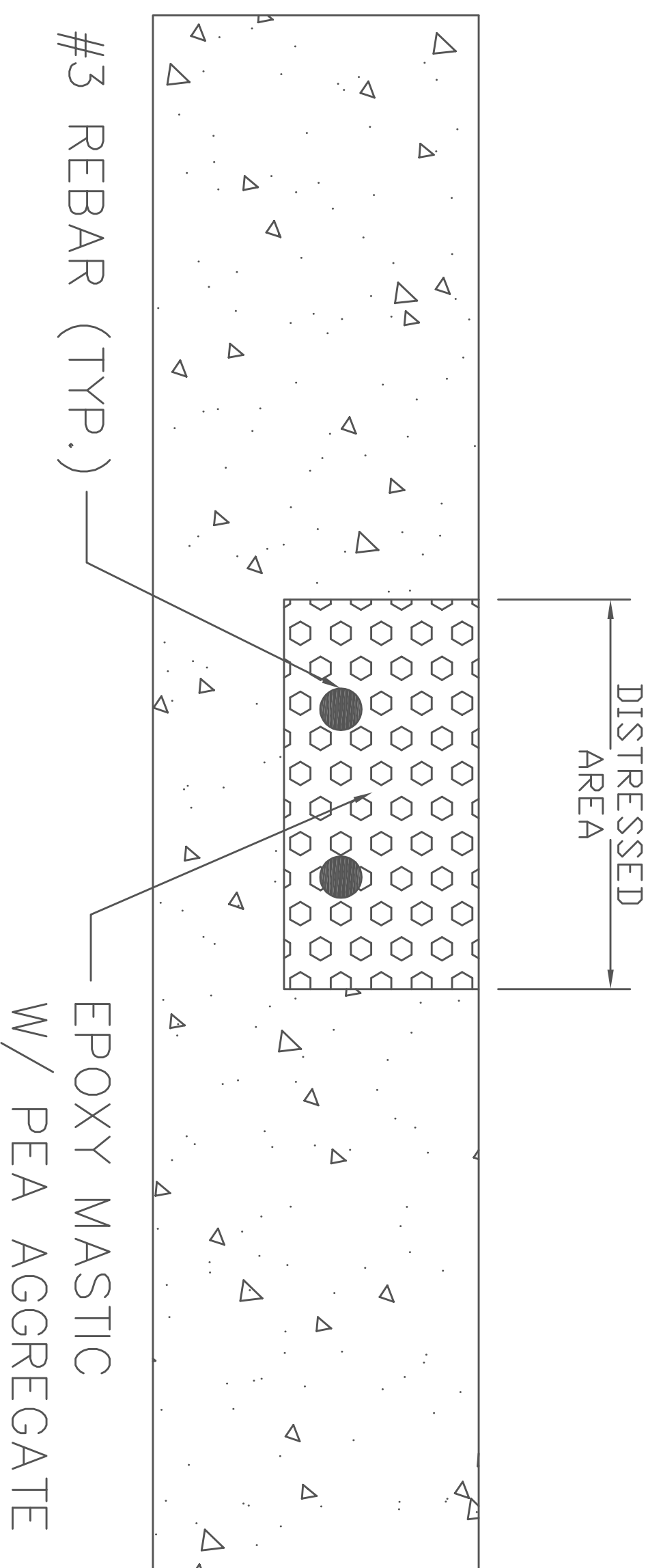
Protect your health! While working with Injection Grout materials, safety goggles, gloves and safety clothing must be worn at all times. While injecting, a full face shield is strongly recommended. Spills and blow-outs do happen! Protect yourself and others on the jobsite. Consider property in proximity of the application area to prevent loss or damage. Protect your jobsite from unauthorized persons. Store all materials and equipment safely and out of reach of children! Observe container MSDS, and instructions before using the product and equipment. In case one of the components comes in contact with the skin, wash

thoroughly with soap and water. Provide adequate ventilation in volume and pattern in working area.

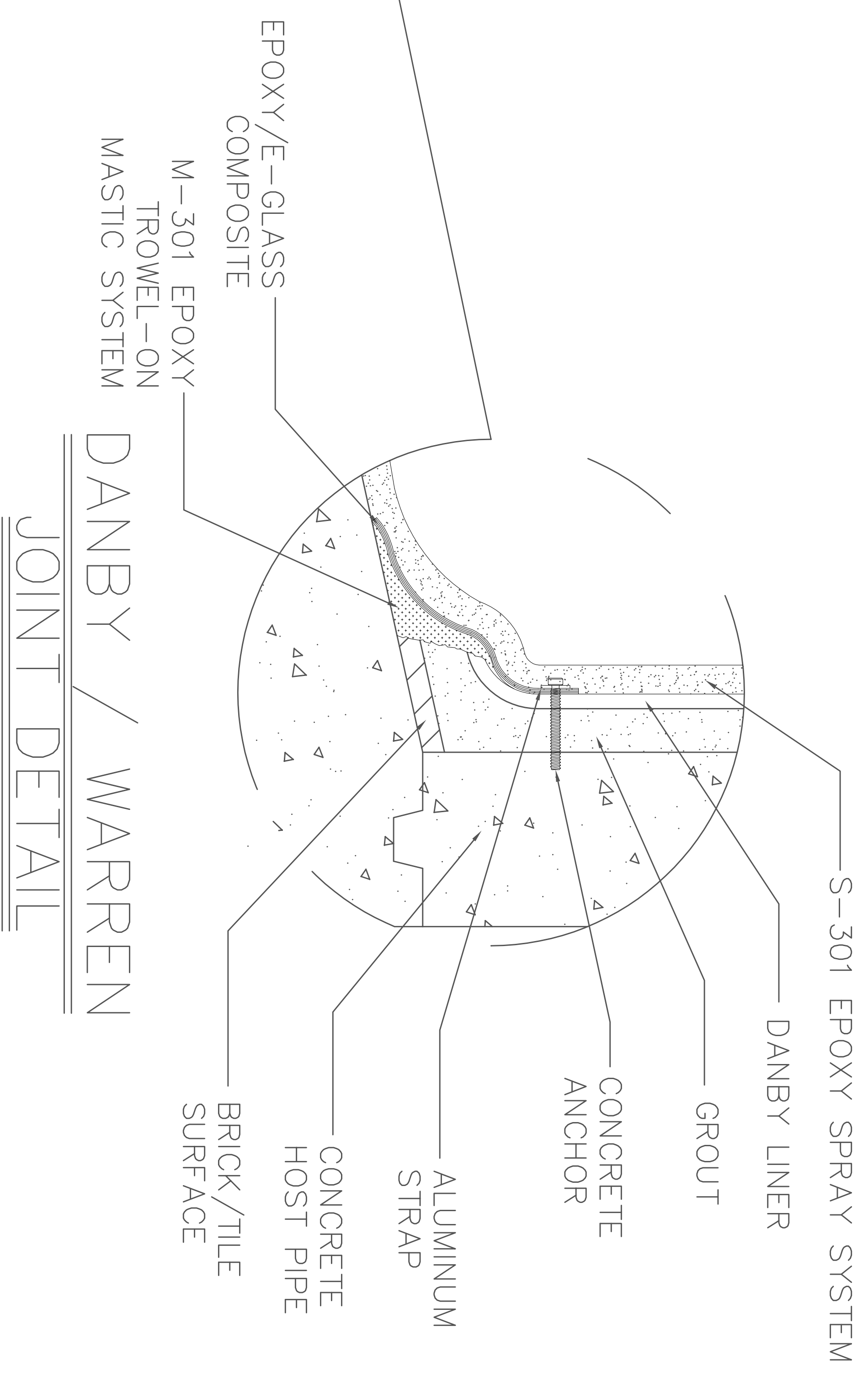
Further protection: emergency showers and eyewash stations.



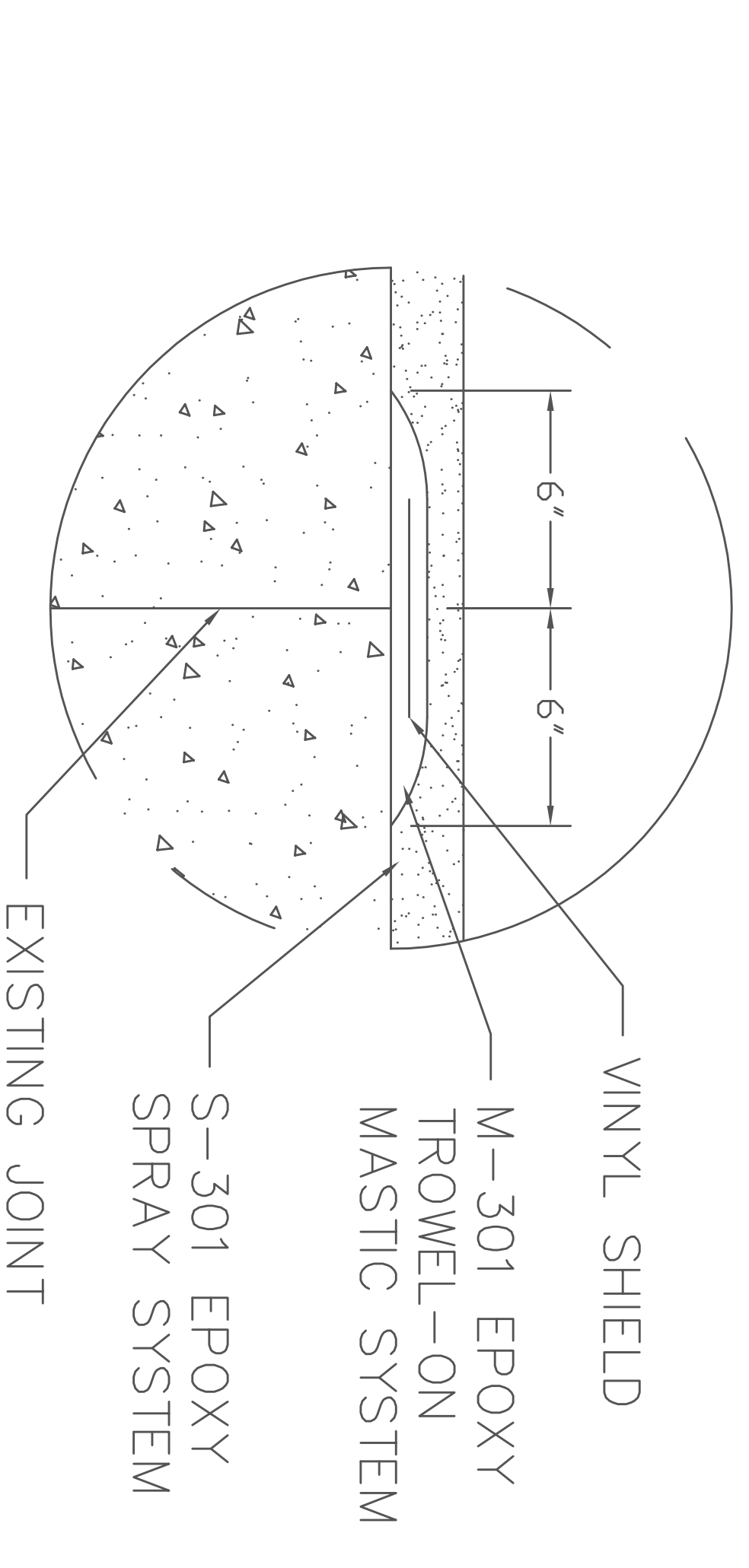
TYPICAL CULVERT SECTION
AT DANBY LINER



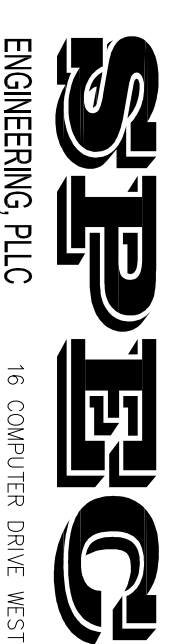
DISTRESSED FLOOR REPAIR



DANBY / WARREN
JOINT DETAIL



EXISTING JOINT DETAIL



16 COMPUTER DRIVE, WEST
ALBANY, NY 12205
PHONE: 518.485.8009
FAX: 518.485.8557

JOB #E12-269

JANNET RUN TUNNEL	
WARREN SYSTEM	
MISCELLANEOUS DETAILS	
SCALE: NTS	DATE: 09-12-13