B D A Associates, LLC
Engineering Consulting Group

Brent Anderson, P.E.
(P) 763-784-8430
(F) 763-784-1509
(C) 612-363-9580

BDA Associates, LLC
7654 Highway 65 N.E
Minneapolis, MN 55432
Email: brent@bda-assoc.com

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Mr. Bradley Fisher
Fisher Bren & Sheridan, LLP
920 Second Avenue South
Suite 975
Minneapolis, MN 55402
Dir: 612-902-2746
Cell: 612-787-8955
Fax: 612-332-9951
bfisher@fisherbren.com
www.fisherbren.com

Brian D. Steffes, Attorney
Fisher Bren & Sheridan, LLP
920 Second Avenue South
Suite 975
Minneapolis, MN 55402
Direct: 612-902-2750
Fax: 612-332-9951
Email: bsteffes@fisherbren.com
Website: www.fisherbren.com

Mr. Dan Weinkauf
Integrity Grading and Excavation, Inc.
605 Grossman Drive
Schofield, WI 54476

Project: 5992-09-82/83/85/86/87/88, CTH M
Raymond Road, Unacceptable Storm Sewer Pipe
Subject: Concrete Pipe Tunnel Restoration Plan

Gentlemen:

This cover letter will provide an executive summary of the Raymond Road Elliptical Pipe Restoration work. BDA Associates, LLC objective was to provide a design:

1.) to mitigate sand piping and active water leakage at joints and cracks, and
2.) increase soil bearing resistance from pipe invert to springlines.

Based on information and reports provided by the following entities:

1.) AET (Tested on 04/24/19 and reported on 05/15/19),
2.) NORCON (Inspected on 10/30/18 and reported on 10/31/18),
3.) SGH (tested on 07/28&29/19 and reported 08/29/19),
4.) Barr Engineering (Tested (06 & 07)/2019) and reported 07/06/19) and further Reports on (08/01/2019),

we determined that an effective interior pipe joint seal would be very difficult to achieve long term.

The most effective pipe joint seal would be via chemical grouting the internal pipe joint (interception grouting) with additional soil solidification (permeation grouting) behind (soil side) of exposed joint. This type of seal will have a long-life expectancy and work in both negative and/or positive side water pressurization. This type of seal will substantially be more effective long term than the designed asphaltic seal. In fact, after successful completion of herein designed grouting techniques per our plans and specifications, the Owner will have a water and sand piping control system exceeding the original design.

For an exterior pipe seal to be effective long term against internal water pressurization, the soil adjacent to the solidified soil must be stable and without voids. Further, pipe segments must be adequately supported against excessive movement near the crown and springlines to additionally ensure stability of the solidified soil pipe seal.

With an effective exterior pipe seal, little interior work needs to be done to remediate loss of asphalt mastic in pipe joints. Our design incorporates a membrane gland when the pipe joint exceeds 1.50 inches in width. This membrane acts as a secondary gland to the primary seal on pipe exterior.

After visually examining the elliptical concrete pipe tunnel on October 29, 2019 it confirmed and verified my opinion(s) regarding the pipe joint conditions.

The design goal of this project is to enhance the service life via increasing durability and performance of Raymond Road elliptical concrete pipe. Chemical grouting at pipe joints and cementitious grouting at pipe haunch areas will serve to perform that function. In addition, treating existing cracks will improve corrosion resistance of reinforcing steel in concrete pipe sections.

Grout materials selected for this project have histories of long service life in municipal environments. Specified manufacturers of grout materials have proven records of performance in tunnel/piping systems.

Soil particles consisting of sand, silt and clay have been piping through various joints into the interior. Loss of soil particles to pipe interior may cause surface sink holes, void zones, and potentially lower the bearing resistance at culvert pipe invert and springlines.

Current seals at pipe joints consists of an asphalt mastic troweled into the tongue-and-recess flanges. In many cases that asphalt mastic has fallen out via groundwater fluctuations; differential, longitudinal or transverse pipe strain; and/or gravity, among other potential environmental considerations.

This elliptical concrete pipe restoration design serves to dramatically improve resistance of soil piping through joints and further increases soil bearing resistance between springlines and invert (haunch areas). The elliptical concrete pipe restoration work shall be performed in the following sequence:

1.) Step 1, Injection of hydrophilic polyurethane grout into elliptical concrete pipe tongue and recess joints to fill voids, adhere materials together, and establish an initial plug on exterior. This procedure will occur at every elliptical concrete pipe joint as noted in the Scope of Work drawings (pages 10 to 24). See “A” series drawings as noted in Section 03 64 13 of the specifications as WP-1.

2.) Step 2, Injection of an acrylic grout through same drill holes, however extended, to create a solidified soil mass at pipe exterior. Solidified soil mass increases soil strength and impedes soil particle flow with water movement at concrete pipe joints. This procedure will occur at every elliptical concrete pipe joint as noted in the Scope of Work drawings (pages 10 to 24). The first 10 pipe sections (joints) at portals will use a glycol modified acrylic grout to provide freeze thaw resistance over time. See "B" series drawings as noted in Section 03 64 20 of the specifications as WP-2.

3.) Step 3, involves soil solidification via permeation grouting (curtain grouting) in granular soils and fracture grouting in cohesive soils (soil stabilization) to improve soil bearing resistance between invert and springline areas (haunch locations). This procedure will occur at every elliptical concrete pipe section joint as noted in the Scope of Work drawings (pages 10 to 24). See "C" series drawings as noted in Section 03 61 10 of the specifications as SS-3.

4.) Steps 4, 5, and 6, could be interchanged without concern of sequence.

5.) Step 4 is treatment procedures for cracks equal to or less than 0.020 inches (0.02" = 20 mils). Crystalline treatment of cracks accelerates autogenous healing and reduces ability of fine silt and clay particle migration through said cracks. This procedure will occur at every elliptical concrete pipe section where noted on the Scope of Work drawings (pages 10 to 24). See "D" series drawings as noted in Section 07 16 16 of the specifications as WP-4.

6.) Step 5 is treatment procedures for cracks less than 0.040 inches (0.040" = 40 mils) and greater than 0.020 inches (0.020" = 20 mils). Polyacrylate grout injection via interception grouting of cracks seals against water leakage and reduces ability of fine sand, silt and clay particle migration through said cracks. This procedure will occur at every elliptical concrete pipe section where noted on the Scope of Work drawings (pages 10 to 24). See "E" series drawings as noted in Section 03 64 10 of the specifications as WP-5.

7.) Step 6 is treatment procedures for cracks less than 0.120 inches (0.120" = 120 mils) equal to and greater than 0.040 inches (0.040" = 40 mils). Epoxy grout injection via surface mounting techniques seals against water leakage and reduces ability of medium sand, silt and clay particle migration through said cracks. This procedure will occur at every elliptical concrete pipe section where noted on the Scope of Work drawings (pages 10 to 24). See "F" series drawings as noted in Section 03 64 23 of the specifications as WP-6.

8.) Step 7 is treatment procedures for joints which exceed 1.50 inches in width equal or exceed one and one-half inches (1.5") in width at any location along the pipe joint. The possibility of interior joint seals falling out from elliptical concrete pipe joints over time is higher in these wider situations. This procedure will occur at every elliptical concrete pipe joint exceeding 1.50 inches and noted on Scope of Work drawings (pages 10 to 24). See "G" series drawings as noted in Section 07 13 56 of the specifications as WP-7.

9.) Step 8 is general filling of lift holes, spalls and chips at most elliptical concrete pipe sections with cementitious mortar equal in strength to the original concrete pipe (pages 10 to 24).

For any additional items of explanation or questions please contact me.

Respectfully submitted.



Brent Anderson, PE
Wis. # 23802 - 6

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I hereby certify that the plan, specifications or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Wisconsin.

Date: 11/22/2019 Registration No: 23802-6

By: Brent Anderson

Section 03 61 10 -- Ultra-Fine Cement, Soil Stabilization

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes micro/ultra-fine cementitious grout injection through concrete culvert pipe haunch areas to fill voids, densify/compact, and partially solidify soil particles on pipe perimeter.

B. Work of this section is designated on drawings as soil solidification/stabilization, SS-3 and is shown and itemized in Scope-of-Work section on Construction Documents.

C. Related Sections: Other specification sections, which directly relate to Work of this Section and include, but are not limited to, the following:
1. Section 03 64 13 Polyurethane Grout, Crack-Joint Injection, WP-1
2. Section 03 64 20 Acrylamide Grout Joint Injection, Soil Solidification, WP- 2
3. Section 03 61 10 Ultra-fine Cement, Soil Stabilization, SS-3
4. Section 07 16 16 Crystalline Waterproofing, WP-4
5. Section 03 64 10 Polyacrylate Grout Crack Injection, WP-5
6. Section 03 64 23 Epoxy Resin Crack Injection, WP-6
7. Section 07 13 56 Thermoplastic Sheet Strip Seals, WP-7

D. Contractor shall be responsible for reviewing site conditions to verify quantities.

E. Contractor shall be responsible for magnitude (depth and width), scope (length) of permeation grouting control as schematically shown and outlined on the contract documents.

F. Contractor shall follow prescriptive requirements of this specification; however, Contractor may modify as necessary the procedures, products, and installation to achieve soil improvement, and water control through leaking concrete culvert pipes if approved via shop drawings.

1.2 SECTION INCLUDES

A. Cementitious injection grouting for solidification of soils from springline to invert on each side of elliptical tunnel cross-section.
1. Examination.
2. Preparation and Layout.
3. Drilling Injection Ports.
4. Setting Injection Ports.
5. Injection Grouting Operations.
6. Solidification Grouting Verification
7. Remediation Grouting.
8. Clean-up and Demobilization.

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
   1. American Society for Testing and Materials (ASTM) - ASTM International:
      a. ASTM C507 Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
      b. ASTM C1840 Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain and Storm Sewer Pipe.
      c. ASTM C42/C42M: Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
      d. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
      e. ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
      f. ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      g. ASTM A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      h. ASTM C33, Standard Specification for Concrete Aggregate
      i. ASTM 050, Standard Specification for Portland Cement.
      j. ASTM C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
      k. ASTM D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
      l. ASTM D2241, Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
      m. ASTM F2304 Standard Practice for Rehabilitation of Sewers using Chemical Grouting (latest revision).
      n. ASTM F2454 Standard Practice for Sealing Lateral Connections and lines from the mainline Sewer Systems by Lateral Packer Method, Using Chemical Grouting (latest revision).
      o. ASTM 091, Standard Test Methods for Time of Setting of Hydraulic Cement by VI cat Needle.

B. State of Wisconsin Department of Transportation (WisDot):
   1. Standard Specification for Construction.
   2. Standard Specifications for Construction of storm sewer and drainage structures.

C. Department of Labor, Occupational Safety and Health Administration (OSHA):
   1. Occupational Safety and Health Standards – Excavations, Final Rule – 29 CFR, Part 1926

D. American National Standards Institute (ANSI):
   1. Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD), Z535.1 Safety Color Code
   2. ANSI/NSF 61, Drinking Water System Components – Health Effects.

E. American Public Works Association (APWA):

1. Uniform Color Code for Temporary Marking of Underground Utility Locations.

F. Other Applicable Standards:
1. API RP 13B-1, Recommended Practice for Field Testing Water-based Drilling Fluids.
2. National Association of Sewer Service Companies (NASSCO) prepared Pipeline Assessment and Certification Program (PACP), TV inspection form and sewer condition codes.

1.4 ABBREVIATIONS:

A. Commonly used abbreviations used in this specification are as follows:
1. OR – Owners Representative
2. CO – Contracting Officer
3. COR -- Contracting Officer's Representative.
4. COTR – Contracting Officer's Technical Representative
5. M/E/P – Mechanical Electrical Plumbing
6. SPI – Safety Performance Index
7. EDR – Engineering Design Representative
8. SDS – Safety Data Sheet
9. HEPA -- High Efficiency Particulate Air
10. mm – millimeters (40 mils = 1 mm)
11. mil – millage, 1/1,000 inch = 0.001"
12. QA – Quality Assurance
13. QC – Quality Control
14. WP –Waterproofing
15. SS – Soil Solidification/Stabilization

1.5 DEFINITIONS

A. Quality Control: A system for verifying and maintaining a desired level of quality in an existing product or service by careful planning, use of proper equipment, continued inspection, and corrective action as required.

B. Quality Assurance: A systematic monitoring and evaluation program for various aspects of a project, service, or facility to ensure that standards of quality are being met.

C. Chemical Grout: A low viscosity, reactive, polymer resin which penetrates soil particle pore space under a gauge pressure; also commonly referred to as grout, injection resin or gel grout.

D. Grout(s): Generic term describing various liquid/gel/paste injection materials-including Portland cement (with or without fine aggregate), micro-fine and ultra-fine cement, and/or bentonite blends, reactive polymer(s) such as urethane (hydrophobic/hydrophilic), silicate, epoxy, acrylamide, methacrylate and polyacrylate resins, solvent based rubber gels, and hot/cold asphalt fluids and/or emulsions.

E. Solidification Grouting: Process of injecting chemical grout under pressure filling

the pore space of soil particles in a specified zone of influence; also referred to as permeation grouting, soil solidification or soil stabilization, chemical grouting, grouting, and/or pressure injection.

1. Grout Curtain: A physical element having volume, -- length, width, and depth of modified or solidified/densified soil having low permeability qualities and increased strength.

F. Sectioning: Grout curtain in soil strata arranged to seal off individual structural sections. Used in connection with “charge” and “re-charge” grouting pipes to create a grout curtain system, which promotes watertightness control and facilitates leakage remediation.

G. Charge and Re-Charge Pipes: Drilled holes for permeation grouting process. Charge holes are pressurized with grout and re-charge holes allow pressure relief and monitoring of grout flow path; also referred to as “inlet/outlet” ports.

H. Control and Grouting Pipes: Pipes typically installed near water barrier intersections to control watertightness of individual membrane sections. If leakage should occur, the pipes are used for remedial grouting specifically located at each connection within the structural element; also referred to as “inlet/outlet” ports.

I. Sleeve Port(s): Injection pipe(s) of various diameters with incremental openings (typically 15 inches on center) along its length, covered with a rubber gasket; also called tube-a-manchette (TAM).

J. Manchette tube:

1. Tube-A-Manchette (TAM) or commonly referred to as Injection pipe(s) of various diameters with incremental openings along its length and covered with a rubber gasket; also called a sleeve port.
2. Mild or stainless-steel tube (various diameters) with or without perforations.

K. Packer(s): A mechanical device, also referred to as a manchette or port, commonly placed onto manchettes and/or drilled holes in soil or concrete, which grout is pumped into, and forced through; also referred to as injection port. Devices shall be chemical resistant HDPE (high density polyethylene), leather or Teflon gaskets, and stainless-steel frame.

L. Slide Packer(s): A mechanical device placed in manchettes with sectionalized inflatable or friction gaskets at each end to distribute pressurized grout to incremental location(s) within the manchette or sleeve port.

M. Injection Head: Mechanical device consisting of a mixing chamber for one or more parts of resin with quick-connects, an on/off switch capability, recirculation, pressure monitoring, and a cleanout; often called a “L”, “F” or “E”-Assembly”.

N. Top-down Grouting: Technique whereby grout curtain is established near ground surface and solidified zone proceeds downward.

O. Bottom-up Grouting: Technique whereby grout curtain is established at bottom of

manchette and grout zone proceeds upward.

P. Grouting Installation Form: Form provided by Contractor, documenting the location and amount of grout at each manchette location.

Q. Fracture Grouting: Pressure injection process whereby some permeation and fracking occurs in soil mass that hardens and compacts cohesive soil to some degree.

R. Remediation Grouting: Additional grouting, as proposed by Contractor and/or directed by COTR, to supplement specified injection grouting program if voids, low solidification density, inadequate permeation, or similar irregularities are identified in the grout curtain during solidification verification.

S. Primary Holes: The first set of drill holes to be injected within the grout zone.

T. Secondary Holes: The second set of drill holes injected within the grout zone. Secondary Holes are typically drilled midway between the Primary Holes.

U. Refusal: Specifications typically dictate injection rate (volume per minute), maximum allowable injection pressure (psig), and a time duration for these qualifying items. The point at which grouting is stopped on a grout hole is defined as “Refusal”. A grout injection rate of 1/4 gallon grout per minute or less, as measured each minute for 5 consecutive minutes at 100 percent of the required grouting pressure and constant grout consistency is considered refusal for this project.

V. Split Spacing Method: The procedure of drilling and grouting an additional grout hole midway between two previously drilled and grouted holes.

W. Stage: A partial grouted zone or complete depth of grouted soil in either horizontal or vertical format within the soil mass.

U. Standpipe: A length of pipe that is grouted into the collar of the probe / grout hole and used to control water inflow and contain grout in the hole.

Y. Tertiary Holes: A third set of drilled holes for grouting in the grout zone. Tertiary Holes are placed between Primary and Secondary Holes.

Z. Test Holes: Holes drilled roughly five feet from perimeter grout zone after the grouting has been completed to determine effectiveness of the grouting performed through this area.

1.6 SUBMITTALS

A. Shop Drawings: Provide project customized plan, sections and associated details showing the following:
   1. Work scope plan,
   2. Manchette locations,
   3. Depth, spacing, and pattern of manchettes,
   4. Details at terminations; interface with existing pipe materials,

5. Sealing of ports at tunnel surface,

6. Volumes of grout expected to be pumped per manchette based on the following items noted in soil investigation and geotechnical report:
   a. Soil strata conditions,
   b. Water table elevations, and
   c. Density and gradations.
7. Proposed means and methods for Remediation Grouting, if required.

B. Product Data: Injection grout material manufacturer's literature (catalogue cuts) Including:
1. written instructions for evaluating,
2. preparation,
3. treating soil,
4. tested physical and performance properties, and
5. injection instructions.

C. Additional technical data including:
1. Include temperature ranges for storage and application of materials, and special warm/cold-weather application requirements or limitations.
2. Include recommended Site protection measures.
3. Include material Safety Data Sheets (SDS) for information only.
4. Name and contact information for injection-material manufacturer's Technical Representative that will attend the Pre-installation Meeting and inspect tunnel/culvert pipe work from time-to-time.

D. Certificates:
1. Signed by injection-material manufacturer, certifying that products furnished comply with requirements and are recommended by manufacturer for uses indicated.
2. Signed by injection-material manufacturer, certifying that company and individuals performing work is approved to install its products.

E. Injection Installer/Subcontractor Qualifications: Provide documentation confirming that Specialty Contractor identified will be performing injection grouting work and his/her qualifications.

F. Installer/Subcontractor's and/or Manufacturer's field reports. Provide sample of field reports for review and approval of Owner.

G. Samples:
1. Reacted Chemical Grout in small plastic bottle or bags; and
2. 24-inch-long manchette of proposed diameter for use.

H. Chemical Grouting protection plan/narrative: Describe the intended procedures to prevent damage during construction operations. The following items shall be addressed:
1. Storage set up of equipment,
2. Storm water control and management,
3. Handling of drilling fluids if any, and
4. Testing to ensure continuous and monolithic grout curtain.

1.7 QUALITY ASSURANCE REQUIREMENTS

A. Grouting contractor/Installer shall be certified and/or an approved applicator of the manufacturer's prior to submitting proposal on this project.

B. Pre-installation Meeting:
   1. Conduct meeting at Site.
   2. Review requirements for injection Work, including:
      a. Safety protocol and tradesmen training,
      b. Construction schedule,
      c. Storm water control in elliptical concrete culvert pipe during Work operations if snow melt or rain events suddenly occur,
      d. Availability of materials, Injection Installer/Subcontractor's personnel, equipment, and facilities needed to make progress and avoid delays,
      e. Site use, access, staging and set-up location limitations,
      f. Cracks, pipe joints and haunch areas to be injected, and condition of other construction that will affect injection Work,
      g. Surface preparation and substrate condition and pretreatment,
      h. Injection procedures,
      i. Testing and inspection requirements,
      j. Site protection measures, and
      k. Governing regulations.
   3. Contractor's Project Manager and Field Superintendent, injection-material manufacturer's Technical Representative, injection subcontractor's Field Superintendent, COTR, and Owner's Grouting Consultant shall attend.

1.8 WEATHER LIMITATIONS

A. Environmental Limitations: Install injection material when existing and forecast weather conditions permit material to be installed and cured according to injection-material manufacturer's written instructions and requirements.
   1. Do not install when air and substrate temperatures or humidity are outside limits permitted by injection-material manufacturer.
   2. Provide enclosures to protect work against freezing temperatures, rain, and over exposure to UV light.
   3. Coordinate work with conditions of snow and/or ice melt, rain/sleet events or similar weather -- to ensure storm water pipe flows do not damage work and create safety issues.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such manner as to prevent damage to materials and existing structure.

B. Deliver materials to Site in original containers with seals unbroken, labeled with manufacturer's name; product brand name and type; date of manufacture; lot number; SPI hazardous rating and appropriate warnings for handling; and directions for storing and mixing.

C. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling and installation. Reject and remove from Site new materials which exhibit evidence of moisture during application or have been exposed to moisture or other deleterious materials.

D. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by injection-material manufacturer.

E. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent structural deflection(s).

F. Conspicuously mark damaged or opened containers with contaminated materials, and remove from Site as soon as possible. Dispose materials per governmental regulations.

G. Remove and replace materials that cannot be installed within stated shelf life or obtain letter from manufacturer that shelf life can be extended.

1.10 PROJECT CONDITIONS

A. Verify existing dimensions and utilities prior to start of injection work. Notify COTR, of conditions found to be different than those indicated in the contract documents or any items that may adversely affect the Work.

B. Exercise care to avoid injection or otherwise damaging embedded items. Remove, replace, or otherwise remedy damage to embedded items at no cost to Owner or Authority.

C. If unusual or concealed conditions are discovered, stop work, and immediately notify COTR in writing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Source Limitations: Obtain injection materials through single manufacturer as much as possible, and/or from sources approved by manufacturer of injection material(s). Basis for Design is:
Avanti International Inc.
822 Bay Star Blvd.
Webster, TX 77598
Phone 281.486.5600
Fax 281.486.7300

B. Cementitious Grout:
1. Ultrafine VX (avg. 3 microns), by Avanti International, or
2. Ultrafine cement shall be Super Fine, as manufactured by:
Nittetsu and distributed by Surecrete Inc.,
155 NE 100th Street,

Suite 300, Seattle, WA 98125, or equal.

3. The addition of catalysts, activators, inhibitors, buffers, viscosity modifiers, fluidizers, soluble additives, and other substances to change the nature of grouting materials shall be fully compatible with grouting materials and with groundwater discharge permit requirements. Tests to demonstrate compatibility shall be conducted by Contractor well in advance of their planned use. Forward test results to District or Owner within 60 days after receiving the Notice to Proceed. Additives shall be approved for use by the District or Owner.
4. Water for grout mixing shall be fresh, clean, and free from injurious amounts of sewage, oil, acid, alkali, salts, or organic matter.

C. Superplasticizer: USG Super (approx. 7 oz. per 44 lb. bag) or approved equal.

D. Auxiliary Materials:
   1. Epoxy gel: Use 1 of following or approved equal:
      a. AV-502 manufactured by Avanti.
      b. SCB Concresive 1446 manufactured by BASF Construction Chemicals, LLC.
      c. Sikadur 31, Hi-Mod Gel manufactured by Sika Corporation.
   2. Hydraulic cement: Use 1 of following or approved equal:
      a. Waterplug manufactured by BASF Construction Chemicals, LLC.
      b. SikaPlug Fast-Setting Water Stop manufactured by Sika Corporation.
   3. Plaster-of-Paris or equal for securing and anchoring manchettes.
   4. Granular bentonite or equal for securing and positioning manchettes.
   5. Manchettes and/or Sleeve Ports:
      a. PVC, schedule 40 tube or pipe, incremental openings with rubber gaskets at 15 inches on-center by Avanti International or equal.
   6. Oakum:
      a. As recommended by the Grout Manufacturer .
   7. Grouting Equipment and Accessories:
      a. All grouting equipment used shall be of a type, capacity, and condition suitable for doing the Work. The equipment and its powering and layout thereof shall meet all applicable requirements of federal, state, and local laws and regulations, and is subject to approval by the District or Owner.
      b. Equipment used for mixing and injecting grout shall be designed for grouting service, shall be maintained in satisfactory operating condition at all times, and shall be capable of satisfactorily mixing and agitating the grout and injecting it into grout holes at an essentially uniform flow rate under constant pressure. It is anticipated that, where possible, two or more holes will be pumped simultaneously using two or more pumps.
      c. The minimum grouting equipment furnished shall include, but is not limited to, the following:
         1) A cement grout mixer shall be high shear colloidal type, capable of providing a homogenized mix with an impeller speed of not less than 1500 rpm or equal.
         2) Equip the mixer with a suitable water measuring

device calibrated to read in cubic feet and tenths and so designed that, after each delivery, the instrument can be conveniently reset to zero. Provide means for accurately measuring the other grout ingredients at the mixer.

3) A mechanically driven grout agitator tank, capable of effectively stirring grout having a water-cement ratio ranging from 0.6:1 to 3:1 measured by weight and holding in suspension all solid matter contained in the grout. The outlet from this tank shall not be less than 2 inches in diameter. Place a 40 mesh-per-inch screen between the mixer discharge and holding tanks to trap any oversize particles.

d. High Shear Colloidal Mixer with agitation tank by Chem-Grout (C-630) or equal.

e. Roto-Stator grout pump (P-25) by C. J. Spray or equal with variable speed control and reverse/forward switch.

1) A cementitious grout pump capable of delivering not less than 10 gpm of grout at a pressure of 300 psi is to be used at the grout hole collar. The grout pump shall be either rotor-stator, progressive cavity type, or positive displacement grout pumps, such as duplex double-acting pumps of the long-stroke type, with large valve openings, equipped with removable valve seats, or equal. In addition to the two pumps being used in the headings, keep on site a backup pump of the same capacity and arrangement, and in good working condition.

2) Such valves, pressure gauges, pressure hose, small tools, and accessories as may be necessary to provide a continuous supply of grout and accurate pressure control. The inside diameter of the delivery, return lines and grout nipples, shall be not less than 1-inch. All hoses, valves, and fittings, etc., must be rated for a working pressure exceeding 300 psig.

f. Stainless Steel, 1-to-1 ratio, dual piston pump, with pressure control gauges.

g. Stainless steel diaphragm pumps for supplying grout to pump from mixing barrows.

h. Stainless steel “F”-Assembly with check-valves and ball valve control.

i. Chemical resistant, insulated injection hose lines for work in cold weather.

j. Stainless steel/HDPE Slide Packers, air-inflatable, or friction gaskets.

k. HDPE and stainless-steel mixing barrows and paddles.

l. Stainless steel packers with needle extensions for localized grout curtain leakage remediation during excavation.

m. Water and/or liquid control meters for grout volume monitoring. Flow meters shall be capable of accurately registering flow rates to 0.2 gpm.

PART 3 - EXECUTION

3.1 GROUTING PHASES AND GENERAL WORK SCOPE

A. Perform injection grouting operations at manchette drill hole locations shown on the contract documents. The grout curtain zone at pipe haunch areas shall include granular soils above and below the groundwater table, and further to improve soil support strength and minimize soil induced settlement of elliptical pipe culvert sections.

B. First Pass: Injection grout all manchette locations. Label manchettes in the field, record locations on a drawing, the date, quantities of grout injected at each manchette, and the grout batch number on an Xcel spreadsheet.

C. Second Pass: In locations identified by soil report where more than 20 percent of soil passes the #200 sieve, repeat injection grouting at all manchette locations the following day (fracture grouting). Record the date, quantities of grout injected at each manchette, and the grout batch number on an Xcel spreadsheet.

D. Remediation Grouting: If voids are identified in the grout curtain during Solidification Grouting Verification, Contractor shall perform Remediation Grouting in accordance with approved shop drawings as directed by the COTR.

3.2 EXAMINATION

A. The injection subcontractor's Field Superintendent and injection-material manufacturer's Technical Representative shall:
   1. Ensure that work done by other trades is complete and ready for injection grouting.
   2. Examine existing substrates and site conditions to confirm compliance with grouting requirements and approved shop drawings.
   3. Notify COTR in writing of substrates or conditions that may adversely affect installation or performance of injection grouting and recommend corrections.

B. Do not proceed with injection work until adverse conditions have been corrected and reviewed by COTR and Grouting Consultant.

C. Commencing injection grouting work constitutes acceptance of work surfaces and conditions

3.3 PROTECTION

A. Protect existing surfaces from work in progress from mechanical damage due to drilling operations, scaffolding, excessive water flow, and/or methods of work and other equipment.

B. Limit access to work areas.

C. Exercise care to avoid injection or otherwise damaging embedded items. Remove and replace or otherwise remedy damage to embedded items, at no cost to the Owner / Authority.

3.4 PRESSURE INJECTION EQUIPMENT

A. Injection equipment shall be capable of pumping injection material under pressure through injection manchettes and/or ports; equipment shall be approved by injection-material manufacturer.

3.5 PREPARATION FOR SOLIDIFICATION GROUTING

A. Inspect surfaces, mark drill hole locations, and areas to be injected from the drawings.

B. Use GPR or micro-cover meter to locate steel on interior tunnel surfaces. The drawings indicate one-inch concrete cover on steel reinforcing. Steel reinforcement spacing and intensity varies at crown, springline, and invert. Three different structural reinforcement patterns are used on the project.

C. Drill holes with hammer or core drill for manchettes/packers/ports in accordance with approved shop drawings.

D. Install sleeve ports/manchettes/packers to achieve spacing patterns shown on the contract drawings.
   1. Drill holes for injection ports or packers at 90-degree angle to curved pipe surface.
   2. Alternate manchette placement from side to side along length of curtain.
   3. Insert manchettes into drilled holes in such manner that cave-ins do not occur.

3.6 MANCHETTE GROUTING

A. Perform grouting in presence of injection-material manufacturer’s Technical Representative. The Technical Representative shall provide documentation confirming that grouting was installed in accordance with requirements or an explanation of why it was not.

B. Maintain conditions and injection material at adequate temperature for suitable Time so that injection material will completely fill the manchette and will achieve full cure.

C. Using the lowest possible pressure to achieve desired result, continuously inject material into manchettes, as recommended by injection-material manufacturer.
   1. Use cementitious grout injection pressure of (15 to 25) pounds per square inch, depending on soil cover depth, manchette spacing, width, depth of grouting column, and condition(s) of soil.
   2. Start injection at lowest packer elevation (bottom up grouting) and continue until injection material reaches the pre-calculated volumes.
   3. Continue to pump cementitious grout into manchette until refusal is met or the designed material quantity is established. Refusal is defined in “Definition” section of this specification.
   4. Remove injection nozzle or head from packer immediately after injection material reaches the pre-calculated volumes.

5. Continue injection process bottom-up from manchette to manchette, monitoring grout volume per manchette.
6. Take care to keep equipment and grout lines clean during grouting operations. Flush out all equipment and grout lines after grouting each stage. Properly dispose of all waste and contaminated water in accordance with the Contract Documents and governmental permit requirements.

3.7 CLEANING

A. Protect existing tunnel surface finish(s) from grout stains where required.

B. Under no circumstances shall any drilled grout or test holes in elliptical concrete culvert pipe tunnel sections be left unsealed with cementitious mortar fill exceeding 6,000 psi compressive strength.

C. Clean surfaces of excess grout, and injection ports or packers.
1. Allow injection material enough time to cure before performing cleanup.
2. Clean surfaces by grinding or other means.
3. Patch holes at injection ports.

PART 4 - CONTRACTOR'S QUALIFICATIONS AND QA/QC REQUIREMENTS

4.1 GENERAL

A. Pre-Installation Meeting: Prior to start of Work and at Contractor's direction, meet at Project site to review methods and sequence of grouting installation, special details and conditions, standard of workmanship, testing and quality control requirements, job organization and other pertinent topics related to the Work. The meeting shall include the COTR, Contractor/Installer's quality assurance technician, Project Superintendent, Contractor's Subcontractor's Superintendent, Grout material manufacturer's representative, inspection and testing services personnel, and any other subcontractors whose work requires coordination.

B. Inspection:
1. Manufacturer's representative to inspect on-going work on a bi-weekly basis and upon completion of each type of grouting, further provide a written report that application complies manufacturer's instructions at the end of each inspection.

C. Product:
1. Supply and install only products specifically designed and manufactured for this type of construction.
2. Select manufacturers of accessory products who are regularly engaged in the production of similar materials for underground structures.

D. Supervision and Training of Personnel:
1. Execute all installation and testing under the direct supervision of an individual with a minimum five (5)-years-experience in installation of grouting systems for underground structures using similar materials.

2. The installer must have a minimum of five (5) years of experience at installation of grouting/injection materials in underground installations.
3. The proficiency of each technician shall be demonstrated in the field for approval by the Contracting Officer's Technical Representative (COTR).
4. The grouting system(s) shall be applied only by an approved contractor authorized by the Manufacturer prior to bid.
5. All work shall be completed by trained and authorized personnel.
6. Installation of grouting/injection system(s) shall be the responsibility of the Grouting Applicator to ensure undivided responsibility.
7. Upon request, the Applicator must submit a list of jobs performed by his employees and supervisors similar to the proposed system being bid.

E. Manufacturer's Performance:
1. Shall have documented experience of more than 10-years supplying grout materials for stormwater piping systems.
2. The grouting/injection products are to made by a nationally-recognized manufacturer specializing in water control systems; have been used successfully on projects similar to this; and are appropriate for the substrate, groundwater, hydrostatic pressure, and soil/rock contamination conditions that may be expected in this Contract.

F. Installation Contractor:
1. Installation contractor of grouting materials shall be certified and/or be approved by the manufacturer in writing prior to bid submission.

4.2 FIELD QUALITY CONTROL

A. Installer's quality assurance technician shall be present during grouting work.

B. Provide:
1. Access to Work.
2. Materials for sampling.
3. Site facilities for sampling, testing, and storage of materials.
4. Incidental labor.

C. Sample each batch of material to be injected to determine reaction times: Obtain 1 sample of the injection material prior to beginning injection Work each day, representing first 50 feet of injection, and 1 sample for every 100 feet of injection thereafter. Provide the following:
1. Allow samples to cure.
2. Do not begin injection Work each day until initial sample has satisfactorily cured from the following day.
3. Label samples:
   a. with injection date, and
   b. location of injected manchette represented by sample.
4. Retain samples in a safe location on site.

D. Monitor and Report:
1. Ambient temperatures,
2. Grout consumption per manchette,

3. Equipment pressures, and
4. Material ratios.

4.3 TESTING AND INSPECTION

A. Soil Stabilization/Solidification Grouting Verification
1. Contractor shall install one boring in grout curtain zone per pipe section or/and at locations determined by the COTR to confirm the extent and effectiveness of the grouting program.
2. Contractor shall collect samples from the borings. Samples shall be examined in the field by Owner's Grouting Consultant to evaluate the effectiveness of the grouting procedure. Two samples may be collected from each boring for laboratory analysis of unconfined compression testing if sampling is suspicious of not meeting requirements.
3. Based on the results of field examination and laboratory analyses, Owner's Grouting Consultant will determine if the solidification grouting program meets Owner's needs or if Remediation Grouting is necessary. The COTR will direct the Contractor accordingly.

B. Field Quality Control
1. An inspection agency may be engaged by the Authority to inspect work specified herein. The presence of the Inspection Agency is for the Authority's own purposes and any information or assistance furnished by this Inspection Agency shall not relieve the Contractor of the responsibility for the Work.

C. Contractor's Responsibility:
1. Attend a pre-installation examination and acceptance of substrate and surface preparation for each stage. Issue report.
2. Be present at initial start-up for each process. Confirm application rates and techniques. Issue report.
3. Issue summary report at completion of installation indicating Manufacturer's acceptance of installed system.
4. Provide any Inspection Agency personnel with safe access to the Work.
5. Notify the Inspection Agency whenever work is to be done, with enough time to arrange inspection, (3-day notice).
6. Cooperate with any inspection and testing service that may be engaged by the Authority to perform on-site inspection of the membrane waterproofing work. Comply with the inspector's request in connection with specific test samples and provide any additional testing that may be requested in order to confirm that the work complies with the requirements.
7. Discontinue any practice immediately when notified, which, in the Inspection Agency's opinion, is not in accordance with the Specifications or will act to the detriment of the system. The Inspection Agency will notify the Authority, the COTR, the Contractor and the manufacturer immediately of all violations. Any work affected by improper practice will be subject to complete replacement.
8. Give written notice to Inspection Agency stating that the installation has been completed in accordance with the Contract Documents and requesting a final inspection to be conducted

4.4 INSPECTION AND TESTING

A. The inspection company must be notified three (3) days in advance of any work to be performed on-site.

B. Contractor shall require Representative of Manufacturer of grouting material to provide field instruction and supervision of grout installation at start of Work of this Section and, while work is occurring. Representative shall make biweekly site inspections and send reports to COTR.

C. Contractor shall require the Manufacturer's Representative to ensure Subcontractor's workmen are fully instructed and trained in handling and application of all the materials and shall see that materials are correctly installed.

D. Upon completion of the installation, Contractor shall submit to COTR written certification that the Representative of the Manufacturer of the fluid-applied membrane waterproofing material has supervised the Work of this Section and that all materials were correctly installed.

4.5 MOCK-UP TESTING FOR CEMENTITIOUS GROUTING

A. Mock-up Test Section:

1. Test two (2) pipe sections (approximately 14 lineal feet) as described below before grouting remainder of elliptical concrete culvert pipe.
2. Test section to verify if bedding conditions meets a Type II or Type III Condition per the American Concrete Pipe Association, design manual.
3. Test holes before grouting to verify potential soil type, thickness and relative compaction of fill material.
4. Test holes after grouting to verify that grout has penetrated or fractured soil and made it more compact.
5. Test holes should verify that haunch soils are more compact than soil at the invert (6 o'clock position).
6. Tests to verify grout type, mix ratio and quantity of grout pumped to increase haunch compaction, however, note that invert area to be less compacted then haunch areas.
8. Test all 8 holes before grouting.
9. Test 6 new holes after grouting.
10. Test with static cone penetrometer to verify it adequately tests for soil resistance present.
11. Test in the presence of a Qualified Engineer.
12. Qualified Engineer to approve grouting of mock-up test section has met above requirements, before grouting remainder culvert pipes.
13. Qualified Engineer to set testing requirements for remainder of pipe to be grouted. As a minimum each pipe must have 1 test hole in the haunch and 1 test hole at the 6 o'clock floor position.

END OF SECTION 03 61 10

Section 03 64 10 -- Polyacrylate Grout, Crack Injection

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes polyacrylate grout injection through the concrete culvert pipe cracks from 21 mils to 39 mils to seal against water entry and solidify soil particles on pipe perimeter.

B. Work of this section will be designated on the drawings as WP-5 and is shown and itemized in the Scope-of-Work section on Construction Documents.

C. Related Sections: Other specification sections, which directly relate to the Work of this Section and include, but are not limited to, the following:
1. Section 03 64 13 Polyurethane Grout, Crack-Joint Injection, WP-1
2. Section 03 64 20 Acrylamide Grout Joint Injection, Soil Solidification, WP- 2
3. Section 03 61 10 Ultra-fine Cement, Soil Stabilization, SS-3
4. Section 07 16 16 Crystalline Waterproofing, WP-4
5. Section 03 64 10 Polyacrylate Grout Crack Injection, WP-5
6. Section 03 64 23 Epoxy Resin Crack Injection, WP-6
7. Section 07 13 56 Thermoplastic Sheet Strip Seals, WP-7

D. Contractor shall be responsible for reviewing site conditions to verify quantities.

E. Contractor shall be responsible for magnitude (depth and width), scope (length) of permeation grouting control as schematically shown and outlined on the contract documents.

F. Contractor shall follow prescriptive requirements of this specification; however, Contractor may modify as necessary the procedures, products, and installation to achieve water control through the leaking concrete culvert pipe if approved via shop drawings.

1.2 SECTION INCLUDES

A. Injection grouting to minimize water leakage post construction and is organized as follows:
1. Examination
2. Preparation and Layout
3. Drilling Injection Ports
4. Air-flushing drill holes
5. Water-flushing drill holes
6. Setting Injection Ports
7. Pressurized Water Testing
8. Pressurized Air Testing
9. Conditions Where Excessive Leakage Occurs
10. Injection Grouting Operations
11. Re-Drilling drill holes

12. Water-flushing drill holes
13. Mortar filling drill holes
14. Clean-up and Demobilization

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
   1. American Society for Testing and Materials (ASTM) - ASTM International:
      a. ASTM C42/C42M: Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
      b. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
      c. ASTM D420: Standard Guide for Investigating and Sampling Soil and Rock.
      d. ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
      e. ASTM F2304 Standard Practice for Rehabilitation of Sewers using Chemical Grouting (latest revision).
      f. ASTM F2454 Standard Practice for Sealing Lateral Connections and lines from the mainline Sewer Systems by Lateral Packer Method, Using Chemical Grouting (latest revision).
      g. ASTM C507 Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
      h. ASTM C1840 Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain and Storm Sewer Pipe.

B. Department of Labor, Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards – Excavations, Final Rule – 29 CFR, Part 1926

C. American National Standards Institute (ANSI):
   1. Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD). Z535.1 Safety Color Code

D. American Public Works Association (APWA):
   1. Uniform Color Code for Temporary Marking of Underground Utility Locations.

E. Other Applicable Standards:
   1. National Association of Sewer Service Companies (NASSCO) prepared Pipeline Assessment and Certification Program (PACP), TV inspection form and sewer condition codes.

1.4 ABBREVIATIONS:

A. Commonly used abbreviations used in this specification are as follows:
   1. OR – Owners Representative
   2. CO – Contracting Officer
   3. COR -- Contracting Officer’s Representative.
   4. COTR – Contracting Officer’s Technical Representative

5. M/E/P – Mechanical Electrical Plumbing
6. SPI – Safety Performance Index
7. EDR – Engineering Design Representative
8. SDS – Safety Data Sheet
9. HEPA – High Efficiency Particulate Air
10. mm – millimeters (40 mils = 1 mm)
11. mil – millage, 1/1,000 inch = 0.001”
12. QA – Quality Assurance
13. QC – Quality Control
14. WP – Waterproofing
15. SS – Soil Solidification/Stabilization

1.5 WATER CONTROL NOMENCLATURE

A. Specification criteria:
   1. Prescriptive based-water control criteria established by design professional’s details and specifications, or
   2. Performance based- water control ways-and-means established by contractor and reviewed by design professional.

B. Water leakage nomenclature:
   1. Crack Root-The point(s) of water ingress into a concrete element.
   2. Crack Mouth- The points of water discharge from a concrete element.
   3. Trail- A noticeable pathway/stain on concrete element surface designating continuous water flow.
   4. Ponding- The accumulation of water leakage through a concrete element.

C. Five levels of water accumulation on a concrete element can be physically described as follows:
   1. Color change (darker), when high moisture content exists at concrete element surface, (white/crystalline or efflorescence) when area has re-sealed itself via autogenous healing), not visually wet to touch, no ponding occurs;
   2. Wet to touch, surface dampness in spots, no sustained water trail present, no ponding occurs;
   3. Weeps and seepage, sustained trail of wetness, however, visual surface flow not apparent, ponding does occur;
   4. Continuous dripping, visual surface flow or water movement over Gushing concrete element, ponding occurs and leaves trail; or
   5. flow, from presence of hydrostatic back pressure, ponding leaves continuous trail of water.

D. Water Control: Water control at concrete elements serves many purpose(s):
   1. Minimizes potential of dissolved oxygen, carbon dioxide, free chlorides and various salts/contaminants from entering concrete through-wall/floor/elevated-deck cracks and joints.
   2. Helps control and potentially mitigate the following:
      a) Internal steel reinforcing bar corrosion,
      b.) Hardware corrosion of externally attached metal adjacent to wet area,

c.) Concrete carbonation,
d.) Alkali Silica Reactivity and Delayed Ettringite Formation,
e.) Surface delamination of paints, coatings, and high build flooring components,
f.) Nutrient Source for mold, algae, and bacterial growth organisms,
g.) Interior surface stains, efflorescence, salt, and carbonate buildups (stalactites/stalagmites),
h.) Ice formation (icicles) in unheated enclosures,
I.) Slippery surfaces,
j.) Electrical short circuits, and/or shocks,
k.) Conductor for stray current corrosion,
l.) Potential soil particle loss, and
m.) Costly cleanup when hazardous contaminants (radioactive or poisonous hydrocarbons) enter and accumulate.

E. Structural Parameters: Three important considerations for successful grouting without damaging the structural concrete elements are as follows:
1. Pressures more than 600 psig can cause tensile damage (fracking) to existing concrete elements;
2. Crack width is inversely proportional to pump gauge pressure; and
3. Crack width is proportional to grout viscosity required for proper penetration.

F. Water leakage flow paths:
1. Through-element primary and secondary cracks/joints;
2. Voids and shadows along horizontal or vertical steel reinforcing bar;
3. Unbonded surfaces between concrete and mechanical, electrical, plumbing, penetrations, inserts, or sleeves and dewatering hardware;
4 Poorly consolidated and/or honeycombs within concrete element at cold and/or construction joints;
5. Porous foreign objects/debris and/or soil deposits trapped within the concrete element during forming/placement construction and subsequent placement;
6. Through element braided copper wire ground cables;
7. Form-tie brackets, anchors, wire, or any such temporary or permanent structural inserts.

G. Crack Nomenclature and Width Definitions:
1. Cracks and joints as fine as 1/1000 inch (1 mil) are subject to water leakage if hydrostatic back pressure exists. Water leakage volumes are related to hydrostatic pressure, crack/joint width, and internal friction at crack/joint sidewalls. Cracks and joints are defined as follows:
a. ultra-fine crack/joint (01 to 05) mils (0.025 to 0.127) mm
b. very-fine crack/joint (06 to 10) mils (0.152 to 0.254) mm
c. fine crack/joint (11 to 15) mils (0.279 to 0.381) mm
d. medium-fine crack/joint (16 to 20) mils (0.406 to 0.508) mm
e. medium crack/joint (21 to 40) mils (0.533 to 1.016) mm
f. medium-wide crack/joint (41 to 60) mils (1.041 to 1.524) mm
g. wide crack/joint (61 to 120) mils (1.549 to 3.048) mm

1.6 DEFINITIONS

A. QA – Quality Assurance: A system for verifying and maintaining a desired level of quality in an existing product or service by careful planning, use of proper equipment, continued inspection, and corrective action as required.

B. QC – Quality Control: A systematic monitoring and evaluation program for various aspects of a project, service, or facility to ensure that standards of quality are being met.

C. Grout(s): Generic term describing various - structural and/or non-structural, cementitious and/or non-cementitious materials which are installed as a liquid, paste or gel/mastic; which may cure-out as a product that exhibits a high or low modulus resulting in an elastic/plastic foam, gel, or paste-like matrix. Injection or placement materials include Portland cement (Types I, II, III, IV, or V, with or without fine aggregate, neat cement as micro-fine and ultra-fine in particle size) and/or bentonite powder blends, potassium/sodium silicates, reactive polymer(s), such as urethane (hydrophobic/hydrophilic), epoxy, methyl-methacrylate, acrylamide and polyacrylate resins, solvent (hydrocarbon or water) based rubber gels, and hot/cold asphalt fluids and/or emulsions. Grout viscosity has a relationship with pumping pressure and crack width, among other parameters such as temperature, cross-sectional width of voids, gel-time, and water chemistry. Four grout designations are as follows:
   1. Low viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material when initially mixed facilitates a viscosity of (1 to 15) centipoise. Said grouts under controlled pressure penetrate ultra-fine cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.
   2. Medium viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material when initially mixed facilitates a viscosity of (50 to 100) centipoise. Said grouts under controlled pressure penetrate fine cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.
   3. High viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material when initially mixed facilitates a viscosity of (500 to1,000) centipoise. Said grouts under controlled pressure penetrate medium-wide cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.
   4. Very-high viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material or non-reactive fluid when initially mixed facilitates a viscosity of (2,000 or greater) centipoise. Said grouts under controlled pressure penetrate wide cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.

D. Interception Grouting: Process by which a crack or joint is intercepted between its mouth and root (origin), and further a chemical grout is pumped into it under gauge pressure to fill any void space left in the concrete matrix.

E. Permeation Grouting: Process of injecting chemical grout under pressure filling the pore space of soil particles in a specified zone of influence; also referred to

as soil solidification, chemical grouting, curtain grouting, and/or pressure injection.

F. Grout Curtain: A solidified soil element (of length, width, and depth) having low permeability qualities.

G. Sectioning: Grout curtain in soil strata arranged to seal off individual structural sections. Used in connection with “charge” and “re-charge” grouting pipes to create a grout curtain system, which promotes control of watertightness and facilitates leakage remediation.

H. Charge and Re-Charge Pipes: Drilled holes for permeation grouting process. Charge holes are pressurized with grout and re-charge holes allow pressure relief and monitoring of grout path; also referred to as “inlet/outlet” ports.

I. Control and Grouting Pipes: Pipes typically installed near water barrier intersections to control water-tightness of individual waterproof membrane sections. If leakage should occur, the pipes are used for remedial grouting specifically located at each connection or interruptions to concrete pours; also referred to as “inlet/outlet” ports.

J. Sleeve Port(s): Injection pipe(s) of various diameters with incremental openings (perforated pipe) along its length, covered with a rubber gasket; also called manchette tube or Tube-A-Manchette (TAM).

K. Manchette tube: Tube-A-Manchette (TAM) or commonly referred to as Injection pipe(s) of various diameters with incremental openings along its length, covered with a rubber gasket; also called a sleeve port.

L. Packer(s): A mechanical device placed into or through drilled holes in concrete elements or driven into soil, through which grout is pumped into, and forced through; also referred to as injection port, expandable packer, or wall sphere. Devices shall be chemical resistant HDPE (high density polyethylene), neoprene rubber, leather or Teflon gaskets, and stainless-steel, brass, aluminum, or carbon steel frame. Most contain a grease zerk, button head, or quick-connect for attachment to the Injection head.

M. Slide Packer(s): A mechanical device placed into plastic manchettes with sectionalized inflatable or friction gaskets (leather or Teflon) at each end to control and distribute pressurized grout to incremental location(s) within the manchette or sleeve port.

N. Injection Head or Gun: Mechanical device consisting of a mixing chamber for one or more parts of resin with quick-connects, zerk grease fitting, button head, and an on/off switch or ball-valve to control flow and capability, recirculation, pressure monitoring, and a cleanout; often called an “E” or “F”-Assembly.

O. Crystalline Waterproofing Mortar: Portland cement/silica sand mortar with reactive chemical admixture that promotes crystalline growth in the reinforced element. Reactive chemicals combine the free calcium hydroxide in concrete to crystallize and imped water flow.

P. Top-down Grouting: Injection technique whereby grout curtain is established near ground or exposed surface, once that solidifies, manchettes are drilled through the solidified zone and grouting proceeds sequentially downward.

Q. Bottom-up Grouting: Technique whereby grout curtain is established at bottom of hole and manchettes are sequentially lifted and grout zone proceeds upward.

R. Grouting Installation Form: Form provided by Contractor, documenting the location and amount of grout in each manchette location.

S. Dual and Single Component Pump(s): Operated with compressed air, electric, hydraulic oil, or mechanically operated pump with single mechanism or multi-ratio mechanisms for pumping various grout components.

1.6 SUBMITTALS

A. Shop Drawings: Provide project customized plan, sections and associated details showing the following:
   1. Work scope plan if different from contract documents.

B. Product Data: Injection grout material manufacturer's literature (catalogue cuts) Including:
   1. Written instructions for handling, mixing, and safety procedures.
   2. Technical data including tested physical and performance properties, including:
      a. Temperature ranges for storage and application of materials, and special warm/cold-weather application requirements or limitations,
      b. Include recommended Site protection measures, and
      c. Safety Data sheets.

C. Certificates:
   1. Signed by injection-material manufacturer, certifying that products furnished comply with requirements and are recommended by manufacturer for uses indicated.
   2. Signed by injection-material manufacturer, certifying that individual(s) performing work is approved to install its products.

D. Injection Installer/Subcontractor Qualifications: Evidence that Subcontractor's existing company has minimum 5 years of continuous experience in injection of specified materials; list of at least 5 representatives, successfully completed projects of similar scope and size, including:
   1. Project name.
   2. Owner's name.
   3. Owner's Representative name, address, and telephone number.
   4. Description of work.
   5. Injection materials used.
   6. Equipment used.
   7. Project supervisor.
   8. Total cost of injection work and total cost of project.
   9. Completion date.

E. Installer/Subcontractor's and/or Manufacturer's field reports.

F. Resume' of chemical grouting installation supervisor.

G. Samples: Reacted Chemical Grout in small plastic bottle.

H. Chemical Grouting protection plan/narrative: Describe the intended procedures to prevent damage during construction operations. The following items shall be addressed:
   1. Storage and set up of equipment,
   2. Restoration of drill holes,
   3. Steel reinforcing location plan,
   4. Handling of drilling fluids and waste products if any, and
   5. Testing to ensure continuous and monolithic grout pattern.

1.7 QUALITY ASSURANCE REQUIREMENTS

A. Personnel identified during prequalification process shall be the personnel conducting the Work.

B. Pre-installation Meeting:
   1. Conduct meeting at Site.
   2. Review requirements for injection Work, including:
      a. Safety protocol and tradesmen training,
      b. Construction schedule,
      c. Availability of materials, Injection Installer/Subcontractor's personnel, equipment, and facilities needed to make progress and avoid delays.
      d. Site use, access, staging and set-up location/limitations.
      e. Cracks and joints to be injected, and condition of other construction activity that will affect injection Work.
      f. Injection procedures.
      g. Testing and inspection requirements.
      h. Site protection measures.
      i. Governing regulations.

C. Contractor's Site superintendent, injection-material manufacturer's technical representative, Injection Subcontractor's foreman, COR, COR's Representative, and Grouting Consultant, shall attend.

1.8 WEATHER LIMITATIONS

A. Environmental Limitations: Install injection material when existing and forecast weather conditions permit material to be installed and cured according to injection-material manufacturer's written instructions and warranty requirements.

B. Do not install when air and substrate temperatures are outside limits permitted by injection-material manufacturer. Provide enclosures to ensure against freezing temperatures and or over exposure to UV light, unless approved in writing by injection-material manufacturer.

C. Contractor/Grouting Installer shall be aware that un-managed water can be a safety issue.

D. Do not work in severe temperatures, moisture, and excessive humidity; these may affect the installation and performance of products during construction. Consult with Manufacturer's Representative and comply with applicable material recommendations for workmanship and handling.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such manner as to prevent damage to materials and existing structure.

B. Deliver materials to Site in original containers with seals unbroken, labeled with manufacturer's name; product brand name and type; date of manufacture; lot number; SPI hazardous rating and appropriate warnings for handling; and directions for storing and mixing.

C. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling and installation. Reject and remove from Site new materials which exhibit evidence of moisture reaction during application or have been exposed to abuse or other deleterious materials.

D. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by injection-material manufacturer.

E. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

F. Conspicuously mark damaged or opened containers with contaminated materials, and remove from Site as soon as possible. Dispose containers to legal dump site.

G. Remove and replace materials that cannot be installed within stated shelf life.

1.10 PROJECT CONDITIONS AND SAFETY PROTOCOL

A. Verify existing dimensions and any known utilities (buried drainpipes, electrical or telecom service) prior to start of injection Work. Notify COR, if conditions found to be different than those indicated in Contract Documents. Be aware of buried utilities, (drainpipes, electrical or telecom service) unknown at time of drilling.

B. If unusual or concealed conditions are discovered, stop work, and immediately notify COR in writing. Be aware of private drain line pipes and fields.

C. Provide adequate ventilation and protect adjacent building air intakes (if any) to ensure no adverse effects from grout fumes, smells or odors. Note the following:
1. Acrylic grout oxidizers give off an ammonia smell/vapor,

2. Urethane grouts give off MDI or TDI smell/vapors,
3. Carbon dioxide is released as part of polyurea/polyurethane reaction,
4. Hot asphalt can give off benzene vapors and hydrocarbon smells,
5. Bentonite and cement grouts give off silica dust when mixing with water,
6. Hydrocarbon solvents are released when used as a viscosity reducer,
7. Drilling into concrete produces silica dust, and
8. Adding ethylene glycol to air intake lines of grout pump can produce hydrocarbons in the immediate area.

D. Follow OSHA regulations during work performance, and particularly when the following occurs:
1. Trades people are working on platforms and scaffolding,
2. Heights more than four feet,
3. When using ladders,
4. When drilling into concrete and creating sparks and dust,
5. Use OSHA approved HEPA dust collection systems when drilling into concrete elements,
6. Wear goggles, face shields, or similar when high grout pressures are used, and
7. Wear proper PPE clothing and gloves when handling solvent, hot, and/or reactive chemicals.

PART 2 – MATERIALS

2.1 PRODUCTS

A. Source Limitations: Obtain injection materials through single manufacturer as much as possible, and/or from sources approved by manufacturer of injection material.

B. Approved Products and Chemical Grout Manufacturers/Suppliers:
1. Aquafin PM-3811-Flex by Aquafin, Inc., 505 Blue Ball Road, No.160, USA - Elkton, MD 21921, Phone: (410) 392-2300, Fax: (410) 392-2324
2. AV-150 by Avanti International, 822 Bay Star Blvd., Webster TX. 77598 Phone: 800-877-2570 Fax: 281-486-7300
3. Or-equal grout manufacturer. Products shown to be equal in viscosity, solids percentage in acrylic resin component, chemical composition, and performance are of consideration by Specifying Engineer. Approved equal products must be approved in writing prior to bid proposal.

C. Approved Products for plugging drill holes:
1. Aquafin Mortar IC or Aquafin-Plug-IC by Aquafin, Inc., 505 Blue Ball Road, No.160, USA - Elkton, MD 21921.

D. Auxiliary Materials:
1. Epoxy gel: Use 1 of following or approved equal:
a. AV-522 Epoxy Paste by Avanti International, 822 Bay Star Blvd., Webster TX. 77598 Phone: 800-877-2570 Fax: 281-486-7300
b. SCB Concresive 1446 manufactured by BASF Construction

Chemicals, LLC.
c. Sikadur 31, Hi-Mod Gel manufactured by Sika Corporation.

2. Crystalline Waterproofing Mortar: Use the following or approved equal:
   a. Aquafin 1C mortar
   b. Aquafin-Plug-IC
3. Hydraulic cement: Use one of following or approved equal:
   a. Aquafin-Plug-IC, manufactured by Aquafin Inc.
   b. Water plug manufactured by BASF Construction Chemicals, LLC. SikaPlug Fast-Setting Water Stop manufactured by Sika Corporation.
4. Oakum:
   a. As recommended by the Grout Manufacturer.
5. Grouting Equipment and Accessories:
   a. Stainless Steel, 1-to-1 ratio, dual piston pump, with pressure control gauges for hydrophilic urethane, acrylamide and polyacrylate grouts.
   b. Stainless steel diaphragm pumps for supplying grout to pump from mixing barrows if necessary.
   c. Stainless steel “E” or “F”-Assembly with check and ball valves.
   d. Chemical resistant, insulated injection hose lines for work in cold or hot weather.
   e. Grease zerk or button head expandable packers to match drill hole size.
   f. HDPE and/or stainless-steel mixing barrows and paddles.
   g. Stainless steel packers with needle extensions where required for localized grout conditions.
   h. Water and/or liquid control meters for grout volume monitoring.

PART 3 - EXECUTION

3.1 GROUTING PHASES AND GENERAL WORK SCOPE

A. There are two scopes of work which polyurethane grout is proposed for use:
   1. Elliptical pipe joint grouting at asphalt mastic seals, and
   2. At cracks in elliptical concrete sections which range from (40-to-120) mils.

B. Perform injection grouting operations at locations shown on contract documents. Inject cracks and joints in elliptical, reinforced, concrete pipe that exhibits water leakage.

C. First Pass: Perform injection grouting at elliptical concrete pipe crack(s) from (10 to 40) mils in width. Label locations using submitted and approved shop drawing(s). Identify locations and quantities of grout injected at each drilled port.

D. Second Pass: The second pass of injection grouting shall be performed within a few (1-5) minutes after the first pass, in an orderly sequence. This will help ensure all drilled ports have all joint voids and cracks, were not missed.

E. Final Inspection: The final inspection shall be performed after second pass is completed. Submit to Owner, recovery plan for leakage control if said leakage

persists after second pass.

3.2 EXAMINATION

A. Injection Subcontractor to examine substrates and conditions with, COTR representative and injection-material manufacturer for compliance with requirements and for other conditions affecting installation or performance of water control Work.
   1. Examine joint and crack widths for determination of which grout types have the appropriate viscosity and will minimize injection pressures and fracking.
   2. Ensure that work done by other trades is complete and ready for injection work. If mechanical or electrical equipment or other obstructions block crack and/or pipe joint access, discuss plan to achieve water control goals.
   3. Verify that areas and conditions with Injection Subcontractor and representative of injection material manufacturer for compliance with requirements and for other conditions affecting installation or performance of water control Work.
   4. Notify COTR, in writing of conditions which may adversely affect installation or performance of injection Work and recommend corrections.
   5. Do not proceed with injection Work until adverse conditions have been corrected and reviewed by COTR, and Grouting Consultant (if any).
   6. Use GPR or equal to mark locations on concrete of steel reinforcing bar and other buried objects prior to injection port drilling.
   7. Commencing injection Work constitutes acceptance of Work surfaces and conditions.

3.3 PROTECTION

A. Protect existing surfaces from injection Work in progress and from mechanical damage due to drilling operations, scaffolding, and/or methods of work and other equipment.

B. Limit access to Work areas. Always wear PPE equipment when using fluids and air under pressure. Wear gloves to avoid skin contact with unreacted grouts. Follow all OSHA and Site Safety protocols.

C. Exercise care to avoid injection or otherwise damaging embedded items. Remove/replace or otherwise remedy damage to embedded items, at no cost to Owner.

3.4 PRESSURIZED INJECTION EQUIPMENT AND PRETESTING

A. Injection equipment shall be capable of pumping injection material under pressure through properly rated hoses and injection ports; equipment shall be approved by injection-material manufacturer.

B. Mark grout component pails and pump intake/discharge lines with color coded tape, colored lines, or designate components of part “A” resins from part “B” resins. Separate mixing devices such that no cross-contamination exists.

C. Use calibrated scale and containers for measuring resins in part “A” and water for part “B” pails. Measure pH and temperature of grouts every eight hours and record on field shop drawings.

D. Perform ratio check on part “A” and part “B” lines prior to any grouting; confer with manufacturer for approval if any ratios are not as specified. Adjust per manufacturer’s instructions and note items on shop drawings.

E. Perform reaction foam/gel time test by mixing part “A” to part “B” resins and noting initial set and viscosity change of mixed grout, document on shop drawings.

3.5 PREPARATION FOR INTERCEPTION GROUTING

A. Inspect surfaces and locate areas to be injected. Locate steel reinforcing mesh/fabric/bar in concrete pipe elements prior to drilling. Survey for suspected utility or electrical lines in concrete.

B. Orient drilling pattern at concrete pipe cracks such that drill hole will intercept midway through the structural element or as shown on contract documents. Drill holes can be staggered from side-to-side or from one-side depending upon accessibility. This requires a drilling angle of 45 degrees from the plane. The spacing is dependent upon concrete element section depth and crack width.

C. Drill holes for injection packers/ports shall be (3/8 to 5/8) inch diameter with coring machine or rotary percussion hammer-drill and bits. Vacuum bits are recommended for silica dust control. Drill hole diameter shall be an appropriable packer diameter match, and/or as shown on the approved shop drawings. After drilling, flush hole with low pressure air, then high pressure water, to rid it of fine dust and debris, which may block the flow of grout into the intercepted crack or joint.

D. Install expandable packers, ball-valve wall spheres, or mechanical ports to achieve spacing pattern as shown by approved shop drawings and provide the following:

1. Number, spacing, and location of drill holes shall be as submitted in the approved shop drawings with noted tolerances.
2. Drill holes for injection ports or packers at 45-degree angle to surface/substrate of interior concrete pipe.
3. Alternate drill hole placement from side-to-side along length of crack or joint at the structural element.
4. If and when a drill hole intercepts a steel object and cannot be advanced, by diamond barrow core drilling, or equal, mark that hole as a “dead hole” and fill it with cementitious grout.
5. Insert expandable packers, wall spheres, or sleeve ports/manchettes into drilled holes in such manner that they are tight, leak free, and are accessible to the injection head.
6. If packer installation cracks or spalls concrete pipe element, re-drill and repeat procedure. Do not inject under pressure at cracked or spalled drill hole locations.

7. Test all drill holes with water prior to starting any chemical grout work. Inject clean water into injection packer with single or dual piston pump to ensure water is displaced at the interior pipe surface. Continue to flush-out any silt/clay accumulation, existing waterproofing, deleterious particles, corrosion byproducts, calcium carbonate, alkali by-products, and various soluble debris in the joint or crack. Pump pressure should not exceed 600 psi for water flushing, otherwise the crack will be subject to hydro-fracture, and damage, creating secondary cracking or joint movement.
8. If water does not flow from crack or joint surface, remove packer from hole: consider drilling hole deeper into element to ensure void/crack or joint was intercepted; re-flush hole with water to rid drilling debris, re-set packer, repeat process.
9. Monitor pressure and time to surface flow of water to gain knowledge of subsequent grouting requirements.
    a. After water flushing under pump pressure is complete, flush with air pressure as noted below:
    b. Continue to flush all water filled drill holes with compressed air pressure at about (100 to 200) psig. Crack or joint shall bubble with entrapped air in the flushing water. Upon completion, chemical grout flushing is complete.

3.6 EXPANDABLE AND TAPERED SHAFT BALL VALVE PACKERS

A. Perform grouting Work in presence of representative of injection-material manufacturer. At conclusion of Work, manufacturer's representative shall prepare and furnish letter or report to COTR, stating whether installation was completed in accordance with requirements. These manufacturer's services shall be provided at no additional cost to Owner.

B. Mix chemical grout components per manufacturers requirements in separate and clean pails. Place dams and spill containment under pump and mixed grout pails. Add colorants or dyes to grout for identification purposes.

C. Maintain conditions and injection material at adequate temperature for suitable time so that injection material will completely fill drill hole or voids, and will achieve full cure.

D. Using the lowest possible pump pressure to achieve desired result, continuously inject material into packers to avoid fracking the concrete element, and as recommended by injection-material manufacturer.
    1. Start injection at lowest packer elevation and move to higher elevations, continue until injection material reaches the pre-calculated volumes and flows from the mouth of crack or joint. Follow procedures outlined in 3.1.
    2. Use injection pressure of 100 to 300 psi (pounds per square inch), depending on port spacing, width of crack, depth of grouting, and condition(s) of concrete. Increase pressure in 100 psi increments to achieve grout flow.
    3. Continue injection process from port-to-port, monitoring grout volume and ensure grout pump pressures do not exceed 600 psig.
    4. Immediately after "Second Pass" of grouting, inject water in

controlled fashion to flush out injection port.

5. Remove injection head after injection material initially sets and reaches the pre-calculated volumes per port and has cured.

3.7 SHUT-DOWN AND PUMP FLUSHING

A. Upon completion of drill hole injection protocol including passes 1 and 2, remove intake lines from grout pails and flush pump with manufacturers approved, solvent, flushing agent. Flushing agent may be water in some cases.

B. Upon completion of pump flushing, fill lines and cylinders with manufacturers approved lubrication and corrosion resistant medium.

C. Remove reacted chemicals and waste flushing agents from the site and dispose at appropriate land fill.

3.8 DRILL HOLE RESTORATION

A. Upon completion of drill hole injection protocol including passes 1 and 2, remove ports/packers, if not done previously, from injected crack or joint locations. Ensure all grout has fully cured prior to packer removal.

B. Re-drill existing injection holes to remove all cured grout in each location. Flush drill hole with pressurized air and water to clean. Wear protective face shields and collect debris from holes with vacuum unit or similar.

C. Mix cement based crystalline waterproofing mortar in clean pail and dry pack into each drill hole with wood rod. Compact mortar into drill hole flush with concrete substrate.

D. Clean surface of injected crack and/or joint prior to demobilization. Remove reacted chemicals and waste flushing agents from the site and dispose of debris off site to a legal dump facility.

3.9 CLEANING

A. Protect existing interior surface finish(s) from grout stains.

B. Clean surfaces of excess grout, and injection ports or packers.

1. Allow injection material enough time to cure before performing cleanup.
2. Clean surfaces by grinding or other means.
3. Ensure all holes are patched at all injection ports.

PART 4 - CONTRACTOR'S QUALIFICATIONS AND QA/QC REQUIREMENTS

4.1 GENERAL

A. Inspection:

1. Manufacturer's representative to inspect completed application and provide a written report that application complies manufacturer's instructions.

B. Product:
1. Supply and install only products specifically designed and manufactured for this type of construction.
2. Select manufacturers of accessory products who are regularly engaged in the production of similar materials for underground structures.

C. Supervision and Training of Personnel:
1. Execute all installation and testing under the direct supervision of an individual with minimum five (5)-years-experience in the installation of grouting systems for underground structures using injection materials as specified.
2. Provide trained personnel for installation and testing operations.
3. The installer must have a minimum of five (5) years of experience at installation of grouting/injection materials in underground installations.
4. The proficiency of each technician shall be demonstrated in the field for approval by the Contracting Officer's Technical Representative (COTR).
5. The grouting system(s) shall be applied only by an approved contractor authorized by the Manufacturer prior to bid.
6. All work shall be completed by trained and authorized personnel.
7. Installation of grouting/injection system(s) shall be the responsibility of the Grouting Applicator to ensure undivided responsibility.
8. Upon request, the Applicator must submit a list of jobs performed by his employees and supervisors similar to the proposed system being bid.

D. Manufacturer's Performance:
1. Shall have documented experience of a minimum of 100,000 square feet or similar.
2. The grouting/injection products are to made by a nationally-recognized manufacturer specializing in water control systems; have been used successfully on projects similar to this; and are appropriate for the substrate, groundwater, hydrostatic pressure, and soil and rock contamination conditions that may be expected in this Contract.

E. Installation Contractor:
1. Installation contractor of grouting materials be certified shall and/or be approved by the manufacturer in writing prior to bid submission.

1.2 FIELD QUALITY CONTROL

A. Installer's quality assurance technician shall be present during grouting work.

B. Provide documentation on the following:
1. Access and location of Work.
2. Materials for sampling.
3. Site facilities for sampling, testing, and storage of materials.

4. Incidental labor.

C. Sample each batch of material to be injected to determine reaction times: Obtain 1 sample of injection material prior to beginning injection Work each day, representing first 50 feet of work, and 1 sample for every 50 feet of injection thereafter. Provide the following:
   1. Allow samples to cure. The reaction should start after ± 60 seconds and end after ± 4:30 seconds.
   2. Do not begin injection Work each day until initial sample has satisfactorily cured.
   3. Label samples with injection date and location of injected packer represented by sample.
   4. Retain samples in a safe location on site.

D. Monitor and Report:
   1. Ambient temperatures,
   2. Grout consumption per packer,
   3. Equipment pressures, and
   4. Material ratios.

END OF SECTION 03 64 10

Section 03 64 13 -- Polyurethane Grout, Crack-Joint Injection

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes polyurethane grout injection for sealing against water leakage and solidifying soil particles on all elliptical concrete culvert pipe joints as shown in “Series A” drawings. Polyurethane grout is designed to seal pipe joint concrete cracks, adhere to asphalt mastic, fill voids in joints and concrete side walls.

B. Work of this section will be designated on drawings as WP-1 and is shown and itemized in Scope-of-Work section on Construction Documents.

C. Related Sections: Other specification sections, which directly relate to the Work of this Section and include, but are not limited to, the following:
1. Section 03 64 13 Polyurethane Grout, Crack-Joint Injection, WP-1
2. Section 03 64 20 Acrylamide Grout Joint Injection, Soil Solidification, WP- 2
3. Section 03 61 10 Ultra-fine Cement, Soil Stabilization, SS-3
4. Section 07 16 16 Crystalline Waterproofing, WP-4
5. Section 03 64 10 Polyacrylate Grout Crack Injection, WP-5
6. Section 03 64 23 Epoxy Resin Crack Injection, WP-6
7. Section 07 13 56 Thermoplastic Sheet Strip Seals, WP-7

D. Contractor shall be responsible for reviewing site conditions to verify quantities.

E. Contractor shall be responsible for magnitude (depth and width), scope (length) of elliptical concrete pipe joint filling and sealing for water and sand control as schematically shown and outlined on contract documents.

F. Contractor shall follow prescriptive requirements of this specification; however, Contractor may modify as necessary the procedures, products, and installation to achieve water and sand control through the leaking concrete culvert pipe joints if approved via shop drawings.

1.2 SECTION INCLUDES

A. Injection grouting to minimize water leakage and sand piping through elliptical culvert pipe joints post construction and is organized as follows:
1. Examination
2. Preparation and Layout
3. Drilling Injection Ports
4. Air-flushing drill holes
5. Water-flushing drill holes
6. Setting Injection Ports
7. Pressurized Water Testing
8. Pressurized Air Testing
9. Conditions Where Excessive Leakage Occurs
10. Injection Grouting Operations

11. Re-Drilling drill holes
12. Water-flushing drill holes
13. Mortar filling drill holes
14. Clean-up and Demobilization

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
   1. American Society for Testing and Materials (ASTM) - ASTM International:
      a. ASTM C42/C42M: Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
      b. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
      c. ASTM D420: Standard Guide for Investigating and Sampling Soil and Rock.
      d. ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
      e. ASTM F2304 Standard Practice for Rehabilitation of Sewers using Chemical Grouting (latest revision).
      f. ASTM F2454 Standard Practice for Sealing Lateral Connections and lines from the mainline Sewer Systems by Lateral Packer Method, Using Chemical Grouting (latest revision).
      g. ASTM C507 Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
      h. ASTM C1840 Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain and Storm Sewer Pipe.

B. Department of Labor, Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards – Excavations, Final Rule – 29 CFR, Part 1926

C. American National Standards Institute (ANSI):
   1. Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD). Z535.1 Safety Color Code

D. American Public Works Association (APWA):
   1. Uniform Color Code for Temporary Marking of Underground Utility Locations.

E. Other Applicable Standards:
   1. National Association of Sewer Service Companies (NASSCO) prepared Pipeline Assessment and Certification Program (PACP), TV inspection form and sewer condition codes.

1.4 ABBREVIATIONS:

A. Commonly used abbreviations used in this specification are as follows:
   1. OR – Owners Representative
   2. CO – Contracting Officer
   3. COR: Contracting Officer’s Representative.

4. COTR – Contracting Officer's Technical Representative
5. M/E/P – Mechanical Electrical Plumbing
6. SPI – Safety Performance Index
7. EDR – Engineering Design Representative
8. SDS – Safety Data Sheet
9. HEPA -- High Efficiency Particulate Air
10. mm – millimeters (40 mils = 1 mm)
11. mil – millage, 1/1,000 inch = 0.001"
12. QA – Quality Assurance
13. QC – Quality Control
14. WP – Waterproofing
15. SS – Soil Solidification/Stabilization

1.5 SECTION INCLUDES

A. The Work shall be performed in the following order and as documented in the contract documents.
   1. Examination
   2. Preparation and Layout
   3. Drilling Injection Ports
   4. Air-flushing drill holes
   5. Water-flushing drill holes
   6. Setting Injection Ports
   7. Pressurized Water Testing
   8. Pressurized Air Testing
   9. Conditions Where Excessive Leakage Occurs
   10. Injection Grouting Operations
   11. Re-Drilling drill holes
   12. Water-flushing drill holes
   13. Mortar filling drill holes
   14. Clean-up and Demobilization

1.6 DEFINITIONS

A. Specification criteria:
   1. Prescriptive based-water control criteria established by design professional's details and specifications, or
   2. Performance based- water control ways-and-means established by contractor and reviewed by design professional.

B. Water leakage nomenclature:
   1. Crack Root-The point(s) of water ingress into a concrete element.
   2. Crack Mouth- The points of water discharge from a concrete element.
   3. Trail- A noticeable pathway/stain on concrete element surface designating continuous water flow.
   4. Ponding- The accumulation of water leakage through a concrete element.

C. Five levels of water accumulation on a concrete element can be physically described as follows:

1. Color change (darker), when high moisture content exists at concrete element surface, (white/crystalline or efflorescence) when area has re-sealed itself via autogenous healing), not visually wet to touch, no ponding occurs;
2. Wet to touch, surface dampness in spots, no sustained water trail present, or, no ponding occurs;
3. Weeps and seepage, sustained trail of wetness, however, visual surface flow not apparent, ponding does occur;
4. Continuous dripping, visual surface flow or water movement over Gushing concrete element, ponding occurs and leaves trail; or
5. Flow, from presence of hydrostatic back pressure, ponding leaves continuous trail of water.

D. Water Control: Water control at concrete elements serves many purpose(s):
1. Minimizes potential of dissolved oxygen, carbon dioxide, free chlorides and various salts/contaminants from entering concrete through-wall/floor/elevated-deck cracks and joints.
2. Helps control and potentially mitigate the following:
   a) Internal steel reinforcing bar corrosion,
   b.) Hardware corrosion of externally attached metal adjacent to wet area
   c.) Concrete carbonation, and
   d.) Alkali Silica Reactivity and Delayed Ettringite Formation.
   e.) Surface delamination of paints, coatings and high build flooring components,
   f.) Nutrient Source for mold, algae, and bacterial growth organisms,
   g.) Interior surface stains, efflorescence, salt and carbonate buildups (stalactites/stalagmites),
   h.) Ice formation (icicles) in unheated enclosures,
   I.) Slippery surfaces,
   j.) Electrical short circuits, and/or shocks,
   k.) Conductor for stray current corrosion,
   l.) Potential soil particle loss, and
   m.) Costly cleanup when hazardous contaminants (radioactive or poisonous hydrocarbons) enter and accumulate.

E. Structural Parameters: Three important considerations for successful grouting without damaging the structural concrete elements are as follows:
1. Pressures more than 600 psig can cause tensile damage (fracking) to existing concrete elements,
2. Crack/joint width is inversely proportional to pump gauge pressure, and
3. Crack/joint width is proportional to grout viscosity required for proper penetration

F. Typical water leakage flow paths at the following locations:
1. Through-element, primary and secondary, cracks/joints;
2. Voids and shadows along/under horizontal or vertical steel reinforcing bar;
3. Unbonded surfaces between concrete and mechanical, electrical, plumbing, penetrations, (MEP) inserts, or sleeves and dewatering hardware;
4. Poorly consolidated and/or honeycombs within concrete element at

cold and/or construction joints;

5. Porous foreign objects/debris and/or soil deposits trapped within the concrete element during forming/placement construction and subsequent placement;
6. Through element braided wire copper ground cables; and
7. Form-tie brackets, anchors, wire, or any such temporary or permanent structural inserts.

G. Crack Nomenclature and Width Definitions:

1. Cracks and joints as fine as 1/1000 inch (1 mil) are subject to water leakage if hydrostatic back pressure exists. Water leakage volumes are related to hydrostatic pressure, crack/joint width, and internal friction at crack/joint sidewalls. Cracks and joints are defined as follows:
   a. ultra-fine crack/joint (01 to 05) mils (0.025 to 0.127) mm
   b. very-fine crack/joint (06 to 10) mils (0.152 to 0.254) mm
   c. fine crack/joint (11 to 15) mils (0.279 to 0.381) mm
   d. medium-fine crack/joint (16 to 20) mils (0.406 to 0.508) mm
   e. medium crack/joint (21 to 40) mils (0.533 to 1.016) mm
   f. medium-wide crack/joint (41 to 60) mils (1.041 to 1.524) mm
   g. wide crack/joint (61 to 120) mils (1.549 to 3.048) mm

H. Grout(s): Generic term describing various - structural and/or non-structural, cementitious and/or non-cementitious materials which are installed as a liquid, paste or gel/mastic; which may cure-out as a product that exhibits a high or low modulus resulting in an elastic/plastic foam, gel, or paste-like matrix. Injection or placement materials include Portland cement (Types I, II, III, IV, or V, with or without fine aggregate, neat cement as micro-fine and ultra-fine in particle size) and/or bentonite powder blends, potassium/sodium silicates, reactive polymer(s), such as urethane (hydrophobic/hydrophilic), epoxy, methyl-methacrylate, acrylamide and polyacrylate resins, solvent (hydrocarbon or water) based rubber gels, and hot/cold asphalt fluids and/or emulsions. Grout viscosity has a relationship with pumping pressure and crack width, among other parameters such as temperature, cross-sectional width of voids, gel-time, and water chemistry. Four grout designations are as follows:

1. Low viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material when initially mixed facilitates a viscosity of (1 to 15) centipoise. Said grouts under controlled pressure penetrate ultra-fine cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.
2. Medium viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material when initially mixed facilitates a viscosity of (50 to 100) centipoise. Said grouts under controlled pressure penetrate fine cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.
3. High viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material when initially mixed facilitates a viscosity of (500 to1,000) centipoise. Said grouts under controlled pressure penetrate medium-wide cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.

4. Very-high viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material or non-reactive fluid when initially mixed facilitates a viscosity of (2,000 or greater) centipoise. Said grouts under controlled pressure penetrate wide cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.

I. Interception Grouting: Process by which a crack or joint is intercepted between its mouth and root (origin), and further a chemical grout is pumped into it under gauge pressure to fill any void space left in the concrete matrix.

J. Permeation Grouting: Process of injecting chemical grout under pressure filling the pore space of soil particles in a specified zone of influence; also referred to as soil solidification, chemical grouting, curtain grouting, and/or pressure.

K. Grout Curtain: A solidified soil element (of length, width, and depth) having low permeability qualities.

L. Sectioning: Grout curtain in soil strata arranged to seal off individual structural sections. Used in connection with “charge” and “re-charge” grouting pipes to create a grout curtain system, which promotes control of watertightness and facilitates leakage remediation.

M. Charge and Re-Charge Pipes: Drilled holes for permeation grouting process. Charge holes are pressurized with grout and re-charge holes allow pressure relief and monitoring of grout path; also referred to as “inlet/outlet” ports.

N. Control and Grouting Pipes: Pipes typically installed near water barrier intersections to control water-tightness of individual waterproof membrane sections. If leakage should occur, the pipes are used for remedial grouting specifically located at each connection or interruptions to concrete pours; also referred to as “inlet/outlet” ports.

O. Sleeve Port(s): Injection pipe(s) of various diameters with incremental openings (perforated pipe) along its length, covered with a rubber gasket; also called manchette tube or Tube-A-Manchette (TAM).

P. Manchette tube: Tube-A-Manchette (TAM) or commonly referred to as Injection pipe(s) of various diameters with incremental openings along its length, covered with a rubber gasket; also called a sleeve port.

Q. Packer(s): A mechanical device placed into or through drilled holes in concrete elements or driven into soil, through which grout is pumped into, and forced through; also referred to as injection port, expandable packer, or wall sphere. Devices shall be chemical resistant HDPE (high density polyethylene), neoprene rubber, leather or Teflon gaskets, and stainless-steel, brass, aluminum, or carbon steel frame. Most contain a grease zerk, button head, or quick-connect for attachment to the Injection head.

R. Slide Packer(s): A mechanical device placed into plastic manchettes with sectionalized inflatable or friction gaskets (leather or Teflon) at each end to

control and distribute pressurized grout to incremental location(s) within the manchette or sleeve port.

S. Injection Head or Gun: Mechanical device consisting of a mixing chamber for one or more parts of resin with quick-connects, zerk grease fitting, button head, and an on/off switch or ball-valve to control flow and capability, recirculation, pressure monitoring, and a cleanout; often called an “E” or “F”-Assembly.

U. Crystalline Waterproofing Mortar: Portland cement/silica sand mortar with reactive chemical admixture that promotes crystalline growth in the reinforced element. Reactive chemicals combine the free calcium hydroxide in concrete to crystallize and imped water flow.

V. Grouting Procedure:
1. Top-down Grouting: Injection technique whereby grout curtain is established near ground or exposed surface, once that solidifies, manchettes are drilled through the solidified zone and grouting proceeds sequentially downward.
2. Bottom-up Grouting: Technique whereby grout curtain is established at bottom of hole and manchettes are sequentially lifted and grout zone proceeds upward.

W. Grouting Installation Form: Form provided by Contractor, documenting the location and amount of grout in each manchette location.

X. Dual and Single Component Pump(s): Operated with compressed air, electric, hydraulic oil, or mechanically operated pump with single mechanism or multi-ratio mechanisms for pumping various grout components.

Y. Quality Control: A system for verifying and maintaining a desired level of quality in an existing product or service by careful planning, use of proper equipment, continued inspection, and corrective action as required.

Z. Quality Assurance: A systematic monitoring and evaluation program for various aspects of a project, service, or facility to ensure that standards of quality are being met.

1.7 SUBMITTALS

A. Shop Drawings: Provide project customized plan, sections and associated details showing the following:
1. Work scope plan if different from contract documents.

B. Product Data: Injection grout material manufacturer’s literature (catalogue cuts) including.
1. Written instructions for handling, mixing, and safety procedures.
2. Technical data including tested physical and performance properties, including:
   a. Temperature ranges for storage and application of materials, and special warm/cold-weather application requirements or limitations,
   b. Include recommended Site protection measures, and

c. Safety Data sheets.

C. Certificates:
1. Signed by injection-material manufacturer, certifying that products furnished comply with requirements and are recommended by manufacturer for uses indicated.
2. Signed by injection-material manufacturer, certifying that individual(s) performing work is approved to install its products.

D. Injection Installer/Subcontractor Qualifications: Evidence that Subcontractor's existing company has minimum 5 years of continuous experience in injection of specified materials; list of at least 5 representatives, successfully completed projects of similar scope and size, including:
1. Project name.
2. Owner's name.
3. Owner's Representative name, address, and telephone number.
4. Description of work.
5. Injection materials used.
6. Equipment used.
7. Project supervisor.
8. Total cost of injection work and total cost of project.
9. Completion date.

E. Installer/Subcontractor's and/or Manufacturer's field reports.

F. Resume' of chemical grouting installation supervisor.

G. Samples: Reacted Chemical Grout in small plastic bottle.

H. Chemical Grouting protection plan/narrative: Describe the intended procedures to prevent damage during construction operations. The following items shall be addressed:
1. Storage and set up of equipment,
2. Restoration of drill holes,
3. Steel reinforcing location plan,
4. Handling of drilling fluids and waste products if any, and
5. Testing to ensure continuous and monolithic grout pattern.

1.8 QUALITY ASSURANCE REQUIREMENTS

A. Personnel identified during prequalification process shall be the personnel conducting the Work.

B. Pre-installation Meeting:
1. Conduct meeting at Site.
2. Review requirements for injection Work, including:
a. Safety protocol and tradesmen training,
b. Construction schedule,
c. Availability of materials, Injection Installer/Subcontractor's personnel, equipment, and facilities needed to make progress and avoid delays.

d. Site use, access, staging and set-up location/limitations.
e. Cracks and joints to be injected, and condition of other construction activity that will affect injection Work.
f. Injection procedures.
g. Testing and inspection requirements.
h. Site protection measures.
i. Governing regulations.

C. Contractor's Site superintendent, injection-material manufacturer's technical representative, Injection Subcontractor's foreman, COR, COR's Representative, and Grouting Consultant, shall attend.

1.9 WEATHER LIMITATIONS

A. Environmental Limitations: Install injection material when existing and forecast weather conditions permit material to be installed and cured according to injection-material manufacturer's written instructions and warranty requirements.

B. Do not install when air and substrate temperatures are outside limits permitted by injection-material manufacturer. Provide enclosures to ensure against freezing temperatures and or over exposure to UV light, unless approved in writing by injection-material manufacturer.

C. Do not work in severe temperatures, moisture, and excessive humidity; these may affect the installation and performance of products during construction. Consult with Manufacturer's Representative and comply with applicable material recommendations for workmanship and handling.

D. Contractor/Grouting Installer shall be aware that un-managed water can be a safety issue.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such manner as to prevent damage to materials and existing structure.

B. Deliver materials to Site in original containers with seals unbroken, labeled with manufacturer's name; product brand name and type; date of manufacture; lot number; SPI hazardous rating and appropriate warnings for handling; and directions for storing and mixing.

C. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling and installation. Reject and remove from Site new materials which exhibit evidence of moisture reaction during application or have been exposed to abuse or other deleterious materials.

D. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by injection-material manufacturer.

E. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

F. Conspicuously mark damaged or opened containers with contaminated materials, and remove from Site as soon as possible. Dispose containers to legal dump site.

G. Remove and replace materials that cannot be installed within stated shelf life.

1.11 PROJECT CONDITIONS AND SAFETY PROTOCOL

A. Verify existing dimensions and any known utilities (buried drainpipes, electrical or telecom service) prior to start of injection Work. Notify COR, if conditions found to be different than those indicated in Contract Documents. Be aware of buried utilities, (drainpipes, electrical or telecom service) unknown at time of drilling.

B. If unusual or concealed conditions are discovered, stop work and immediately notify COR in writing. Be aware of private drain line pipes and fields.

C. Provide adequate ventilation and protect adjacent building air intakes (if any) to ensure no adverse effects from grout fumes, smells, or odors. Note the following:
1. Acrylic grout oxidizers give off an ammonia smell/vapor,
2. Urethane grouts give off MDI or TDI smell/vapors,
3. Carbon dioxide is released as part of polyurea/polyurethane reaction,
4. Hot asphalt can give off benzene vapors and hydrocarbon smells,
5. Bentonite and cement grouts give off silica dust when mixing with water,
6. Hydrocarbon solvents are released when used as a viscosity reducer,
7. Drilling into concrete produces silica dust, and
8. Adding ethylene glycol to air intake lines of grout pump can produce hydrocarbons in the immediate area.

D. Follow OSHA regulations during work performance, and particularly when the following occurs:
1. Trades people are working on platforms and scaffolding,
2. Heights more than four feet,
3. When using ladders,
4. When drilling into concrete and creating sparks and dust,
5. Use OSHA approved HEPA dust collection systems when drilling into concrete elements,
6. Wear goggles, face shields, or similar when high grout pressures are used, and
7. Wear proper PPE clothing and gloves when handling solvent, hot, and/or reactive chemicals.

PART 2 – MATERIALS

2.1 PRODUCTS

A. Source Limitations: Obtain injection materials through single manufacturer as

much as possible, and/or from sources approved by manufacturer of injection material.

B. Approved Products and Chemical Grout Manufacturers/Suppliers:
   1. AV-202 by Avanti International, 822 Bay Star Blvd., Webster TX. 77598 Phone: 800-877-2570 Fax: 281-486-7300 (Basis for Design)
   2. Aquafin InjectProECO-Polygel by Aquafin, Inc., 505 Blue Ball Road, No.160, USA - Elkton, MD 21921, Phone: (410) 392-2300, Fax: (410) 392-2324

C. Or-equal grout manufacturer. Products shown to be equal in viscosity, solids percentage, chemical composition, and performance are of consideration by Specifying Engineer. Approved equal products must be approved in writing prior to bid proposal.

D. Approved Products for sealing tops of drill holes:
   1. Aquafin Mortar IC or Aquafin-Plug-IC by Aquafin, Inc., 505 Blue Ball Road, No.160, USA - Elkton, MD 21921.

E. Auxiliary Materials:
   1. Epoxy gel: Use 1 of following or approved equal:
      a. SCB Concresive 1446 manufactured by BASF Construction Chemicals, LLC.
      b. AV-202 by Avanti International, 822 Bay Star Blvd., Webster TX. 77598 Phone: 800-877-2570 Fax: 281-486-7300
      c. Prime Gel 2000 High Mod manufactured by Prime Resins, Inc.
      d. Sikadur 31, Hi-Mod Gel manufactured by Sika Corporation.
   2. Crystalline Waterproofing Mortar: Use the following or approved equal:
      a. Aquafin 1C mortar
      b. Aquafin-Plug-IC
   3. Hydraulic cement: Use one of following or approved equal:
      a. Aquafin-Plug-IC, manufactured by Aquafin Inc.
      b. Water plug manufactured by BASF Construction Chemicals, LLC. SikaPlug Fast-Setting Water Stop manufactured by Sika Corporation.
   4. Oakum:
      a. As recommended by the Grout Manufacturer.
   5. Grouting Equipment and Accessories:
      a. Stainless Steel, 1-to-1 ratio, dual piston pump, with pressure control gauges for hydrophilic urethane, acrylamide and polyacrylate grouts.
      b. Stainless steel diaphragm pumps for supplying grout to pump from mixing barrows if necessary.
      c. Stainless steel “E” or “F”-Assembly with check and ball valves.
      d. Chemical resistant, insulated injection hose lines for work in cold or hot weather.
      e. Grease zerk or button head expandable packers to match drill hole size.
      f. HDPE and/or stainless-steel mixing barrows and paddles.
      g. Stainless steel packers with needle extensions where required for

localized grout conditions.

h. Water and/or liquid control meters for grout volume monitoring.

PART 3 - EXECUTION

3.1 GROUTING PHASES AND GENERAL WORK SCOPE

A. Perform injection grouting operations at all elliptical concrete culvert pipe joint locations and as shown on “Series A” drawings in contract documents.

B. First Pass: Perform injection grouting all elliptical concrete pipe joint areas. Label locations using submitted and approved shop drawing(s). Identify locations and quantities of grout injected at each drilled port.

C. Second Pass: The second pass of injection grouting shall be performed within a few (1-5) minutes after the first pass, in an orderly sequence. This will help ensure all drilled ports are injected to ensure grout “take” and voids were not missed.

D. Third Pass: The third pass of hydrophilic urethane injection grouting shall be performed after acrylamide grout has been injected and if water or grout leaks through joints. Re-grout all locations where water leakage continues to persist and label locations using the approved shop drawing(s).

E. Final Inspection: The final inspection shall be performed after third pass is completed. Submit to Owner, recovery plan for leakage control if said leakage persists after third pass.

3.2 EXAMINATION

A. Injection Subcontractor to examine substrates and conditions with, COR representative and injection-material manufacturer for compliance with requirements and for other conditions affecting installation or performance of water control Work.

1. Examine crack and joint widths for determination of which grout types have the appropriate viscosity and will minimize injection pressures and fracking.
2. Ensure that work done by other trades is complete and ready for Injection work. If mechanical or electrical equipment or other obstructions block crack and/or joint access, discuss plan to achieve water control goals.
3. Verify that areas and conditions with Injection Subcontractor and representative of injection material manufacturer for compliance with requirements and for other conditions affecting installation or performance of water control Work.
   Notify COR, in writing of conditions which may adversely affect installation or performance of injection Work and recommend corrections.
4. Do not proceed with injection Work until adverse conditions have been corrected and reviewed by COR, and Grouting Consultant (if any).
5. Use GPR or equal to mark locations on concrete steel reinforcing bar. and other buried objects prior to injection port drilling.

6. Commencing injection Work constitutes acceptance of Work surfaces and conditions.

3.3 PROTECTION

A. Protect existing surfaces from injection Work in progress and from mechanical damage due to drilling operations, scaffolding, and/or methods of work and other equipment.

B. Limit access to Work areas. Always wear PPE equipment when using fluids and air under pressure. Wear gloves to avoid skin contact with unreacted grouts. Follow all OSHA and Site Safety protocols.

C. Exercise care to avoid injection or otherwise damaging embedded items. Remove or replace or otherwise remedy damage to embedded items, at no cost to Owner.

3.4 PRESSURIZED INJECTION EQUIPMENT AND PRETESTING

A. Injection equipment shall be capable of pumping injection material under pressure through properly rated hoses and injection ports; equipment shall be approved by injection-material manufacturer.

B. Mark grout component pails and pump intake/discharge lines with colored coded tape, colored lines, or designate components of part “A” resins from part “B” resins. Separate mixing devices such that no cross-contamination exists.

C. Use calibrated scale and containers for measuring accelerators in part “A” and hardeners for part “B” resin pails. Measure pH and temperature of grouts every two hours and record on the shop drawings.

D. Perform ratio check on part “A” and part “B” lines prior to any grouting; confer with manufacturer for approval if any ratios are not as specified. Adjust per manufacturer’s instructions and note items on shop drawings.

E. Perform reaction foam/gel time test by mixing part “A” to part “B” resins and noting initial set and viscosity change of mixed grout, document on shop drawings.

3.5 PREPARATION FOR INTERCEPTION GROUTING AT JOINTS

A. Inspect surfaces and locate areas to be injected. Locate steel bar in concrete elements prior to drilling.

B. Orient drilling pattern at concrete pipe joints such that drill hole will intercept midway through the structural element and as shown on the contract documents. Drill holes can be staggered from side-to-side or from one-side depending upon accessibility. Drill approximately 6 inches deep into the 8.5-inch deep joint section. Ensure the joint is intersected.

C. Drill holes for injection packers/ports shall be (3/8 to 5/8) inch diameter with coring machine or rotary percussion hammer-drill and bits. Vacuum bits are recommended for silica dust control. Drill hole diameter shall be matched with an appropriable packer diameter, and/or as shown on approved shop drawings. After drilling, flush hole with low pressure air, then water, to rid it of fine dust and debris, which may block the flow of grout into the intercepted joint.

D. Install expandable packers, wall spheres, or sleeve ports/manchettes to achieve spacing pattern as shown by approved shop drawings and provide the following:

1. Number, spacing, and location of drill holes shall be as submitted in the approved shop drawings with noted tolerances.
2. Drill holes for injection ports or packers at 90-degree angle to surface. Alternate drill hole placement from side-to-side along length of joint at the structural element.
3. If and when a drill hole intercepts a steel object and cannot be advanced, mark that hole as a “dead hole” and fill with cementitious grout and re-drill.
4. Insert expandable packers, wall spheres, or sleeve ports/manchettes into drilled holes in such manner that they are tight, leak free, and are accessible to the injection head.
5. If packer installation cracks or spalls the concrete element, re-drill and repeat procedure. Do not inject under pressure at cracked or spalled drill hole locations. Repair spalled concrete at joints.
6. Test all drill holes with water pressure (5-to-10 psig minimum) prior to starting any chemical grout work. Inject clean water into injection packer with single or dual piston pump to ensure water gauge pressure is established or is displaced at the surface. Continue to flush-out any silt/clay accumulation, existing soil debris, deleterious asphalt particles, corrosion byproducts, calcium carbonate, alkali by-products, and/or soluble debris in the joint.
7. If water does not flow from joint surface, remove packer from hole: consider drilling hole deeper into element to ensure void or joint was intercepted; re-flush hole with water to rid drilling debris, re-set packer, repeat process.
8. Monitor pressure and time to surface flow of water to gain knowledge of subsequent grouting requirements.
    a. After water flushing under pump pressure is complete, flush with air pressure as noted below.
    b. Continue to flush all water filled drill holes with compressed air pressure at about (100 to 200) psi. Joint shall bubble with entrapped air in the flushing water. Upon completion, chemical grout flushing is complete.

3.6 EXPANDABLE AND TAPERED SHAFT BALL VALVE PACKERS

A. Perform grouting Work in presence of representative of injection-material manufacturer. At conclusion of Work, manufacturer’s representative shall prepare and furnish letter or report to COR, stating whether installation was completed in accordance with requirements. These manufacturer’s services shall be provided at no additional cost to Owner.

B. Mix chemical grout components per manufacturers requirements in separate

and clean pails. Place dams and spill containment under pump and mixed grout pails. Add colorants or dyes to grout for identification purposes.

C. Maintain conditions and injection material at adequate temperature for suitable time period so that injection material will completely fill the drill hole or void and will achieve full cure.

D. Using the lowest possible pump pressure to achieve desired result, continuously inject material into packers to avoid fracking the concrete element, and as recommended by injection-material manufacturer.

1. Start injection at lowest packer elevation and move to higher elevations, continue until injection material reaches the pre-calculated volumes and flows from joint mouth. Follow procedures outlined in 3.1 (above).
2. Use injection pressure of 10 to 30 psi (pounds per square inch), depending on port spacing, width of joint, depth of grouting, and condition(s) of concrete. Increase pressure in 10 psi increments to achieve sufficient grout flow.
3. Continue injection process from port-to-port, monitoring grout volume and ensure grout pump pressures do not exceed 60 psig.
4. Immediately after “Second Pass” of grouting, inject water/hydrocarbon solvent in controlled fashion to flush out injection port.
5. Remove injection head after injection material initially sets and reaches the pre-calculated volumes per port and has cured.

3.7 SHUT-DOWN AND PUMP FLUSHING

A. Upon completion of drill hole injection protocol including passes 1 and 2, remove intake lines from grout pails and flush pump with manufacturers approved, solvent, flushing agent. Flushing agent may be water in some cases.

B. Upon completion of pump flushing, fill lines and cylinders with manufacturers approved lubrication and corrosion resistant medium.

C. Remove reacted chemicals and waste flushing agents from the site and dispose at appropriate land fill.

3.8 DRILL HOLE RESTORATION

A. Upon completion of drill hole injection protocol including passes 1 and 2, remove ports/packers, if not done previously, from injected joint locations. Ensure all grout has fully cured prior to packer removal.

B. Re-drill existing injection holes to remove all cured grout in each location. Flush drill hole with pressurized air and water to clean. Wear protective face shields and collect debris from holes with vacuum unit or similar.

C. Mix cement based high strength mortar in clean pail and dry pack into each drill hole with wood rod. Compact mortar into drill hole flush with concrete substrate.

D. Clean surface of injected joint prior to demobilization. Remove reacted chemicals and waste flushing agents from the site and dispose of debris off site to a legal dump facility.

3.9 CLEANING

A. Protect existing surface finish(s) from grout stains.

B. Clean surfaces of excess grout, and injection ports or packers.
1. Allow injection material enough time to cure before performing cleanup.
2. Clean surfaces by grinding or other means.
3. Ensure all holes are patched at injection ports.

PART 4 - CONTRACTOR'S QUALIFICATIONS AND QA/QC REQUIREMENTS

4.1 GENERAL

A. Inspection:
1. Manufacturer's representative to inspect completed application and provide a written report that application complies manufacturer's instructions.

B. Product:
1. Supply and install only products specifically designed and manufactured for this type of construction.
2. Select manufacturers of accessory products who are regularly engaged in the production of similar materials for underground structures.

C. Supervision and Training of Personnel:
1. Execute all installation and testing under the direct supervision of an individual with minimum five (5)-years-experience in the installation of grouting systems for underground structures using injection materials as specified.
2. Provide trained personnel for installation and testing operations.
3. The installer must have a minimum of five (5) years of experience at installation of grouting/injection materials in underground installations.
4. The proficiency of each technician shall be demonstrated in the field for approval by the Contracting Officer's Technical Representative (COTR).
5. The grouting system(s) shall be applied only by an approved contractor authorized by the Manufacturer prior to bid.
6. All work shall be completed by trained and authorized personnel.
7. Installation of grouting/injection system(s) shall be the responsibility of the Grouting Applicator to ensure undivided responsibility.
8. Upon request, the Applicator must submit a list of jobs performed by his employees and supervisors similar to the proposed system being bid.

D. Manufacturer's Performance:

1. Shall have documented experience of a minimum of 100,000 square feet or similar.
2. The grouting/injection products are to made by a nationally-recognized manufacturer specializing in water control systems; have been used successfully on projects similar to this; and are appropriate for the substrate, groundwater, hydrostatic pressure, and soil and rock contamination conditions that may be expected in this Contract.

E. Installation Contractor:
1. Installation contractor of grouting materials be certified shall and/or be approved by the manufacturer in writing prior to bid submission.

4.2 FIELD QUALITY CONTROL

A. Installer's quality assurance technician shall be present during grouting work.

B. Provide:
1. Access to Work.
2. Materials for sampling.
3. Site facilities for sampling, testing, and storage of materials.
4. Incidental labor.

C. Sample each batch of material to be injected to determine reaction times: Obtain one sample of injection material prior to beginning injection Work each day, representing first 50 feet of injection, and one sample for every 300 feet of injection thereafter. Provide the following:
1. Allow samples to cure. The reaction should start after ± 60 seconds and end after ± 4:30 seconds.
2. Do not begin injection Work each day until initial sample has satisfactorily cured.
3. Label samples with injection date and location of injected packer represented by sample.
4. Retain samples in a safe location on site.

D. Monitor and Report:
1. Ambient temperatures,
2. Grout consumption per packer,
3. Equipment pressures, and
4. Material ratios.

END OF SECTION 03 64 15

Section 03 64 20 -- Acrylamide Grout Joint Injection, Soil Solidification

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes acrylamide grout injection through all concrete culvert pipe joint(s) from invert to crown, to seal against water entry and solidify soil particles on pipe joint perimeter.

B. Work of this section is designated on drawings as WP-2 and is itemized in the Scope-of-Work section on Construction Documents.

C. Related Sections: Other specification sections, which directly relate to Work of this Section include, but are not limited to, the following:
1. Section 03 64 13 Polyurethane Grout, Crack-Joint Injection, WP-1
2. Section 03 64 20 Acrylamide Grout Joint Injection, Soil Solidification, WP- 2
3. Section 03 61 10 Ultra-fine Cement, Soil Stabilization, SS-3
4. Section 07 16 16 Crystalline Waterproofing, WP-4
5. Section 03 64 10 Polyacrylate Grout Crack Injection, WP-5
6. Section 03 64 23 Epoxy Resin Crack Injection, WP-6
7. Section 07 13 56 Thermoplastic Sheet Strip Seals, WP-7

D. Contractor shall be responsible for reviewing site conditions to verify quantities.

E. Contractor shall be responsible for magnitude (depth, length, and width), scope of permeation grouting control as schematically shown and outlined on the contract documents.

F. Contractor shall generally follow prescriptive requirements of this specification; however, Contractor may modify as necessary the procedures, products, and installation to achieve water and soil control through the leaking concrete culvert pipe joints when approved via shop drawings.

1.2 SECTION INCLUDES

A. Injection grouting to minimize water leakage post construction.
1. Examination
2. Preparation and Layout
3. Drilling Injection Ports
4. Setting Injection Ports
5. Injection Grouting Operations
6. Permeation Grouting Verification
7. Remediation Grouting After Verification
8. Clean-up and Demobilization

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
1. American Society for Testing and Materials (ASTM) - ASTM International:

a. ASTM C42/C42M: Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
b. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
c. ASTM D420: Standard Guide for Investigating and Sampling Soil and Rock.
d. ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
e. ASTM C507 Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
f. ASTM C1840 Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain and Storm Sewer Pipe.

B. Department of Labor, Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards – Excavations, Final Rule – 29 CFR, Part 1926

C. Other Applicable Standards:
1. National Association of Sewer Service Companies (NASSCO) prepared Pipeline Assessment and Certification Program (PACP), TV inspection form and sewer condition codes.

1.4 ABBREVIATIONS:

A. Commonly used abbreviations used in this specification are as follows:
1. OR – Owners Representative
2. CO – Contracting Officer
3. COR – Contracting Officer's Representative
4. COTR – Contracting Officer's Technical Representative
5. M/E/P – Mechanical Electrical Plumbing
6. SPI – Safety Performance Index
7. EDR – Engineering Design Representative
8. SDS – Safety Data Sheet
9. HEPA – High Efficiency Particulate Air
10. mm – millimeters (40 mils = 1 mm)
11. mil – millage, 1/1,000 inch = 0.001"
12. QA – Quality Assurance
13. QC – Quality Control
14. WP – Waterproofing
15. SS – Soil Solidification/Stabilization

1.5 DEFINITIONS

A. Grout(s): Generic term describing various liquid/gel/paste injection materials:
1. Types 1 and/or 3, Portland cement (with or without fine aggregate),
2. Micro-fine and ultra-fine Portland cement,
3. Reactive polymer(s):
a. urethane (hydrophobic/hydrophilic),
b. polyacrylate, methacrylate and acrylamide,
c. epoxy, and

d. silicate based resins.
4. Bentonite blends,
5. Solvent based rubber gels, and
6. Hot/cold asphalt fluids and/or emulsions.

B. Chemical Grout: A low viscosity, reactive, polymer, resin which penetrates soil particle pore space under a gauge pressure; also commonly referred to as grout, injection resin or gel grout.

C. Grouting Types and Procedures:
1. Interception Grouting: Process by which a crack or joint is intercepted between its mouth and root (origin), and further a chemical grout is pumped into it under gauge pressure to fill any void space left in the concrete matrix.
2. Backside Grouting: Process in which a drill hole penetrates completely through concrete or structural element and leakage area is sealed with grout from backside, similar to Curtain grouting.
3. Surface Mounted Grouting: Process in which injection ports are installed on exposed surface of concrete defect area and injected from one side.

D. Permeation Grouting: Process of injecting chemical grout under pressure filling the pore space of soil particles in a specified zone of influence; sometimes referred to as soil solidification, backside chemical grouting, curtain grouting, and/or pressure injection.

E. Curtain: A volumetric element (having length, width, and depth) of solidified soil with low permeability qualities and increased compressive strength. Soil pore space shall be filled to 85 percent of its capacity to act as a water impedance grout. Compressive strength increases can range from (10 to 1000) psi depending upon grout chosen.

F. Sleeve Port(s): Injection pipe(s) of various diameters with incremental openings along their length, covered with a rubber gasket; also called manchette tube.

G. Manchette tube: Tube-A-Manchette (TAM) or commonly referred to as Injection Pipe of various diameters with incremental openings along its length, covered with a rubber gasket; also called a sleeve port.

H. Packer(s): Also called a port, sleeve port, injection port or sometimes referred to as a manchette. A mechanical device placed on manchettes and/or in drilled holes in soil or concrete, which grout is pumped into, and forced through; devices shall be chemical resistant HDPE (high density polyethylene), leather or Teflon gaskets, and stainless-steel frame.

I. Slide Packer(s): A mechanical device placed in manchettes with sectionalized inflatable or friction gaskets at each end to distribute pressurized grout to incremental location(s) within the manchette or sleeve port.

J. Injection Head: Mechanical device consisting of a mixing chamber for one or more parts of resin with quick-connects, an on/off switch capability, recirculation, pressure monitoring, and a cleanout; often called an “L”, “E” or “F-Assembly”.

K. Top-down Grouting: Technique whereby grout curtain is established near ground surface and solidified zone proceeds downward.

L. Bottom-up Grouting: Technique whereby grout curtain is established at bottom of manchette and grout zone proceeds upward.

M. Charge and Re-Charge Pipes: Drilled holes for permeation grouting process. Charge holes are pressurized with grout and re-charge holes allow pressure relief and monitoring of grout path and translation; also referred to as “inlet/outlet” ports. Pipes typically installed near water barrier Intersections to control watertightness of individual membrane sections. If leakage should occur, the pipes are used for remedial grouting specifically located at each connection into the terminal; also referred to as “inlet/outlet” ports.

N. Grouting Installation Form: Form provided by Contractor, documenting the location and amount of grout in each manchette location.

O. “Elliptical concrete culvert pipe” may be described as or referred to as a tunnel or simply as a pipe for purposes of this specification.

1.6 SUBMITTALS

A. Shop Drawings: Provide project customized plan, sections and associated details showing the following:
   1. Work scope plan,
   2. Manchette, sleeve port, Inlet/Outlet port, or Charge/Re-charge port locations,
   3. Depth, spacing, and pattern of manchettes,
   4. Details at terminations; interface with existing pipe materials,
   5. Sealing of ports at ground surface,
   6. Grout tube anchorage,
   7. Volumes of grout expected to be pumped per manchette based on the following items noted in the soil investigation and geotechnical report:
      a. Soil strata conditions,
      b. Water table elevations, and
      c. Density and gradations,
   8. Proposed means and methods for Remediation Grouting, if required.

B. Product Data: Injection grout material manufacturer’s literature (catalogue cuts) Including:
   1. Include temperature ranges for storage and application of materials, and special warm/cold-weather application requirements or limitations.
   2. Include recommended Site protection measures.
   3. Include material Safety Data Sheets (SDS) for information only.
   4. Name and contact information for injection-material manufacturer’s Technical Representative that will attend the Pre-installation Meeting.

C. Certificates:
   1. Signed by injection-material manufacturer, certifying that products

furnished comply with requirements and are recommended by manufacturer for uses indicated.

2. Signed by injection-material manufacturer, certifying that individual performing work is approved to install its products.

D. Injection Installer/Subcontractor Qualifications: Provide documentation confirming that the Specialty Contractor is qualified for performing the injection grouting work.

E. Installer/Subcontractor's and/or Manufacturer's field reports.

F. Samples:
1. Reacted Chemical Grout in small plastic bottle; and
2. 24-inch long manchette of proposed diameter for use.

G. Chemical Grouting protection plan/narrative: Describe the intended procedures to prevent damage during construction operations. The following items shall be addressed:
1. Storage set up of equipment; and
2. Handling of drilling fluids if any.

1.7 QUALITY ASSURANCE REQUIREMENTS

A. Pre-installation Meeting:
1. Conduct meeting at Site.
2. Review requirements for injection Work, including:
   a. Safety protocol and tradesmen training,
   b. Construction schedule,
   c. Availability of materials, Injection Installer/Subcontractor's personnel, equipment, and facilities needed to make progress and avoid delays.
   d. Site use, access, staging and set-up location limitations.
   e. Cracks, joints and (M/E/P) to be injected, and condition of other construction that will affect injection Work.
   f. Surface preparation and substrate condition and pretreatment.
   g. Injection procedures.
   h. Testing and inspection requirements.
   i. Site protection measures.
   j. Governing regulations.
3. Contractor's Project Manager and Field Superintendent, injection-material manufacturer's Technical Representative, injection subcontractor's Field Superintendent, OR, and EDR/Grouting Consultant shall attend.

1.8 WEATHER LIMITATIONS

A. Environmental Limitations: Install injection material when existing and forecast weather conditions permit material to be installed and cured according to injection-material manufacturer's written instructions and warranty requirements.
1. Do not install when air and substrate temperatures or humidity are outside limits permitted by injection-material manufacturer.

2. Provide enclosures to protect the work against freezing temperatures, rain, and over exposure to UV light.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such manner as to prevent damage to materials and existing structure.

B. Deliver materials to Site in original containers with seals unbroken, labeled with manufacturer's name; product brand name and type; date of manufacture; lot number; SPI hazardous rating and appropriate warnings for handling; and directions for storing and mixing.

C. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling and installation. Reject and remove from Site new materials which exhibit evidence of moisture during application or have been exposed to moisture or other deleterious materials.

D. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by injection-material manufacturer.

E. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

F. Conspicuously mark damaged or opened containers with contaminated materials, and remove from Site as soon as possible.

G. Remove and replace materials that cannot be installed within stated shelf life.

1.10 PROJECT CONDITIONS

A. Verify existing dimensions and utilities prior to start of injection work. Notify EDR, of conditions found to be different than those indicated in the contract documents.

B. Exercise care to avoid injection or otherwise damaging embedded items. Remove, replace, or otherwise remedy damage to embedded items at no cost to Owner.

C. If unusual or concealed conditions are discovered, stop work and immediately notify EDR in writing.

D. Provide adequate ventilation to ensure no adverse effects from grout fumes, smells, or odors.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Source Limitations: Obtain injection materials through single manufacturer as Much as possible, and/or from sources approved by manufacturer of injection material.

B. Chemical Grout "A" Side by Avanti International, 822 Bay Star Blvd., Webster, TX. 77598 Phone: 800.877.2570 Fax: 281.486.7300:
   1. AV-100, Chemical Grout (Granular), plus AV-101 Accelerator,
   2. AV-100, Chemical Grout (Liquid), plus AV-101 Accelerator,
   3. AV-118, Duriflex Liquid, plus AV-101 Accelerator,
   4. AV-160, SuperGel Liquid, plus AV-101 Accelerator, and/or
   5. Approved equals from one of the following:
      a. PM-3811 plus Accelerator by Aquafin, Inc.
      b. Gelacyl SR De Neef chemical grout by Grace Construction Products.

C. Chemical Grout "B" Side:
   1. AV-102, Catalyst AP, by Avanti International, 822 Bay Star Blvd., Webster, TX. 77598 Phone: 800.877.2570 Fax: 281.486.7300
   2. Approved equals from one of the following:
      a. PM-3811 Hardener by Aquafin, Inc.
      c. Gelacyl SR De Neef chemical grout by Grace Construction Products.

D. Auxiliary Materials:
   1. Epoxy gel: Use 1 of following or approved equal:
      a. AV-522, by Avanti International, 822 Bay Star Blvd., Webster, TX. 77598 Phone: 800.877.2570 Fax: 281.486.7300
      b. SCB Concresive 1446 manufactured by BASF Construction Chemicals, LLC.
      c. Sikadur 31, Hi-Mod Gel manufactured by Sika Corporation.
   2. Hydraulic cement: Use 1 of following or approved equal:
      a. Waterplug manufactured by BASF Construction Chemicals, LLC.
      b. SikaPlug Fast-Setting Water Stop manufactured by Sika Corporation.
   3. Plaster-of-Paris or equal for securing and anchoring manchettes.
   4. Granular bentonite or equal for securing and anchoring manchettes.
   5. Manchettes and/or Sleeve Ports:
      a. PVC, schedule 40 tube or pipe, incremental openings with rubber Gaskets at 15 inches on center by Avanti International or equal.
   6. Oakum:
      a. As recommended by the Grout Manufacturer
   7. Grouting Equipment and Accessories:
      a. Stainless Steel, 1-to-1 ratio dual piston pump, with pressure Control gauges.
      b. Stainless steel diaphragm pumps for supplying grout to pump from Mixing barrows.
         Stainless steel "E" or "F"-Assembly with check-valves and ball valve Control.
      c. Chemical resistant, insulated injection hose lines for work in cold Weather.
      d. Stainless steel/HDPE Slide Packers, air or friction gaskets.

e. HDPE and stainless-steel mixing barrows and paddles.
f. Stainless steel packers with needle extensions for localized grout Curtain leakage remediation during excavation.
g. Water and/or liquid control meters for grout volume monitoring.

PART 3 - EXECUTION

3.1 GROUTING PHASES AND GENERAL WORK SCOPE

A. Curtain Tunnel Section Grouting shall be performed by one of four procedures, these are as follows:
1. Penetration into soil backfill through existing concrete pipe walls with perforated pipe,
2. Penetration into soil backfill through existing concrete pipe walls with solid pipe and performing top-down grouting,
3. Penetration into soil backfill through existing concrete pipe walls with solid pipe and performing bottom-up grouting, or
4. Surface mounted packer or injection port set into concrete pipe walls allowing for top-down grouting, (basis-for-design).

B. The Contractor shall perform a mock-up at the site to establish/verify injection grout spacing for manchette/packer/port locations. The contractor shall determine which of the four methods, or a combination thereof, that will provide water-and-soil tightness. The mock-up shall provide for the following:
1. Drill hole spacing's for manchettes/packers shall not exceed 1'-4" on center unless it is shown to accomplish design results.
2. Drill hole diameters shall be between 3/8" to ¾" in diameter.
3. Injection grout pressures shall be between 10 and 30 psig.
4. Grout volume shall be determined by translation from port-to-port of injection material and/or approximately 3 gallons per port.

C. First Pass: Inject all manchette/packer/port locations. Label drill holes locations in the field; record drill hole locations on a drawing, the date, quantities of grout injected at each location, and the grout batch number on an Xcel spreadsheet.

D. Second Pass: Repeat injection grouting at any locations if leakage persists. Record the date, quantities of grout injected at each location, and the grout batch number on an Xcel spreadsheet.

E. Remediation Grouting: If excessive groundwater seepage continues to occur after the second pass, consult with OR and EDR.

3.2 EXAMINATION

A. The injection subcontractor's Field Superintendent and injection-material manufacturer's Technical Representative shall:
1. Ensure that work done by other trades is complete and ready for injection grouting.
2. Examine existing substrates and site conditions to confirm compliance with grouting requirements and approved shop drawings.

3. Notify EDR in writing of substrates or conditions that may adversely affect installation or performance of injection grouting and recommend corrections.

B. Do not proceed with injection work until adverse conditions have been corrected and reviewed by EDR.

C. Commencing injection grouting work constitutes acceptance of work surfaces and conditions.

3.3 PROTECTION

A. Protect existing surfaces from Work in progress from mechanical damage due to drilling operations, scaffolding, and/or methods of work and other equipment.

B. Limit access to work areas.

C. Exercise care to avoid injection or otherwise damaging embedded items. Remove, replace, or otherwise remedy damage to embedded items at no cost to Owner.

3.4 PRESSURE INJECTION EQUIPMENT

A. Injection equipment shall be capable of pumping injection material under pressure through manchettes/packers and/or ports; and shall be approved by injection-material manufacturer.

3.5 PREPARATION FOR PERMEATION GROUTING

A. Inspect surfaces and locate areas to be injected.

B. Holes for acrylamide grout shall be same holes as used for hydrophilic urethane grout at concrete pipe joints.

C. Locate steel reinforcing prior to any new or additional drilling.

D. Drill holes for manchettes/packers/ports in accordance with approved shop drawings.

E. Install manchettes/packers/ports to achieve spacing patterns shown on the contract drawings based on mock-up.
1. Drill holes for injection ports or packers at 90-degree angle to surface.
2. After packer is set into place, test hole with pressurized water.
3. If pressurized water leaks through concrete pipe joint, hydrophilic urethane grout has not properly sealed the joint.
4. Reinject that location according to “B-Series” drawings.

3.6 PACKER / PORT / MANCHETTE GROUTING

A. Perform grouting in the presence of the injection-material manufacturer’s Technical Representative. The Technical Representative shall provide

documentation confirming that grouting was installed in accordance with requirements or an explanation why it was not.

B. Maintain conditions and injection material at adequate temperatures for suitable time so that injection material will fill soil voids and achieve full cure.

C. Using the lowest possible pressure to achieve desired result, continuously inject material into manchettes/packers/ports, as recommended by injection-material manufacturer.
   1. Use injection pressure of 10 to 30 pounds per square inch, depending on Manchette/packer/port spacing, width, depth of grouting, and condition(s) of soil.
   2. Start injection at pipe invert or lowest packer elevation and work towards crown; continue until injection material reaches the pre-calculated volumes.
   3. If colored acrylamide grout penetrates the previously injected concrete pipe joint, mark location and resume “Series B” grouting protocol with hydrophilic urethane grout.
   4. Remove injection nozzle or head from packer immediately after injection material reaches the pre-calculated volumes.
   5. Continue injection process bottom-up and from port-to-port, monitoring grout volume at each location.

D. When grouting from port-to-port, if-and-when uncured or un-gelled material comes up adjacent injection hole. Stop injecting for a minute or two until it solidifies, flush static mixer on “E” assembly injection gun.

E. Upon grout solidification of adjacent injection hole, resume grouting operations as per specified quantity of grout.

3.7 CLEANING

A. Protect existing tunnel surface finish(s) from grout stains.

B. Clean surfaces of excess grout, and injection ports or packers.
   1. Allow injection material enough time to cure before performing cleanup.
   2. Clean surfaces by grinding or other means.

C. Plug drill holes with mortar comparable in strength to concrete culvert pipe and top hole with crystalline waterproofing slurry after grouting is complete.

D. Patch holes at injection ports.

PART 4 - CONTRACTOR’S QUALIFICATIONS AND QA/QC REQUIREMENTS

4.1 GENERAL

A. Inspection:
   1. Manufacturer’s representative to inspect completed application and provide a written report that application complies manufacturer’s instructions.

B. Product:
1. Supply and install only products specifically designed and manufactured for this type of construction.
2. Select manufacturers of accessory products who are regularly engaged in the production of similar materials for underground structures.

C. Supervision and Training of Personnel:
1. Execute all installation and testing under the direct supervision of an individual with minimum five (5)-years-experience in the installation of grouting systems for underground structures using injection materials as specified.
2. Provide trained personnel for installation and testing operations.
3. The installer must have a minimum of five (5) years of experience at installation of grouting/injection materials in underground installations.
4. The proficiency of each technician shall be demonstrated in the field for approval by the Contracting Officer's Technical Representative (COTR).
5. The grouting system(s) shall be applied only by an approved contractor authorized by the Manufacturer prior to bid.
6. All work shall be completed by trained and authorized personnel.
7. Installation of grouting/injection system(s) shall be the responsibility of the Grouting Applicator to ensure undivided responsibility.
8. Upon request, the Applicator must submit a list of jobs performed by his employees and supervisors similar to the proposed system being bid.

D. Manufacturer's Performance:
1. Shall have documented experience of a minimum of 10 projects of similar scope.
2. The grouting/injection products are to made by a nationally-recognized manufacturer specializing in water control systems; have been used successfully on projects similar to this; and are appropriate for the substrate, groundwater, hydrostatic pressure, and soil and rock contamination conditions that may be expected in this Contract.

E. Installation Contractor:
1. Installation contractor of grouting materials be certified shall and/or be approved by the manufacturer in writing prior to bid submission.

4.2 FIELD QUALITY CONTROL

A. Installer's quality assurance technician shall be present during grouting work.

B. Provide:
1. Access to Work.
2. Materials for sampling.
3. Site facilities for sampling, testing, and storage of materials.
4. Incidental labor.

C. Sample each batch of material to be injected to determine reaction times:

Obtain 1 sample of injection material prior to beginning injection Work each day, representing first 50 feet of injection, and 1 sample for every 100 feet of injection thereafter. Provide the following:

1. Allow samples to cure. The reaction should start after ± 30 seconds and will end after ± 2:30 minutes.
2. Do not begin injection Work each day until initial sample has satisfactorily cured.
3. Label samples with injection date and location of injected manchette represented by sample.
4. Retain samples in a safe location on site.

D. Monitor and Report:
   1. Ambient temperatures,
   2. Grout consumption per manchette/packer/port,
   3. Equipment pressures, and
   4. Material ratios.

4.3 TESTING AND INSPECTION

A. Permeation Grouting Verification:
   1. After installation of soil permeation grouting, OR and EDR shall conduct visual surveys to determine whether soil-tightness exists at pipe joints.

B. Permeation Grouting Verification by Core Sampling:
   1. At completion of permeation grouting OR and EDR may require contractor at his expense to perform auger core samples of treated soil at its discretion. A minimum of 10 samples at various joint locations will be surveyed. Inconsistent samples shall be re-grouted and then re-sampled at contractor's expense.

C. Sampled cores in the grout curtain shall have permeation grout filling a minimum of 85 percent pore space with gel, depending upon product chosen. Areas of deficient grout in soil pore space matrix shall be drilled and re-grouted at contractor's expense to ensure compliance.

D. Injected permeation grout curtain shall be uniform consistency in soil pore space. Soil or core boring samples taken after permeation grouting is completed showing inconsistent grout matrix shall not constitute satisfactory performance and will not be included in the pay items until drilled and re-grouted to meet compliance.

END OF SECTION 03 64 20

Section 03 64 23 -- Epoxy Resin Crack Injection

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes epoxy resin grout injection through cracks in concrete within the elliptical culvert pipe from 40 mils (1 mm) to 120 mils (3 mm). Epoxy injection is specified to seal against water entry and re-establish concrete structural integrity.

B. Work of this section will be designated on the drawings as WP-6 and is itemized in Scope-of-Work sections on the Construction Documents.

C. Related Sections: Other specification sections, which directly relate to the Work of this Section and include, but are not limited to, the following:
1. Section 03 64 13 Polyurethane Grout, Crack-Joint Injection, WP-1
2. Section 03 64 20 Acrylamide Grout Joint Injection, Soil Solidification, WP- 2
3. Section 03 61 10 Ultra-fine Cement, Soil Stabilization, SS-3
4. Section 07 16 16 Crystalline Waterproofing, WP-4
5. Section 03 64 10 Polyacrylate Grout Crack Injection, WP-5
6. Section 03 64 23 Epoxy Resin Crack Injection, WP-6
7. Section 07 13 56 Thermoplastic Sheet Strip Seals, WP-7

D. Contractor shall be responsible for reviewing site conditions to verify quantities.

E. Contractor shall be responsible for magnitude (depth and width), scope (length) of epoxy resin grouting control as schematically shown and outlined on the contract documents.

F. Contractor shall follow prescriptive requirements of this specification; however, Contractor may modify as necessary the procedures, products, and installation to achieve water control through the leaking concrete culvert pipe if approved via shop drawings.

1.2 SECTION INCLUDES

A. Injection grouting to minimize water leakage post construction and is organized as follows:
1. Examination
2. Preparation and Layout
3. Mounting Injection Ports
4. Air-flushing Injection Ports
5. Setting Injection Ports
6. Injection Grouting Operations
7. Port Removal
8. Clean-up and Demobilization

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
   1. American Society for Testing and Materials (ASTM) - ASTM International:
      a. ASTM C42/C42M: Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
      b. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
      c. ASTM D420: Standard Guide for Investigating and Sampling Soil and Rock.
      d. ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
      e. ASTM F2304 Standard Practice for Rehabilitation of Sewers using Chemical Grouting (latest revision).
      f. ASTM F2454 Standard Practice for Sealing Lateral Connections and lines from the mainline Sewer Systems by Lateral Packer Method, Using Chemical Grouting (latest revision).

B. Department of Labor, Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards – Excavations, Final Rule – 29 CFR, Part 1926

C. American National Standards Institute (ANSI):
   1. Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD). Z535.1 Safety Color Code

D. American Public Works Association (APWA):
   1. Uniform Color Code for Temporary Marking of Underground Utility Locations.

E. Other Applicable Standards:
   1. API RP 13B-1, Recommended Practice for Field Testing Water-based Drilling Fluids.
   2. National Association of Sewer Service Companies (NASSCO) prepared Pipeline Assessment and Certification Program (PACP), TV inspection form and sewer condition codes.

1.4 ABBREVIATIONS:

A. Commonly used abbreviations used in this specification are as follows:
   1. OR – Owners Representative
   2. CO – Contracting Officer
   3. COR – Contracting Officer's Representative
   4. COTR – Contracting Officer's Technical Representative
   5. M/E/P – Mechanical Electrical Plumbing
   6. SPI – Safety Performance Index
   7. EDR – Engineering Design Representative
   8. SDS – Safety Data Sheet
   9. HEPA – High Efficiency Particulate Air
   10. mm – millimeters (40 mils = 1 mm)
   11. mil – millage, 1/1,000 inch = 0.001"
   12. QA – Quality Assurance
   13. QC – Quality Control

14. WP -- Waterproofing
15. SS – Soil Solidification/Stabilization

1.5 DEFINITIONS

A. Specification criteria:
   1. Prescriptive based-structural repair/water control criteria established by design professional's details and specifications, or
   2. Performance based- structural repair/water control ways-and-means established by contractor and reviewed by design professional.

B. Water leakage nomenclature:
   1. Crack Root-The point(s) of water ingress into a concrete element.
   2. Crack Mouth- The points of water discharge from a concrete element.
   3. Trail- A noticeable pathway/stain on concrete element surface designating continuous water flow.
   4. Ponding- The accumulation of water leakage through a concrete element.

C. Five levels of water accumulation on a concrete element can be physically described as follows:
   1. Color change (darker), when high moisture content exists at concrete element surface, (white/crystalline or efflorescence) when area has re-sealed itself via autogenous healing), not visually wet to touch, no ponding occurs;
   2. Wet to touch, surface dampness in spots, no sustained water trail present, no ponding occurs;
   3. Weeps and seepage, sustained trail of wetness, however, visual surface flow not apparent, ponding does occur;
   4. Continuous dripping, visual surface flow or water movement over Gushing concrete element, ponding occurs and leaves trail; or
   5. flow, from presence of hydrostatic back pressure, ponding leaves continuous trail of water.

D. Water Control: Water control at concrete elements serves many purpose(s):
   1. Minimizes potential of dissolved oxygen, carbon dioxide, free chlorides and various salts/contaminants from entering concrete through-wall/floor/elevated-deck cracks and joints.
   2. Helps control and potentially mitigate the following:
      a) Internal steel reinforcing bar corrosion,
      b.) Hardware corrosion of externally attached metal adjacent to wet area
      c.) Concrete carbonation, and
      d.) Alkali Silica Reactivity and Delayed Ettringite Formation.
      e.) Surface delamination of paints, coatings and high build flooring components,
      f.) Nutrient Source for mold, algae, and bacterial growth organisms,
      g.) Interior surface stains, efflorescence, salt and carbonate buildups (stalactites/stalagmites),
      h.) Ice formation (icicles) in unheated enclosures,
      I.) Slippery surfaces,

j.) Electrical short circuits, and/or shocks,
k.) Conductor for stray current corrosion,
l.) Potential soil particle loss, and
m.) Costly cleanup when hazardous contaminants (radioactive or poisonous hydrocarbons) enter and accumulate.

E. Structural Parameters: Three important considerations for successful grouting without damaging the structural concrete elements are as follows:
1. Pressures more than 600 psig can cause tensile damage (fracking) to existing concrete elements;
2. Crack width is inversely proportional to pump gauge pressure; and
3. Crack width is proportional to grout viscosity required for proper penetration.

F. Water leakage flow paths:
1. Through-element primary and secondary cracks/joints;
2. Voids and shadows along horizontal or vertical steel reinforcing bar;
3. Unbonded surfaces between concrete and mechanical, electrical, plumbing, penetrations, inserts, or sleeves and dewatering hardware;
4 Poorly consolidated and/or honeycombs within concrete element at
5. Porous foreign objects/debris and/or soil deposits trapped within the concrete element during forming/placement construction and subsequent placement;
6. Through element braided copper ground cables;
7. Form-tie brackets, anchors, wire, or any such temporary or permanent structural inserts.

G. Crack Nomenclature and Width Definitions:
1. Cracks and joints as fine as 1/1000 inch (1 mil) are subject to water leakage if hydrostatic back pressure exists. Water leakage volumes are related to hydrostatic pressure, crack/joint width, and internal friction at crack/joint sidewalls. Cracks and joints are defined as follows:
a. ultra-fine crack/joint (01 to 05) mils (0.025 to 0.127) mm
b. very-fine crack/joint (06 to 10) mils (0.152 to 0.254) mm
c. fine crack/joint (11 to 15) mils (0.279 to 0.381) mm
d. medium-fine crack/joint (16 to 20) mils (0.406 to 0.508) mm
e. medium crack/joint (21 to 40) mils (0.533 to 1.016) mm
f. medium-wide crack/joint (41 to 60) mils (1.041 to 1.524) mm
g. wide crack/joint (61 to 120) mils (1.549 to 3.048) mm

H. Grout(s): Generic term describing various - structural and/or non-structural, cementitious and/or non-cementitious materials which are installed as a liquid, paste or gel/mastic; which may cure-out as a product that exhibits a high or low modulus resulting in an elastic/plastic foam, gel, or paste-like matrix. Injection or placement materials include Portland cement (Types I, II, III, IV, or V, with or without fine aggregate, neat cement as micro-fine and ultra-fine in particle size) and/or bentonite powder blends, potassium/sodium silicates, reactive polymer(s), such as urethane (hydrophobic/hydrophilic), epoxy, methyl-methacrylate, acrylamide and polyacrylate resins, solvent (hydrocarbon or water) based rubber gels, and hot/cold asphalt fluids and/or emulsions. Grout viscosity has a relationship with pumping pressure and crack width, among other parameters

such as temperature, cross-sectional width of voids, gel-time, and water chemistry. Four grout designations are as follows:

1. Low viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material when initially mixed facilitates a viscosity of (1 to 15) centipoise. Said grouts under controlled pressure penetrate ultra-fine cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.
2. Medium viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material when initially mixed facilitates a viscosity of (50 to 100) centipoise. Said grouts under controlled pressure penetrate fine cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.
3. High viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material when initially mixed facilitates a viscosity of (500 to1,000) centipoise. Said grouts under controlled pressure penetrate medium-wide cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.
4. Very-high viscosity chemical grout: A three-, two-, or one-part reactive resinous polymer material or non-reactive fluid when initially mixed facilitates a viscosity of (2,000 or greater) centipoise. Said grouts under controlled pressure penetrate wide cracks/joints in concrete elements with minimal secondary fracking; sets-up (cures) to a flexible or rigid, resin, gel or foam consistency.

I. Grouting Types and Procedures:

1. Interception Grouting: Process by which a crack or joint is intercepted between its mouth and root (origin), and further a chemical grout is pumped into it under gauge pressure to fill any void space left in the concrete matrix.
2. Backside Grouting: Process in which a drill hole penetrates completely through concrete or structural element and leakage area is sealed with grout from backside, similar to Curtain grouting.
3. Surface Mounted Grouting: Process in which injection ports are installed on exposed surface of concrete defect area and injected from one side.

J Permeation Grouting: Process of injecting chemical grout under pressure filling the pore space of soil particles in a specified zone of influence; also referred to as soil solidification, chemical grouting, curtain grouting, and/or pressure injection.

K. Grout Curtain: A solidified soil element (of length, width, and depth) having low permeability qualities.

L. Sectioning: Grout curtain in soil strata arranged to seal off individual structural sections. Used in connection with “charge” and “re-charge” grouting pipes to create a grout curtain system, which promotes control of watertightness and facilitates leakage remediation.

M. Charge and Re-Charge Pipes: Drilled holes for permeation grouting process. Charge holes are pressurized with grout and re-charge holes allow pressure

relief and monitoring of grout path; also referred to as “inlet/outlet” ports.

N. Control and Grouting Pipes: Pipes typically installed near water barrier intersections to control water-tightness of individual waterproof membrane sections. If leakage should occur, the pipes are used for remedial grouting specifically located at each connection or interruptions to concrete pours; also referred to as “inlet/outlet” ports.

O. Sleeve Port(s): Injection pipe(s) of various diameters with incremental openings (perforated pipe) along its length, covered with a rubber gasket; also called manchette tube or Tube-A-Manchette (TAM).

P. Manchette tube: Tube-A-Manchette (TAM) or commonly referred to as Injection pipe(s) of various diameters with incremental openings along its length, covered with a rubber gasket; also called a sleeve port.

Q. Packer(s): A mechanical device placed into or through drilled holes in concrete elements or driven into soil, through which grout is pumped into, and forced through; also referred to as injection port, expandable packer, or wall sphere. Devices shall be chemical resistant HDPE (high density polyethylene), neoprene rubber, leather or Teflon gaskets, and stainless-steel, brass, aluminum, or carbon steel frame. Most contain a grease zerk, button head, or quick-connect for attachment to the Injection head.

R. Slide Packer(s): A mechanical device placed into plastic manchettes with sectionalized inflatable or friction gaskets (leather or Teflon) at each end to control and distribute pressurized grout to incremental location(s) within the manchette or sleeve port.

S. Injection Head or Gun: Mechanical device consisting of a mixing chamber for one or more parts of resin with quick-connects, zerk grease fitting, button head, and an on/off switch or ball-valve to control flow and capability, recirculation, pressure monitoring, and a cleanout; often called an “E” or “F”-Assembly.

U. Crystalline Waterproofing Mortar: Portland cement/silica sand mortar with reactive chemical admixture that promotes crystalline growth in the reinforced element. Reactive chemicals combine the free calcium hydroxide in concrete to crystallize and imped water flow.

V. Grouting Procedures:

1. Top-down Grouting: Injection technique whereby grout curtain is established near ground or exposed surface, once that solidifies, manchettes are drilled through the solidified zone and grouting proceeds sequentially downward.
2. Bottom-up Grouting: Technique whereby grout curtain is established at bottom of hole and manchettes are sequentially lifted and grout zone proceeds upward.

W. Grouting Installation Form: Form provided by Contractor, documenting the location and amount of grout in each manchette location.

X. Dual and Single Component Pump(s): Operated with compressed air, electric, hydraulic oil, or mechanically operated pump with single mechanism or multi-ratio mechanisms for pumping various grout components.

Y. Quality Control: A system for verifying and maintaining a desired level of quality in an existing product or service by careful planning, use of proper equipment, continued inspection, and corrective action as required.

Z. Quality Assurance: A systematic monitoring and evaluation program for various aspects of a project, service, or facility to ensure that standards of quality are being met.

1.6 SUBMITTALS

A. Shop Drawings: Provide project customized plan, sections and associated details showing the following:
1. Work scope plan if different from contract documents.

B. Product Data: Injection grout material manufacturer's literature (catalogue cuts) including;
1. Written instructions for handling, mixing, and safety procedures.
2. Technical data including tested physical and performance properties, including:
a. Temperature ranges for storage and application of materials, and special warm/cold-weather application requirements or limitations,
b. Include recommended Site protection measures, and
c. Safety Data sheets.

C. Certificates:
1. Signed by injection-material manufacturer, certifying that products furnished comply with requirements and are recommended by manufacturer for uses indicated.
2. Signed by injection-material manufacturer, certifying that individual(s) performing work is approved to install its products.

D. Injection Installer/Subcontractor Qualifications: Evidence that Subcontractor's existing company has minimum 5 years of continuous experience in injection of specified materials; list of at least 5 representatives, successfully completed projects of similar scope and size, including:
1. Project name.
2. Owner's name.
3. Owner's Representative name, address, and telephone number.
4. Description of work.
5. Injection materials used.
6. Equipment used.
7. Project supervisor.
8. Total cost of injection work and total cost of project.
9. Completion date.

E. Installer/Subcontractor's and/or Manufacturer's field reports.

F. Resume' of epoxy grouting installation supervisor.

G. Samples: Reacted epoxy grout in small plastic bottle.

H. Epoxy Grouting protection plan/narrative: Describe the intended procedures to prevent damage during construction operations. The following items shall be addressed:
   1. Storage and set up of equipment;
   2. Restoration of drill holes;
   3. Steel reinforcing location plan;
   4. Handling of drilling fluids and waste products if any; and
   5. Testing to ensure continuous and monolithic grout pattern.

1.7 QUALITY ASSURANCE REQUIREMENTS

A. Personnel identified during prequalification process shall be the personnel conducting the Work.

B. Pre-installation Meeting:
   1. Conduct meeting at Site.
   2. Review requirements for injection Work, including:
      a. Safety protocol and tradesmen training,
      b. Construction schedule,
      c. Availability of materials, Injection Installer/Subcontractor's personnel, equipment, and facilities needed to make progress and avoid delays.
      d. Site use, access, staging and set-up location/limitations.
      e. Cracks and joints to be injected, and condition of other construction activity that will affect injection Work.
      f. Injection procedures.
      g. Testing and inspection requirements.
      h. Site protection measures.
      i. Governing regulations.

C. Contractor's Site superintendent, injection-material manufacturer's technical representative, Injection Subcontractor's foreman, COR, COR's Representative, and Grouting Consultant, shall attend.

1.8 WEATHER LIMITATIONS

A. Environmental Limitations: Install injection material when existing and forecast weather conditions permit material to be installed and cured according to injection-material manufacturer's written instructions and warranty requirements.

B. Do not install when air and substrate temperatures are outside limits permitted by injection-material manufacturer. Provide enclosures to ensure against freezing temperatures and or over exposure to UV light, unless approved in writing by injection-material manufacturer.

C. Contractor/Grouting Installer shall be aware that un-managed water can be a safety issue.

D. Do not work in severe temperatures, moisture, and excessive humidity; these may affect the installation and performance of products during construction. Consult with Manufacturer's Representative and comply with applicable material recommendations for workmanship and handling.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such manner as to prevent damage to materials and existing structure.

B. Deliver materials to Site in original containers with seals unbroken, labeled with manufacturer's name; product brand name and type; date of manufacture; lot number; SPI hazardous rating and appropriate warnings for handling; and directions for storing and mixing.

C. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling and installation. Reject and remove from Site new materials which exhibit evidence of moisture reaction during application or have been exposed to abuse or other deleterious materials.

D. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by injection-material manufacturer.

E. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

F. Conspicuously mark damaged or opened containers with contaminated materials, and remove from Site as soon as possible. Dispose containers to legal dump site.

G. Remove and replace materials that cannot be installed within stated shelf life.

1.10 PROJECT CONDITIONS AND SAFETY PROTOCOL

A. Verify existing dimensions and any known utilities (buried drainpipes, electrical or telecom service) prior to start of injection Work. Notify COR, if conditions found to be different than those indicated in Contract Documents. Be aware of buried utilities, (drainpipes, electrical or telecom service) unknown at time of drilling.

B. If unusual or concealed conditions are discovered, stop work and immediately notify COR in writing. Be aware of private drain line pipes and fields.

C. Provide adequate ventilation and protect adjacent building air intakes (if any) to ensure no adverse effects from grout fumes, smells or odors. Note the following:
   1. Acrylic grout oxidizers give off an ammonia smell/vapor;
   2. Urethane grouts give off MDI or TDI smell/vapors;
   3. Epoxy grouts can give off hydrocarbon smells.

4. Carbon dioxide is released as part of polyurea/polyurethane reaction:
5. Hot asphalt can give off benzene vapors and hydrocarbon smells;
6. Bentonite and cement grouts give off silica dust when mixing with water;
7. Hydrocarbon solvents are released when used as a viscosity reducer;
8. Drilling into concrete produces silica dust; and
9. Adding ethylene glycol to air intake lines of grout pump can produce air-borne hydrocarbons in the immediate area.

D. Follow OSHA regulations during work performance, and particularly when the following occurs:
1. Trades people are working on platforms and scaffolding;
2. Heights more than four feet;
3. When using ladders;
4. When drilling into concrete and creating sparks and dust;
5. Use OSHA approved HEPA dust collection systems when drilling into concrete elements;
6. Wear goggles, face shields, or similar when high grout pressures are used;
7. Wear proper PPE clothing and gloves when handling solvent, hot, and/or reactive chemicals.

PART 2 – MATERIALS

2.1 PRODUCTS

A. Source Limitations: Obtain injection materials through single manufacturer as much as possible, and/or from sources approved by manufacturer of injection material.

B. Approved Products and Chemical Grout Manufacturers/Suppliers:
1. Sikadur 32 or 52, Injection Adhesive manufactured by Sika Corporation.
2. AV-502 LV or AV-502 HV by Avanti International, 822 Bay Star Blvd., Webster TX. 77598 Phone: 800-877-2570 Fax: 281-486-7300

C. Or-equal grout manufacturer. Products shown to be equal in viscosity, solids percentage in acrylic resin component, chemical composition, and performance are of consideration by Specifying Engineer. Approved equal products must be approved in writing prior to bid proposal.

D. Auxiliary Materials:
1. Epoxy gel: Use 1 of following or approved equal:
   a. AV-520 by Avanti International, 822 Bay Star Blvd., Webster TX. 77598 Phone: 800-877-2570 Fax: 281-486-7300
   b. SCB Concresive 1446 manufactured by BASF Construction Chemicals, LLC.
   c. Sikadur 31, Hi-Mod Gel manufactured by Sika Corporation.
2. Hydraulic cement: Use one of following or approved equal:
   a. Aquafin-Plug-IC, manufactured by Aquafin Inc.
   b. Water plug manufactured by BASF Construction Chemicals, LLC. SikaPlug Fast-Setting Water Stop manufactured by Sika Corporation.

3. Oakum:
   a. As recommended by the Grout Manufacturer.
4. Grouting Equipment and Accessories:
   a. Stainless Steel or equal, 1-to-1 ratio, dual piston pump, with pressure control gauges for epoxy or urethane grouts.
   b. Chemical resistant, insulated injection hose lines for work in cold or hot weather.
   c. Plastic ports for surface mounted injection.
   d. Water and/or liquid control meters for grout volume monitoring.

PART 3 - EXECUTION

3.1 GROUTING PHASES AND GENERAL WORK SCOPE

A. Perform injection grouting operations at locations shown on the contract documents. Inject cracks and joints in heavily reinforced concrete that exhibits structural damage or water leakage.

B. Perform injection grouting all concrete crack and joint areas. Label locations using submitted and approved shop drawing(s). Identify locations and quantities of grout injected at each drilled port.

C. Final Inspection: The final inspection shall be performed after injection is completed. Submit to Owner, recovery plan for leakage control if said leakage persists after third pass.

3.2 EXAMINATION

A. Injection Subcontractor to examine substrates and conditions with, COR representative and injection-material manufacturer for compliance with requirements and for other conditions affecting installation or performance of structural and water control Work.
   1. Examine crack and joint widths for determination of which grout types have the appropriate viscosity and will minimize injection pressures and fracking.
   2. Injection pressure limited to bond strength of epoxy paste on surface of crack.
   3. Ensure that work done by other trades is complete and ready for Injection work. If mechanical or electrical equipment or other obstructions block crack and/or joint access, discuss plan to achieve structural and/or water control goals.
   4. Verify that areas and conditions with Injection Subcontractor and representative of injection material manufacturer for compliance with requirements and for other conditions affecting installation or performance of structural or water control Work.
      Notify COR, in writing of conditions which may adversely affect installation or performance of injection Work and recommend corrections.
   5. Do not proceed with injection Work until adverse conditions have been corrected and reviewed by COR, and Grouting Consultant (if any).
   6. Commencing injection Work constitutes acceptance of Work surfaces and conditions.

3.3 PROTECTION

A. Protect existing surfaces from injection Work in progress and from mechanical damage due to drilling operations, scaffolding, and/or methods of work and other equipment.

B. Limit access to Work areas. Always wear PPE equipment when using fluids and air under pressure. Wear gloves to avoid skin contact with unreacted grouts. Follow all OSHA and Site Safety protocols.

C. Exercise care to avoid injection or otherwise damaging embedded items. Remove or replace or otherwise remedy damage to embedded items, at no cost to Owner.

3.4 PRESSURIZED INJECTION EQUIPMENT AND PRETESTING

A. Injection equipment shall be capable of pumping injection material under pressure through properly rated hoses and injection ports; equipment shall be approved by injection-material manufacturer.

B. Mark grout component pails and pump intake/discharge lines with colored coded tape, colored lines, or designate components of part “A” resins from part “B” resins. Separate mixing devices such that no cross-contamination exists.

C. Perform ratio check on part “A” and part “B” lines prior to any grouting; confer with manufacturer for approval if any ratios are not as specified. Adjust per manufacturer’s instructions and note items on shop drawings.

D. Perform reaction time test by mixing part “A” to part “B” resins and noting initial set and viscosity change of mixed grout, document on shop drawings.

3.5 PREPARATION FOR INTERCEPTION GROUTING

A. Inspect surfaces and locate areas to be injected. Locate steel bar in concrete elements prior to drilling. Survey for suspected utility or electrical lines in concrete.

B. Install surface mounted ports to achieve spacing pattern as shown by approved shop drawings and provide the following:
   1. Number, spacing, and location of ports shall be as submitted in the approved shop drawings with noted tolerance.

3.6 SURFACE MOUNTED VALVE PACKERS

A. Perform grouting Work in presence of representative of injection-material manufacturer. At conclusion of Work, manufacturer’s representative shall prepare and furnish letter or report to COR, stating whether installation was completed in accordance with requirements. These manufacturer’s services shall be provided at no additional cost to Owner.

B. Mix chemical grout components per manufacturers requirements in separate and clean pails. Place dams and spill containment under pump and mixed grout pails. Add colorants or dyes to grout for identification purposes, if desired.

C. Maintain conditions and injection material at adequate temperature for suitable time so that injection material will completely fill the drill hole and void and will achieve full cure.

D. Using the lowest possible pump pressure to achieve desired result, continuously inject material into packers to avoid fracking the concrete element, and as recommended by injection-material manufacturer.
   1. Start injection at lowest packer elevation and move to higher elevations, continue until injection material reaches the pre-calculated volumes and flows from the mouth of crack or joint.
   2. Use injection pressure of 10 to 50 psi (pounds per square inch), depending on port spacing, width of crack, depth of grouting, and condition(s) of concrete. Increase pressure in 10 psi increments to achieve grout flow.
   3. Continue injection process from port to port, monitoring grout volume and ensure grout pump pressures do not exceed 600 psig.
   4. Immediately after second “Second Pass” of grouting, inject water in controlled fashion to flush out injection port.
   5. Remove injection head after injection material initially sets and reaches the pre-calculated volumes per port and has cured.

3.7 SHUT-DOWN AND PUMP FLUSHING

A. Upon completion of injection protocol including passes 1 and 2, remove intake lines from grout pails and flush pump with manufacturers approved, solvent, flushing agent. Flushing agent may be water in some cases.

B. Upon completion of pump flushing, fill lines and cylinders with manufacturers approved lubrication and corrosion resistant medium.

C. Remove reacted chemicals and waste flushing agents from the site and dispose at appropriate land fill.

3.8 DRILL HOLE RESTORATION

A. Upon completion of drill hole injection protocol including passes 1 and 2, remove ports/packers, if not done previously, from injected crack or joint locations. Ensure all grout has fully cured prior to packer removal.

B. Clean surface of injected crack and/or joint prior to demobilization. Remove reacted chemicals and waste flushing agents from the site and dispose of debris off site to a legal dump facility.

3.9 CLEANING

A. Protect existing building surface finish(s) from grout stains.

B. Clean surfaces of excess grout, and injection ports or packers.
   1. Allow injection material enough time to cure before performing cleanup.
   2. Clean surfaces by grinding or other means.
   3. Ensure all holes are patched at injection ports.

PART 4 - CONTRACTOR'S QUALIFICATIONS AND QA/QC REQUIREMENTS

4.1 GENERAL

A. Inspection:
   1. Manufacturer's representative to inspect completed application and provide a written report that application complies manufacturer's instructions.

B. Product:
   1. Supply and install only products specifically designed and manufactured for this type of construction.
   2. Select manufacturers of accessory products who are regularly engaged in the production of similar materials for underground structures.

C. Supervision and Training of Personnel:
   1. Execute all installation and testing under the direct supervision of an individual with minimum five (5)-years-experience in the installation of grouting systems for underground structures using injection materials as specified.
   2. Provide trained personnel for installation and testing operations.
   3. The installer must have a minimum of five (5) years of experience at installation of grouting/injection materials in underground installations.
   4. The proficiency of each technician shall be demonstrated in the field for approval by the Contracting Officer's Technical Representative (COTR).
   5. The grouting system(s) shall be applied only by an approved contractor authorized by the Manufacturer prior to bid.
   6. All work shall be completed by trained and authorized personnel.
   7. Installation of grouting/injection system(s) shall be the responsibility of the Grouting Applicator to ensure undivided responsibility.
   8. Upon request, the Applicator must submit a list of jobs performed by his employees and supervisors similar to the proposed system being bid.

D. Manufacturer's Performance:
   1. Shall have documented experience of a minimum of 100,000 square feet or similar.
   2. The grouting/injection products are to made by a nationally-recognized manufacturer specializing in water control systems; have been used successfully on projects similar to this; and are appropriate for the substrate, groundwater, hydrostatic pressure, and soil and rock contamination conditions that may be expected in this Contract.

E. Installation Contractor:

1. Installation contractor of grouting materials be certified shall and/or be approved by the manufacturer in writing prior to bid submission.

4.2 FIELD QUALITY CONTROL

A. Installer's quality assurance technician shall be present during grouting work.

B. Provide:
   1. Access to Work.
   2. Materials for sampling.
   3. Site facilities for sampling, testing, and storage of materials.
   4. Incidental labor.

C. Sample each batch of material to be injected to determine reaction times: Obtain 1 sample of the injection material prior to beginning injection Work each day, representing first 50 feet of injection, and 1 sample for every 30 feet of injection thereafter. Provide the following:
   1. Allow samples to cure. The reaction should start after ±10 minutes and end after 2 hours.
   2. Do not begin injection Work each day until initial sample has satisfactorily cured.
   3. Label samples with injection date and location of injected packer represented by sample.
   4. Retain samples in a safe location on site.

D. Monitor and Report:
   1. Ambient temperatures;
   2. Grout consumption per packer;
   3. Equipment pressures; and
   4. Material ratios.

END OF SECTION 03 64 23

Section 07 13 56 -- Thermoplastic Sheet Strip Seals

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes thermoplastic strip seal waterproofing for interior pipe culvert in widths greater than 1.50 inches or where defects exist.

B. Work of this section will be designated on the drawings as WP-7 and is itemized in the Scope-of-Work sections on the Construction Documents.

C. Related Sections: Other specification sections, which directly relate to the Work of this Section and include, but are not limited to, the following:
1. Section 03 64 13 Polyurethane Grout, Crack/Joint Injection, WP-1
2. Section 03 64 20 Acrylamide Grout Joint Injection, Soil Solidification, WP- 2
3. Section 03 61 10 Ultra-fine Cement, Soil Stabilization, SS-3
4. Section 07 16 16 Crystalline Waterproofing, WP-4
5. Section 03 64 10 Polyacrylate Grout Crack Injection, WP-5
6. Section 03 64 23 Epoxy Resin Crack Injection, WP-6
7. Section 07 13 56 Thermoplastic Sheet Strip Seals, WP-7

D. Contractor shall be responsible for reviewing site conditions to verify quantities.

E. Contractor shall be responsible for magnitude (depth and width), scope (length) of joint strip seals as schematically shown and outlined on the contract documents.

F. Contractor shall follow prescriptive requirements of this specification; however, Contractor may modify as necessary the procedures, products, and installation to achieve water control through the leaking concrete culvert pipe joints if approved via shop drawings.

1.2 SUBMITTALS

A. All items listed below shall be submitted altogether, in one set, to form a complete design review package. Approval of Work scope shop drawings by the COTR shall not relieve installation contractor of specified Work in this section, which may have been missing on the approved shop drawings.

B. Shop Drawings shall be submitted to COTR for approval prior to start of work. Prepare and provide standard, project customized details at a scale appropriate for understanding layering, terminations, anchorage, overlaps and embedment's. Do not proceed with WP-7 waterproofing installation without approved shop drawings. Submit drawings of Work Scope in plan and sections, in addition all penetration(s), anchorage and special details of the following:
1. Sequence of waterproofing installation relative to construction sequence, including detailed installation procedure and system tie-ins to other systems when required.
2. Build-up of layered waterproofing at cracks and/or joints.

C. Product Data: Include material descriptions, 8” x 8” samples, SDS, technical data sheets, and installation instructions for crystalline waterproofing. Include the following:
   1. 60-mil membrane sheet,
   2. Epoxy Adhesive,
   3. Stainless steel anchors,
   4. Termination bar, and
   5. Sample Panel 8”x 8” represents WP-7 as entire system with each layer visible and labeled.

D. Qualification Data: For Installer.

E. Manufacturer’s inspection reports of completed installation.

F. Minutes of preinstallation conference.

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
   1. American Society for Testing and Materials (ASTM) - ASTM International:
      a. ASTM C507 Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
      b. ASTM C1840 Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain and Storm Sewer Pipe.
      c. ASTM C42/C42M: Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
      d. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
      e. ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
      f. ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      g. ASTM A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      h. ASTM C33, Standard Specification for Concrete Aggregate
      i. ASTM 050, Standard Specification for Portland Cement.
      j. ASTM C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
      k. ASTM D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
      l. ASTM D2241, Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
      m. ASTM F2304 Standard Practice for Rehabilitation of Sewers using Chemical Grouting (latest revision).
      n. ASTM F2454 Standard Practice for Sealing Lateral Connections and lines from the mainline Sewer Systems by Lateral Packer Method, Using Chemical Grouting (latest revision).

o. ASTM 091, Standard Test Methods for Time of Setting of Hydraulic Cement by VI cat Needle.

B. State of Wisconsin Department of Transportation (Wis-Dot):
1. Standard Specification for Construction.
2. Standard Specifications for Construction of storm sewer and drainage structures.

C. Department of Labor, Occupational Safety and Health Administration (OSHA):
1. Occupational Safety and Health Standards – Excavations, Final Rule – 29 CFR, Part 1926.

D. American National Standards Institute (ANSI):
1. Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD), Z535.1 Safety Color Code
2. ANSI/NSF 61, Drinking Water System Components – Health Effects.

E. American Public Works Association (APWA):
1. Uniform Color Code for Temporary Marking of Underground Utility Locations.

F. Other Applicable Standards:
1. API RP 13B-1, Recommended Practice for Field Testing Water-based Drilling Fluids.
2. National Association of Sewer Service Companies (NASSCO) prepared Pipeline Assessment and Certification Program (PACP), TV inspection form and sewer condition codes.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer. Workers shall have not less than 5 years documented, successful experience with waterproofing work comparable to Work on this Project.

B. Preinstallation Conference: Conduct conference at Project site and document all discussions and agreements.

1.5 PROJECT CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit crystalline waterproofing to be performed according to manufacturer's written instructions and warranty requirements.

B. Ambient Conditions: Proceed with WP-7 waterproofing work only if temperature is maintained at 40 degrees F or above during work and cure period, and space is well ventilated and kept free of water.

C. Proceed with WP-7 waterproofing work only after all other grouting and waterproofing has been completed. Further proceed only after concrete substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of soil debris and water.

1.6 MOCK-UP

A. Prior to application of specified WP-7 membrane/coating/slurry, and after approval of shop drawings, erect sample panel on site for mock-up using materials and joint details required for final work. Build mock-up at the site, where directed by COTR, of full thickness indicating the proposed color, texture, and workmanship to be expected in the completed work. Obtain COTR's acceptance of visual qualities of the mock-up before start of Work.

PART 2 – PRODUCTS

2.1 MANUFACTURERS.

A. Available Products: Subject to compliance with requirements, products for PVC sheet waterproofing that may be incorporated into the Work include, but are not limited to, the following:
1. Cooley Engineered Membranes Cooley, Inc.
2. Seaman's Corporation.
3. Sarnafil, Inc.
4. Contractor Option to provide Interior Joint Seals by one of the following:
   a. HydraTite Joint System, from
      1. HydraTech Engineered Products, LLC
         10448 Chester Rd.
         Cincinnati, OH 45215
         Phone (513) 827-9169
         www.hydratechllc.com
   b. "Or Equal" interior are acceptable

2.2 MATERIALS

A. Elvaloy PVC Sheet Membranes:
1. Coolguard MPK (60-mil) KEE-Elvaloy Terpolymer Sheet, reinforced with a polyester scrim.
2. Fibertite XTreme (60-mil) KEE-Elvaloy Terpolymer Sheet, reinforced with a polyester scrim.

B. Epoxy Adhesive/gel: Use 1 of following or approved equal:
   a. AV-520 by Avanti International, 822 Bay Star Blvd., Webster TX. 77598 Phone: 800-877-2570 Fax: 281-486-7300
   b. SCB Concresive 1446 manufactured by BASF Construction Chemicals, LLC.
   c. Sikadur 31, Hi-Mod Gel manufactured by Sika Corporation.

C. Termination Bar:
1. Termination Bar: 14-gauge by 25-mm (1-inch) wide channel profiled stainless steel bar, pre-punched 100-mm (4-inches) on-center.

D. Anchors:

1. Fasteners and other hardware shall be stainless steel conforming to ASTM F 593; 6-mm x 38-mm (1/4-inch by 1-½ inch) nylon anchors with stainless steel pins.
2. Bonded neoprene washers or other device acceptable to the COTR, capable of ensuring the prevention of intrusion of water under hydrostatic pressure along the fasteners.

E. Weld-Strip: As supplied by Manufacturer for hot-air welding to vertical thermoplastic waterproofing membrane.

F. Grid Adhesive: 100% solids, two-part urethane, with minimum tensile strength of 150-psi (ASTM D 412) and adhesion to concrete of 12-psi (ASTM D 429). Trowel grade. Grid adhesive is available in both vertical and horizontal grade viscosity.

G. Stainless Steel Band (Hose Clamp), Stainless steel, for use at pipe or conduit penetrations.

H. Membrane Cleaner: Recommended solvent cleaner by Manufacturer.

I. Welder:
1. Hand-held hot-air welding apparatus for flashing of sheets and sheet anchorage and seaming.

J. Sheet Metal Flashing: Provide 20-gauge, stainless steel.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Acceptance of Conditions: Examine substrates, with Applicator present, where waterproofing is to be applied.
1. Proceed with application only after unsatisfactory conditions have been corrected.
2. Notify COTR in writing of active leaks or structural defects that would affect system performance.

3.2 PREPARATION

A. Protect other work from damage from cleaning, preparation, and application of membrane waterproofing.

B. Repair damaged or unsatisfactory concrete according to manufacturer’s written instructions.

C. Surface Preparation: Comply with waterproofing manufacturer’s written instructions to remove efflorescence, chalk, dust, dirt/soil, mortar spatter, grease, oils, curing compounds, and form-release agents to ensure that waterproofing bonds to concrete surfaces.

1. Clean concrete surfaces according to ASTM D 4258. Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-last cleaning according to ASTM D 4259.
2. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

3.3 APPLICATION

A. General: Comply with waterproofing manufacturer's written instructions for application.
1. Clean and roughen concrete surfaces prior to placing epoxy adhesive.
2. Apply waterproofing membrane over epoxy adhesive.
3. Allow epoxy adhesive to cure and adhere membrane.
4. Weld membrane overlap near crown of tunnel.
5. Drill anchors through membrane and into concrete substrate.
6. Place anchors secure bar.

3.4 PROTECTION

A. Protect membrane waterproofing from severe weather exposure until it has cured, and from water accumulation. Maintain completed Work in dry conditions for not less than three days by procedures recommended in writing by waterproofing manufacturer. Protect waterproofing from temperatures below 36 deg F.

PART 4 - CONTRACTOR'S QUALIFICATIONS AND QA/QC REQUIREMENTS

4.1 GENERAL

A. Inspection:
1. Manufacturer's representative to inspect completed application and provide a written report that application complies manufacturer's instructions.

B. Product:
1. Supply and install only products specifically designed and manufactured for this type of construction.
2. Select manufacturers of accessory products who are regularly engaged in the production of similar materials for underground structures.

C. Supervision and Training of Personnel:
1. Execute all installation and testing under the direct supervision of an individual with minimum five (5)-years-experience in the installation of waterproofing systems for underground structures using membrane materials as specified.
2. Provide trained personnel for installation and testing operations.
3. The installer must have a minimum of five (5) years of experience in the installation of membranes/coatings in underground waterproofing installations.

4. The proficiency of each technician shall be demonstrated in the field for approval by the Contracting Officer's Technical Representative (COTR).
5. The waterproofing system shall be applied only by an approved contractor authorized by the Manufacturer prior to bid.
6. All work shall be completed by trained and authorized personnel.
7. Installation of waterproofing system shall be the responsibility of the Membrane Applicator to ensure undivided responsibility.
8. Upon request, the Applicator must submit a list of jobs performed by his employees and supervisors similar to the proposed system being bid.

D. Manufacturer's Performance:
1. Shall have documented experience of a minimum of 100,000 square feet.
2. The waterproofing products are to made by a nationally-recognized manufacturer specializing in waterproofing systems; have been used successfully on projects similar to this; and are appropriate for the substrate, groundwater, hydrostatic pressure, and soil and rock contamination conditions that may be expected in this Contract.

E. Installation Contractor:
1. Installation contractor of waterproofing and grouting materials shall be certified and/or approved by the manufacturer in writing prior to bid submission.

END OF SECTION 07 13 56

Section 07 16 16 -- Crystalline Waterproofing

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes crystalline waterproofing for interior pipe culvert substrates) on concrete faces where cracks in width are less than 0.021 inches (21-mils) and/or where surface defects exist.

B. Work of this section will be designated on the drawings as WP-4. Areas receiving this treatment are noted in the Scope-of-Work section of Construction Documents. Contractor has option to treat bottom section of tunnel/pipe 62 inches each side of invert.

C. Related Sections: Other specification sections, which directly relate to the Work of this Section and include, but are not limited to, the following:
1. Section 03 64 13 Polyurethane Grout, Crack/Joint Injection, WP-1
2. Section 03 64 20 Acrylamide Grout Joint Injection, Soil Solidification, WP- 2
3. Section 03 61 10 Ultra-fine Cement, Soil Stabilization, SS-3
4. Section 07 16 16 Crystalline Waterproofing, WP-4
5. Section 03 64 10 Polyacrylate Grout Crack Injection, WP-5
6. Section 03 64 23 Epoxy Resin Crack Injection, WP-6
7. Section 07 13 56 Thermoplastic Sheet Strip Seals, WP-7

D. Contractor shall be responsible for reviewing site conditions to verify quantities.

E. Contractor shall be responsible for magnitude (depth and width), scope (length) of permeation grouting control as schematically shown and outlined on the contract documents.

F. Contractor shall follow prescriptive requirements of this specification; however, Contractor may modify as necessary the procedures, products, and installation to achieve water and sand control through leaking concrete culvert pipe joints and cracks if approved via shop drawings.

1.2 SUBMITTALS

A. All items listed below shall be submitted altogether, in one set, to form a complete design review package. Approval of Work scope shop drawings by the COTR shall not relieve installation contractor of specified Work in this section, which may have been missing on the approved shop drawings.

B. Shop Drawings shall be submitted to COTR for approval prior to start of work. Prepare and provide standard, project customized details at a scale appropriate for understanding layering, terminations, anchorage, overlaps and embedment's. Do not proceed with WP-4 waterproofing installation without approved shop drawings. Submit drawings of Work Scope in plan

and sections, in addition all penetration(s), anchorage and special details of the following:

1. Sequence of waterproofing installation relative to construction sequence, including detailed installation procedure and system tie-ins to other systems when required.
2. Build-up of layered waterproofing at cracks and/or joints.

A. Product Data: Include material descriptions, 12” x 12” samples, SDS, technical data sheets, and installation instructions for crystalline waterproofing. Include the following:
1. Concentrated, reactive waterproofing powder,
2. Modified, reactive waterproofing powder,
3. Hydraulic cement,
4. Curing agents,
5. Reactive waterproofing mortars, and
6. Sample Panel 12”x12” represents WP-4 as entire system with each layer visible and labeled.

B. Product Certificates: For crystalline waterproofing, signed by product manufacturer.

C. Qualification Data: For Installer.

D. Manufacturer’s inspection reports of completed installation.

E. Minutes of preinstallation conference.

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
1. American Society for Testing and Materials (ASTM) - ASTM International:
   a. ASTM C507 Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
   b. ASTM C1840 Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain and Storm Sewer Pipe.
   c. ASTM C42/C42M: Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   d. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
   f. ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   g. ASTM A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
   h. ASTM C33, Standard Specification for Concrete Aggregate
   i. ASTM 050, Standard Specification for Portland Cement.

j. ASTM C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
k. ASTM D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
l. ASTM D2241, Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
m. ASTM F2304 Standard Practice for Rehabilitation of Sewers using Chemical Grouting (latest revision).
n. ASTM F2454 Standard Practice for Sealing Lateral Connections and lines from the mainline Sewer Systems by Lateral Packer Method, Using Chemical Grouting (latest revision).
o. ASTM 091, Standard Test Methods for Time of Setting of Hydraulic Cement by VI cat Needle.

B. State of Wisconsin Department of Transportation (Wis-Dot):
1. Standard Specification for Construction.
2. Standard Specifications for Construction of storm sewer and drainage structures.

C. Department of Labor, Occupational Safety and Health Administration (OSHA):
1. Occupational Safety and Health Standards – Excavations, Final Rule – 29 CFR, Part 1926

D. American National Standards Institute (ANSI):
1. Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD), Z535.1 Safety Color Code
2. ANSI/NSF 61, Drinking Water System Components – Health Effects.

E. American Public Works Association (APWA):
1. Uniform Color Code for Temporary Marking of Underground Utility Locations.

F. Other Applicable Standards:
1. API RP 13B-1, Recommended Practice for Field Testing Water-based Drilling Fluids.
2. National Association of Sewer Service Companies (NASSCO) prepared Pipeline Assessment and Certification Program (PACP), TV inspection form and sewer condition codes.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer. Workers shall have not less than 5 years documented successful experience with waterproofing work comparable to Work on this Project.

B. Preinstallation Conference: Conduct conference at Project site and document all discussions and agreements.

1.5 PROJECT CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit crystalline waterproofing to be performed according to manufacturer's written instructions and warranty requirements.

B. Proceed with WP-4 waterproofing work only after all other grouting and waterproofing has been completed. Further proceed only after concrete substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of soil debris and water.

C. Ambient Conditions: Proceed with WP-4 waterproofing work only if temperature is maintained at 40 degrees F or above during work and cure period, and space is well ventilated and kept free of water.

1.6 MOCK-UP

A. Prior to application of specified WP-4 membrane/coating/slurry, and after of shop drawings, erect sample panel on site for mock-up using materials and joint details required for final work. Build mock-up at the site, where directed by COTR, of full thickness indicating the proposed color, texture, and workmanship to be expected in the completed work. Obtain COTR's acceptance of visual qualities of the mock-up before start of Work.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products for crystalline waterproofing that may be incorporated into the Work include, but are not limited to, the following:
   1. Aquafin, Inc: IC
   2. Vandex International, Ltd: Vandex Super.
   3. Xypex Chemical Corporation: Xypex.

2.2 MATERIALS

A. Crystalline Waterproofing: For first and second slurry coats, dry packing joints, and detail work. A prepackaged, gray-colored proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates by capillary action into concrete and reacts chemically with free lime in the presence of water to develop crystalline growth within concrete capillaries to produce an impervious, dense, waterproof concrete with properties meeting or exceeding the following criteria:
   1. Permeability: 0 for water at 33 feet when tested according to CE CRD-C48.

2. Compressive Strength: 3000 psi when tested according to ASTM C 109/C109M.

B. Patching Compound: For mortar fill and dry-pack joints and cracks. Cementitious waterproofing and repair mortar for filling and patching drill holes, honeycombs, reveals, and other imperfections; with properties meeting or exceeding the following criteria:
   1. Compressive Strength: 5600 psi at 28 days when tested according to ASTM C 109/C 109M.
   2. Flexural Strength: 710 psi at 28 days when tested according to ASTM C 348.
      Shrinkage: Minus 0.093 percent at 28 days and plus 0.073 percent at 90 days when tested according to ASTM C 596.

C. Plugging Compound: Cementitious compound with hydrophobic properties and resistant to water and moisture but vapor permeable for all standard applications; with properties meeting or exceeding the following criteria:
   1. Permeability: 30 feet when tested according to CE CRD-C 48.
   2. Compressive Strength: 6000 psi at 28 days when tested according to ASTM C 109/C 109 M.
   3. Flexural Strength: 1000 psi at 28 days when tested according to ASTM C 348.
   4. Bond Strength: 300 psi at 14 days when tested according to ASTM C 321.

D. Water: Potable.

E. First Slurry Coat: A coating on concentrated crystalline mortar.

F. Second Slurry Coat: A coating of modified crystalline mortar.

G. Curing Membrane: A spray applied manufacturer's approved curing compound.

H. Dry-pack mortar: A high viscosity mortar matrix of concentrated crystalline waterproofing agent.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Acceptance of Conditions: Examine substrates, with Applicator present, where waterproofing is to be applied.
   1. Proceed with application only after unsatisfactory conditions have been corrected.
   2. Notify COTR in writing of active leaks or structural defects that would affect system performance.

3.2 PREPARATION

A. Protect other work from damage from cleaning, preparation, and application of crystalline waterproofing. Provide temporary enclosure if spraying operation is used to confine and ensure adequate ambient temperatures and ventilation conditions for application.

B. Stop active water leaks according to waterproofing manufacturer's written instructions.

C. Repair damaged or unsatisfactory concrete according to manufacturer's written instructions.

D. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt/soil, mortar spatter, grease, oils, curing compounds, and form-release agents to ensure that waterproofing bonds to concrete surfaces.
   1. Clean concrete surfaces according to ASTM D 4258. Prepare -formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
   2. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

3.3 APPLICATION

A. General: Comply with waterproofing manufacturer's written instructions for application.
   1. Dampen surface with water and maintain damp condition until applying waterproofing.
   2. Apply waterproofing to interior concrete (inside) surfaces.
   3. Number of Coats: Two coats (1.5 pounds per square yard), for brush or spray application.
   4. Dampen surface between coats and cure per manufacturer's requirements.

B. Final Coat Finish: Brushed.

C. Moist-cure waterproofing for three days immediately after application has set followed by two days of air drying as recommended in writing by manufacture.

3.4 PROTECTION

A. Protect applied crystalline waterproofing from rapid drying, severe weather exposure, and water accumulation. Maintain completed Work in moist condition for not less than three days by procedures recommended in writing by waterproofing manufacturer. Protect waterproofing from temperatures below 36 deg F.

PART 4 - CONTRACTOR'S QUALIFICATIONS AND QA/QC REQUIREMENTS

4.1 GENERAL

A. Inspection:

1. Manufacturer's representative to inspect completed application and provide a written report that application complies manufacturer's instructions.

B. Product:
1. Supply and install only products specifically designed and manufactured for this type of construction.
2. Select manufacturers of accessory products who are regularly engaged in the production of similar materials for underground structures.

C. Supervision and Training of Personnel:
1. Execute all installation and testing under the direct supervision of an individual with minimum five (5)-years-experience in the installation of waterproofing systems for underground structures using membrane materials as specified.
2. Provide trained personnel for installation and testing operations.
3. The installer must have a minimum of five (5) years of experience in the installation of membranes/coatings in underground waterproofing installations.
4. The proficiency of each technician shall be demonstrated in the field for approval by the Contracting Officer's Technical Representative (COTR).
5. The waterproofing system shall be applied only by an approved contractor authorized by the Manufacturer prior to bid.
6. All work shall be completed by trained and authorized personnel.
7. Installation of waterproofing system shall be the responsibility of the Membrane Applicator to ensure undivided responsibility.
8. Upon request, the Applicator must submit a list of jobs performed by his employees and supervisors similar to the proposed system being bid.

D. Manufacturer's Performance:
1. Shall have documented experience of a minimum of 100,000 square feet.
2. The waterproofing products are to made by a nationally-recognized manufacturer specializing in waterproofing systems; have been used successfully on projects similar to this; and are appropriate for the substrate, groundwater, hydrostatic pressure, and soil and rock contamination conditions that may be expected in this Contract.

E. Installation Contractor:
1. Installation contractor of waterproofing and grouting materials shall be certified and/or approved by the manufacturer in writing prior to bid submission.

END OF SECTION 07 16 16

Project: 68" x 106" Horizontal Elliptical Reinforced Concrete Pipe Design, along Raymond Road, Madison, WI. Wisconsin Department of Transportation (WisDOT) Federal Project ID WISC 2017 402, State Project ID 5992-09-83, City of Madison, CTH M (CTH PD Intersection)

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Section 03 64 10 Polyacrylate Grout Crack Injection	WP-5
Section 03 64 23 Epoxy Resin Crack Injection	WP-6
Section 07 13 56 Thermoplastic Sheet Strip Seals	WP-7

Series: D, E, F - restoration technique & requirements for crack(s) in concrete pipe.
Series: A, B, G - restoration technique & requirements for tongue & groove pipe joints.
Series: C - soil stabilization & requirements at mid-section pipe haunch areas.

I hereby certify that the plan, specifications or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Wisconsin.

Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISION	BY
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DES	BA	1/9/2020
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CHK	BA	1/9/2020

JOB NO.

BDA Associates, LLC.
7854 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: COVER

Project Narrative:

The design goal of this project is to enhance the service life via increasing durability and performance of Raymond Road elliptical concrete pipe. Chemical grouting at pipe joints and cementitious grouting at pipe haunch areas will serve to perform that function. In addition, treating existing cracks will improve corrosion resistance of reinforcing steel in concrete pipe sections.

Grout materials selected for this project have histories of long service life in municipal environments. Grout materials from specified manufacturers have proven records of performance in tunnel/piping systems.

Soil particles consisting of fine sand, silt and clay have been piping through various culvert pipe joints into the interior. Significant loss of soil particles to pipe interior may cause surface sink holes, void zones, and potentially lower the bearing resistance at culvert pipe invert and springlines, further sink holes appearing at the roadbed surface may occur.

Current seals at pipe joints consists of an asphalt mastic troweled into the tongue-and-recess flanges. In many cases that asphalt mastic has fallen out via groundwater fluctuations; differential, longitudinal or transverse pipe strain; and/or gravity, among other potential environmental considerations.

This elliptical concrete pipe restoration design serves to dramatically improves resistance of soil piping through joints and further increases soil bearing resistance between springlines and invert (haunch areas). The elliptical concrete pipe restoration work shall be performed in the following sequence:

1.) Step 1, Injection of hydrophilic polyurethane grout into elliptical concrete pipe tongue and recess joints to fill voids, adhere materials together, and establish an initial plug on exterior. This procedure will occur at every elliptical concrete pipe joint (approximately 495) as noted in Scope of Work drawings (pages 10 to 24). See “A” series drawings and Section 03 64 13 of the specifications as WP-1.

2.) Step 2, Injection of an acrylic grout (acrylamide) through same step 1 drill holes, however extended, to create a solidified soil mass at pipe joint exterior. Solidified soil mass increases soil strength and impedes soil particle flow with water movement at concrete pipe joints. This procedure will occur at every elliptical concrete pipe joint as noted in Scope of Work drawings (pages 10 to 24). The first 10 pipe sections (joints) at portals will use a glycol modified acrylic grout to provide freeze thaw resistance over time. See “B” series drawings and Section 03 64 20 of the specifications as WP-2.

3.) Step 3, involves soil solidification (SS) via permeation grouting (curtain grouting) in granular soils and fracture grouting in cohesive soils (soil stabilization) to improve soil bearing resistance between invert and springline areas (haunch locations). This procedure will occur at every elliptical concrete pipe mid-section joint as noted in the Scope of Work drawings (pages 10 to 24). See “C” series drawings and Section 03 61 10 of the specifications as SS-3.

4.) Steps 4, 5, and 6, could be interchanged without concern of sequence.

5.) Step 4 treatment procedures are for cracks equal to or less than 0.02 inches (0.02” = 20 mils). Crystalline treatment of cracks accelerates autogenous healing and reduces ability of fine silt and clay particle migration through said cracks. This procedure will occur at every elliptical concrete pipe section where noted on Scope of Work drawings (pages 10 to 24). See “D” series drawings and Section 07 16 16 of the specifications as WP-4.

6.) Step 5 treatment procedures are for cracks less than 0.040 inches (0.040” = 40 mils) and greater than 0.020 inches (0.020” = 20 mils). Polyacrylate grout crack injection via interception grouting of seals against water leakage and reduces ability of fine sand, silt and clay particle migration through said cracks. This procedure will occur at every elliptical concrete pipe mid-section where noted on the Scope of Work drawings (pages 10 to 24). See “E” series drawings and Section 03 64 10 of the specifications as WP-5.

7.) Step 6 treatment procedures are for cracks less than 0.120 inches (0.120” = 120 mils) and equal-to and greater than 0.040 inches (0.040” = 40 mils). Epoxy grout injection via surface mounting techniques seals against water leakage and reduces ability of medium sand, silt and clay particle migration through said cracks. This procedure will occur at every elliptical concrete pipe mid-section where noted on the Scope of Work drawings (pages 10 to 24). See “F” series drawings and Section 03 64 23 of the specifications as WP-6.

8.) Step 7 is treatment procedures for joints which equal or exceed one and one-half inches (1.5") in width at any location along the pipe joint. The possibility of interior joint seals (trowled-applied asphalt mastic) falling out from elliptical concrete pipe joints over time is higher in these wider situations. This procedure will occur at every elliptical concrete pipe joint in excess of 1.5 inches and where noted on the Scope of Work drawings (pages 10 to 24). See “G” series drawings and Section 07 13 56 of the specifications as WP-7.

9.) Step 8 is general filling (concrete mortar repair) of lift holes, spalls, through-anchor locations, divits, and chips at most elliptical concrete pipe sections with cementitious mortar equal in strength to the original concrete pipe (6,000 psi) (page 2).

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BDA

BDA Associates, LLC.
7954 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

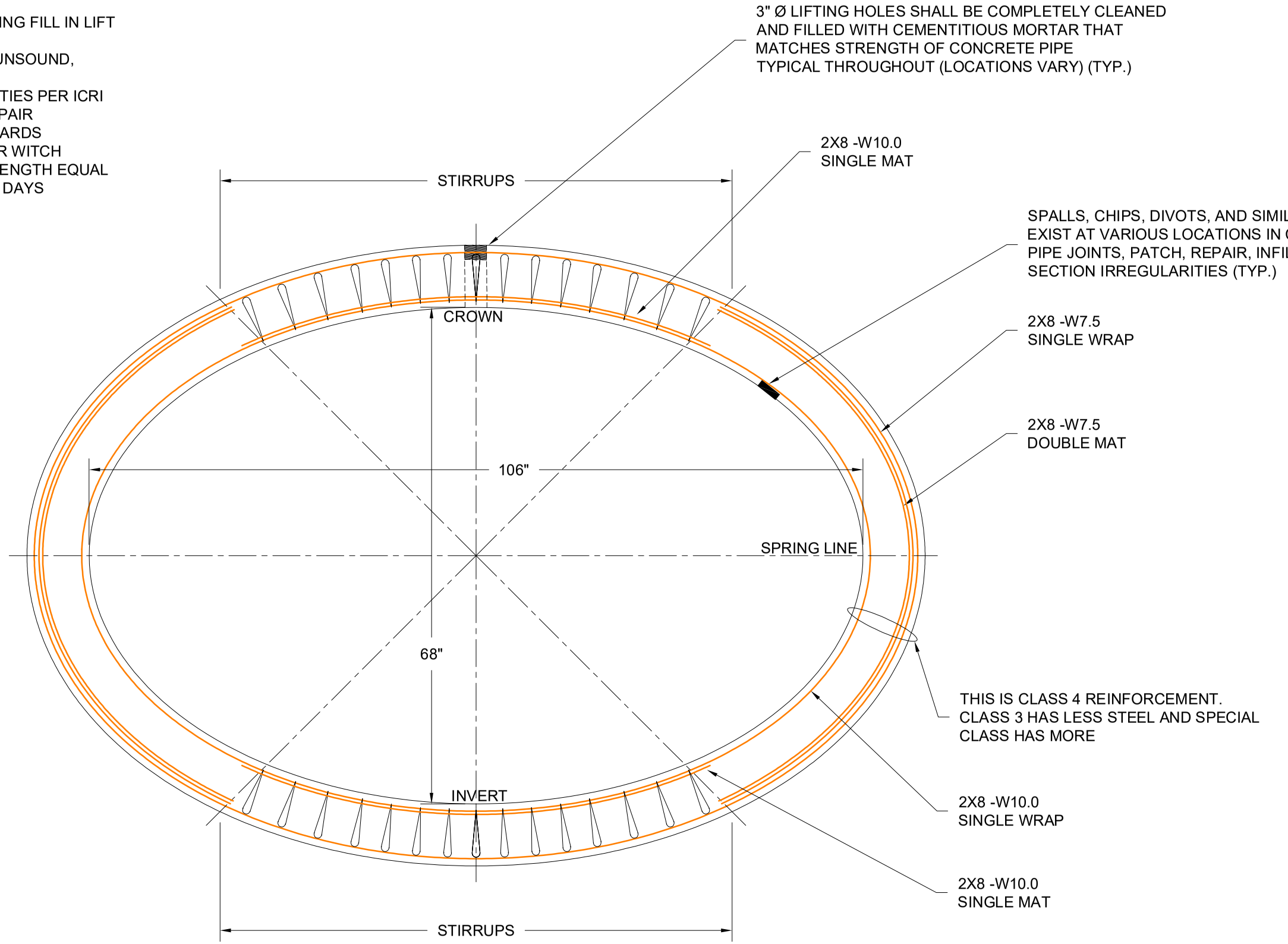
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 1

LIFT HOLES:

1. SOUND AREA TO ENSURE EXISTING FILL IN LIFT HOLE IS SOUND AND BONDED.
2. IF EXISTING PATCH MORTAR IS UNSOUND, REMOVE AND REPLACE
3. REPAIR CONCRETE IRREGULARITIES PER ICRI (INTERNATIONAL CONCRETE REPAIR INSTITUTE) ACCEPTABLE STANDARDS
4. USE CONCRETE REPAIR MORTAR WITCH PROVIDES A COMPRESSIVE STRENGTH EQUAL TO 6,000 PSI OR GREATER AT 28 DAYS



2 TYPICAL ELLIPTICAL PIPE REINFORCED CONCRETE PIPE

REPAIR OF LIFT HOLES AND SURFACE IRREGULARITIES

NOTE: THERE ARE 3 DIFFERENT REINFORCEMENT PATTERNS
SCALE: 1-1/2"=1'-0"

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

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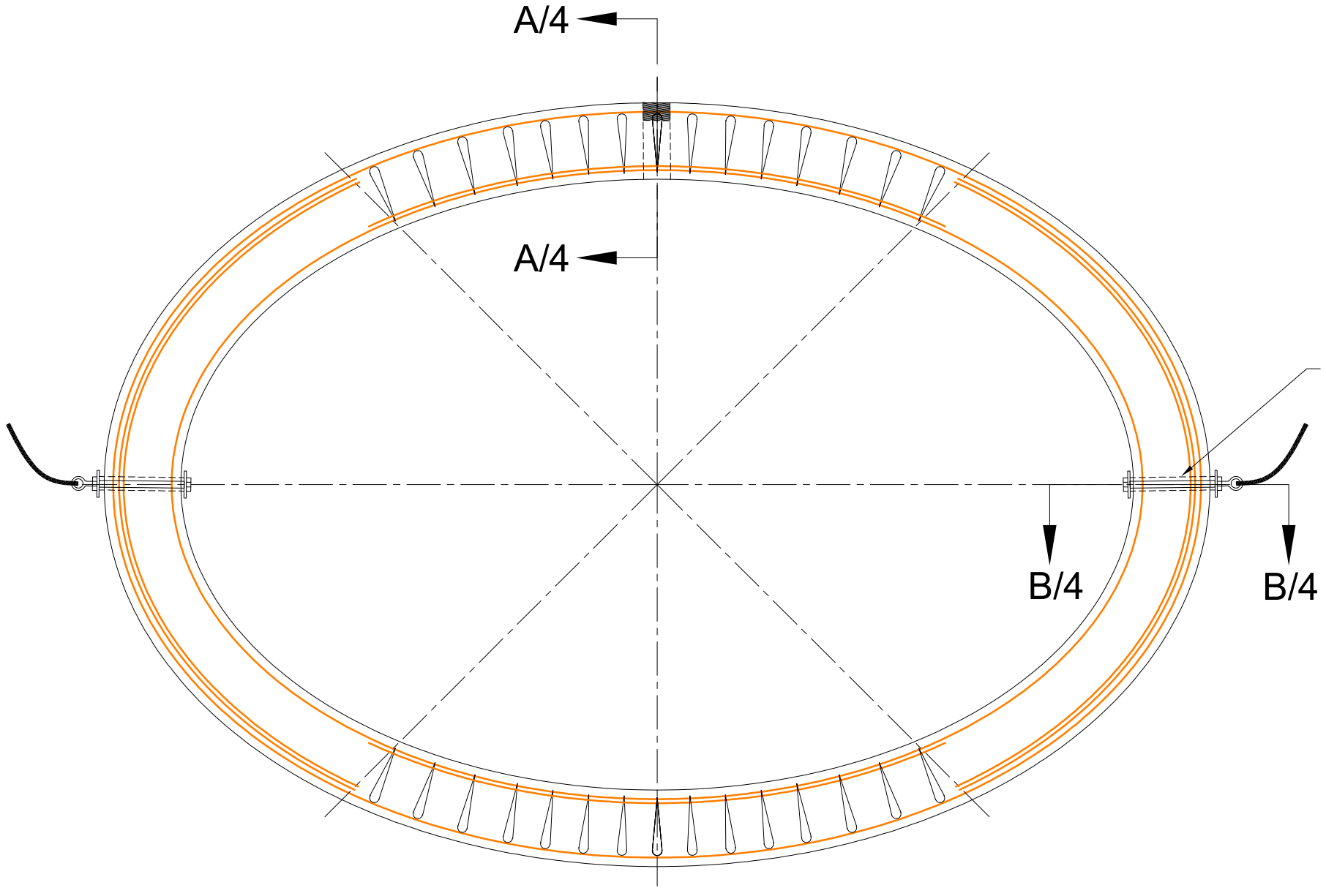
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 2

THRUST ANCHORS:

1. INJECT POLYURETHANE GROUT "A" SERIES PROTOCOL INTO ANNULUS SPACE OF EXPOSED ANCHORS NEAR PORTAL



3 STEEL THRUST ANCHOR, SEALS
SEALING ANCHOR PENETRATIONS AT PORTAL

SCALE: 1-1/2"=1'-0"

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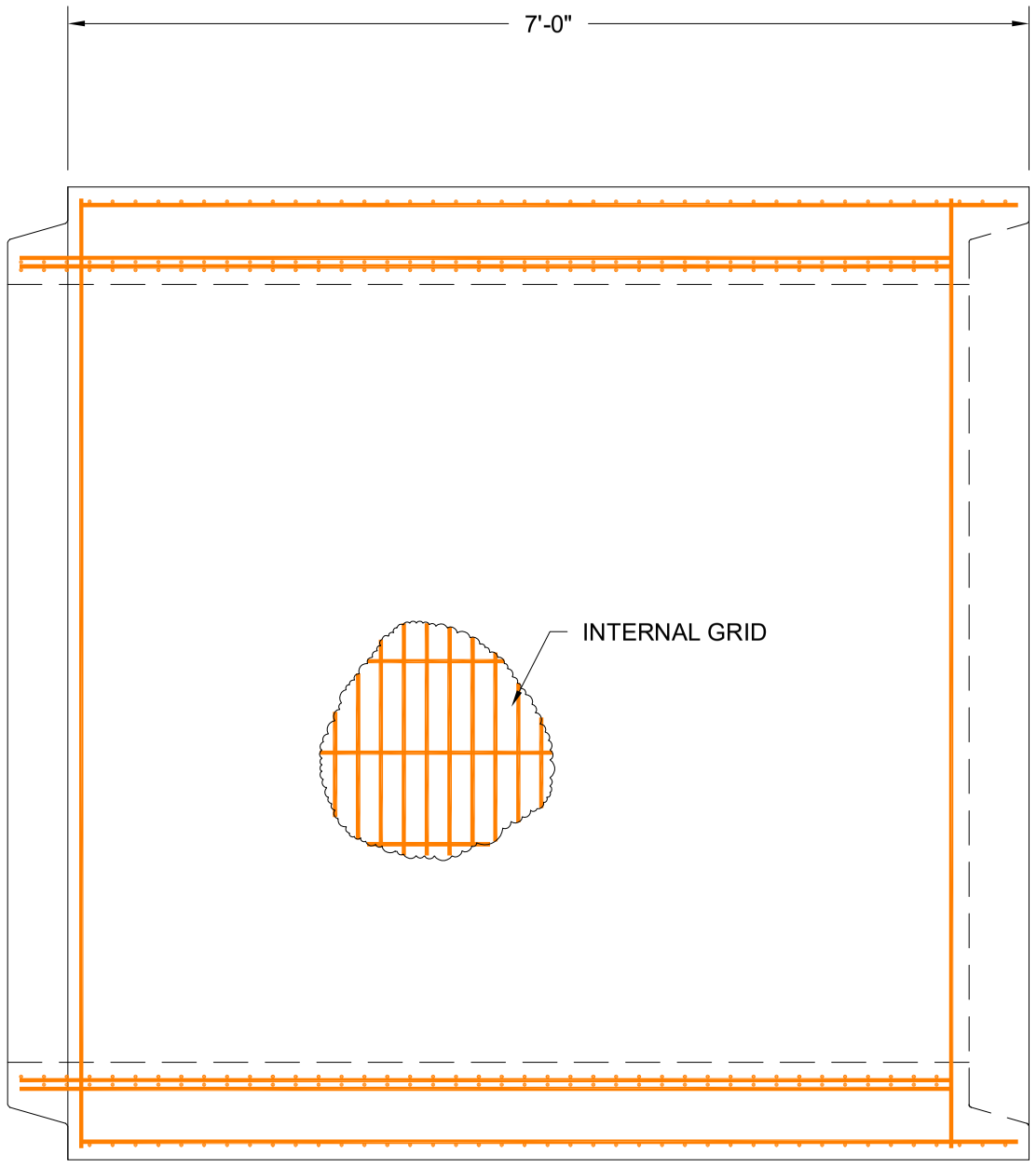
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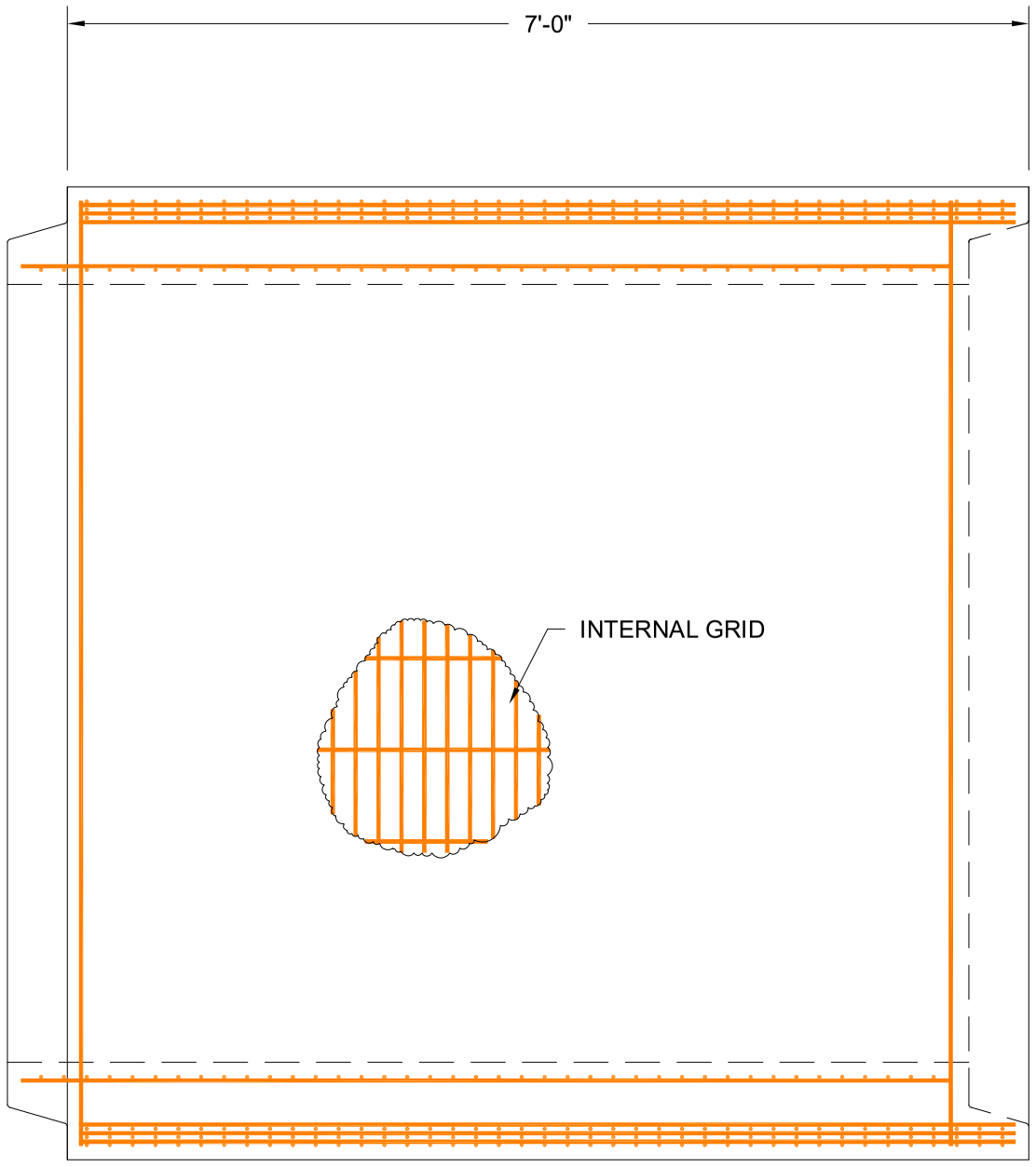
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 3



4A SECTION / ELEVATION OF CONCRETE PIPE @ CROWN & INVERT
Scale 1-1/2"=1'-0"



4B SECTION / ELEVATION OF CONCRETE @ SPRINGLINE
Scale 1-1/2"=1'-0"

4 TYPICAL ELLIPTICAL PIPE REINFORCED CONCRETE PIPE
NOTE: THERE ARE 3 DIFFERENT REINFORCEMENT PATTERNS

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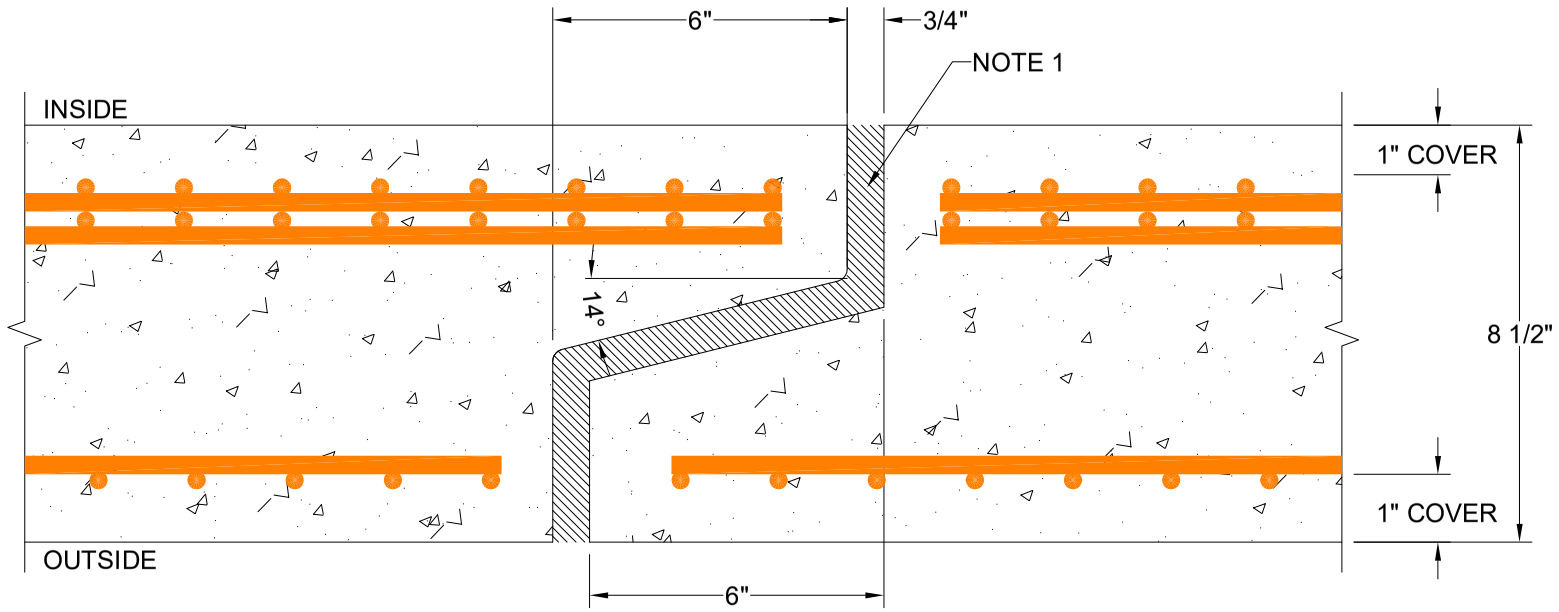
BDA Associates, LLC.
7654 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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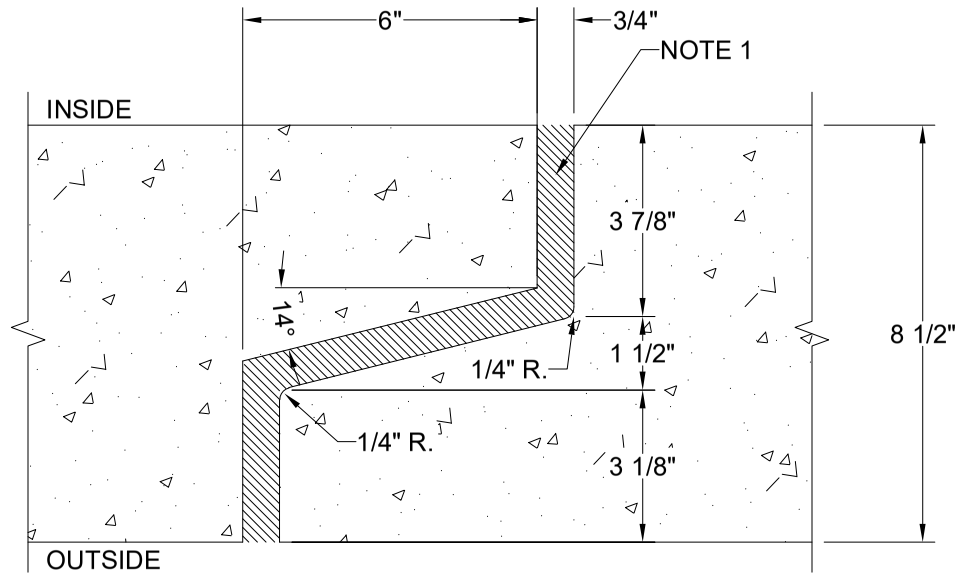
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 4

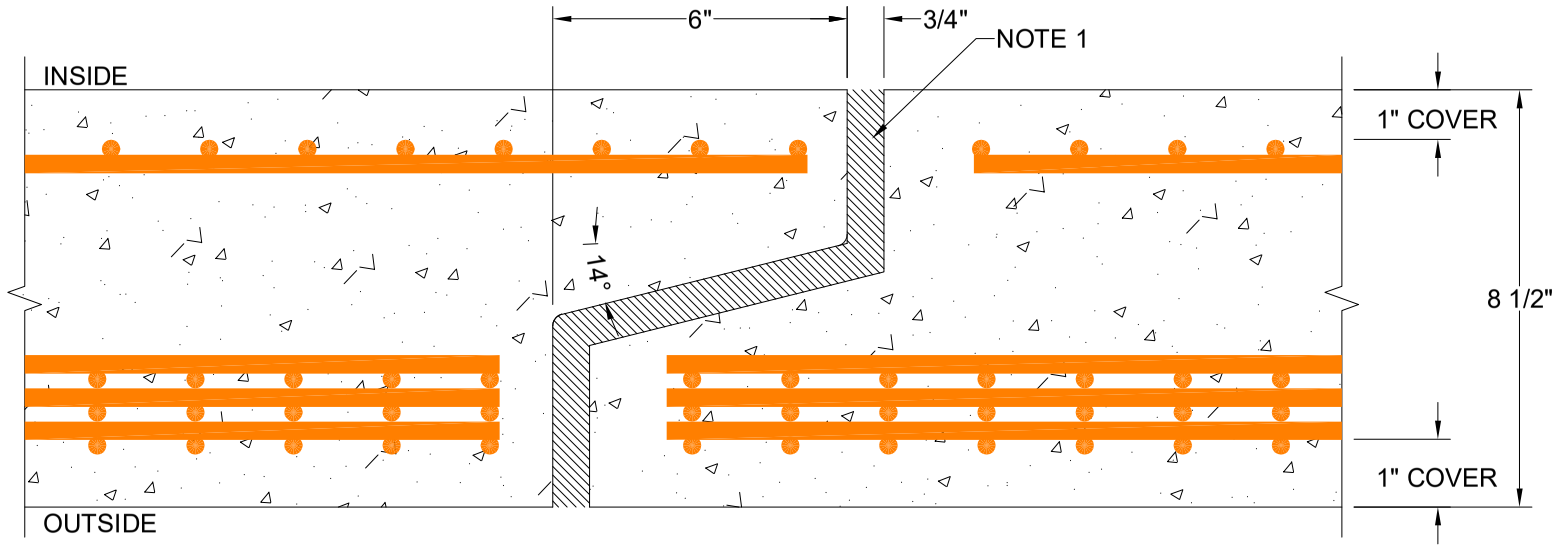
NOTE 1: PER PROJECT SPECIFICATIONS,
TROWELLED IN ASPHALT MASTIC IS TO BE
INSTALLED AT +/- 3/4" THICKNESS



5A CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"



5C CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"



5B CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"

5 SPECIFIED JOINT WIDTH
Scale 3"=1'-0"

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISION	BY
1	1/9/2020	REVISIONS	TB

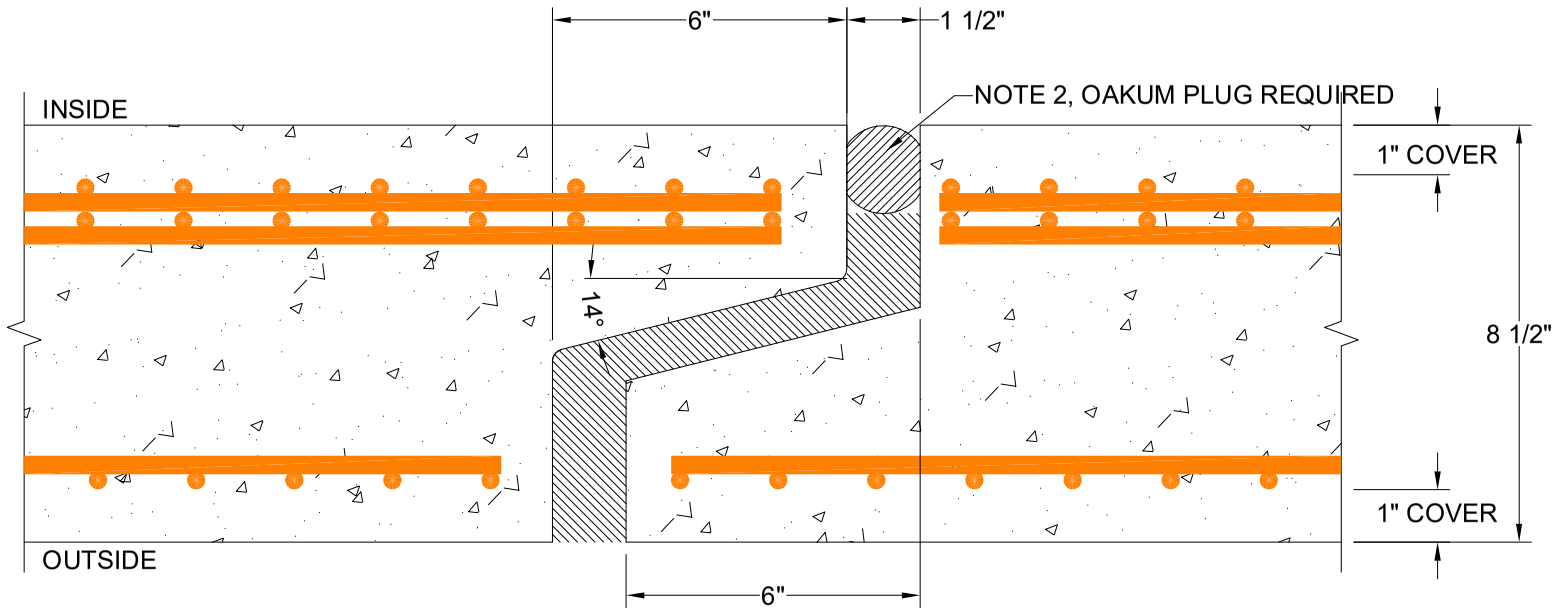
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BA	TB	BA	
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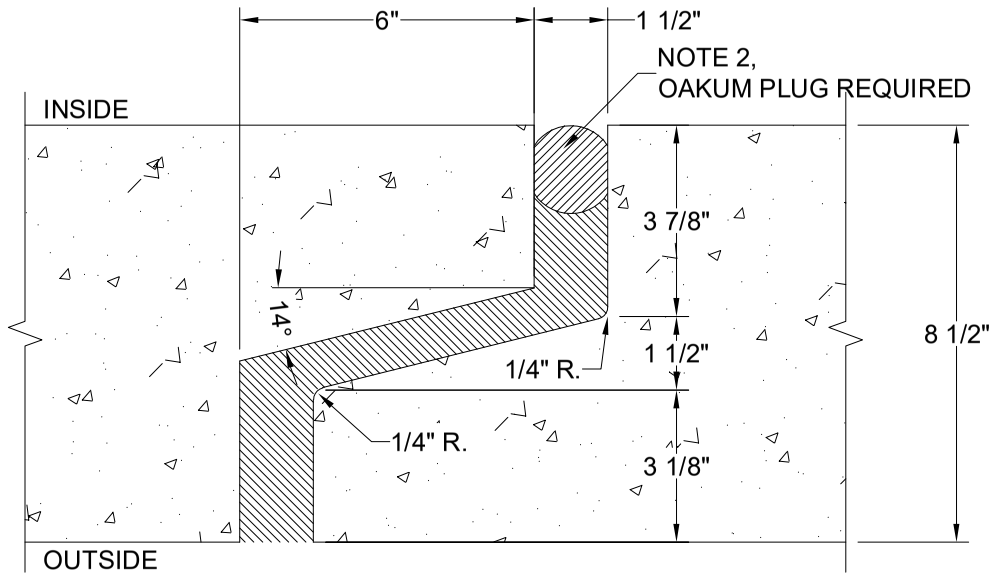
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RAYMOND ROAD CULVERT PIPE RESTORATION

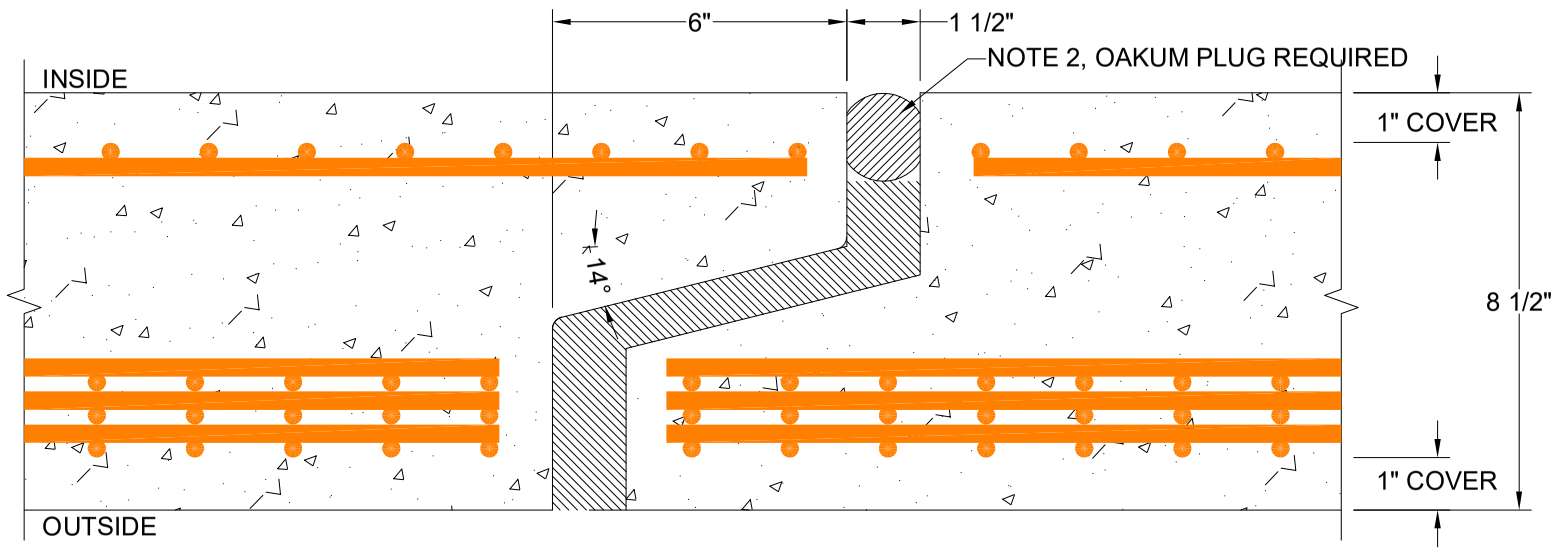
NOTE 2: ANY ELLIPTICAL CONCRETE PIPE JOINT THAT EXCEEDS 1.5 INCHES AT ANY LOCATION SHALL BE NOTED FOR INTERIOR TREATMENT IN ADDITION TO SERIES "A" AND "B" TREATMENTS



6A CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS



6C CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS



6B CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS

6 1-1/2" JOINT WIDTH
Scale 3"=1'-0"

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By: Brent Anderson

NO.	DATE	REVISION	BY
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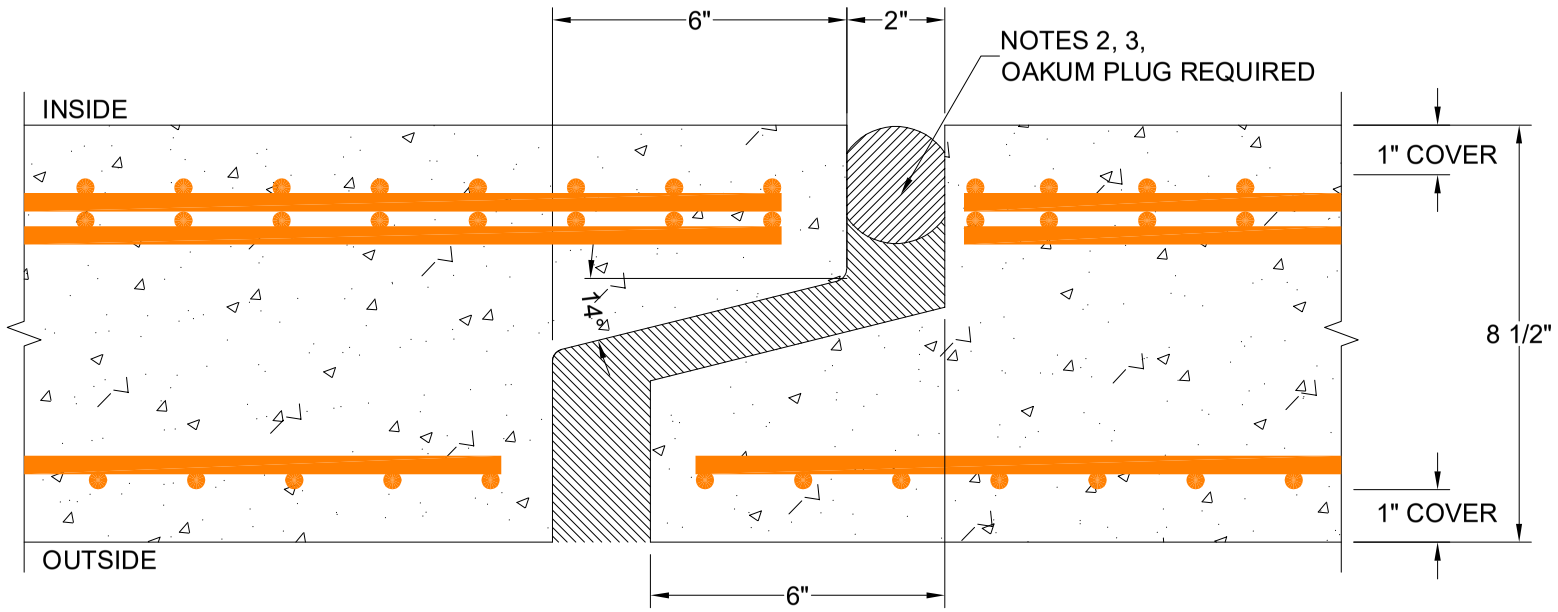
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RAYMOND ROAD CULVERT PIPE RESTORATION

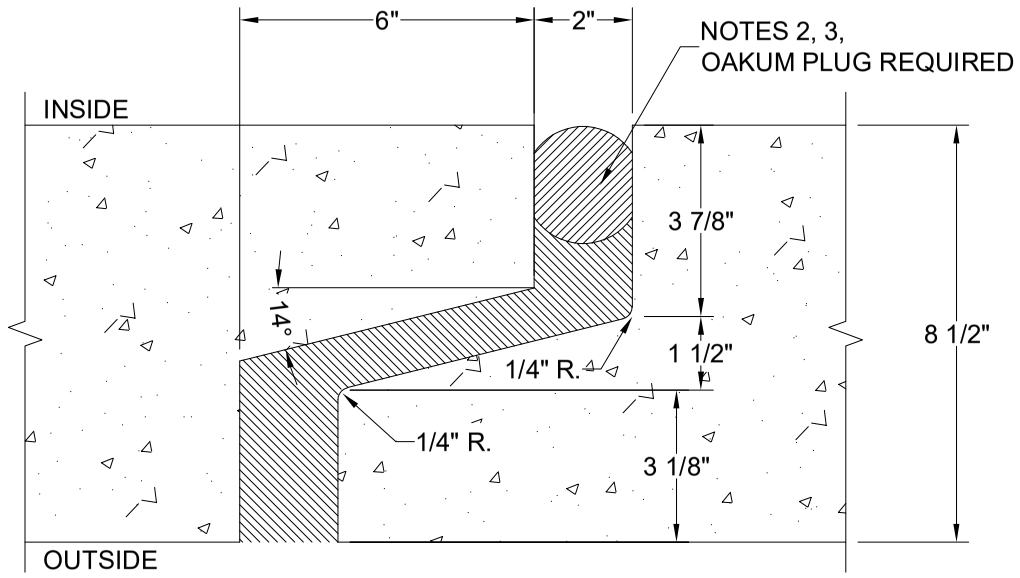
SHEET: 6

SEE SHEET 6 FOR NOTE 2

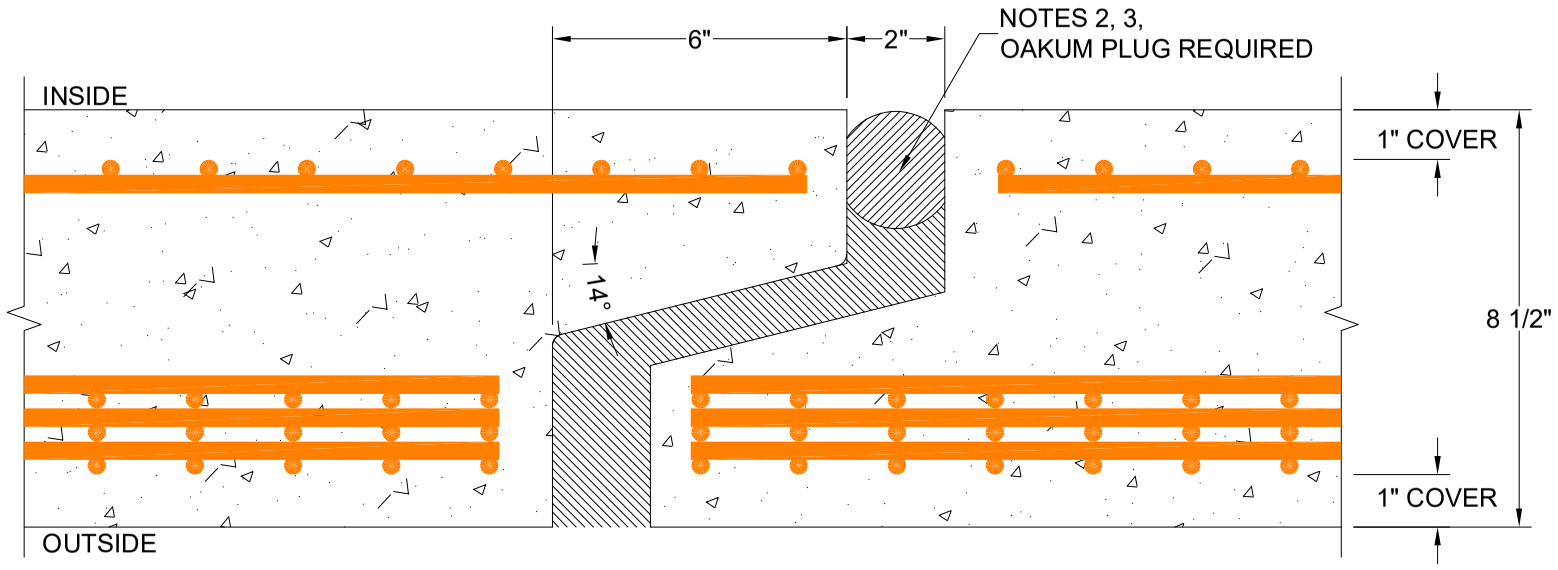
NOTE 3: JOINTS 2" AND WIDER MAY REQUIRE ADDITIONAL MATERIAL IN "A" AND "B" SERIES PROTOCOLS



7A CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS



7C CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS



7B CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS

7 2" JOINT WIDTH
Scale 3"=1'-0"

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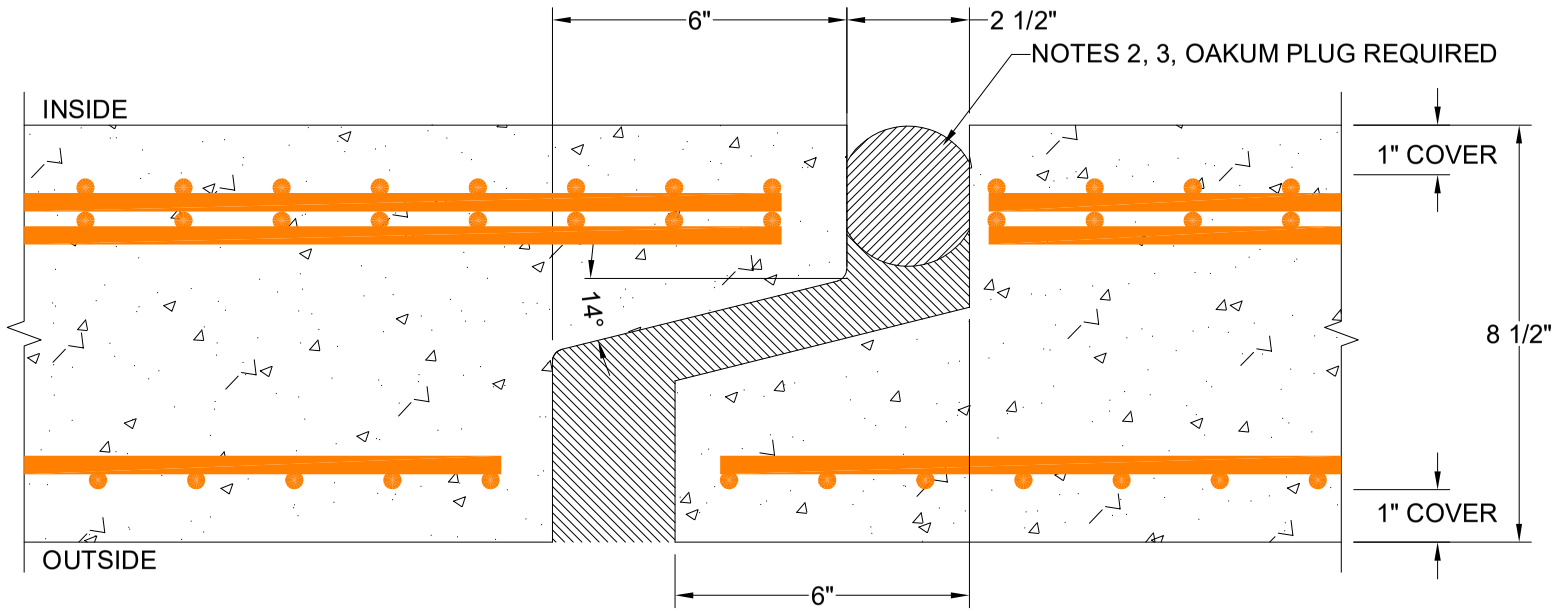
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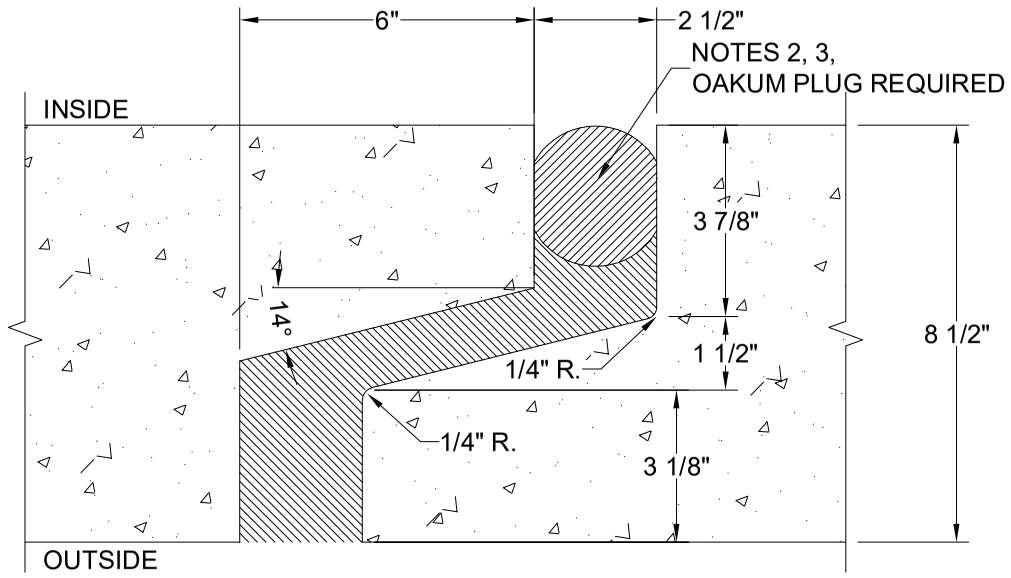
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RAYMOND ROAD CULVERT PIPE RESTORATION

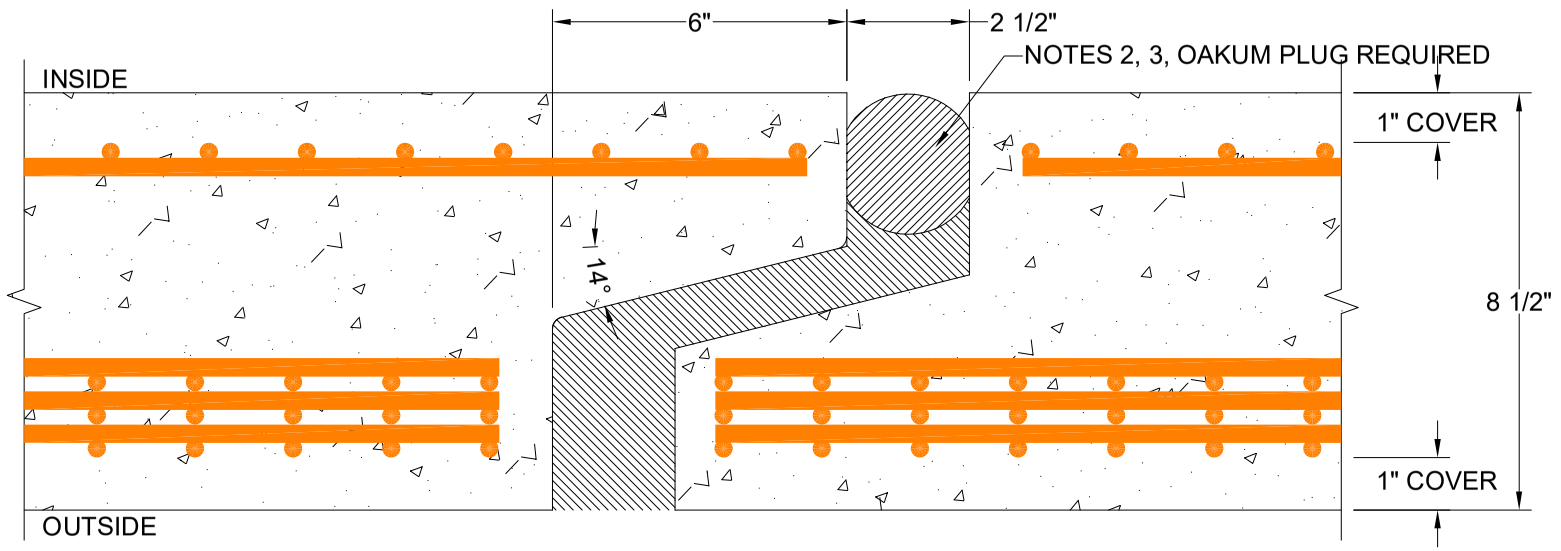
SHEET: 7



8A CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS



8C CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS



8B CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS

8 2-1/2" JOINT WIDTH
Scale 3"=1'-0"

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By: Brent Anderson

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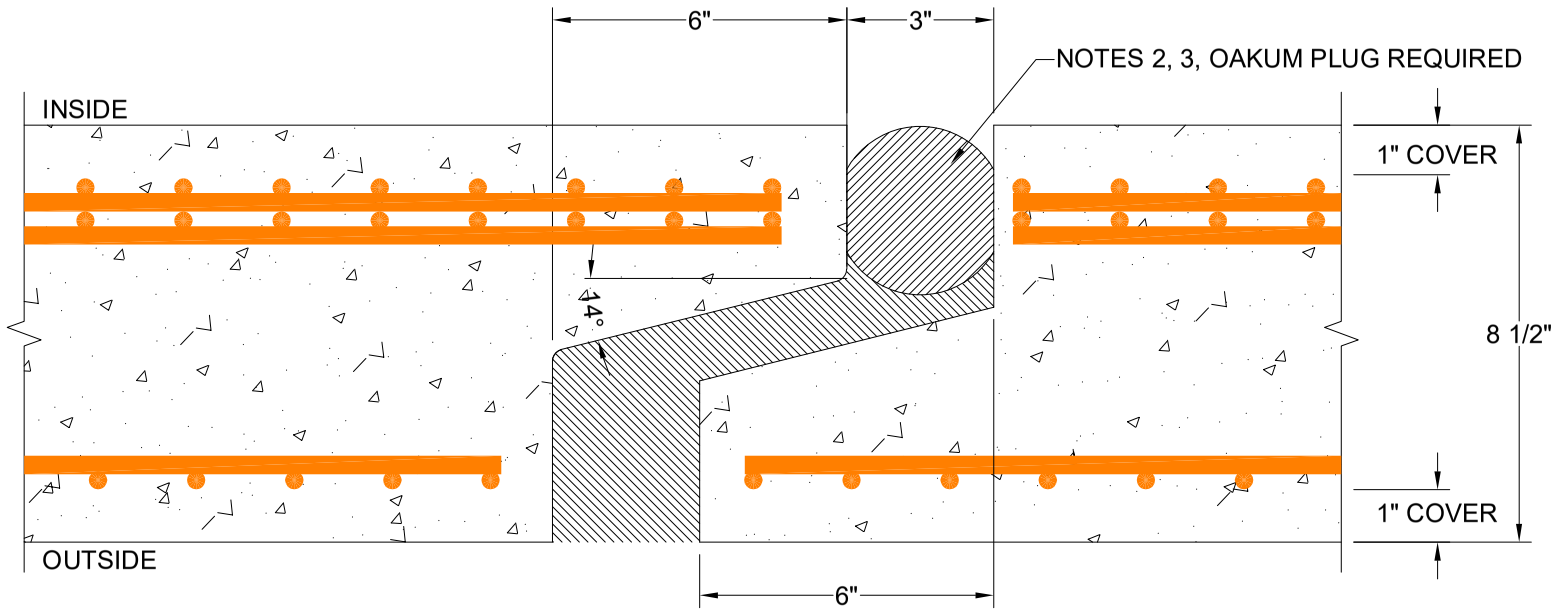
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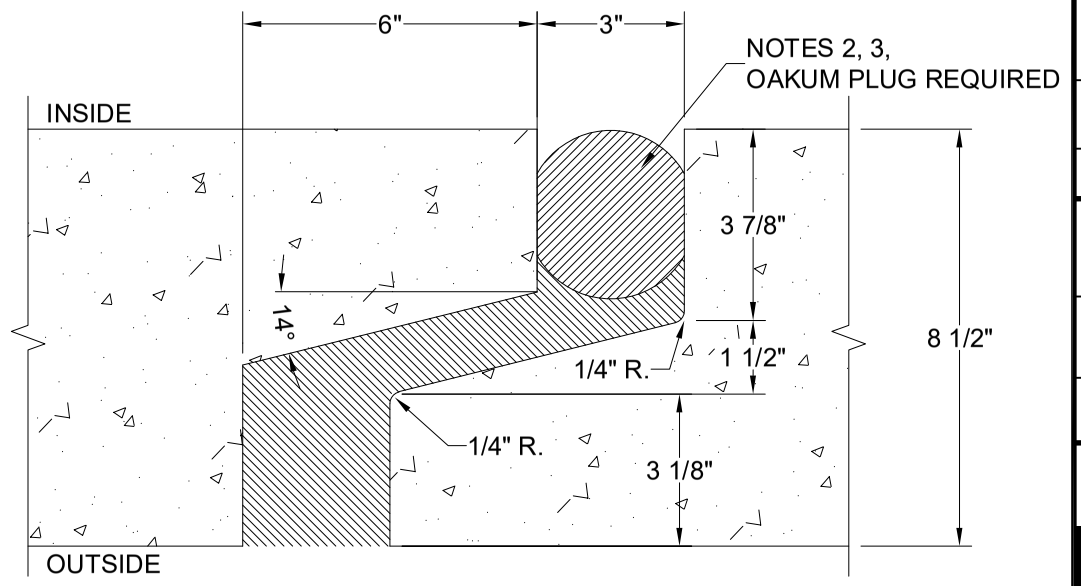
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RAYMOND ROAD CULVERT PIPE RESTORATION

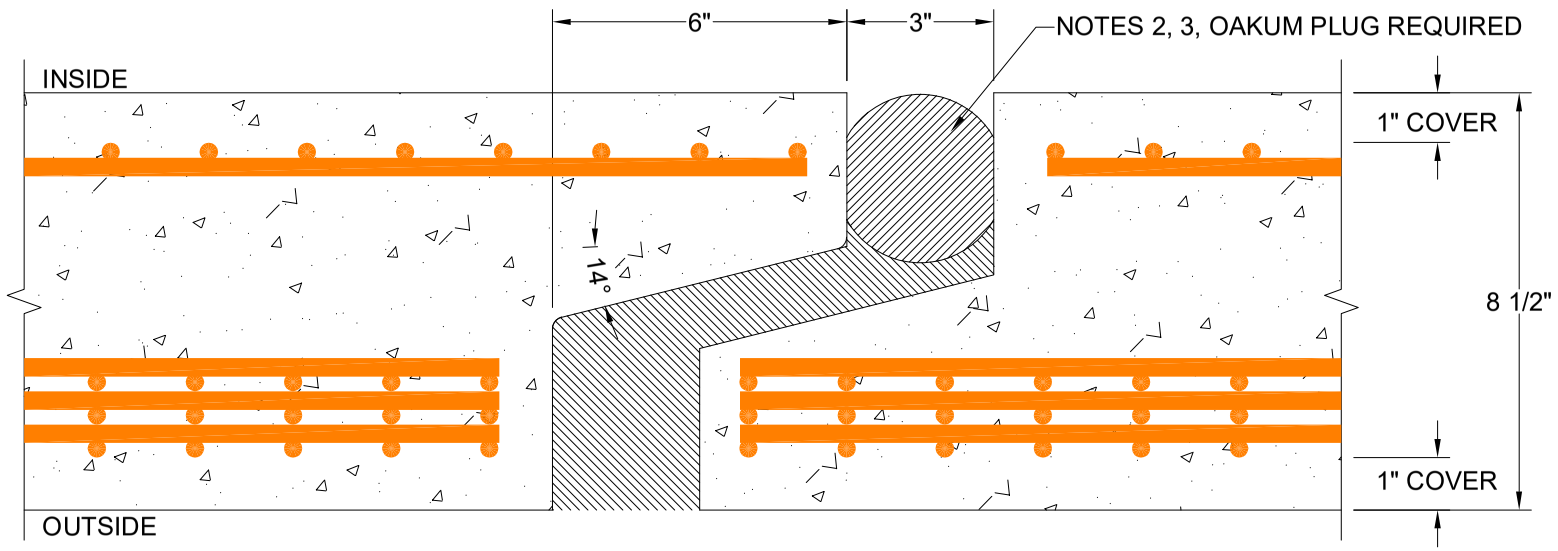
SHEET: 8



9A CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS



9C CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS



9B CONCRETE PIPE CULVERT TONGUE & GROOVE JOINT
Scale 3"=1'-0"
VARIOUS PIPE JOINT WIDTHS

9 3" JOINT WIDTH
Scale 3"=1'-0"

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By: Brent Anderson

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 9

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
500+50		Survey Start								Direction of Survey is downstream goingup-stationing								
500+50		Access Point Manhole			12	12				Precast Box Manhole								
500+50		Miscellaneous General Observation		5.6	7	8.75				Precast elliptical pipe								
500+50		Deposits Settled Fine					1	5	7									
500+55		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
500+62		Crack Longitudinal			2	0.02		12						Y				
500+64		Surface Damage Other						11		Joint Chipped								Y
500+64		Surface Damage Other						1		Joint Chipped								Y
500+75		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
500+85		Surface Damage Other						10		Joint Chipped								Y
500+89		Surface Damage Reinforcement Visable	0.75					12		Lift Hole								Y
500+93		Crack Longitudinal			1	0.02		12						Y				
501+02		Crack Longitudinal			2	0.015		12						Y				
501+05		Crack Longitudinal			2	0.02		12						Y				
501+07		Crack Longitudinal			3	0.02		12						Y				
501+07		Miscellaneous General Observation		5.6	7.08	8.81				Barrel Check								
501+12		Crack Longitudinal			1.5	0.02		12						Y				
501+12		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
501+22		Crack Longitudinal			3	0.015		12						Y				
501+30		Crack Longitudinal			7	0.02		12						Y				
501+30		Crack Longitudinal			7	0.02		12						Y				
501+34		Crack Longitudinal			7	0.02		12						Y				
501+34		Crack Longitudinal			3	0.025		12							Y			
501+40		Crack Longitudinal			4	0.015		12						Y				
501+40		Crack Longitudinal			7	0.015		6						Y				
501+40		Crack Longitudinal			7	0.015		6						Y				
501+40		Crack Longitudinal			7	0.015		6						Y				
501+44		Crack Longitudinal			4	0.02		12						Y				
501+44		Crack Longitudinal			2	0.015		11						Y				
501+47		Crack Longitudinal			4	0.01		12						Y				
501+47		Crack Longitudinal			7	0.015		6						Y				
501+64		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
501+75		Crack Longitudinal			2	0.015		5						Y				
501+82		Crack Longitudinal			0.5	0.015		12						Y				
501+86		Joint Separated				1.75										Y		
501+86		Joint Offset				1				Vertical offset								
501+86		Miscellaneous General Observation		5.61	7.04	8.8				Barrel Check								
501+93		Crack Longitudinal			7	0.015		6						Y				
501+93		Crack Longitudinal			3	0.012		12						Y				
501+97		Surface Damage Surface Spalling			0.75	1.33				Lift Hole								Y
502+01		Joint Separated				2.5										Y		
502+03		Crack Longitudinal			3	0.15		12						Y				
502+09		Crack Longitudinal			7	0.015		12						Y				
502+12		Crack Longitudinal			7	0.02		6						Y				
502+13		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
502+23		Surface Damage Reinforcement Visable	0.08					12		Lift Hole								Y

10 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISIONS	BY
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1/9/2020	1/9/2020	1/9/2020

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 10

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
Start	End	Description	Feet			ft. / in.		At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
			Dia	H	L	W	D											
502+32		Joint Separated				1											Y	
502+32		Joint Offset				0.875				Vertical								
502+38		Crack Longitudinal			3	0.01		12						Y				
502+38		Joint Separated				3											Y	
502+41		Crack Longitudinal			5	0.012		12						Y				
502+45		Crack Longitudinal			2.5	0.025		6							Y			
502+45		Crack Longitudinal			3	0.03		6							Y			
502+46		Surface Damage Surface Spalling						6		Joint								Y
502+47		Crack Longitudinal			5	0.03		12							Y			
502+55		Surface Damage Reinforcement Visable			0.58	0.83		12		Lift Hole								Y
502+59		Crack Longitudinal			7	0.015		12						Y				
502+66		Joint Separated				2											Y	
502+66		Joint Offset				0.25				Vertical								
502+66		Crack Longitudinal			4	0.15		5						Y				
502+66		Crack Longitudinal			7	0.03		12							Y			
502+70		Crack Longitudinal			2	0.02		1						Y				
502+76		Access Point Manhole			2.25	2		12										
502+80		Crack Longitudinal			7	0.02		6						Y				
502+80		Crack Longitudinal			3	0.012		6						Y				
502+80		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
502+80		Crack Longitudinal			4	0.02		12						Y				
502+82		Miscellaneous General Observation		5.6	7.04	8.83				Barrel Check								
502+82		Crack Longitudinal			1.5	0.03		9							Y			
502+82		Crack Circumferential			3	0.02		9	11	At a pipe bend				Y				
502+82		Crack Circumferential			7	0.035		1	5	At a pipe bend					Y			
502+83		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
502+85		Crack Longitudinal			5	0.012		6						Y				
502+85		Crack Longitudinal			5	0.012		7						Y				
502+85		Surface Damage Other						11		Chipped Joint								Y
502+85		Surface Damage Other						1		Chipped Joint								Y
502+85		Crack Longitudinal			1.5	0.015		12						Y				
502+85		Line Right																
502+90		Crack Longitudinal			4	0.015		12						Y				
502+94		Crack Longitudinal			1.5	0.02		12						Y				
503+04		Crack Longitudinal			4	0.025		12							Y			
503+07		Surface Damage Other						10		Chipped Joint								Y
503+19		Surface Damage Reinforcement Visable			1.17	0.67		12		Lift Hole								Y
503+21		Crack Longitudinal			0.75	0.01		12						Y				
503+22		Crack Longitudinal			7	0.02		12						Y				
503+25		Crack Longitudinal			3.5	0.012		5						Y				
503+30		Crack Longitudinal			3	0.02		12						Y				
503+30		Crack Longitudinal			3	0.02		12						Y				
503+34		Crack Longitudinal			3	0.01		12						Y				
503+36		Crack Longitudinal			7	0.012		12						Y				
503+37		Surface Damage Other						11		Chipped Joint								Y

11 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

BY	REVISION	DATE	NO.
TB	REVISIONS	1/9/2020	1

DES	BA	1/9/2020
DRN	TB	1/9/2020
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 11

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
503+37		Surface Damage Other						1		Chipped Joint								Y
503+44		Crack Longitudinal			3	0.025		12							Y			
503+55		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
503+68		Crack Longitudinal			4	0.012		12						Y				
503+71		Crack Longitudinal			7	0.01		12						Y				
503+81		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
503+83		Surface Damage Reinforcement Visable						11	12									Y
503+85		Crack Longitudinal			3	0.02		12						Y				
503+88		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
503+92		Crack Longitudinal			3	0.02		12						Y				
503+97		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
504+01		Crack Longitudinal			1.5	0.01		12						Y				
504+14		Crack Longitudinal			2	0.02		12						Y				
504+15		Crack Longitudinal			3	0.02		6						Y				
504+48		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
504+56		Crack Longitudinal			7	0.03		12							Y			
504+70		Crack Longitudinal			7	0.016		6						Y				
504+78		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
504+93		Crack Longitudinal			3	0.025		12							Y			
504+99		Surface Damage Reinforcement Visable	0.25					7										Y
505+11		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
505+25		Surface Damage	0.5					12		Lift Hole								Y
505+28		Surface Damage Other			1.5	5		7		Chipped Joint								Y
505+36		Crack Longitudinal			5	0.02		12						Y				
505+50		Crack Longitudinal			1.5	0.01		12						Y				
505+52		Crack Longitudinal			5	0.012		5						Y				
505+52		Crack Longitudinal			5	0.016		6						Y				
505+53		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
505+62		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
505+67		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
505+71		Surface Damage Reinforcement Visable			1			2										Y
505+82		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
505+89		Joint Separated				1.375											Y	
505+90		Surface Damage	0.5					12		Lift Hole								Y
505+98		Crack Longitudinal			3	0.02		12						Y				
506+07		Surface Damage Reinforcement Visable	0.5					12		Lift Hole								Y
506+11		Surface Damage AggregateVisable						11	12	At Joint								Y
506+35		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
506+48		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
506+48		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
506+50		Access Point Manhole			2	2		12										
506+52		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
506+52		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
506+55		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
506+65		Crack Longitudinal			7	0.03		7							Y			

12 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

I hereby certify that the plan, specifications or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Wisconsin.

Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISIONS	BY
1	1/9/2020		TB

REVISION

DES	DRN	CHK
BA	TB	BA
1/9/2020	1/9/2020	1/9/2020

JOB NO.

BDA Associates, LLC.
7954 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 12

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
506+72		Crack Longitudinal			7	0.03		5							Y			
506+80		Crack Longitudinal			7	0.03		5							Y			
506+85		Crack Longitudinal			7	0.02		5		Healed				Y				
506+85		Crack Longitudinal			7	0.02		7		Healed				Y				
506+88		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
506+92		Crack Longitudinal			7	0.18		5		Healed				Y				
506+92		Crack Longitudinal			5	0.028		12							Y			
506+98		Crack Longitudinal			7	0.028		5		Healed					Y			
506+98		Crack Longitudinal			7	0.02		6		Healed				Y				
507+06		Crack Longitudinal			3	0.025		12							Y			
507+10		Crack Longitudinal			2	0.015		12						Y				
507+13		Crack Longitudinal			7	0.02		5		Healed				Y				
507+13		Crack Longitudinal			2	0.02		12						Y				
507+20		Crack Longitudinal			2	0.02		12						Y				
507+23		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
507+43		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
507+47		Surface Damage Other						6		Chipped Joint								Y
507+61		Crack Longitudinal			7	0.01		5		Healed				Y				
507+91		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
508+00		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
508+20		Miscellaneous GeneralObservation		5.6	7.04	8.78				Barrel Check								
508+23		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
508+47		Surface Damage ReinforcementVisable	0.5					12		At Joint								Y
508+47		Surface Damage AggregateVisable						10	12	At Joint								Y
508+54		Joint Separated				1.75											Y	
508+54		Joint Offset				0.5				Vertical								
508+55		Surface Damage ReinforcementVisable			0.25	0.08		3		Rebar spacer visable, at joint								Y
508+68		Joint Separated				1.75											Y	
508+68		Joint Offset				0.5												
508+90		Surface Damage ReinforcementVisable			2	1		10	12									Y
508+90		Surface Damage Other						10		Chipped Joint								Y
508+90		Surface Damage Other						2		Chipped Joint								Y
509+05		Surface Damage Other						11		Chipped Joint								Y
509+05		Surface Damage Other						1		Chipped Joint								Y
509+29		Crack Longitudinal			7	0.03		5							Y			
509+45		Surface Damage ReinforcementVisable			1			11										Y
509+62		Crack Longitudinal			2	0.014		12						Y				
509+69		Surface Damage Other						7		Joint Chipped								Y
509+83		Crack Longitudinal			3	0.01		12						Y				
509+90		Joint Separated				2											Y	
509+93		Surface Damage AggregateVisable			1	7		12										Y
509+95		Crack Longitudinal			3.5	0.015		12						Y				
510+16		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
510+19		Crack Longitudinal			7	0.014		6		Healed				Y				
510+19		Crack Longitudinal			8	0.01		11						Y				

13 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

I hereby certify that the plan, specifications or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Wisconsin.

Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISION	BY
1	1/9/2020	REVISIONS	TB

DES	DRN	CHK	JOB NO.
BA	TB	BA	
1/9/2020	1/9/2020	1/9/2020	

BDA Associates, LLC.
7954 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 13

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
510+19		Crack Longitudinal			2	0.016		12						Y				
510+28		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
510+46		Surface Damage AggregateMissing	1					12		Lift Hole								Y
510+76		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
510+95		Surface Damage Surface Spalling						1		At joint								Y
511+09		Surface Damage ReinforcementVisable						10		At joint								Y
511+15		Crack Longitudinal			6	0.01		11						Y				
511+20		Crack Longitudinal			4	0.014		5		Healed				Y				
511+21		Crack Longitudinal			3.5	0.01		12						Y				
511+24		Crack Longitudinal			7	0.01		12						Y				
511+24		Crack Longitudinal			7	0.01		12						Y				
511+27		Surface Damage ReinforcementVisable	0.67					12		Lift Hole								Y
511+68		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
511+76		Surface Damage ReinforcementVisable	0.75					12		Lift Hole								Y
511+89		Crack Longitudinal			4	0.016		6						Y				
511+94		Joint Offset				0.875											Y	
511+97		Surface Damage AggregateMissing			0.83	1		12		Lift Hole								Y
512+18		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
512+25		Crack Circumferential			0.5	0.1		12		Possibly a tear						Y		
512+68		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
512+82		Surface Damage ReinforcementVisable	0.42					10										Y
512+83		Surface Damage ReinforcementVisable			1.75	1.5		12		Lift Hole								Y
512+90		Surface Damage ReinforcementVisable	0.67					12		Lift Hole								Y
512+97		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
513+04		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
513+11		Miscellaneous GeneralObservation						10		Debris in Lift Hole								Y
513+11		Miscellaneous GeneralObservation						2		Debris in Lift Hole								
513+13		Access Point Manhole			2	2		12										
513+15		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
513+15		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
513+22		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
513+40		Surface Damage Surface Spalling						11		At Joint								Y
513+69		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
514+12		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
514+18		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
514+29		Joint Separated				1.5											Y	
514+29		Joint Offset				0.75												
514+29		Miscellaneous GeneralObservation		5.55	7	8.83				Barrel Check								
514+43		Joint Separated				2.5											Y	
514+43		Joint Offset				0.5												
514+47		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
514+61		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
514+68		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
514+80		Joint Separated				1.9											Y	
514+80		Joint Offset				0.25												

14 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

BY	REVISION	DATE	NO.
TB	REVISIONS	1/9/2020	1

DES	DRN	CHK	JOB NO.
BA	TB	BA	
1/9/2020	1/9/2020	1/9/2020	

BDA Associates, LLC.
7954 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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RAYMOND ROAD CULVERT PIPE RESTORATION

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
514+90		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
514+93		Crack Longitudinal			7	0.016		5		Healed				Y				
514+93		Crack Longitudinal			7	0.014		6		Healed				Y				
514+93		Crack Longitudinal			7	0.016		6		Healed				Y				
514+97		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
515+00		Crack Longitudinal			7	0.016		6		Healed				Y				
515+14		Joint Separated				2											Y	
515+14		Joint Offset				0.25												
515+43		Joint Separated				2.5											Y	
515+43		Joint Offset				0.5												
515+68		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
515+72		Crack Longitudinal			7	0.02		7		Healed				Y				
515+79		Crack Longitudinal			7	0.02		7		Healed				Y				
515+86		Crack Longitudinal			7	0.02		7		Healed				Y				
515+93		Crack Longitudinal			7	0.02		7		Healed				Y				
516+00		Crack Longitudinal			7	0.02		5		Healed				Y				
516+00		Crack Longitudinal			7	0.02		7		Healed				Y				
516+07		Crack Longitudinal			7	0.02		5		Healed				Y				
516+14		Crack Longitudinal			7	0.02		5		Healed				Y				
516+14		Crack Longitudinal			7	0.02		7		Healed				Y				
516+21		Crack Longitudinal			7	0.02		5		Healed				Y				
516+21		Crack Longitudinal			7	0.02		7		Healed				Y				
516+28		Crack Longitudinal			7	0.015		7		Healed				Y				
516+32		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
516+35		Crack Longitudinal			7	0.02		5		Healed				Y				
516+35		Crack Longitudinal			7	0.02		7		Healed				Y				
516+43		Joint Separated				2											Y	
516+43		Joint Offset				0.25												
516+43		Crack Longitudinal			7	0.02		5		Healed				Y				
516+43		Crack Longitudinal			7	0.02		7		Healed				Y				
516+50		Crack Longitudinal			7	0.02		5		Healed				Y				
516+50		Crack Longitudinal			7	0.02		7		Healed				Y				
516+50		Surface Damage AggregateMissing			0.83	0.13		7		At Joint								Y
516+60		Surface Damage ReinforcementVisable	0.67					12		Lift Hole								Y
516+64		Crack Longitudinal			7	0.02		5		Healed				Y				
516+64		Crack Longitudinal			7	0.02		7		Healed				Y				
516+64		Surface Damage Surface Spalling						11		At Joint								Y
516+71		Crack Longitudinal			7	0.02		7		Healed				Y				
516+78		Crack Longitudinal			7	0.02		7		Healed				Y				
516+79		Surface Damage Surface Spalling						11		At Joint								Y
516+85		Joint Separated				1.75											Y	
516+85		Joint Offset				0.125												
516+85		Crack Longitudinal			7	0.014		5		Healed				Y				
516+85		Crack Longitudinal			7	0.014		7		Healed				Y				
516+86		Surface Damage Surface Spalling						11		At Joint								Y

15 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISIONS	BY
1	1/9/2020		TB

REVISION

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1/9/2020	1/9/2020	1/9/2020

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Phone: 612-363-9580
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 15

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
516+93		Crack Longitudinal			7	0.014		5		Healed				Y				
516+93		Crack Longitudinal			7	0.014		7		Healed				Y				
517+00		Crack Longitudinal			7	0.014		5		Healed				Y				
517+00		Crack Longitudinal			7	0.014		7		Healed				Y				
517+07		Crack Longitudinal			7	0.014		5		Healed				Y				
517+10		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
517+14		Crack Longitudinal			7	0.014		7		Healed				Y				
517+14		Surface Damage Surface Spalling						10		At Joint								Y
517+21		Crack Longitudinal			7	0.014		5		Healed				Y				
517+21		Crack Longitudinal			7	0.014		7		Healed				Y				
517+25		Surface Damage ReinforcementVisable			1.5	0.67		12		Lift Hole								Y
517+28		Crack Longitudinal			7	0.014		5		Healed				Y				
517+28		Crack Longitudinal			7	0.015		7		Healed				Y				
517+32		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
517+35		Crack Longitudinal			7	0.015		5		Healed				Y				
517+35		Crack Longitudinal			7	0.015		7		Healed				Y				
517+50		Joint Separated				2.125											Y	
517+50		Joint Offset				0.8												
517+58		Crack Longitudinal			7	0.015		5		Healed				Y				
517+61		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
517+65		Crack Longitudinal			7	0.15		7						Y				
517+71		Surface Damage ReinforcementVisable						6										Y
517+82		Surface Damage ReinforcementVisable	0.67					12		Lift Hole								Y
517+88		Surface Damage ReinforcementVisable	0.67					12		Lift Hole								Y
517+93		Crack Longitudinal			7	0.018		7		Healed				Y				
518+00		Joint Separated				0.25											Y	
518+00		Joint Offset				0.75												
518+10		Surface Damage ReinforcementVisable						6										Y
518+10		Surface Damage	0.67					12		Lift Hole								Y
518+14		Joint Separated				1.75											Y	
518+14		Joint Offset				0.125												
518+21		Joint Separated				2											Y	
518+21		Joint Offset				0.25												
518+42		Joint Separated				2											Y	
518+42		Joint Offset				0.25												
518+66		Crack Longitudinal			4	0.15		5						Y				
518+73		Joint Separated				1.75											Y	
518+73		Joint Offset				0.25												
518+79		Crack Longitudinal			7	0.015		7						Y				
519+15		Access Point Manhole			2	2		12										
519+43		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
519+50		Crack Longitudinal			7	0.016		5		Healed				Y				
519+50		Crack Longitudinal			7	0.016		7		Healed				Y				
519+55		Crack Longitudinal			3	0.02		12						Y				
519+57		Crack Longitudinal			7	0.016		5		Healed				Y				

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

16 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

NO.	DATE	REVISIONS	BY
1	1/9/2020		TB

REVISION

DES	DRN	CHK
BA	TB	BA
1/9/2020	1/9/2020	1/9/2020

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BDA
BDA Associates, LLC.
7854 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 16

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
519+57		Crack Longitudinal			7	0.016		7		Healed				Y				
519+72		Crack Longitudinal			1.5	0.02		12						Y				
519+74		Crack Longitudinal			3	0.01		12						Y				
519+95		Crack Longitudinal			3	0.016		7		Healed				Y				
519+95		Crack Longitudinal			3	0.016		5		Healed				Y				
519+97		Crack Longitudinal			7	0.02		5		Healed				Y				
519+97		Crack Longitudinal			7	0.02		7		Healed				Y				
520+00		Surface Damage ReinforcementVisable	0.83					12		Lift Hole								Y
520+03		Surface Damage Surface Spalling						2		At Joint								Y
520+04		Crack Longitudinal			7	0.02		7		Healed				Y				
520+22		Surface Damage Surface Spalling						11		At Joint								Y
520+30		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
520+33		Crack Longitudinal			2	0.02		6		Healed				Y				
520+37		Joint Separated				1.75											Y	
520+37		Joint Offset				0.25												
520+37		Crack Longitudinal			7	0.018		5		Healed				Y				
520+37		Crack Longitudinal			7	0.018		7		Healed				Y				
520+80		Joint Separated				1.75											Y	
520+80		Joint Offset				0												
520+83		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
521+05		Surface Damage AggregateMissing	1					12		Lift Hole								Y
521+30		Crack Longitudinal			7	0.01		12						Y				
521+30		Crack Longitudinal			4	0.01		5		Healed				Y				
521+30		Joint Separated				2.25											Y	
521+39		Crack Longitudinal			2	0.02		12						Y				
521+45		Surface Damage Surface Spalling						10		At Joint								Y
521+48		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
521+48		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
521+50		Access Point Manhole			2	2		12										
521+52		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
521+52		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
521+53		Surface Damage Surface Spalling						7		At Joint								Y
521+55		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
521+56		Crack Circumferential				0.02		3	6					Y				
521+57		Line Right																
521+58		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
521+68		Surface Damage Surface Spalling						1		At Joint								
521+68		Surface Damage Surface Spalling						10	11	At Joint								Y
521+82		Crack Longitudinal			7	0.016		5		Healed				Y				
521+82		Crack Longitudinal			7	0.016		7		Healed				Y				
521+82		Joint Separated				2											Y	
521+82		Joint Offset				0.125												
521+89		Crack Longitudinal			7	0.02		5		Healed				Y				
521+89		Crack Longitudinal			7	0.02		7		Healed				Y				
522+10		Joint Separated				2.5											Y	

17 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

I hereby certify that the plan, specifications or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Wisconsin.

Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISIONS	BY
1	1/9/2020		TB

DES	DRN	CHK
BA	TB	BA
1/9/2020	1/9/2020	1/9/2020

JOB NO.

BDA
BDA Associates, LLC.
7954 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 17

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
Start	End	Description	Feet			ft. / in.		At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
			Dia	H	L	W	D											
522+25		Joint Separated				2.5											Y	
522+28		Surface Damage ReinforcementVisable	1					12		Lift Hole								Y
522+33		Crack Longitudinal			7	0.02		5		Healed				Y				
522+33		Crack Longitudinal			7	0.02		7		Healed				Y				
522+33		Crack Longitudinal			2	0.05		6								Y		
522+35		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
522+40		Crack Longitudinal			7	0.02		5		Healed				Y				
522+40		Crack Longitudinal			7	0.02		7		Healed				Y				
522+40		Joint Separated				2											Y	
522+40		Joint Offset				0.25												
522+64		Surface Damage ReinforcementVisable	0.83					12		Lift Hole								Y
522+82		Surface Damage Surface Spalling						10	11	At Joint								Y
522+98		Surface Damage ReinforcementVisable	0.67					12		Lift Hole								Y
523+10		Crack Longitudinal			7	0.02		5		Healed				Y				
523+10		Crack Longitudinal			7	0.02		7		Healed				Y				
523+17		Crack Longitudinal			7	0.02		5		Healed				Y				
523+17		Crack Longitudinal			7	0.02		7		Healed				Y				
523+21		Surface Damage ReinforcementVisable	0.83					12		Lift Hole								Y
523+31		Joint Separated				1.75											Y	
523+31		Joint Offset				0.25												
523+36		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
523+36		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
523+38		Access Point Manhole			2	2		12										
523+40		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
523+40		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
523+43		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
523+44		Line Right																
523+47		Crack Longitudinal			6	0.02		6		Healed				Y				
523+47		Crack Longitudinal			6	0.02		6		Healed				Y				
523+48		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
523+50		Joint Separated				1.75											Y	
523+50		Joint Offset				0.25												
523+50		Crack Longitudinal			3	0.016		5		Healed				Y				
523+50		Crack Longitudinal			3	0.016		7		Healed				Y				
523+51		Crack Longitudinal			2	0.005		12						Y				
523+54		Joint Separated				1.75											Y	
523+54		Joint Offset				0												
523+54		Crack Longitudinal			7	0.016		5		Healed				Y				
523+54		Crack Longitudinal			7	0.016		7		Healed				Y				
523+56		Crack Longitudinal			7	0.016		6						Y				
523+61		Crack Longitudinal			7	0.02		5		Healed				Y				
523+68		Crack Longitudinal			7	0.02		5		Healed				Y				
523+71		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
523+75		Crack Longitudinal			7	0.028		5		Healed					Y			
523+82		Crack Longitudinal			7	0.016		5		Healed				Y				

18 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

I hereby certify that the plan, specifications or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Wisconsin.

Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

BY	REVISION	DATE	NO.
TB	REVISIONS	1/9/2020	1

DES	DRN	CHK
BA	TB	BA
1/9/2020	1/9/2020	1/9/2020

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BDA Associates, LLC.
7954 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 18

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
Start	End	Description	Feet			ft. / in.		At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
			Dia	H	L	W	D											
523+82		Crack Longitudinal			7	0.016		6		Healed				Y				
523+82		Joint Separated				2											Y	
523+82		Joint Offset				1								Y				
523+82		Crack Longitudinal			7	0.05		6								Y		
523+86		Crack Longitudinal			4	0.05		6								Y		
523+94		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
524+01		Crack Longitudinal			7	0.016		6		Healed				Y				
524+10		Surface Damage Surface Spalling						10		At Joint								Y
524+25		Surface Damage Surface Spalling						10		At Joint								Y
524+28		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
524+32		Joint Separated				1.75											Y	
524+32		Joint Offset				0.25												
524+35		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
524+42		Infiltration Weeper						6		At joint	*	*						
524+43		Infiltration Weeper						6		At joint	*	*						
524+69		Surface Damage ReinforcementVisable	0.67					12		Lift Hole								Y
524+83		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
524+83		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
524+85		Access Point Manhole			2	2		12										
524+87		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
524+87		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
524+91		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
524+92		Line Right																
524+96		Surface Damage Surface Spalling						10		At Joint								Y
524+98		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
525+00		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
525+17		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
525+30		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
525+34		Infiltration Weeper						4			*	*						
525+34		Joint Separated				2.5											Y	
525+34		Infiltration Runner						8			*	*						
525+35		Joint Separated				2											Y	
525+35		Joint Offset				0.125												
525+48		Crack Longitudinal			2	0.005		12						Y				
525+52		Surface Damage ReinforcementVisable	1					12		Lift Hole								Y
525+70		Surface Damage Surface Spalling						10		At Joint								Y
525+70		Surface Damage Surface Spalling						2		At Joint								Y
525+85		Surface Damage Surface Spalling						1		At Joint								Y
525+85		Surface Damage Surface Spalling						10		At Joint								Y
525+89		Surface Damage ReinforcementVisable	0.67					12		Lift Hole								Y
525+92		Crack Longitudinal			7	0.025		6		Healed					Y			
525+99		Crack Longitudinal			7	0.016		5		Healed				Y				
525+99		Crack Longitudinal			7	0.02		7		Healed				Y				
526+09		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
526+11		Crack Longitudinal			7	0.012		5		Healed				Y				

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

19 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

NO.	DATE	REVISIONS	BY
1	1/9/2020		TB

REVISION

DES	DRN	CHK
BA	TB	BA
1/9/2020	1/9/2020	1/9/2020

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BDA Associates, LLC.
7854 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 19

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
526+11		Crack Longitudinal			7	0.012		7		Healed				Y				
526+11		Crack Longitudinal			5	0.01		6						Y				
526+11		Crack Longitudinal			5	0.01		6						Y				
526+11		Crack Longitudinal			5	0.01		6						Y				
526+18		Crack Longitudinal			7	0.01		5		Healed				Y				
526+18		Crack Longitudinal			7	0.01		7		Healed				Y				
526+26		Crack Longitudinal			7	0.014		5		Healed				Y				
526+26		Crack Longitudinal			7	0.014		6		Healed				Y				
526+26		Crack Longitudinal			7	0.014		7		Healed				Y				
526+33		Crack Longitudinal			7	0.01		5		Healed				Y				
526+40		Crack Longitudinal			7	0.02		5		Healed				Y				
526+40		Crack Longitudinal			7	0.02		7		Healed				Y				
526+44		Surface Damage ReinforcementVisable	0.67					12		Lift Hole								Y
526+47		Joint Separated				1.75											Y	
526+47		Joint Offset				0.5												
526+47		Crack Longitudinal			7	0.028		5		Healed					Y			
526+47		Crack Longitudinal			7	0.028		7		Healed					Y			
526+54		Crack Longitudinal			7	0.016		6						Y				
526+54		Crack Longitudinal			7	0.01		5		Healed				Y				
526+54		Crack Longitudinal			7	0.01		7		Healed				Y				
526+59		Surface Damage ReinforcementVisable			1	1.5		12		Lift Hole								Y
526+61		Crack Longitudinal			7	0.01		5		Healed				Y				
526+61		Crack Longitudinal			7	0.01		6		Healed				Y				
526+61		Crack Longitudinal			7	0.01		7		Healed				Y				
526+69		Crack Longitudinal			7	0.016		5		Healed				Y				
526+69		Crack Longitudinal			7	0.016		6		Healed				Y				
526+76		Crack Longitudinal			7	0.02		6		Healed				Y				
526+76		Crack Longitudinal			7	0.01		5		Healed				Y				
526+76		Crack Longitudinal			7	0.01		7		Healed				Y				
526+87		Crack Longitudinal			7	0.02		7		Healed				Y				
526+87		Crack Longitudinal			7	0.02		6		Healed				Y				
526+92		Crack Longitudinal			7	0.01		5		Healed				Y				
526+96		Crack Longitudinal			7	0.01		5		Healed				Y				
526+96		Crack Longitudinal			5	0.02		6						Y				
526+97		Crack Longitudinal			5	0.02		7						Y				
526+98		Surface Damage AggregateMissing			2	0.25		6	7									Y
527+00		Crack Longitudinal			7	0.01		5		Healed				Y				
527+00		Crack Longitudinal			7	0.02		6						Y				
527+00		Crack Longitudinal			7	0.01		7		Healed				Y				
527+03		Surface Damage ReinforcementVisable	1.5					12		Lift Hole								Y
527+05		Crack Longitudinal			7	0.01		6						Y				
527+12		Crack Longitudinal			4	0.01		5						Y				
527+12		Crack Longitudinal			4	0.01		12						Y				
527+13		Crack Longitudinal			7	0.02		6						Y				
527+13		Crack Longitudinal			7	0.01		5		Healed				Y				

20 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

I hereby certify that the plan, specifications or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Wisconsin.

Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISION	BY
1	1/9/2020	REVISIONS	TB

DES	DRN	CHK
BA	TB	BA
1/9/2020	1/9/2020	1/9/2020

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 20

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
527+16		Crack Longitudinal			3	0.005		12						Y				
527+19		Crack Longitudinal			7	0.02		6						Y				
527+20		Crack Longitudinal			7	0.01		5		Healed				Y				
527+20		Crack Longitudinal			7	0.02		6		Healed				Y				
527+20		Crack Longitudinal			7	0.02		7		Healed				Y				
527+27		Crack Longitudinal			7	0.1		5		Healed						Y		
527+27		Crack Longitudinal			7	0.02		6		Healed				Y				
527+30		Crack Longitudinal			3	0.005		12						Y				
527+34		Crack Longitudinal			7	0.01		7		Healed				Y				
527+34		Crack Longitudinal			7	0.01		5		Healed				Y				
527+34		Crack Longitudinal			4	0.02		6						Y				
527+38		Crack Longitudinal			7	0.01		7		Healed				Y				
527+44		Crack Longitudinal			4	0.02		7						Y				
527+44		Crack Longitudinal			4	0.03		5							Y			
527+44		Crack Longitudinal			3	0.01		12						Y				
527+46		Crack Longitudinal			5	0.02		6						Y				
527+51		Crack Longitudinal			3	0.01		7						Y				
527+55		Joint Separated				2.25											Y	
527+55		Crack Longitudinal			1	0.02		7						Y				
527+65		Crack Longitudinal			5	0.01		5						Y				
527+65		Crack Longitudinal			5	0.01		7						Y				
527+68		Crack Longitudinal			7	0.01		5		Healed				Y				
527+68		Crack Longitudinal			7	0.01		7		Healed				Y				
527+75		Infiltration Runner						4		1 GPM, at joint	*	*						
527+84		Crack Longitudinal			5	0.02		6						Y				
527+84		Crack Longitudinal			7	0.035		7							Y			
527+87		Crack Longitudinal			5	0.06		6								Y		
527+87		Crack Longitudinal			7	0.02		7						Y				
527+90		Crack Multiple			4.5	0.02		6						Y				
527+97		Crack Longitudinal			7	0.015		5		Healed				Y				
527+97		Crack Longitudinal			7	0.015		6		Healed				Y				
527+97		Crack Longitudinal			7	0.02		6		Healed				Y				
527+98		Crack Longitudinal			7	0.01		5		Healed				Y				
527+98		Crack Longitudinal			7	0.016		6		Healed				Y				
528+04		Crack Longitudinal			7	0.01		5		Healed				Y				
528+04		Crack Longitudinal			7	0.018		6						Y				
528+04		Crack Longitudinal			7	0.01		5						Y				
528+07		Crack Longitudinal			3	0.015		7						Y				
528+10		Crack Longitudinal			7	0.015		6						Y				
528+24		Surface Damage ReinforcementVisable						6		Circumferential bars visable								Y
528+24		Crack Longitudinal			3	0.01		7		Healed				Y				
528+25		Crack Longitudinal			3	0.01		5		Healed				Y				
528+26		Crack Longitudinal			7	0.025		6							Y			
528+33		Crack Longitudinal			7	0.015		5						Y				
528+33		Crack Longitudinal			7	0.025		6							Y			

21 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

NO.	DATE	REVISIONS	BY
1	1/9/2020		TB

DES	DRN	CHK
BA	TB	BA
1/9/2020	1/9/2020	1/9/2020

JOB NO.

BDA Associates, LLC.
7854 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 21

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
Start	End	Description	Feet			ft. / in.		At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
			Dia	H	L	W	D											
528+38		Crack Longitudinal			5	0.005		12						Y				
528+40		Crack Longitudinal			8	0.005		12						Y				
528+40		Crack Longitudinal			7	0.025		7							Y			
528+41		Crack Longitudinal			1	0.01		6						Y				
528+44		Crack Longitudinal			5	0.015		5		Healed				Y				
528+47		Joint Separated				1.25											Y	
528+47		Surface Damage AggregateMissing			1.58	0.21		6	7						Y			Y
528+54		Crack Longitudinal			4	0.01		5		Healed				Y				
528+54		Infiltration Weeper						7			*	*						
528+61		Crack Longitudinal			3	0.01		5		Healed				Y				
528+73		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
528+73		Crack Multiple			7	0.02		7						Y				
528+73		Crack Multiple			7	0.02		5						Y				
528+76		Infiltration Weeper						3		At Joint	*	*						
528+76		Crack Longitudinal			7	0.02		5						Y				
528+76		Crack Longitudinal			4	0.01		7		Healed				Y				
528+76		Crack Longitudinal			7	0.015		6						Y				
528+76		Crack Longitudinal			1	0.005		11						Y				
528+76		Crack Longitudinal			1	0.005		12						Y				
528+78		Crack Longitudinal			4	0.01		5						Y				
528+80		Crack Longitudinal			4	0.015		7						Y				
528+81		Crack Longitudinal			7	0.015		6						Y				
528+82		Crack Longitudinal			4	0.02		7						Y				
528+83		Joint Separated				1.75											Y	
528+83		Joint Offset				0.125												
528+83		Crack Longitudinal			7	0.02		5						Y				
528+83		Crack Longitudinal			7	0.02		7						Y				
528+83		Crack Circumferential			1	0.035		6	7	At Joint					Y			
528+84		Infiltration Weeper						9			*	*						
528+86		Crack Longitudinal			4	0.02		6						Y				
528+90		Crack Longitudinal			4	0.01		5		Healed				Y				
528+90		Crack Longitudinal			4	0.02		7						Y				
528+90		Joint Separated				3											Y	
528+90		Joint Offset				0.5												
528+90		Crack Multiple			4.5	0.02		6	7					Y				
528+96		Crack Longitudinal			2	0.005		12						Y				
529+06		Crack Longitudinal			3	0.02		6						Y				
529+08		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
529+25		Surface Damage Surface Spalling						7		At Joint								Y
529+26		Crack Longitudinal			1	0.01		12						Y				
529+26		Crack Longitudinal			7	0.02		6						Y				
529+42		Crack Longitudinal			7	0.025		6							Y			
529+45		Crack Longitudinal			7	0.005		7						Y				
529+51		Crack Longitudinal			7	0.01		6						Y				
529+75		Crack Circumferential			2	0.03		4	5						Y			

22 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

NO.	DATE	REVISIONS	BY
1	1/9/2020		TB

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 22

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
529+90		Joint Separated				2.25											Y	
529+95		Miscellaneous GeneralObservation		5.55	7	8.72				Barrel Check								
529+97		Surface Damage Surface Spalling						3		At Joint								Y
529+98		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
529+98		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
530+00		Obstruction Construction Debris			2.5	2		6		Concrete overpour								
530+00		Access Point Manhole			2	2		12										
530+02		Surface Damage ReinforcementVisable	0.5					10		Lift Hole								Y
530+02		Surface Damage ReinforcementVisable	0.5					2		Lift Hole								Y
530+03		Crack Longitudinal			7	0.25		6							Y			
530+07		Crack Circumferential			4	0.005		3	5					Y				
530+07		Line Right																
530+13		Crack Longitudinal			2	0.005		12						Y				
530+14		Crack Longitudinal			3	0.01		12						Y				
530+14		Surface Damage Surface Spalling						1		At Joint								Y
530+15		Crack Longitudinal			2	0.01		12						Y				
530+15		Surface Damage Surface Spalling						5		At Joint								Y
530+22		Crack Longitudinal			7	0.01		5		Healed				Y				
530+23		Surface Damage ReinforcementVisable	0.75					12		Lift Hole								Y
530+23		Crack Longitudinal			2	0.01		12						Y				
530+25		Crack Longitudinal			4	0.01		1						Y				
530+27		Crack Longitudinal			7	0.01		12						Y				
530+28		Joint Separated				2.25											Y	
530+29		Crack Longitudinal			7	0.01		7		Healed				Y				
530+31		Surface Damage ReinforcementVisable	0.5					12		Lift Hole								Y
530+31		Surface Damage AggregateMissing	1					12		Lift Hole								Y
530+31		Crack Longitudinal			3	0.01		12						Y				
530+35		Crack Longitudinal			2	0.005		12						Y				
530+40		Crack Longitudinal			5	0.01		1						Y				
530+42		Crack Longitudinal			7	0.01		12						Y				
530+42		Crack Longitudinal			7	0.01		11						Y				
530+47		Crack Spiral			6	0.02		6	7					Y				
530+50		Crack Longitudinal			7	0.03		6							Y			
530+57		Crack Longitudinal			7	0.025		6							Y			
530+57		Joint Separated				2.75											Y	
530+57		Surface Damage AggregateMissing			2	0.5		6	7									Y
530+58		Crack Longitudinal			7	0.015		7						Y				
530+64		Crack Longitudinal			7	0.02		6						Y				
530+64		Crack Longitudinal			7	0.03		7							Y			
530+64		Crack Longitudinal			7	0.01		8		Healed				Y				
530+66		Crack Longitudinal			7	0.005		6						Y				
530+67		Crack Longitudinal			7	0.015		6						Y				
530+72		Crack Longitudinal			7	0.005		6						Y				
530+72		Crack Longitudinal			7	0.005		7						Y				
530+78		Crack Longitudinal			7	0.025		6							Y			

23 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

NO.	DATE	REVISIONS	BY
1	1/9/2020		TB

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7854 Highway 65 NE
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 23

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
530+78		Crack Longitudinal			7	0.025		7							Y			
530+85		Crack Longitudinal			7	0.05		5								Y		
530+85		Crack Longitudinal			7	0.05		6								Y		
530+85		Crack Longitudinal			7	0.04		7							Y			
530+85		Surface Damage Surface Spalling						11		At Joint								Y
530+89		Crack Longitudinal			5	0.005		11						Y				
530+90		Access Point Manhole			2	2		12										
530+92		Crack Longitudinal			7	0.005		12						Y				
530+92		Crack Longitudinal			4	0.01		12						Y				
530+92		Crack Longitudinal			7	0.03		6							Y			
530+96		Line Right																
530+98		Crack Circumferential				0.02		3	5					Y				
530+99		Surface Damage Surface Spalling			1	1		6		At Joint								Y
531+00		Joint Separated				2											Y	
531+00		Joint Offset				0.25												
531+00		Crack Longitudinal			7	0.01		5		Healed				Y				
531+00		Crack Longitudinal			7	0.01		7		Healed				Y				
531+01		Surface Damage Surface Spalling						5		At Joint								Y
531+15		Crack Longitudinal			7	0.01		5		Healed				Y				
531+15		Crack Longitudinal			7	0.01		7		Healed				Y				
531+15		Crack Longitudinal			4	0.025		6							Y			
531+18		Joint Separated				2											Y	
531+18		Joint Offset				0.25												
531+23		Crack Longitudinal			5	0.05		6								Y		
531+25		Crack Longitudinal			7	0.03		6							Y			
531+25		Crack Longitudinal			7	0.01		5		Healed				Y				
531+25		Crack Longitudinal			7	0.01		7		Healed				Y				
531+30		Crack Longitudinal			7	0.018		5		Healed				Y				
531+30		Crack Longitudinal			7	0.01		7		Healed				Y				
531+32		Miscellaneous GeneralObservation		5.55	7	8.72				Barrel Check								
531+34		Crack Longitudinal			3	0.11		6						Y				
531+37		Crack Longitudinal			7	0.02		6						Y				
531+38		Crack Longitudinal			7	0.02		6						Y				
531+38		Crack Longitudinal			7	0.03		7							Y			
531+38		Crack Longitudinal			4	0.01		5						Y				
531+41		Crack Longitudinal			4	0.03		6							Y			
531+51		Crack Longitudinal			3	0.025		6							Y			
531+55		Crack Longitudinal			7	0.01		5		Healed				Y				
531+55		Crack Longitudinal			7	0.01		7		Healed				Y				
531+69		Crack Longitudinal			7	0.03		5							Y			
531+75		Crack Longitudinal			7	0.05		6								Y		
531+85		Crack Longitudinal			7	0.03		6							Y			
531+86		Crack Spiral			5	0.03		6	7						Y			
531+86		Crack Spiral			4	0.01		5	6	Healed				Y				
531+93		Crack Longitudinal			7	0.03		6							Y			

NO.	DATE	REVISIONS	BY
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7854 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 24

Inspection		Code	Value					Circumferential* (Orientation is looking upstream)		Note 1: Cementitious Mortar Fill or Repair * Active Water Leakage	WP1 - All joints shall be sealed WP2 - All joints shall be sealed SS3 - All pipe sections shall be grouted							
			Feet			ft. / in.												
Start	End	Description	Dia	H	L	W	D	At / From	To	Remarks	WP1 Urethane	WP2 Acrylamide	SS3 Cement	WP4 Crystal	WP5 Acrylic	WP6 Epoxy	WP7 Sheet	Note 1 Mortar
531+96		Crack Longitudinal			7	0.01		6		Healed				Y				
531+97		Crack Longitudinal			7	0.025		6							Y			
532+04		Crack Longitudinal			7	0.025		6							Y			
532+04		Crack Longitudinal			7	0.025		6							Y			
532+10		Crack Longitudinal			7	0.01		5		Healed				Y				
532+10		Crack Longitudinal			7	0.01		7		Healed				Y				
532+25		Crack Longitudinal			7	0.01		7		Healed				Y				
532+32		Infiltration Weeper						5	8		*	*						
532+34		Crack Longitudinal			2	0.011		5						Y				
532+34		Crack Longitudinal			2	0.011		7		Healed				Y				
532+39		Crack Longitudinal			7	0.01		7		Healed				Y				
532+39		Infiltration Weeper						7			*	*						
532+61		Joint Separated				2											Y	
532+61		Joint Offset				0.125												
532+61		Surface Damage Surface Spalling						12		At Joint								Y
532+64		Crack Longitudinal			4	0.02		6						Y				
532+82		Infiltration Runner						5		At Joint	*	*						
532+89		Infiltration Weeper						5		At Joint	*	*						
532+96		Joint Separated				1.75											Y	
532+96		Joint Offset				0.5												
533+03		Joint Separated				1.75											Y	
533+03		Joint Offset				0.25												
533+03		Infiltration Runner						7			*	*						
533+03		Infiltration Runner						5			*	*						
533+25		Joint Separated				2											Y	
533+25		Joint Separated				2											Y	
533+25		Joint Offset				0.5												
533+32		Joint Separated				1.75											Y	
533+39		Joint Separated				2											Y	
533+39		Surface Damage AggregateMissing			2	0.5		4	5									Y
533+46		Joint Separated				1.625											Y	
533+54		Surface Damage Surface Spalling						9										Y
533+34		Survey End																

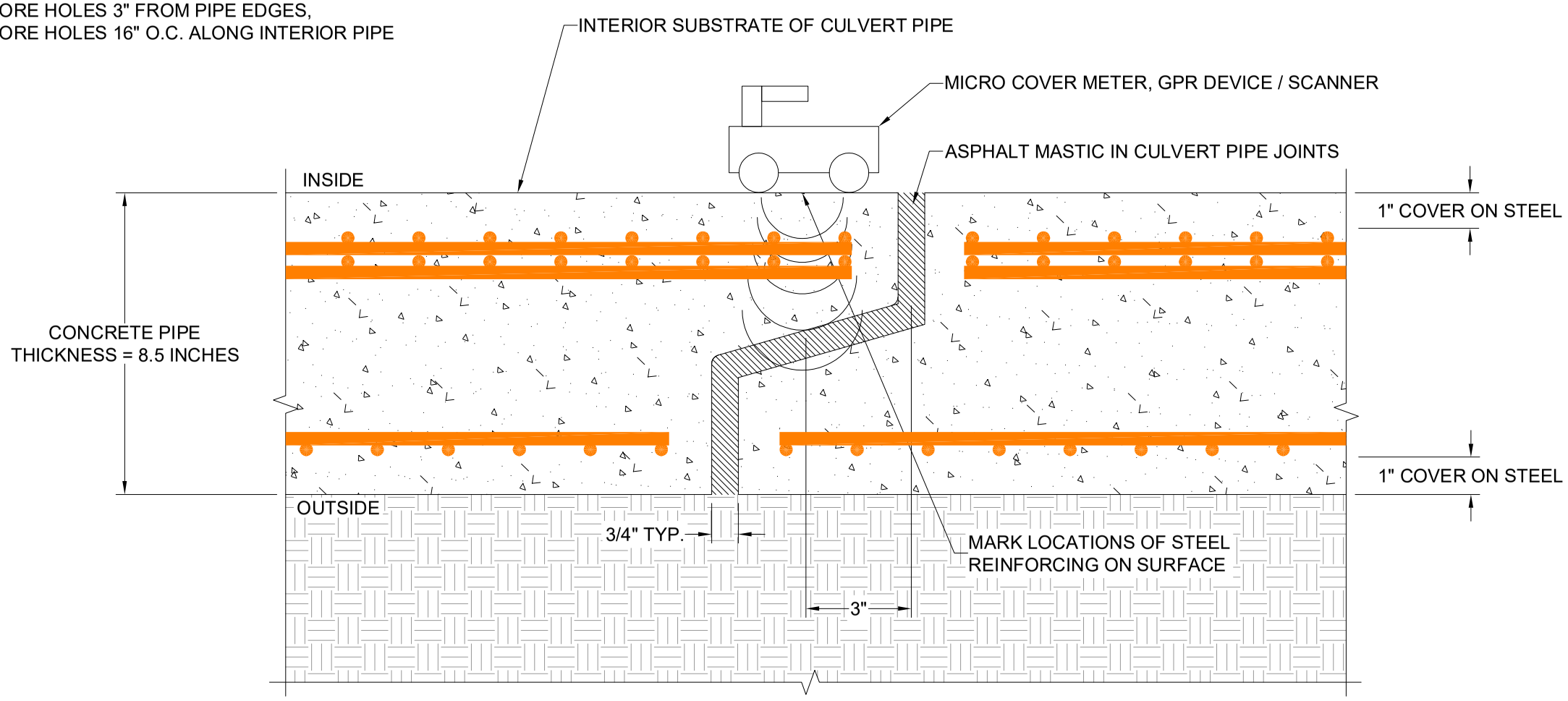
25 SCOPE OF WORK
WP-1, WP-2, SS-3, WP-4, WP-5, WP-6, WP-7, NOTE 1

BY	REVISION
TB	

GENERAL CONDITIONS:

1. COORDINATE SAFETY PLAN TO INCLUDE MANAGEMENT OF MANCHETTE TOPS TO AVOID TRIP HAZARDS TO TRADESMEN
2. COORDINATE ACCESS/EGREE PLAN IN CASE OF HIGH WATER, EXCESS CARBON DIOXIDE, LACK OF LIGHTING AND/OR OTHER ISSUES THAT MAY REQUIRE UNPLANNED EVACUATION OF CULVERT PIPE
3. COORDINATE WORKING TIMES TO ENSURE STORM WATER DRAINAGE DOES NOT INTERFERE WITH GROUTING OPERATIONS BEYOND MANAGED WATER RE-ROUTING
4. ENSURE PROJECT TEAM IS COORDINATED WITH WEATHER FORECASTS AND CURRENT CONDITIONS
5. ENSURE WATER DIVERSION PLAN IS APPROVED BY OWNER
6. FOLLOW ALL OSHA REQUIREMENTS FOR CONFINED SPACE
7. ENSURE:
   - 7.1. PROPER & ADEQUATE LIGHTING & ELECTRICAL SUPPLY
   - 7.2. PROPER & ADEQUATE FRESH AIR-SUPPLY
   - 7.3. PROPER & ADEQUATE AIR QUALITY MONITORING
   - 7.4. PROPER & ADEQUATE EYE WASH STATIONS ARE SETUP
8. IDENTIFY ALL BURIED UTILITIES WITHIN IMMEDIATE GROUT ZONE AREA.
9. IDENTIFY STORM OR SANITARY SEWER PIPES WITHIN 10 FEET OF GROUT ZONE, AND ESTABLISH SOME CRITERIA TO MONITOR EXISTING PIPING DURING CHEMICAL GROUTING TO ENSURE NO STRAY GROUT MIGRATION OCCURS.

1. CLEAN DRY SUBSTRATES IN GROUT ZONE
2. GPR OR EQUAL TO LOCATE STEEL REINFORCING
3. MARK DRILL / CORE LOCATIONS IN CONCRETE SUBSTRATE AS FOLLOWS:
   - 3.1. LOCATE DRILL / CORE HOLES 3" FROM PIPE EDGES,
   - 3.2. LOCATE DRILL / CORE HOLES 16" O.C. ALONG INTERIOR PIPE CIRCUMFERENCE



1 POLYURETHANE GROUT, JOINT INJECTION

GENERAL CONDITIONS, LOCATION OF STEEL REINFORCEMENT

Scale 1-1/2"=1'-0"

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"B" SERIES DRAWINGS	1B-30B	Section 03 64 20 Acrylamide Grout Joint Injection, Soil Solidification	WP-2
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GENERAL NOTES:			
1. STEEL REINFORCING VARIES AT LOCATIONS IN CULVERT PIPE.			

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BDA Associates, LLC.
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RAYMOND ROAD CULVERT PIPE RESTORATION

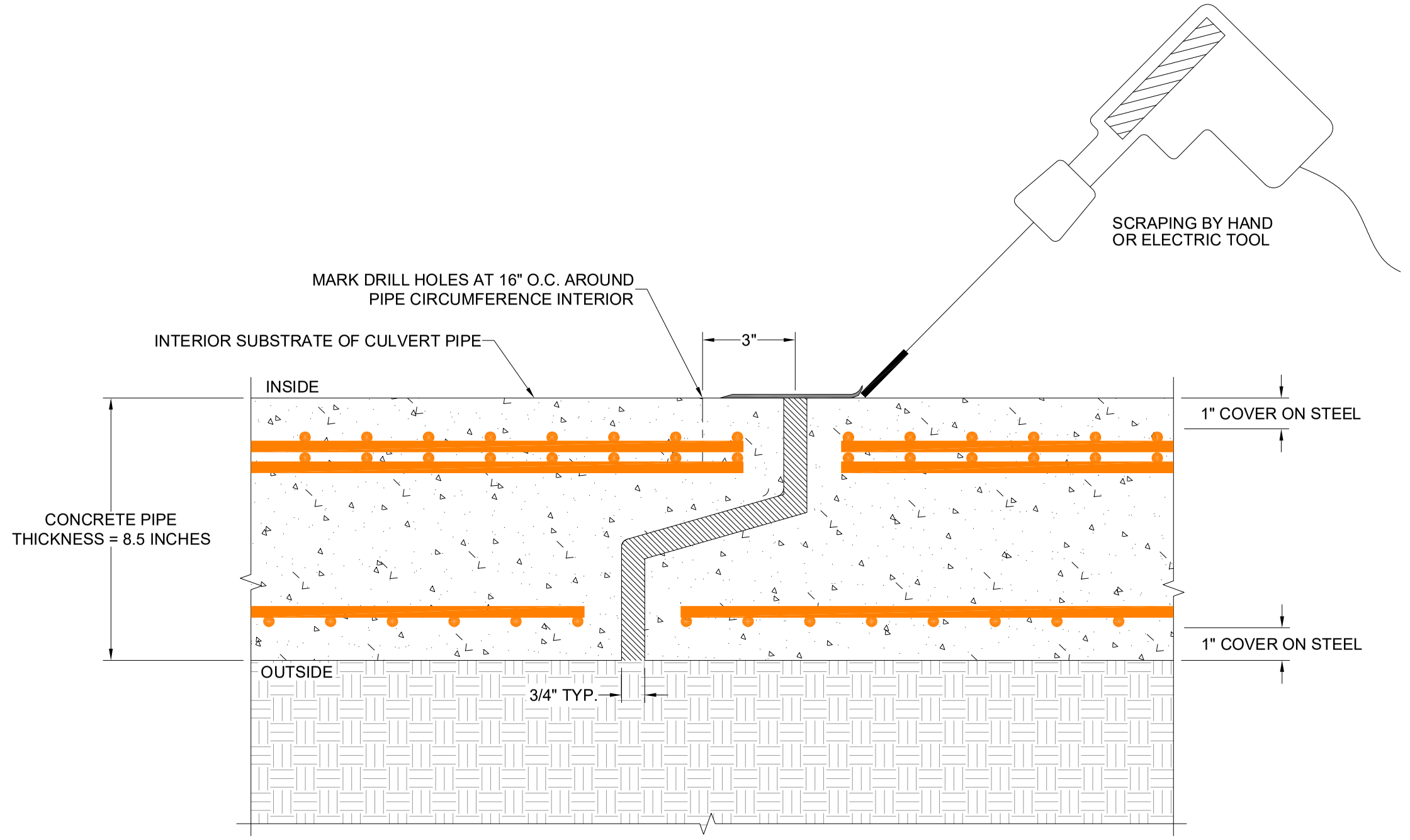
I hereby certify that the plan, specifications or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Wisconsin.

Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

SHEET: 1A

1. CLEAN EXCESS ASPHALT JOINT COMPOUND FROM PIPE FLANGE AREA
2. ENSURE ORIENTATION OF PIPE FLANGE JOINT IS KNOWN



2 POLYURETHANE GROUT, JOINT INJECTION
JOINT PREPERATION

Scale 1-1/2"=1'-0"

I hereby certify that the plan, specifications or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Wisconsin.

Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

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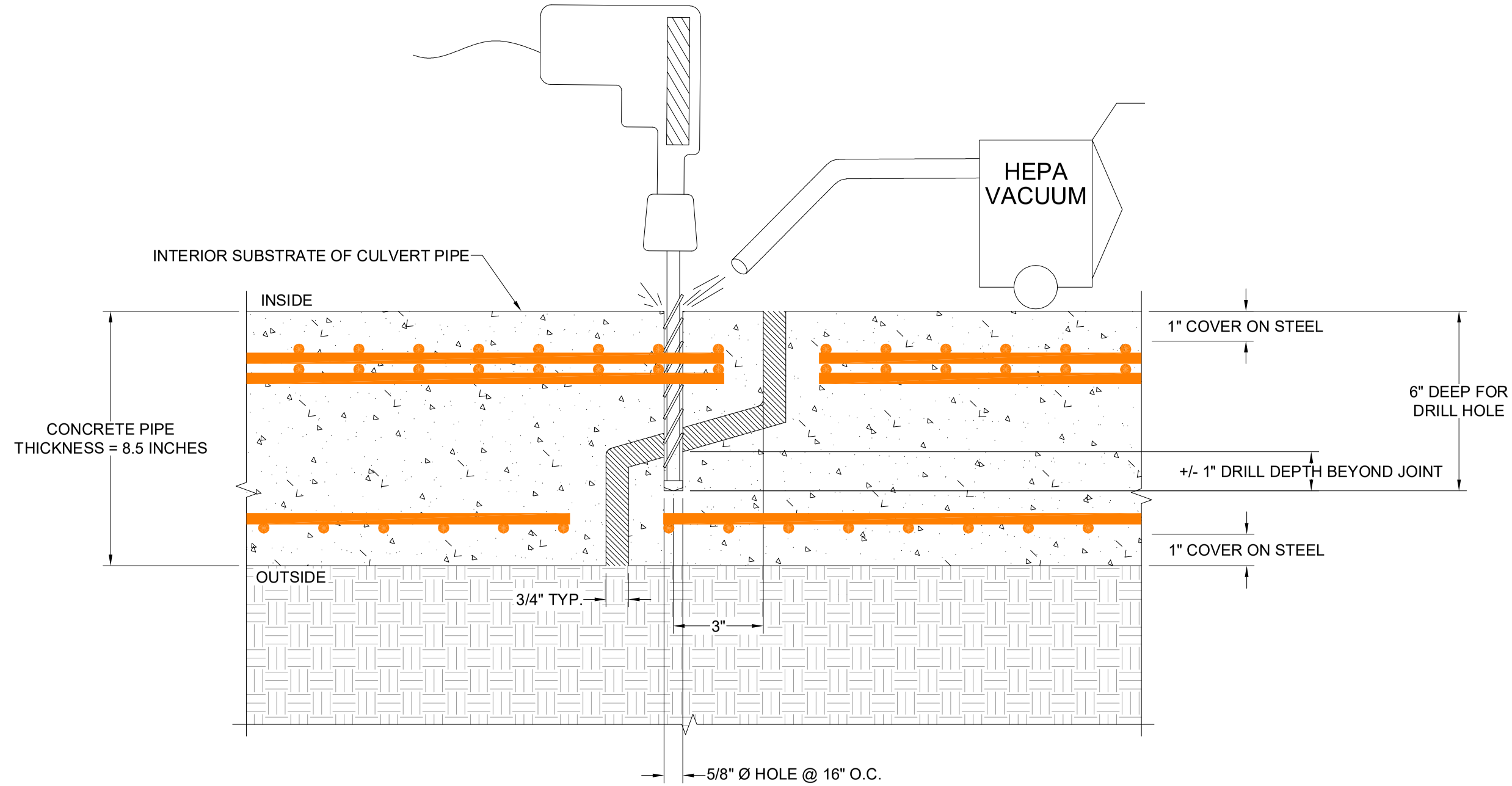
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 2A

1. DRILL / CORE 5/8" Ø HOLE THROUGH CONCRETE PIPE FLANGE 6" DEEP
2. DUST CONTROL PER OSHA REGULATIONS
3. USE HEPA VAC FOR DUST CONTROL WHERE REQUIRED



3 POLYURETHANE GROUT, JOINT INJECTION
MAPPING DRILL HOLES, DRILLING

Scale 1-1/2"=1'-0"

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISIONS	BY
1	1/9/2020		TB

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BA	TB	BA	
1/9/2020	1/9/2020	1/9/2020	

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Fridley, MN 55432
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RAYMOND ROAD CULVERT PIPE RESTORATION

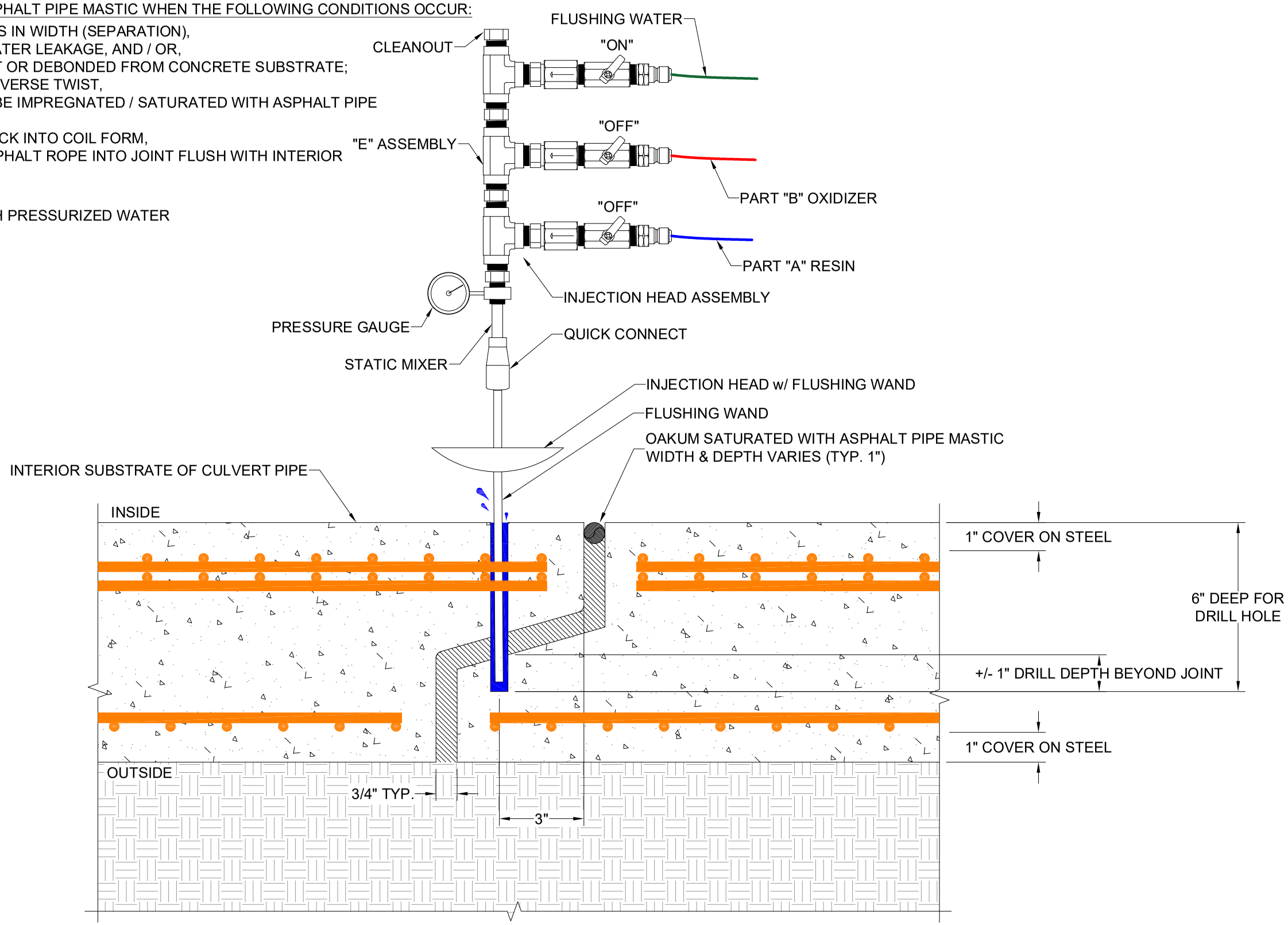
SHEET: 3A

PLACE OAKUM ROPE SATURATED WITH ASPHALT PIPE MASTIC WHEN THE FOLLOWING CONDITIONS OCCUR:

1. THE PIPE JOINT EXCEEDS 1.25 INCHES IN WIDTH (SEPARATION),
2. THE PIPE JOINT SHOWS SIGNS OF WATER LEAKAGE, AND / OR,
3. THE ASPHALT PIPE MASTIC HAS SPLIT OR DEBONDED FROM CONCRETE SUBSTRATE;
   - 3.1. TAKE NON-OILED OAKUM AND REVERSE TWIST,
   - 3.2. UNWRAVELED OAKUM ROPE TO BE IMPREGNATED / SATURATED WITH ASPHALT PIPE MASTIC,
   - 3.3. COIL OAKUM / ASPHALT ROPE BACK INTO COIL FORM,
   - 3.4. POUND AND WEDGE OAKUM / ASPHALT ROPE INTO JOINT FLUSH WITH INTERIOR SURFACE.

NOTE:

1. FLUSH DRILL HOLE / CORE HOLE WITH PRESSURIZED WATER



4 POLYURETHANE GROUT, JOINT INJECTION
DRILL HOLE FLUSHING AND OAKUM PLACEMENT

Scale 1-1/2"=1'-0"

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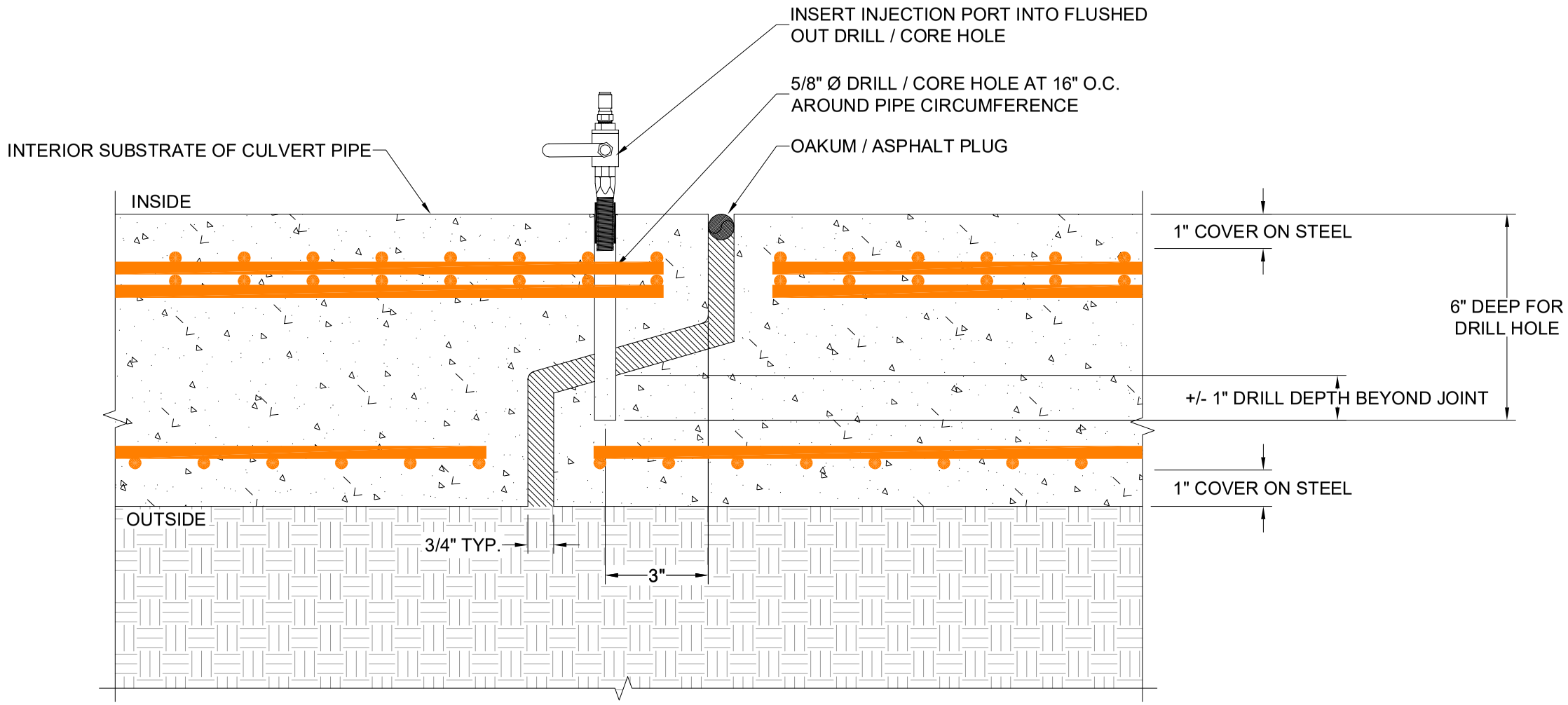
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 4A

1. INSERT INJECTION PORT INTO WATER FLUSHED DRILL / CORE HOLE AT 16" O.C. ALONG PIPE CIRCUMFERENCE
2. USE PLASTIC COUPLER ON TAPERED SHAFT OF PORT / PACKER AND TIGHTEN INTO POSITION



5 POLYURETHANE GROUT, JOINT INJECTION
PLACEMENT OF INJECTION PORT / PACKER

Scale 1-1/2"=1'-0"

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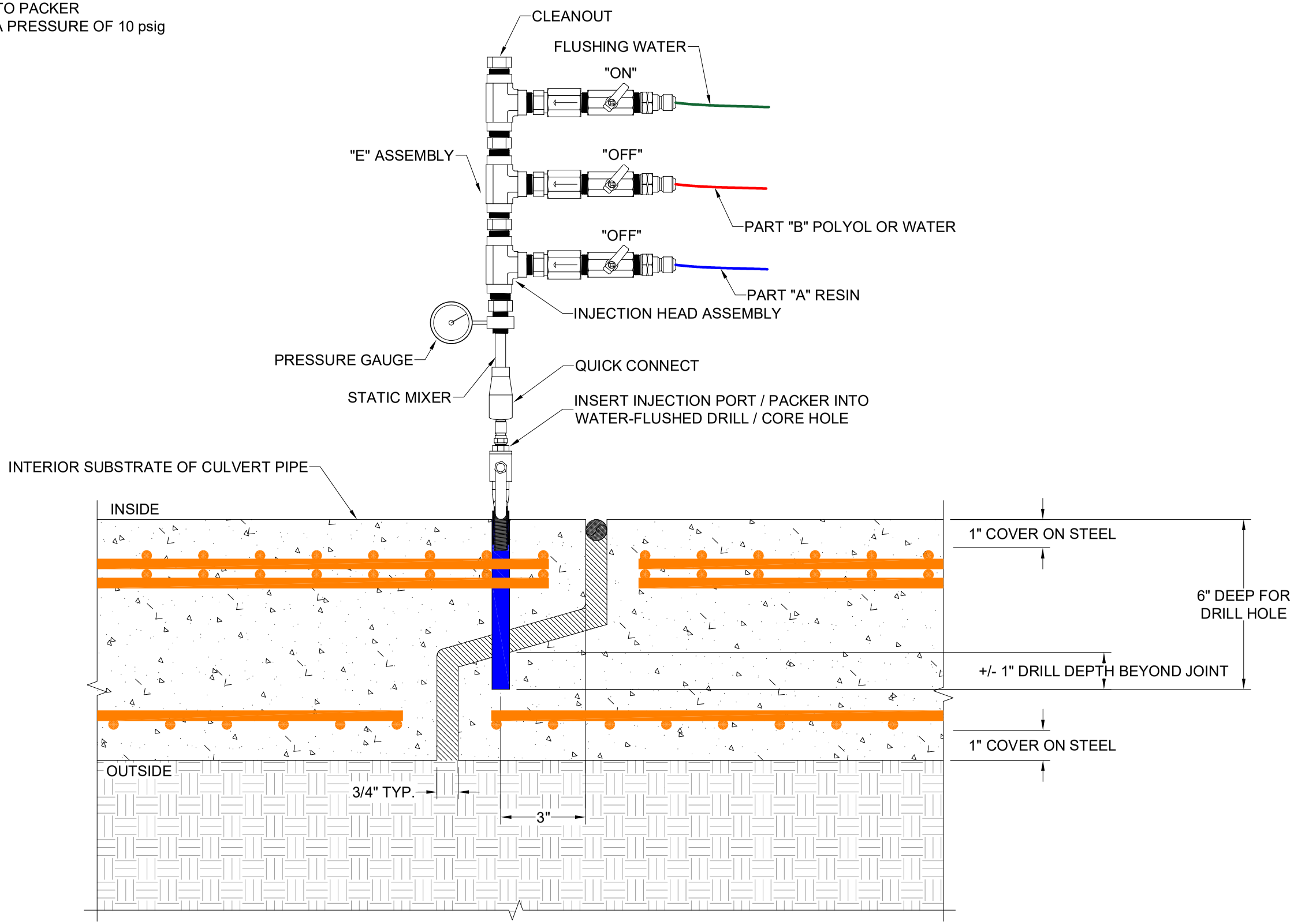
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 5A

1. ATTACH FLUSHING PUMP ASSEMBLY TO PACKER
2. OPEN BALL-VALVE, PUMP WATER TO A PRESSURE OF 10 psig



6 POLYURETHANE GROUT, JOINT INJECTION

WATER TESTING DRILL HOLES, SET-UP

Scale 1-1/2"=1'-0"

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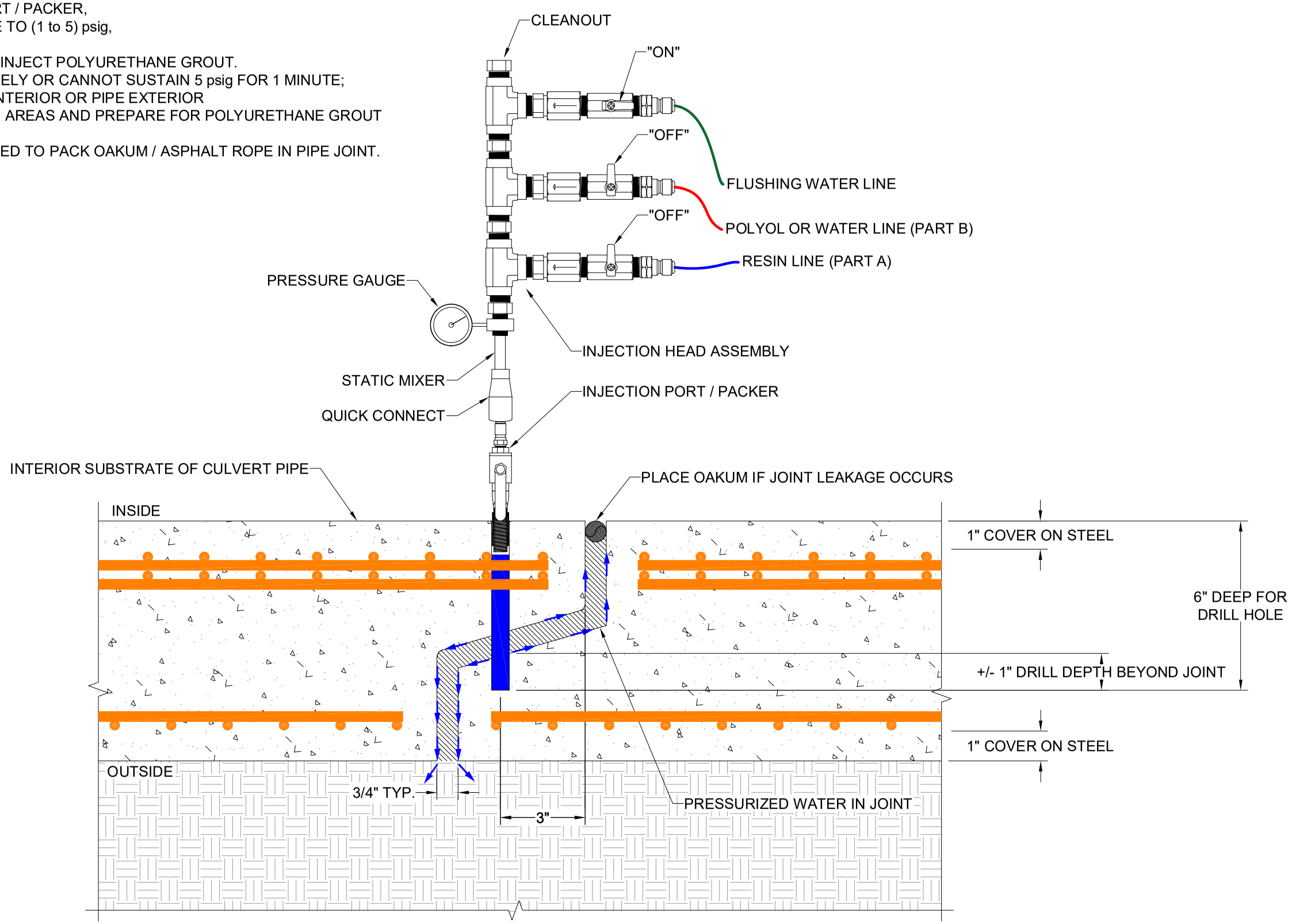
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 6A

1. OPEN BALL-VALVE ON INJECTION PORT / PACKER,
2. PUMP WATER UNDER LOW PRESSURE TO (1 to 5) psig,
3. IF PRESSURE HOLDS AT 5 psig,
   3.1. JOINT IS WATERTIGHT, NO NEED TO INJECT POLYURETHANE GROUT.
4. IF PUMP PRESSURE DROPS IMMEDIATELY OR CANNOT SUSTAIN 5 psig FOR 1 MINUTE;
   4.1. WATER LEAKAGE IS OCCURING AT INTERIOR OR PIPE EXTERIOR
5. NOTE PIPE JOINT EXTERIOR LEAKAGE AREAS AND PREPARE FOR POLYURETHANE GROUT INJECTION.
6. IF PIPE LEAKAGE IS INTERIOR, PROCEED TO PACK OAKUM / ASPHALT ROPE IN PIPE JOINT.



7 POLYURETHANE GROUT, JOINT INJECTION

WATER TEST FOR LEAKAGE RATE, PLACE OAKUM PLUG WHEN REQUIRED

Scale 1-1/2"=1'-0"

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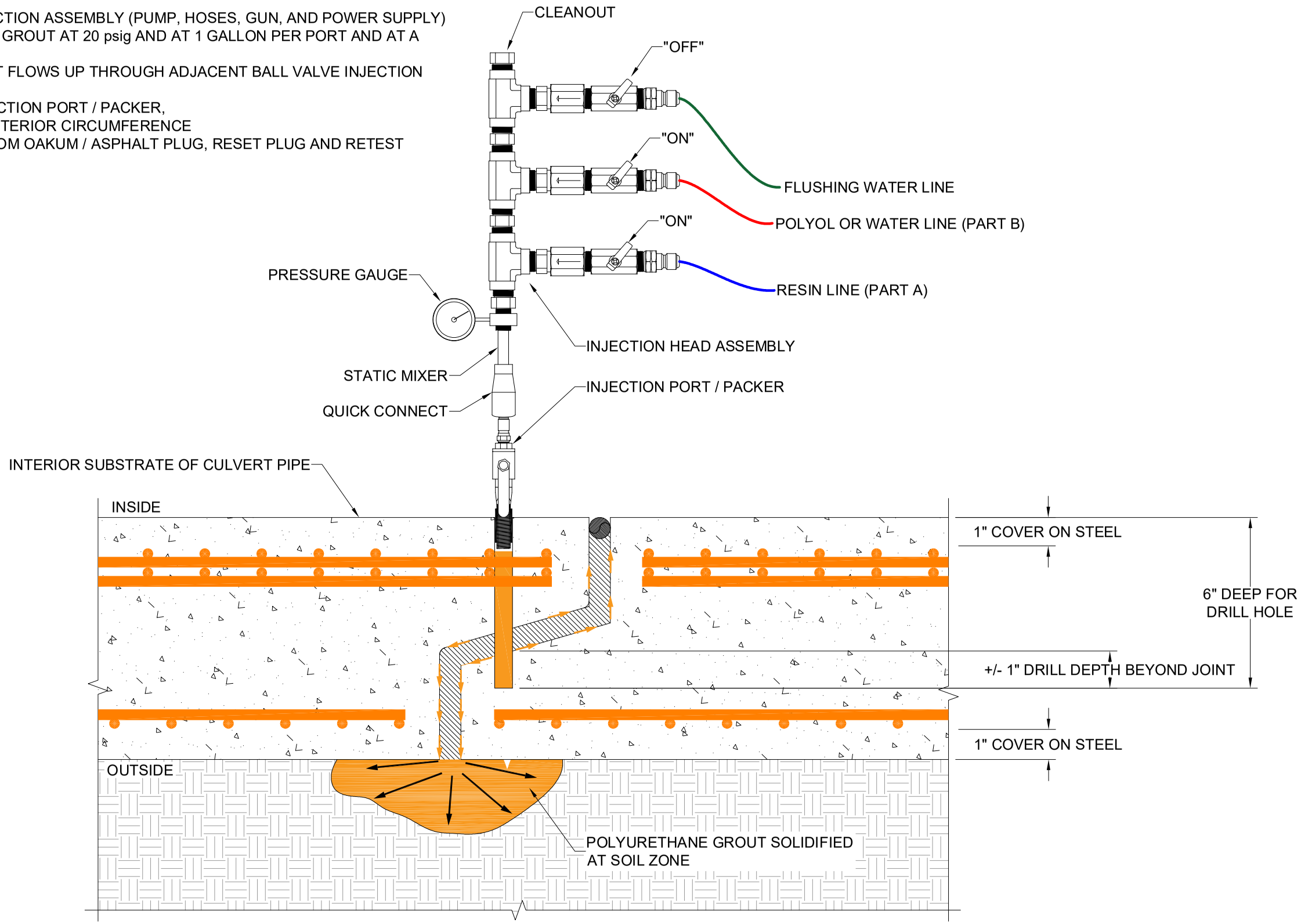
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 7A

1. SETUP POLYURETHANE GROUT INJECTION ASSEMBLY (PUMP, HOSES, GUN, AND POWER SUPPLY)
2. PUMP HYDROPHILIC POLYURETHANE GROUT AT 20 psig AND AT 1 GALLON PER PORT AND AT A RATE OF 1/4 GAL. PER MINUTE
3. IF OR / WHEN POLYURETHANE GROUT FLOWS UP THROUGH ADJACENT BALL VALVE INJECTION PORT / PACKER;
   - 3.1. MOVE TO NEXT BALL VALVE INJECTION PORT / PACKER,
   - 3.2. REPEAT PROCEDURE AROUND INTERIOR CIRCUMFERENCE
4. IF POLYURETHANE GROUT LEAKS FROM OAKUM / ASPHALT PLUG, RESET PLUG AND RETEST



8 POLYURETHANE GROUT, JOINT INJECTION

POLYURETHANE GROUT SET-UP AND INJECTION

Scale 1-1/2"=1'-0"

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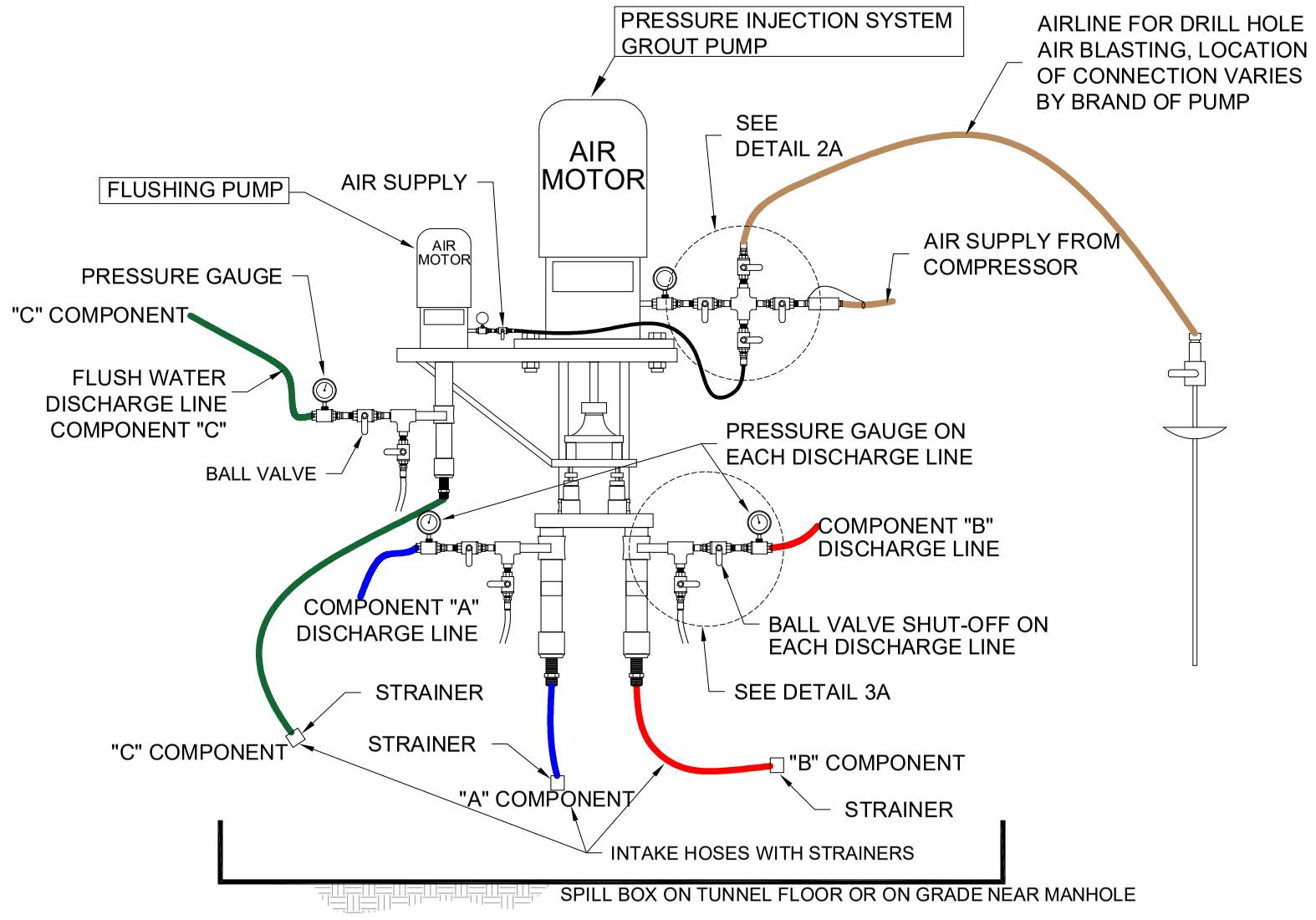
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 8A

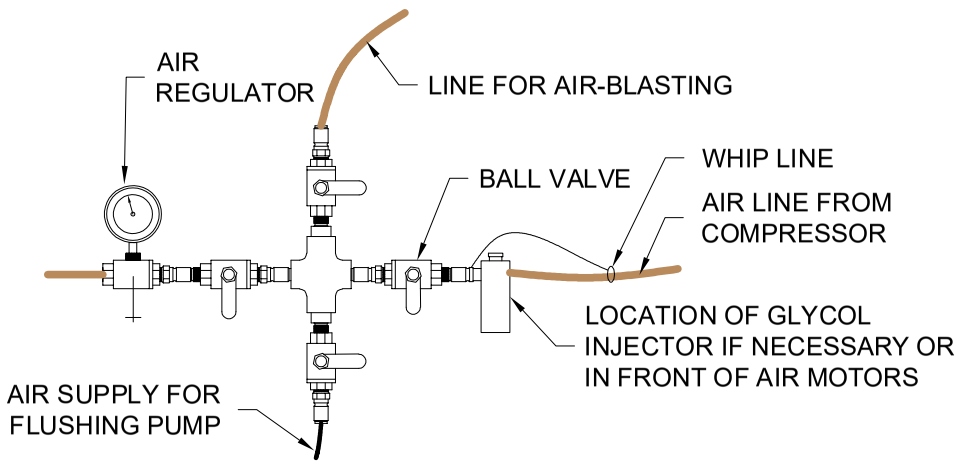
HYDROPHILIC URETHANE GROUT EQUIPMENT AND PROCEDURES:

EQUIPMENT SETUP FOR CHEMICAL GROUT SYSTEM (CGS) - CLEANING, FLUSHING, PRESSURE INJECTION AND STORAGE

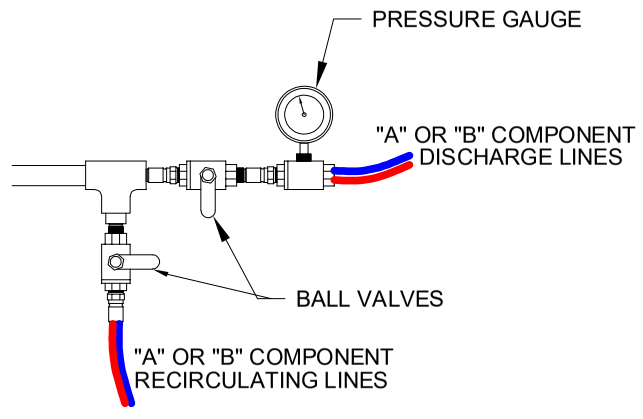


9 POLYURETHANE GROUT, JOINT INJECTION

GROUT & FLUSHING PUMP SET-UP & COMPONENTS



2A DETAIL OF AIR LINE SET-UP



3A DETAIL OF DISCHARGE AND RE-CIRCULATING LINES

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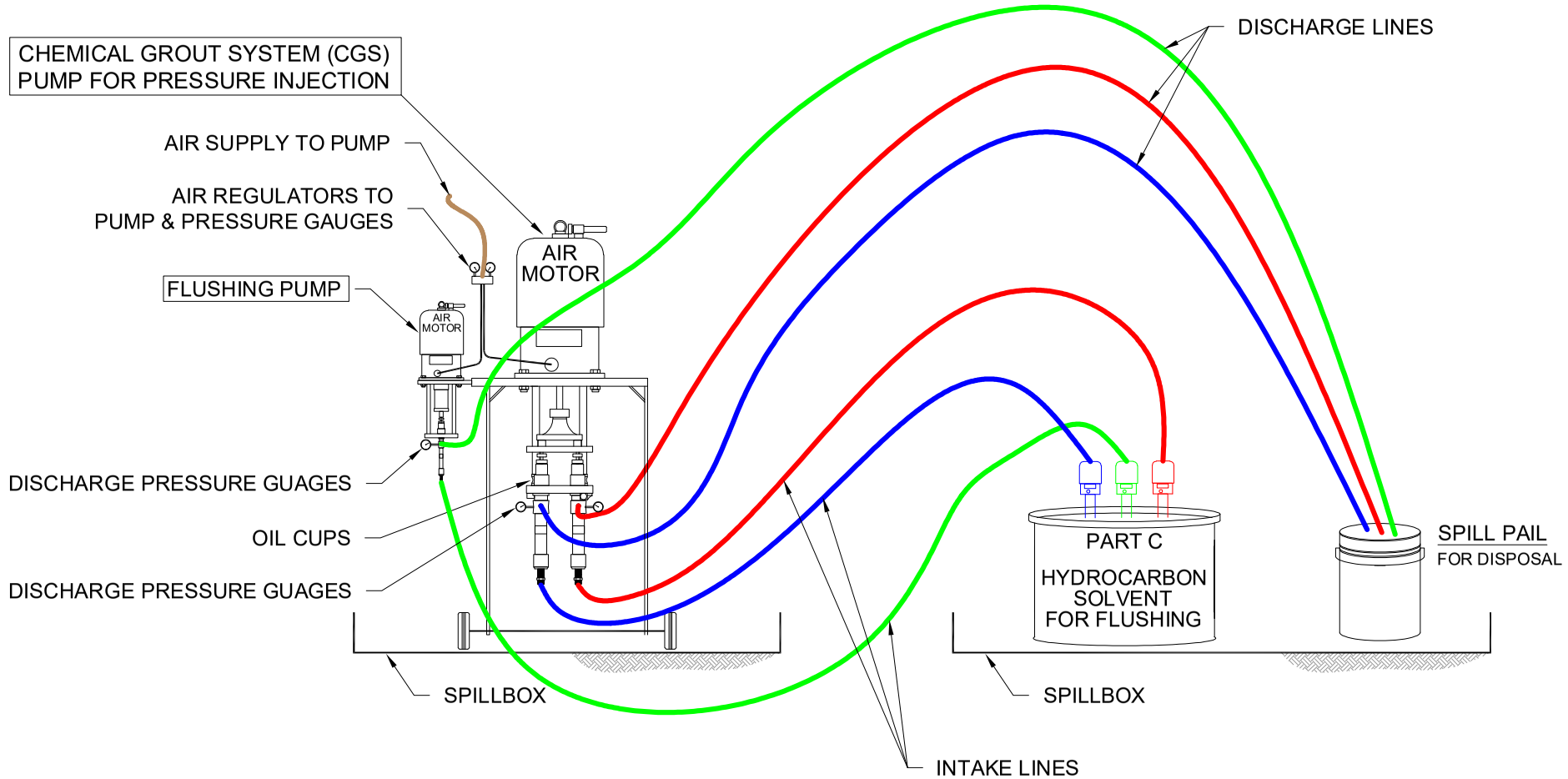
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 9A

1. SET PUMP ON / WITHIN SPILL BOX WITH TEAR RESISTANT MEMBRANE, RAISED ON SIDES
2. ATTACH AIR COMPRESSOR HOSE TO AIR LINE INTAKE ON PRESSURE INJECTION PUMP WITH APPROVED FITTING AND ANTI-WHIP LINE
3. INSTALL ETHYLENE GLYCOL LUBRICATOR IF COLD TEMPERATURES ARE PRESENT OR CONSTANT PUMPING IS REQUIRED
4. FILL PART "C" CONTAINER WITH HYDROCARBON SOLVENT (ACETONE, MEK, TOULENE OR MINERAL SPIRITS), NOTE THESE MATERIALS REQUIRE SPECIAL DISPOSAL PROTOCOL
5. PLACE INTAKE LINE FROM FLUSHING PUMP AND BOTH "A" & "B" COMPONENT PRESSURE INJECTION PUMP LINE OF CHEMICAL GROUT SYSTEM (CGS) INTO PART "C" CONTAINER
6. PLACE ALL THREE DISCHARGE LINES IN SPILL PAIL
7. TURN CHEMICAL GROUT SYSTEM (CGS) PUMP ON AT LOW SPEED AND PRESSURE, ENSURE ALL THREE LINES DISCHARGE LIQUIDS INTO SPILL PAIL
8. CIRCULATE WATER THROUGH SYSTEM UNTIL ALL OIL FROM STORAGE IS FLUSHED OUT OF THE SYSTEM
9. CHECK TO ENSURE RATIO OF "A" & "B" COMPONENTS IS EQUAL OR WITHIN 10% OF EACH OTHER, SEE SHEET 14A
10. PUT INJECTION HEAD ("E" ASSEMBLY) ONTO (USE QUICK CONNECT FITTINGS) DISCHARGE LINES AND CLOSE BALL-VALVES, ENSURE NO LEAKAGE EXISTS AT HIGH FLUID PRESSURE (PRESSURE-CHECK)
11. MAKE ADJUSTMENTS WHERE NECESSARY IF LEAKAGE AT MECHANICAL CONNECTIONS OCCUR



* NOTE:
- RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY
- PUMP IS USUALLY STORED WITH VEGETABLE OIL IN SYSTEM. THIS IS NON-HAZARDOUS AND CAN EASILY BE DISPOSED OF.

10 POLYURETHANE GROUT, JOINT INJECTION
PUMP FLUSHING OF STORAGE OIL OUT FROM SYSTEM
GROUT PUMP PREPERATION

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 10A

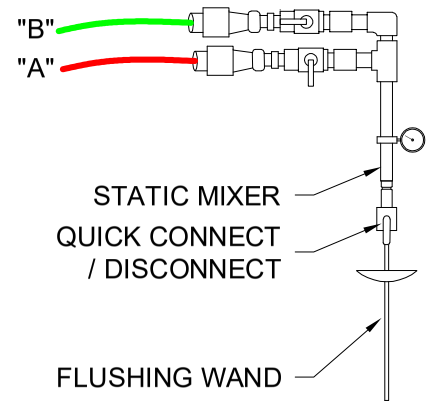
WATER FLUSHING DRILL HOLES WITH SINGLE COMPONENT PUMP:

1. OPEN BALL VALVE ON "L" ASSEMBLY FOR COMPONENT "B", WATER
2. PLACE WATER BLAST WAND ON "E" ASSEMBLY
3. TURN FLUSHING PUMP "ON", ADJUST TO DESIRED WATER BLAST PRESSURE
4. PLACE FLUSHING WAND DOWN DRILL HOLE TO FLUSH DRILLING DEBRIS FROM HOLE

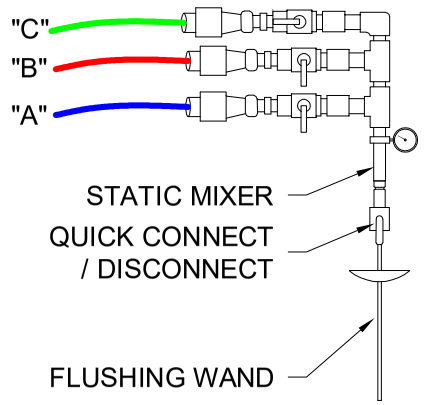
WATER FLUSHING CRACK:

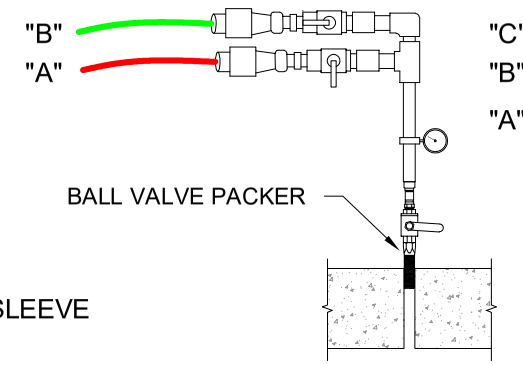
1. REMOVE WATER BLAST WAND FROM "E" OR "L" ASSEMBLY
2. PLACE BALL-VALVE PACKER ON DRILL HOLE, SECURE & TIGHTEN
3. PLACE "E" OR "L" ASSEMBLY ON BALL VALVE PACKER
4. TURN FLUSHING PUMP ON, ADJUST PRESSURE TO ENSURE WATER FLUSHES OUT CRACK 6" ON EACH SIDE OF DRILL HOLE
5. TURN FLUSHING PUMP OFF - REMOVE "E" OR "L" ASSEMBLY FROM PACKER

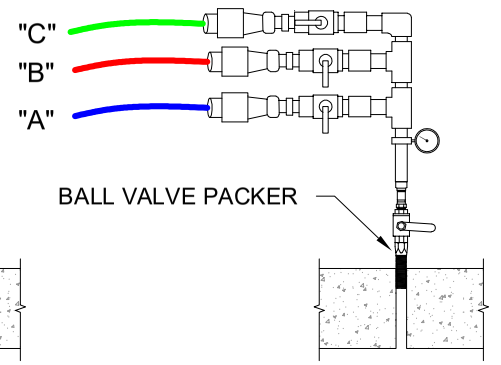
"F" ASSEMBLY

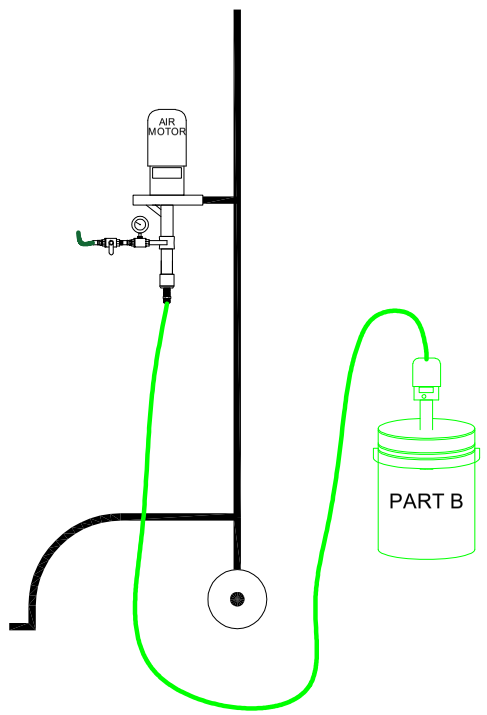


"E" ASSEMBLY

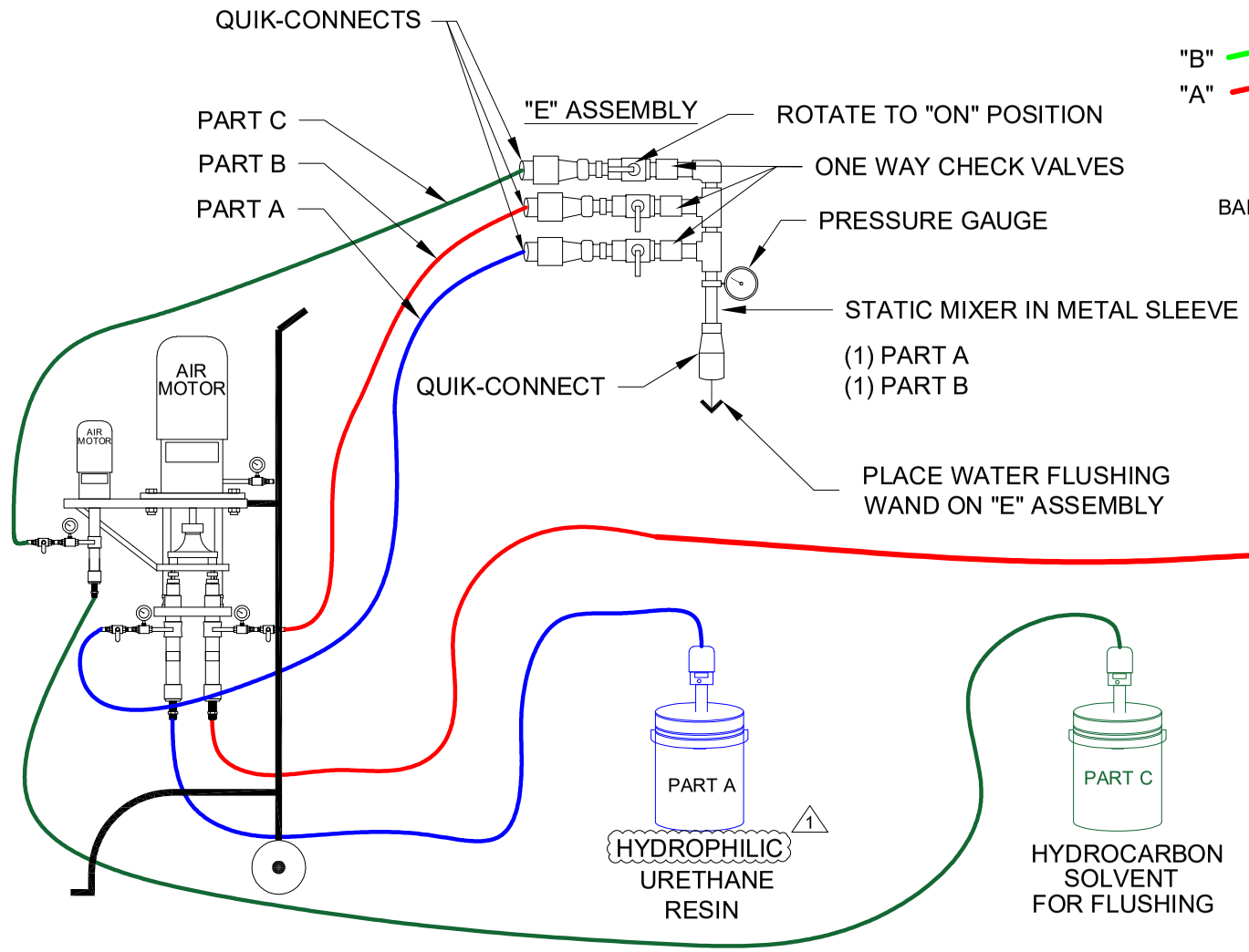






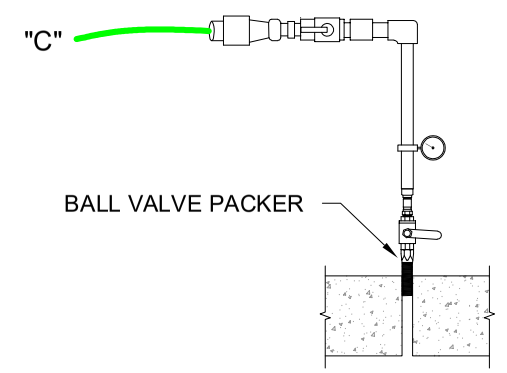


11A SINGLE COMPONENT PUMP
FOR OPTIONAL FLUSHING



11B DUEL COMPONENT PUMP WITH FLUSHING PUMP

"L" ASSEMBLY



11 POLYURETHANE GROUT, JOINT INJECTION
CLASSIC SET-UP FOR FLUSHING GROUT & PUMPING WATER FOR CRACK / JOINT FLUSHING
* NOTE: RE-CIRCULATING LINES NOT SHOWN FOR CLARITY
* NOTE: SPILL BOX NOT SHOWN FOR CLARITY

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RAYMOND ROAD CULVERT PIPE RESTORATION

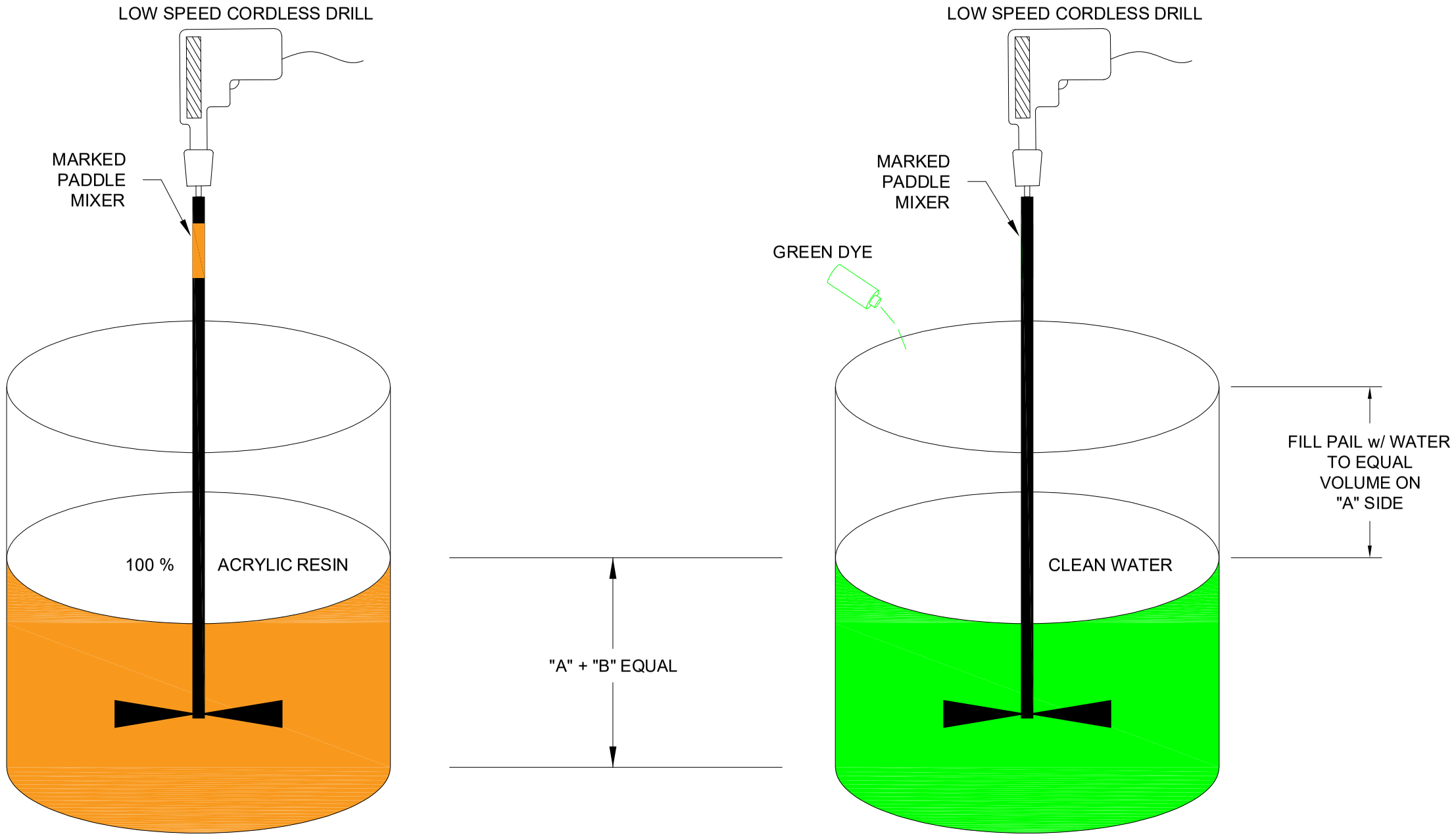
SHEET: 11A

"A" COMPONENT MIXING

1. POSITION 100% HYDROPHILIC URETHANE PAIL ON SPILL PAD
2. OPEN LID ON PAIL
3. PLACE PADDLE IN "A" PAIL AND SLOWLY MIX FOR 2 MINUTES
4. MEASURE TEMPERATURE OF "A" COMPONENT
5. HEAT OR COOL IF NECESSARY
6. PLACE LID BACK ON PAIL UNTIL READY FOR USE
7. MARK "A" PADDLE WITH ORANGE LABEL OR TAPE TO ENSURE AGAINST CROSS-CONTAMINATION IN "B" COMPONENT

"B" COMPONENT MIXING

1. POSITION WATER PAIL AND FILL WITH 4 GALLONS OF CLEAN WATER
2. ADD 2-3 TEASPOONS OF GREEN DYE TO PAIL
3. PLACE PADDLE IN "B" WATER PAIL AND SLOWLY MIX FOR 2 MINUTES
4. MEASURE TEMPERATURE OF "B" COMPONENT FLUID
5. HEAT OR COOL IF NECESSARY
6. PLACE LID BACK ON PAIL UNTIL READY FOR USE
7. MARK "B" RESIN PADDLE WITH GREEN LABEL OR TAPE TO ENSURE AGAINST CROSS-CONTAMINATION IN "A" COMPONENTS
8. FILL PAIL TO AN EQUAL VOLUME AS ON "A" SIDE



100% HYDROPHILIC URETHANE

100% WATER

12 POLYURETHANE GROUT, JOINT INJECTION
MIXING / FORMULATING A&B COMPONENTS

12A "A" COMPONENT MIXING
"A" HYDROCARBON URETHANE PAIL

12B "B" COMPONENT MIXING
"B" WATER PAIL

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISION	BY
1	1/9/2020	REVISIONS	TB

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DRN	TB	1/9/2020
CHK	BA	1/9/2020

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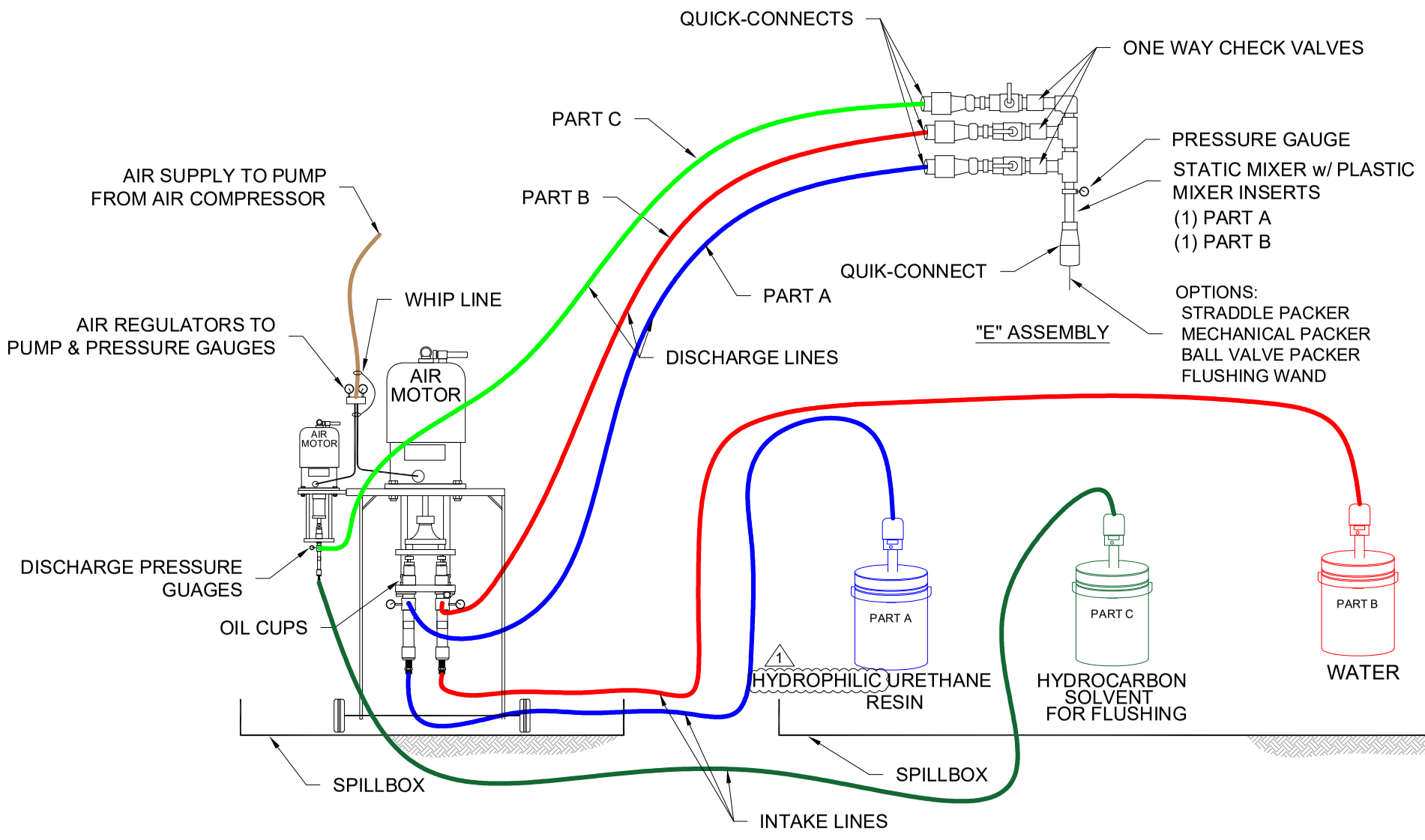
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 12A

1. REFER TO SHEET 14A AND 15A, FOR GEL-TIME CUP TEST, AND RATIO CHECK
2. NOTE: STATIC MIXER NEEDS TO BE FLUSHED WITH SOLVENT PRIOR TO GEL-TIME REACTION
3. TURN ON AIR PRESSURE TO CHEMICAL GROUT SYSTEM PUMP, TURN OFF AIR PRESSURE TO FLUSHING PUMP
4. REGULATE AIR PRESSURE TO OBTAIN A STEADY FLOW OF MATERIAL THROUGH INJECTION GUN*
5. HOOK UP INJECTION HEAD* TO QUICK CONNECT OF BALL VALVE PACKER ASSEMBLY
6. START INJECTION PRESSURE AT (1-5) psig, MONITOR PISTONS ON PUMP FOR FLOW
7. CONTINUE PUMPING UNTIL MIXED GROUT EXTENDS HALF WAY TO EACH ADJACENT PORT
8. IF RESISTANCE TO CHEMICAL GROUT FLOW DOES NOT ALLOW PISTON MOVEMENT, INCREASE PRESSURE TO AIR MOTOR ON CHEMICAL GROUT SYSTEM (CGS) PRESSURE INJECTION PUMP IN 100 psig INCREMENTS UNTIL FLOW OCCURS
9. DO NOT EXCEED 10 psig AT DISCHARGE PRESSURE GAUGES
10. IF CHEMICAL GROUT DOES NOT CONTINUE TO FLOW, REMOVE "E" ASSEMBLY FROM PACKER, FLUSH LINE WITH WATER, REPEAT PROCESS OF DRILLING NEW DRILL HOLE IN VICINITY OF "DEAD HOLE". NOTE THAT THIS SHOULD NOT OCCUR BECAUSE THE HOLE WAS TESTED WITH WATER PREVIOUSLY.
11. MOVE TO NEXT PACKER ASSEMBLY.

* INJECTION GUN = INJECTION HEAD = "E" ASSEMBLY



13 POLYURETHANE GROUT, JOINT INJECTION

CHEMICAL GROUT INJECTION OPERATION AND PLUMBING

* NOTE - RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY

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RAYMOND ROAD CULVERT PIPE RESTORATION

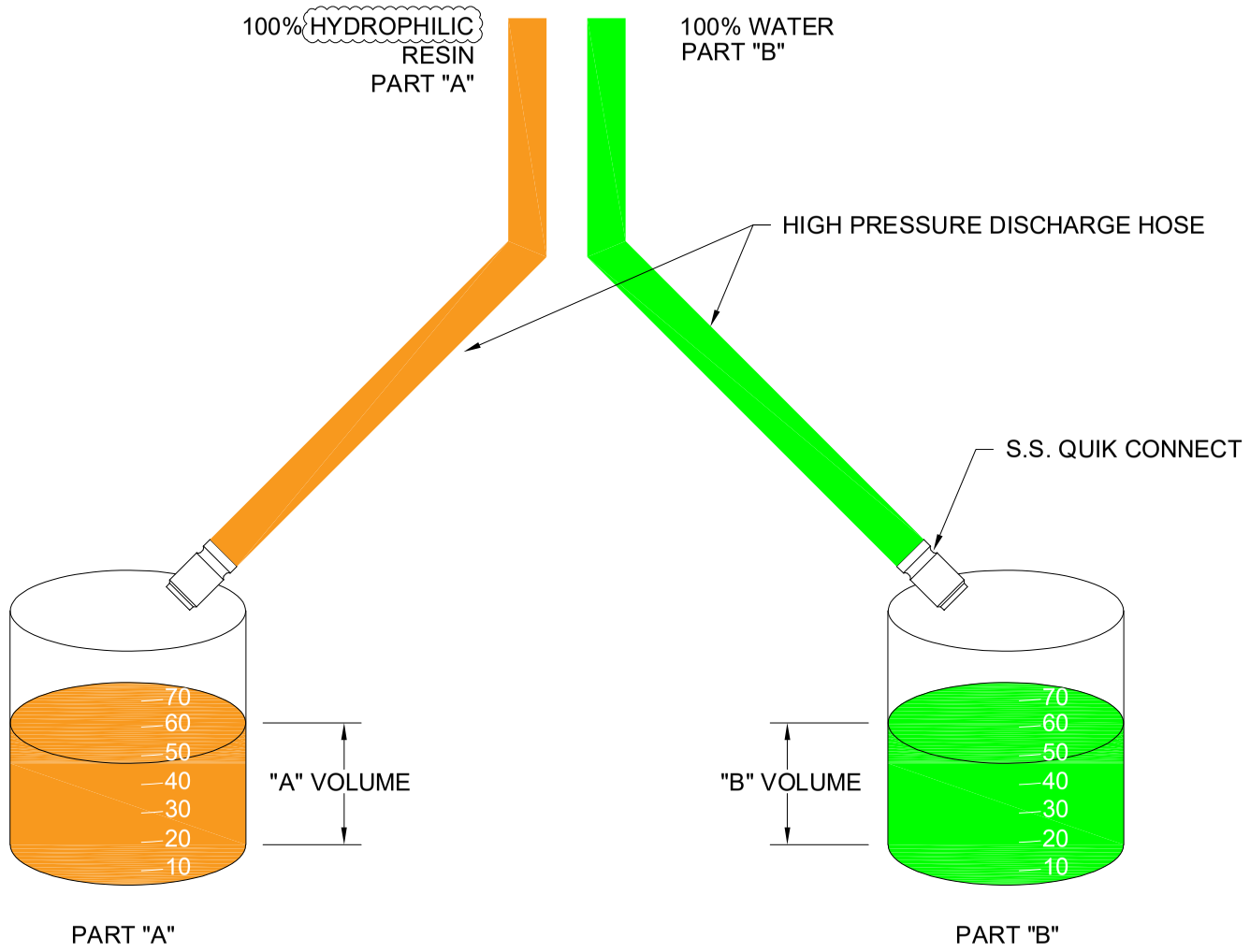
SHEET: 13A

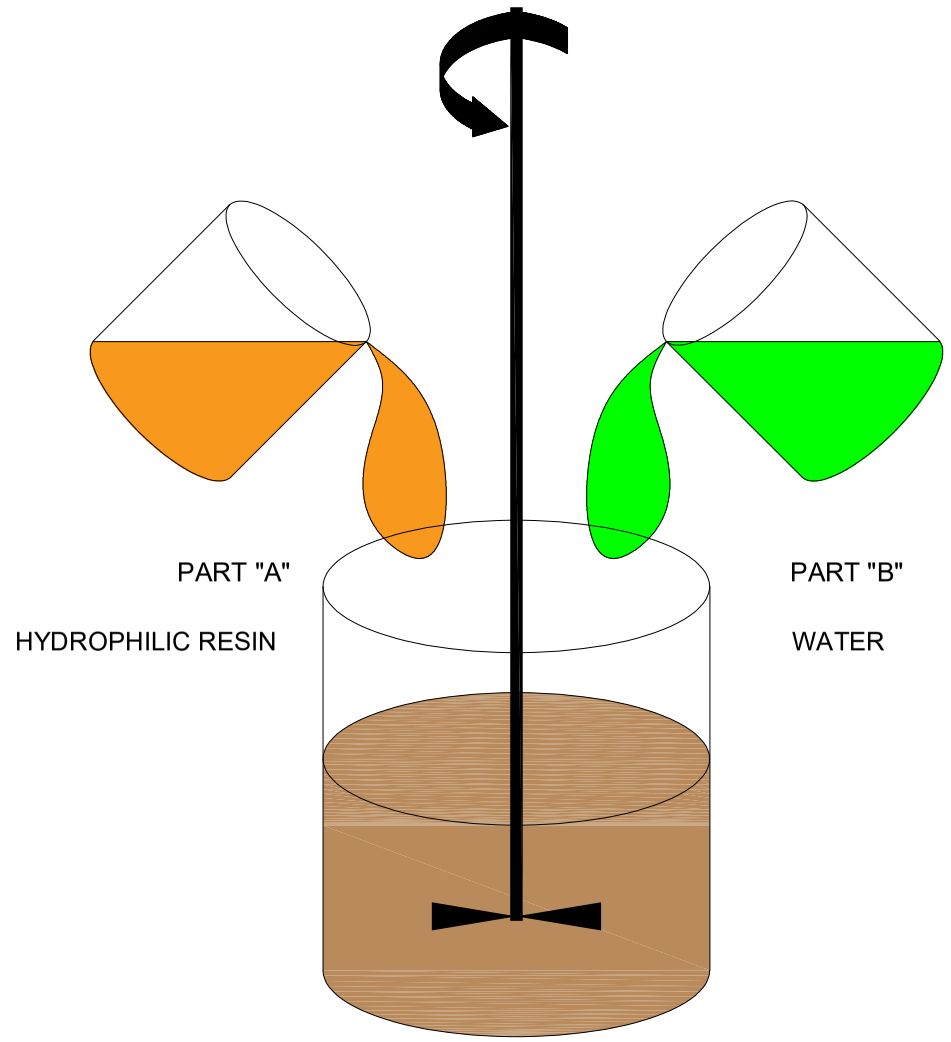
1. PRIOR TO PUMPING:
   1.1. DISCONNECT "E" OR "F" ASSEMBLY
   1.2. PUMP PARTS "A" & "B" INTO MEASURING CUPS TO ENSURE PROPER 1-TO-1 RATIO, TOLERANCE MAY BE 10% EITHER WAY
   1.3. ADJUST PUMP STROKE LENGTH IF NOT IN RATIO OF 1-TO-1
2. RATIO BALANCE CAN BE INFLUENCED BY PARTICLES OR DEBRIS BUILD UP IN VALVES OF PUMP

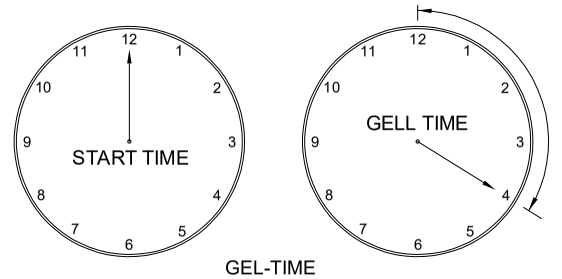
GEL TIME INFLUENCED BY:

1. TEMPERATURE OF LIQUIDS "A" & "B"
2. pH OF WATER ON "B" SIDE
3. IRON CONTENT IN WATER IN "B" SIDE

1. TAKE "A" & "B" COMPONENTS AND MIX TOGETHER, NOTE START TIME.
2. AFTER SHORT PERIOD (30 SECONDS TO 3 MINUTES) GROUT VISCOSITY INCREASES AND SHOULD START TO FOAM.
3. RATHER QUICKLY GROUT SOLIDIFIES INTO A FOAM MASS. NOTE GEL SET TIME.
4. IF GEL TIME IS TOO SHORT:
   4.1. REDUCE PART "A" RESIN BY 20°F INTO PART "A"
   4.2. REDUCE WATER TEMPERATURE IN PART "B" BY 20°F.
   4.3. MEASURE NEW GEL TIME.
5. IF GEL TIME IS TOO LONG:
   5.1. INCREASE TEMPERATURE BY 20° F INTO PART "A"
   5.2. INCREASE TEMPERATURE IN PART "B" BY 20°F
   5.3. MEASURE NEW GEL TIME
6. GEL-TIME IS INFLUENCED BY FLUID TEMPERATURE "A" & "B" RESIN TEMPERATURE CAN BE VARIED FROM 40° F TO 120° F.
7. PAIL AND/OR DRUM HEATERS ARE COMMONLY USED IF WARMING IS REQUIRED.







14 POLYURETHANE GROUT, JOINT INJECTION
RATIO AND GEL-TIME CHECK

14A QA / QC, T-to-1 RATIO CHECK

14B GEL TIME CHECK

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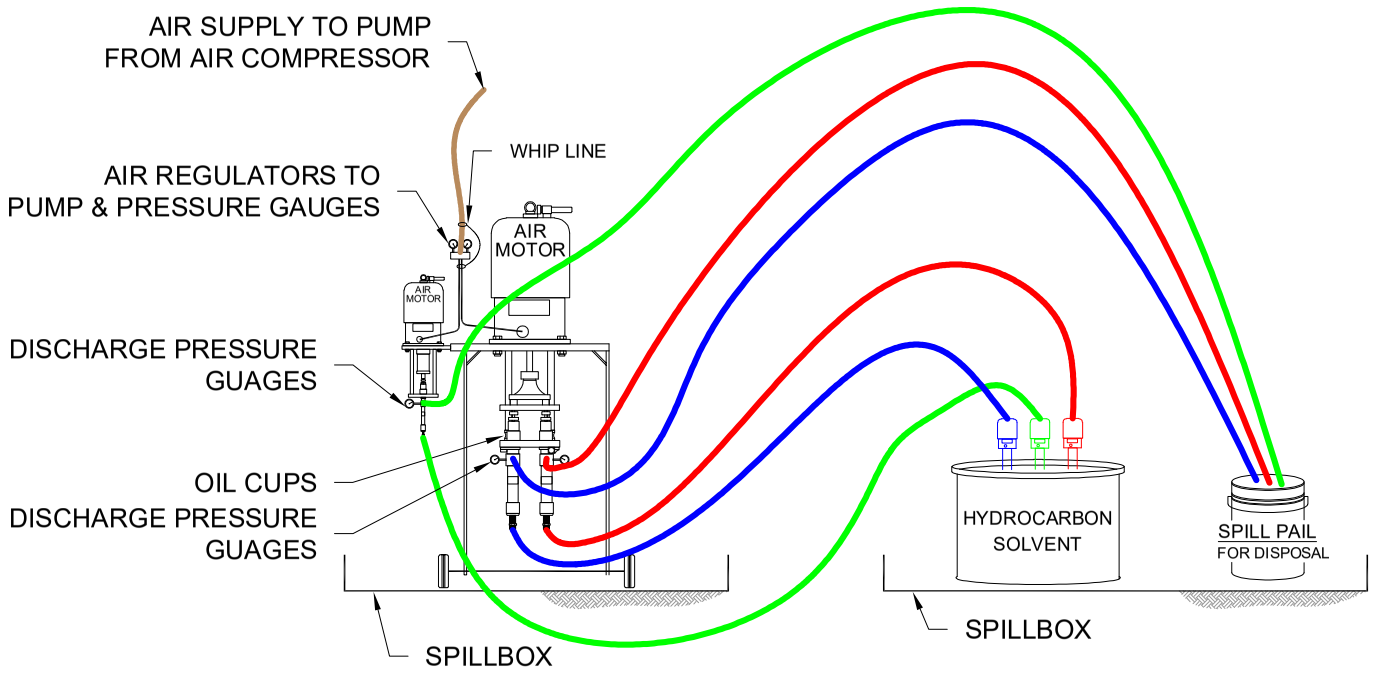
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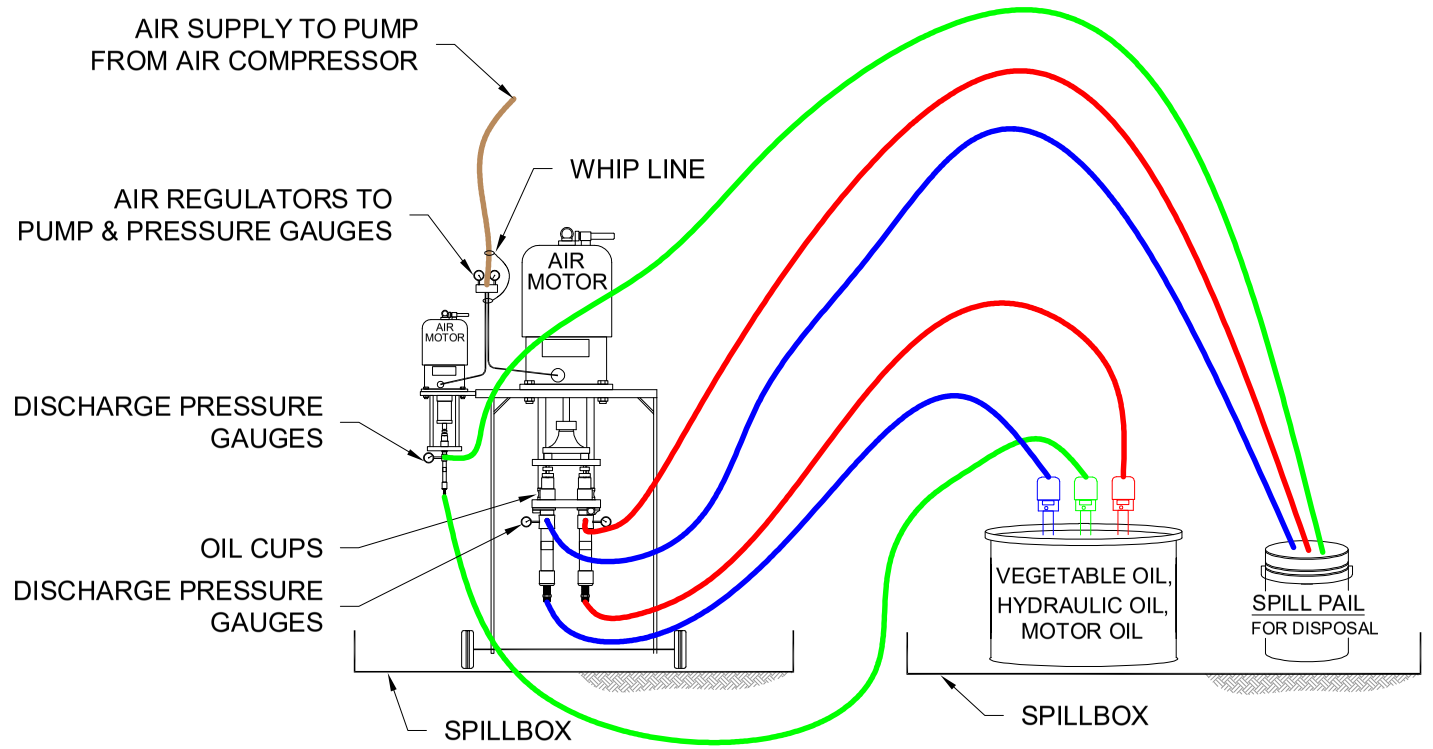
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 14A

1. UPON COMPLETION OF PRESSURE INJECTION OPERATIONS, FLUSH PUMPS (CHEMICAL GROUT SYSTEMS (CGS) PRESSURE INJECTION PUMP AND ATTACHED FLUSHING PUMP) WITH HYDROCARBON SOLVENT INTO SPILL PAIL.
2. DISPOSE OF HAZARDOUS WASTE SOLVENT COMPONENTS.



1. AFTER FLUSHING, PUMP VEGETABLE, OR MOTOR OIL IN (CHEMICAL GROUT SYSTEMS (CGS) PRESSURE INJECTION PUMP AND ATTACHED FLUSHING PUMP) SYSTEM FOR STORAGE AND UNTIL NEXT USAGE.
2. DISPOSE WASTE IN HAZARDOUS STORAGE CONTAINERS

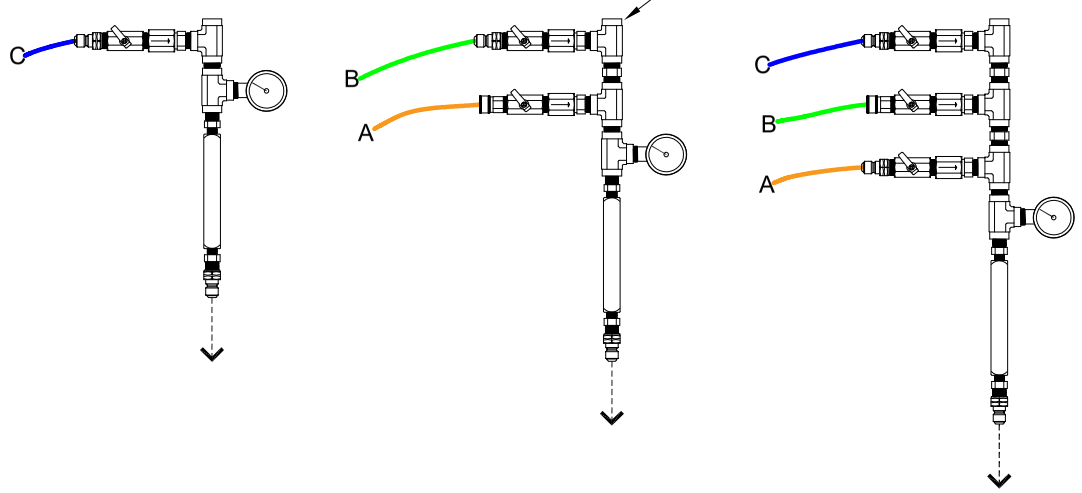


15 POLYURETHANE GROUT, JOINT INJECTION

FLUSHING GROUT PUMP, PREPARING FOR STORAGE AND GROUT PUMP CLEANUP
* NOTE - RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY

WATER FLUSHING LINE IN OPEN POSITION, MEANING PRESSURIZED WATER FLOW TO OCCUR FROM FLUSHING PUMP

CALLED: INJECTION HEAD INJECTION GUN OR "E" ASSEMBLY

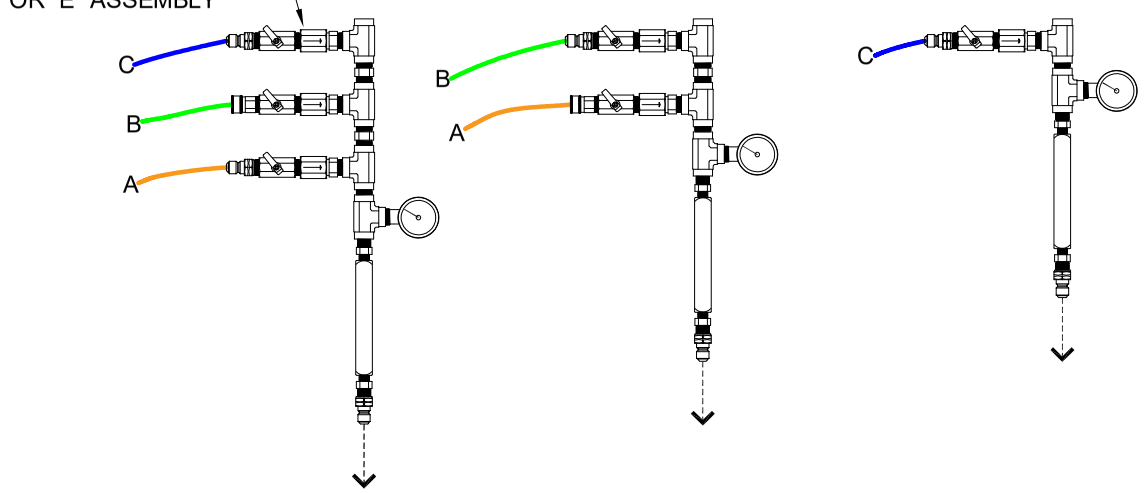


"L" ASSEMBLY "F" ASSEMBLY "E" ASSEMBLY

BALL VALVES, CLOSED POSITION FOR CHEMICAL GROUT FLOW FROM GROUT PUMP

CALLED: INJECTION HEAD INJECTION GUN OR "E" ASSEMBLY

WATER FLUSHING LINE IN CLOSED POSITION, MEANING NO WATER FLOW FROM FLUSHING PUMP



"E" ASSEMBLY "F" ASSEMBLY "L" ASSEMBLY

BALL VALVES, OPEN POSITION FOR CHEMICAL GROUT FLOW FROM GROUT PUMP

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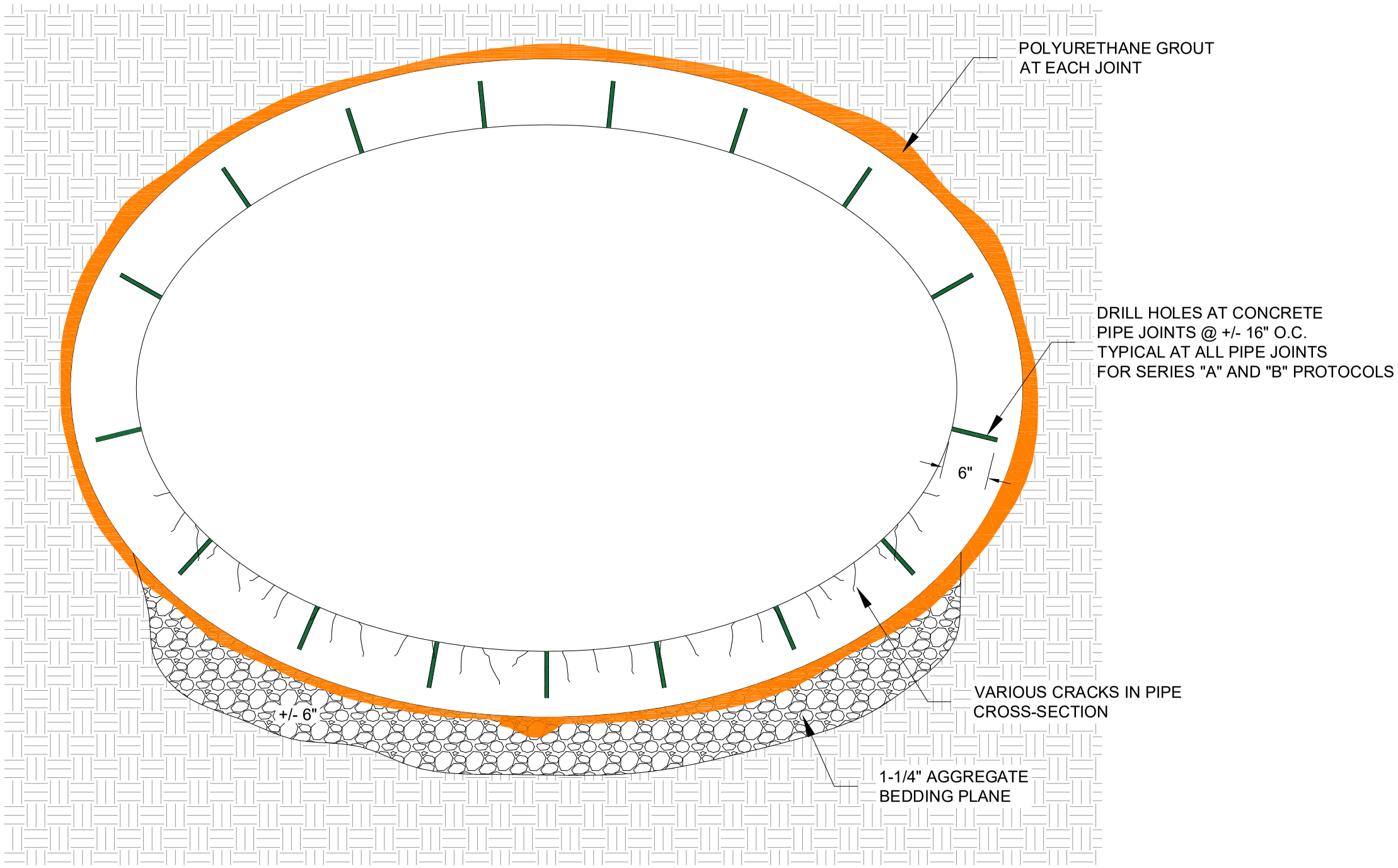
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 15A



16 DRILL HOLE LAYOUT AT +/- 16" O.C. AT CONCRETE PIPE JOINTS

POLYURETHANE GROUT PLUG AROUND PERIMETER OF PIPE JOINTS

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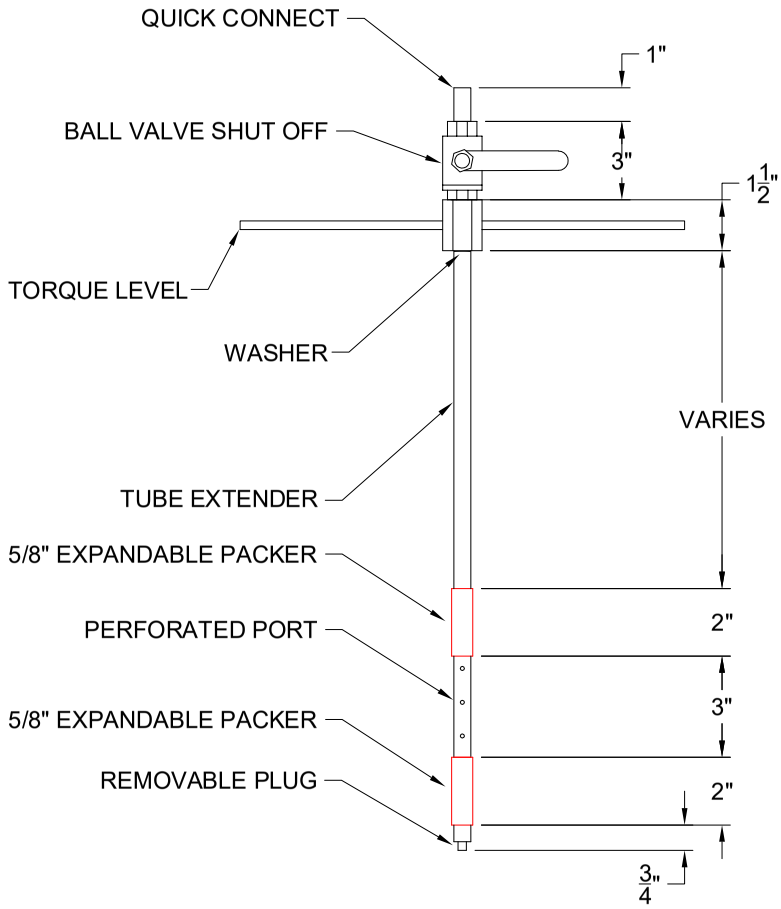
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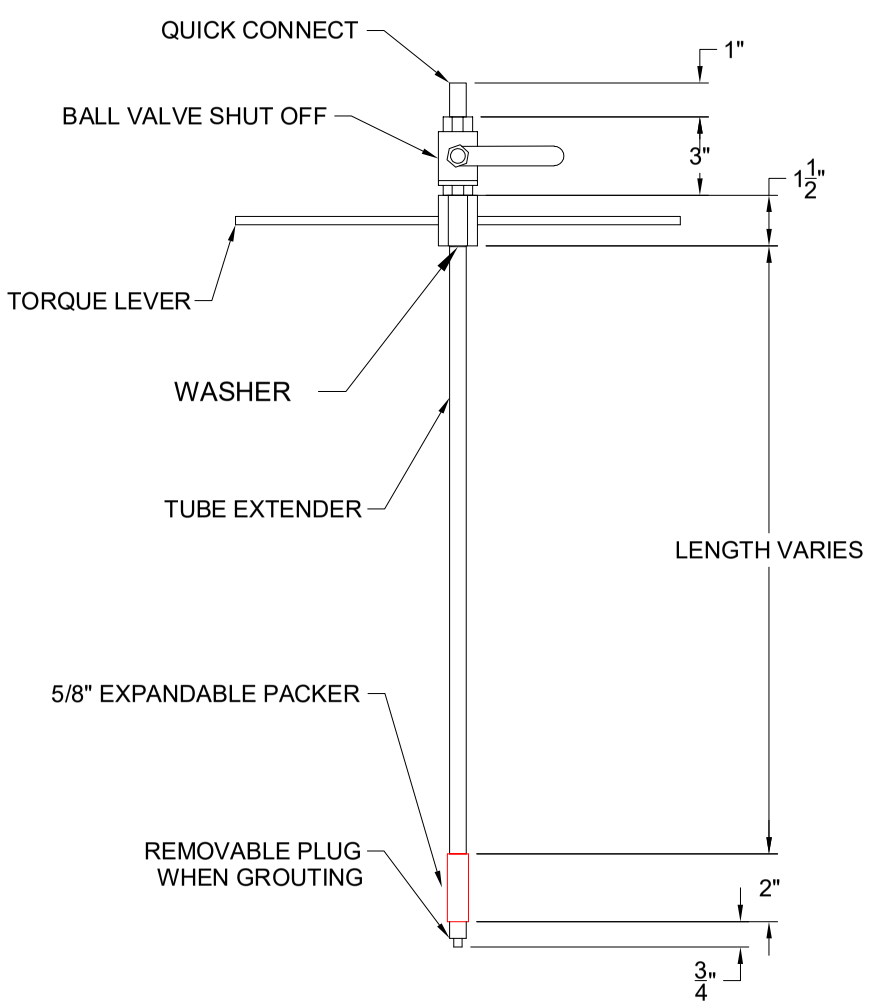
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RAYMOND ROAD CULVERT PIPE RESTORATION

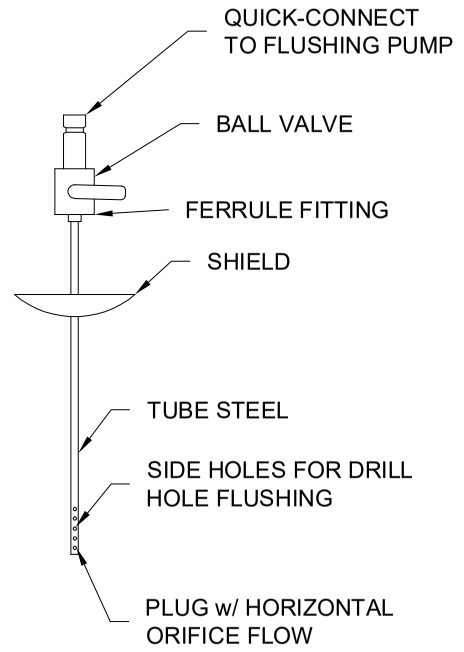
SHEET: 16A



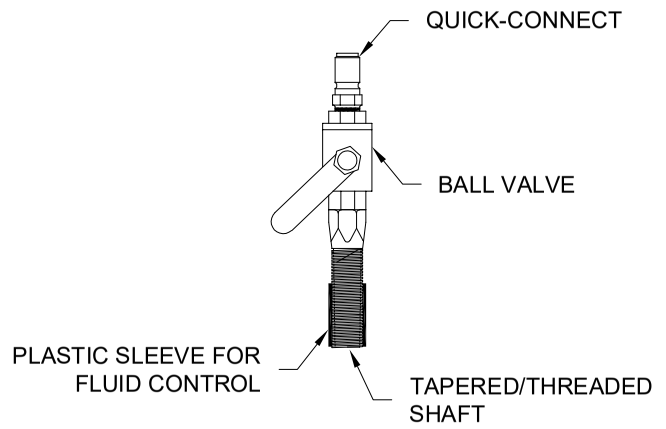
STRADDLE MECHANICAL PACKER



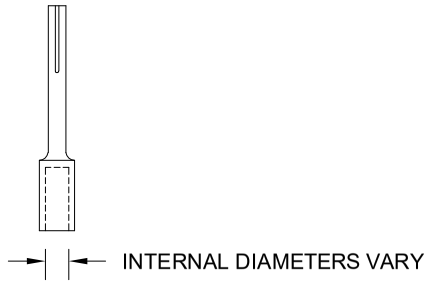
MECHANICAL PACKER



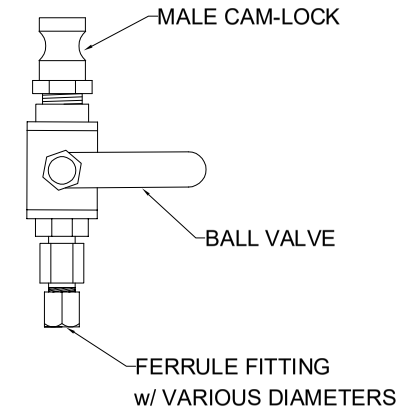
DRILL HOLE FLUSHING WAND



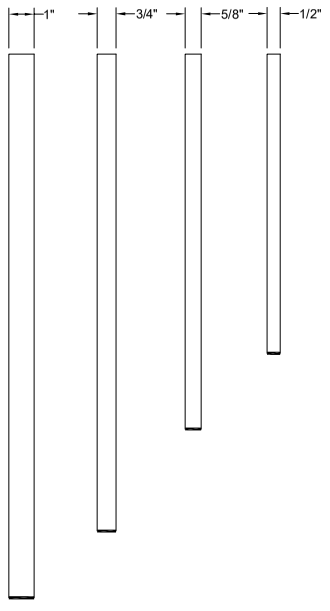
(TSBV) PACKER
TAPERED SHAFT, BALL VALVE (TSBV)



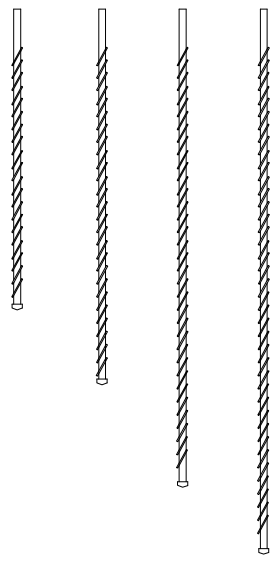
MANCHETTE DRIVER
w/ VARIOUS INTERNAL DIAMETERS



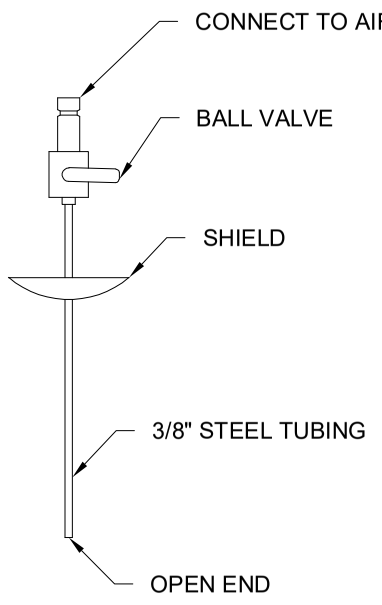
CAM / BALL VALVE / FERRULE



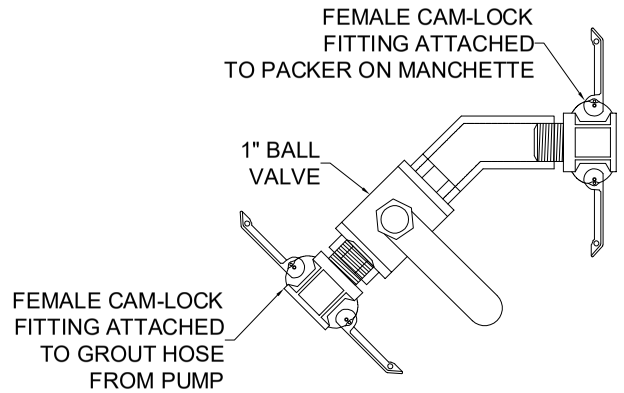
CORE BITS OF VARIOUS
LENGTHS & DIAMETERS



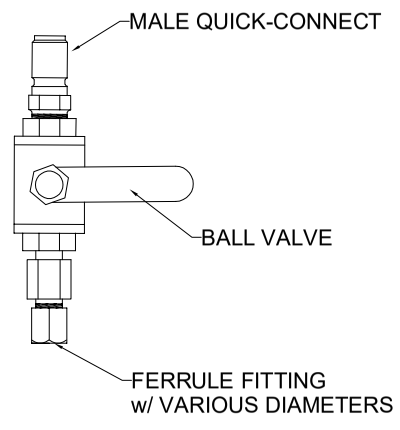
DRILL BITS OF VARIOUS
LENGTHS & DIAMETERS



AIR FLUSHING WAND FOR
INITIAL DRILL HOLE CLEANING



CEMENT GROUT CAM-LOCK INJECTION GUN



QUICK-CONNECT / BALL VALVE / FERRULE

17 POLYURETHANE GROUT, JOINT INJECTION
EXAMPLES OF GROUTING ACCESSORIES

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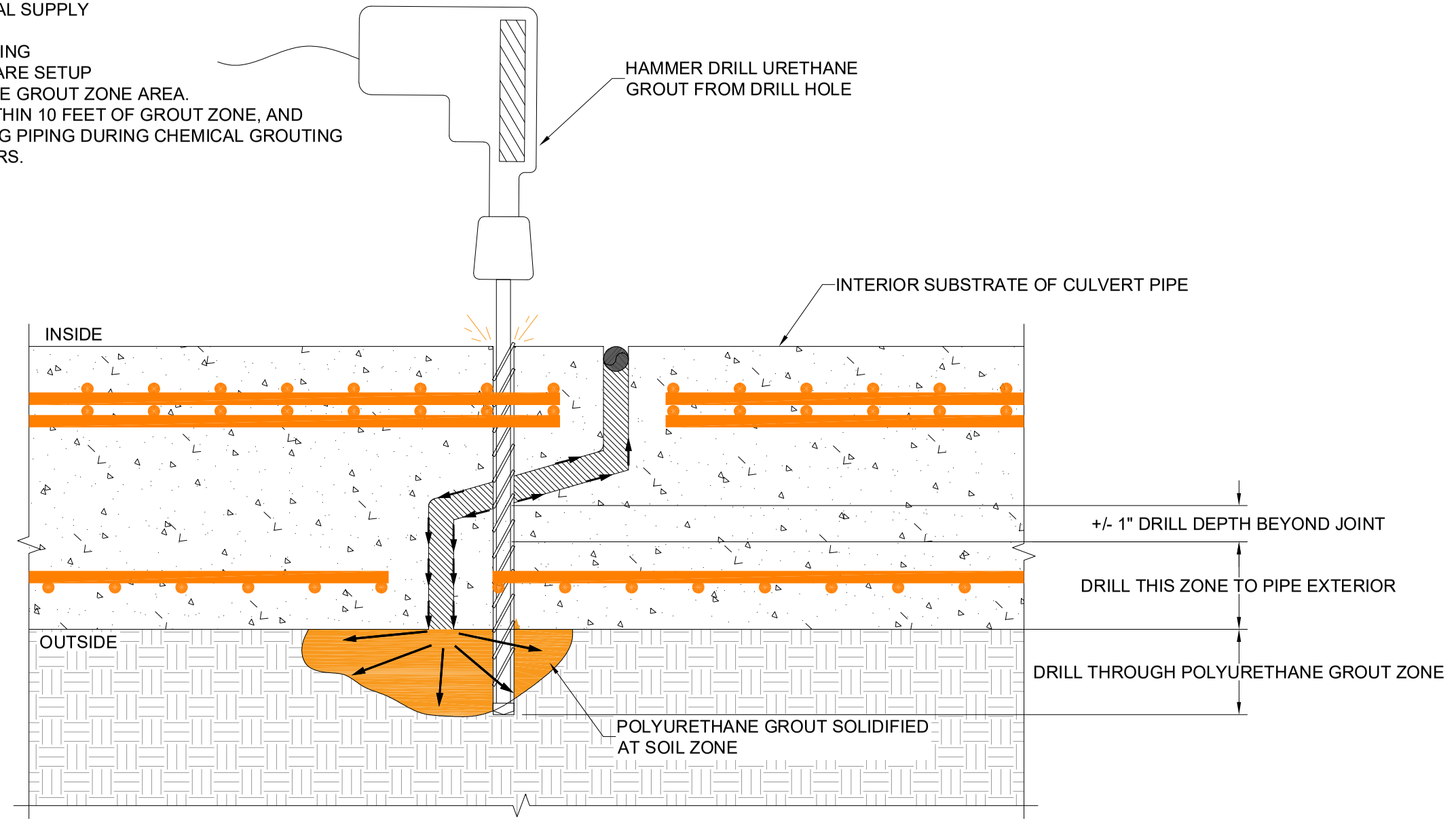
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 17A

1. COORDINATE SAFETY PLAN TO INCLUDE MANAGEMENT OF PACKER/PORT/MANCHETTE TOPS TO AVOID TRIP HAZARDS TO TRADESMEN
2. COORDINATE ACCESS/EGRESS PLAN IN CASE OF HIGH WATER, EXCESS CARBON DIOXIDE, LACK OF LIGHTING AND/OR OTHER ISSUES THAT MAY REQUIRE UNPLANNED EVACUATION OF CULVERT PIPE
3. COORDINATE WORKING TIMES TO ENSURE STORM WATER DRAINAGE DOES NOT INTERFERE WITH GROUTING OPERATIONS BEYOND MANAGED WATER RE-ROUTING
4. ENSURE PROJECT TEAM IS COORDINATED WITH WEATHER FORECASTS AND CURRENT CONDITIONS
5. ENSURE WATER DIVERSION PLAN IS APPROVED BY OWNER
6. FOLLOW ALL OSHA REQUIREMENTS FOR CONFINED SPACE
7. ENSURE:
   - 7.1. PROPER & ADEQUATE LIGHTING & ELECTRICAL SUPPLY
   - 7.2. PROPER & ADEQUATE FRESH AIR-SUPPLY
   - 7.3. PROPER & ADEQUATE AIR QUALITY MONITORING
   - 7.4. PROPER & ADEQUATE EYE WASH STATIONS ARE SETUP
8. IDENTIFY ALL BURIED UTILITIES WITHIN IMMEDIATE GROUT ZONE AREA.
9. IDENTIFY STORM OR SANITARY SEWER PIPES WITHIN 10 FEET OF GROUT ZONE, AND ESTABLISH SOME CRITERIA TO MONITOR EXISTING PIPING DURING CHEMICAL GROUTING TO ENSURE NO STRAY GROUT MIGRATION OCCURS.

1. REMOVE BALL VALVE INJECTION PORT / PACKER FROM INJECTION HOLE AND CLEAN FOR REUSE.
2. HAMMER OR CORE DRILL SAME INJECTION HOLE THRU CONCRETE PIPE FLANGE.

NOTE THE FOLLOWING:
- A. THE PIPE CIRCUMFERENCE IS 23 LINEAL FEET
- B. DRILL HOLES AT +/- 16" O.C. EQUATES TO 17 HOLES PER PIPE JOINT



1 ACRYLAMIDE GROUT, JOINT INJECTION
RE-DRILLING POLYURETHANE GROUT HOLES

Scale 1-1/2"=1'-0"

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GENERAL NOTES:
1. STEEL REINFORCING VARIES AT LOCATIONS IN CULVERT PIPE.

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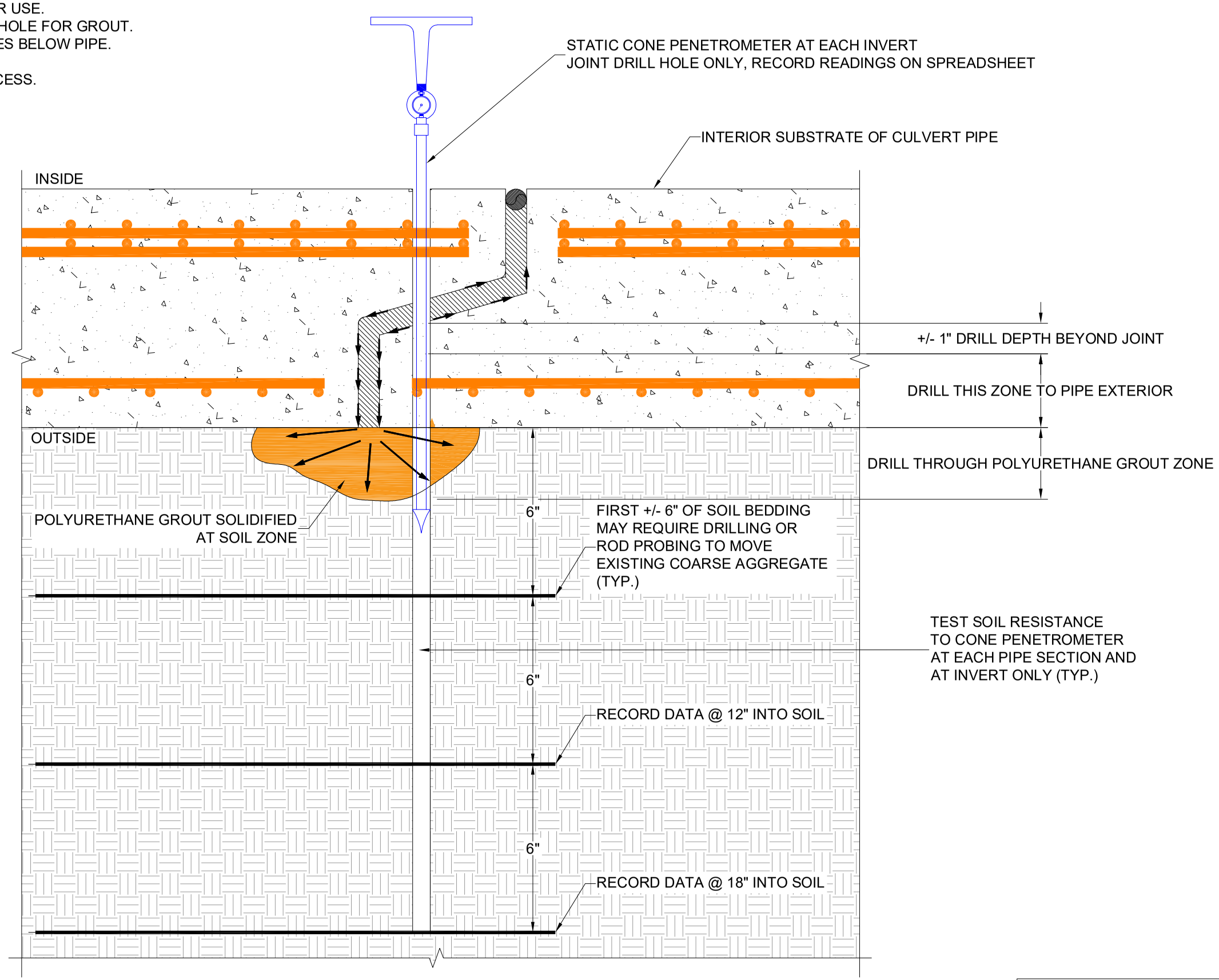
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SHEET: 1B

1. CALIBRATE STATIC CONE PENETROMETER.
2. FOLLOW MANUFACTURER'S INSTRUCTIONS FOR USE.
3. INSERT PENETROMETER INTO EXISTING DRILL HOLE FOR GROUT.
4. RECORD SOIL RESISTANCE AT 12 AND 18 INCHES BELOW PIPE.
5. EXTRACT PENETROMETER.
6. CONTINUE WITH ACRYLAMIDE GROUTING PROCESS.



2 ACRYLAMIDE GROUT, JOINT INJECTION
RE-DRILLING POLYURETHANE GROUT HOLES

Scale 1-1/2"=1'-0"

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

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1	1/9/2020	REVISIONS	TB

DES	DRN	CHK
BA	TB	BA
1/9/2020	1/9/2020	1/9/2020

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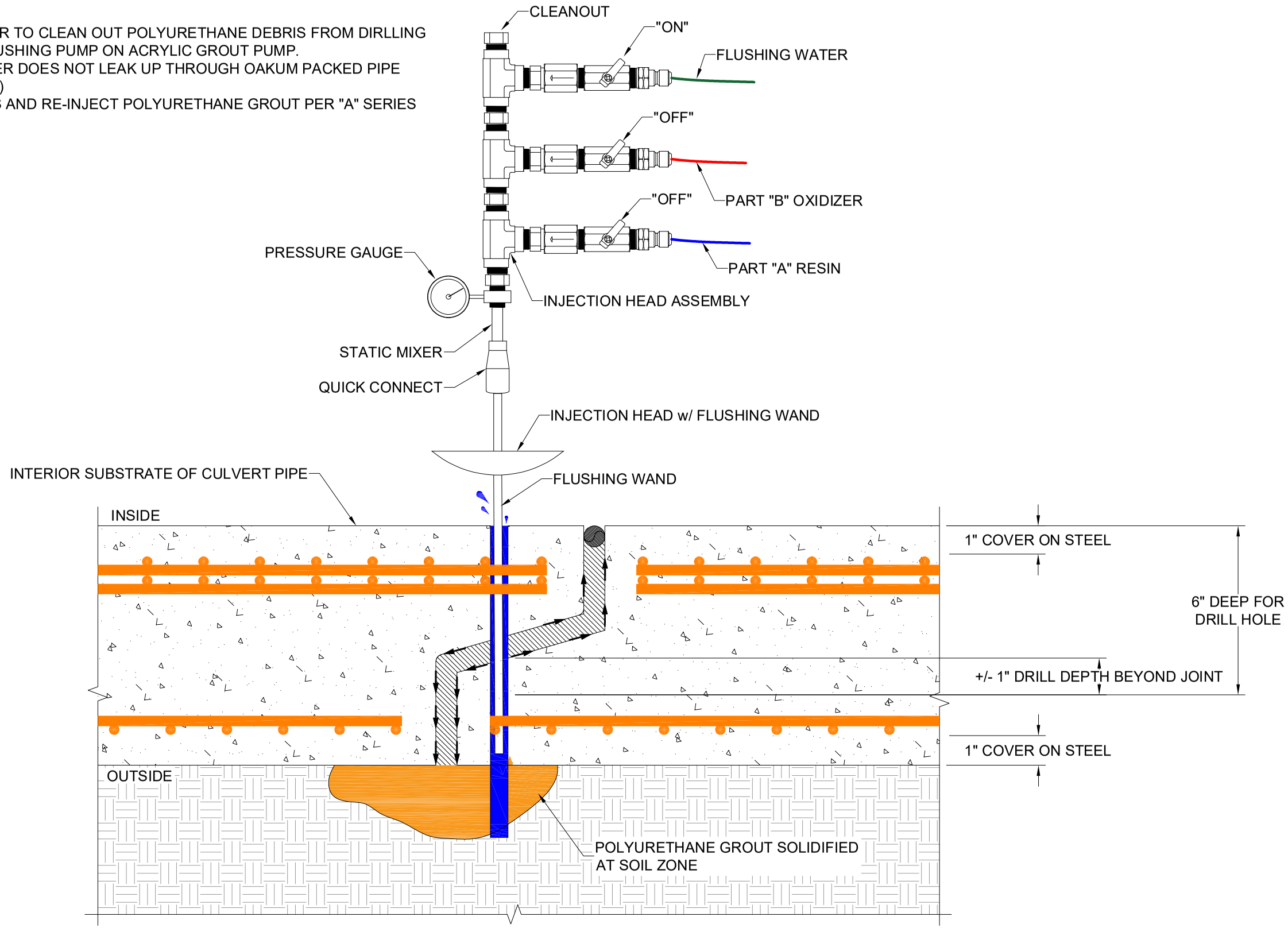
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 2B

1. FLUSH DRILL WITH PRESSURIZED WATER TO CLEAN OUT POLYURETHANE DEBRIS FROM DIRLLING
2. USE SEPARATE FLUSHING PUMP OR FLUSHING PUMP ON ACRYLIC GROUT PUMP.
3. ENSURE PRESSURIZED FLUSHING WATER DOES NOT LEAK UP THROUGH OAKUM PACKED PIPE FLANGE JOINT. (THIS IS A QA/QC CHECK)
4. IF LEAKAGE OCCURS, MARK LOCATIONS AND RE-INJECT POLYURETHANE GROUT PER "A" SERIES DRAWINGS.



3 ACRYLAMIDE GROUT, JOINT INJECTION

FLUSHING POLYURETHANE GROUT HOLES, LEAKAGE TESTING

Scale 1-1/2"=1'-0"

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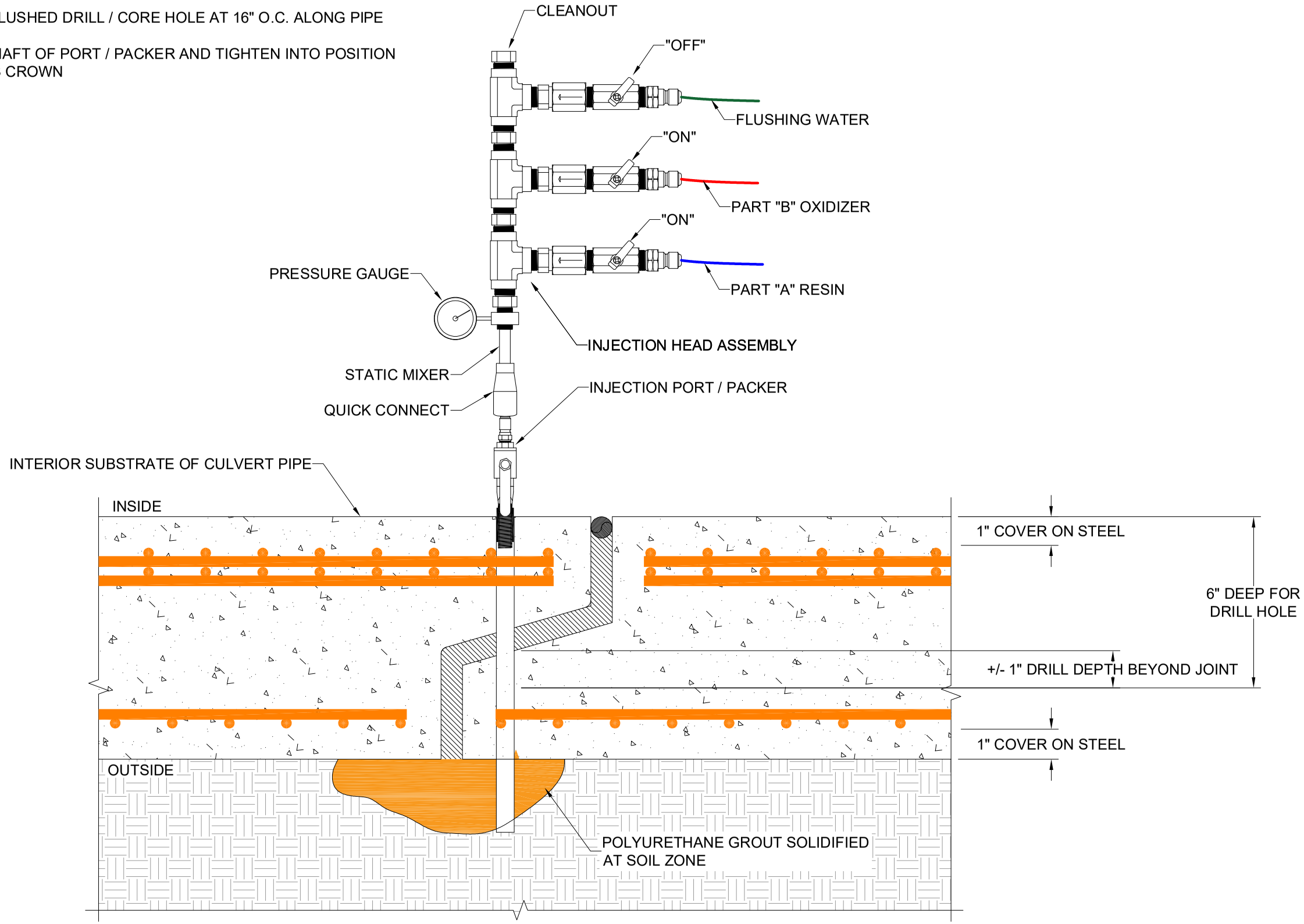
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 3B

1. INSERT INJECTION PORT INTO WATER FLUSHED DRILL / CORE HOLE AT 16" O.C. ALONG PIPE CIRCUMFERENCE
2. USE PLASTIC COUPLER ON TAPERED SHAFT OF PORT / PACKER AND TIGHTEN INTO POSITION
3. START AT INVERT AND WORK TOWARDS CROWN



4 ACRYLAMIDE GROUT, JOINT INJECTION

PLACEMENT OF INJECTION PORT / PACKER

Scale 1-1/2"=1'-0"

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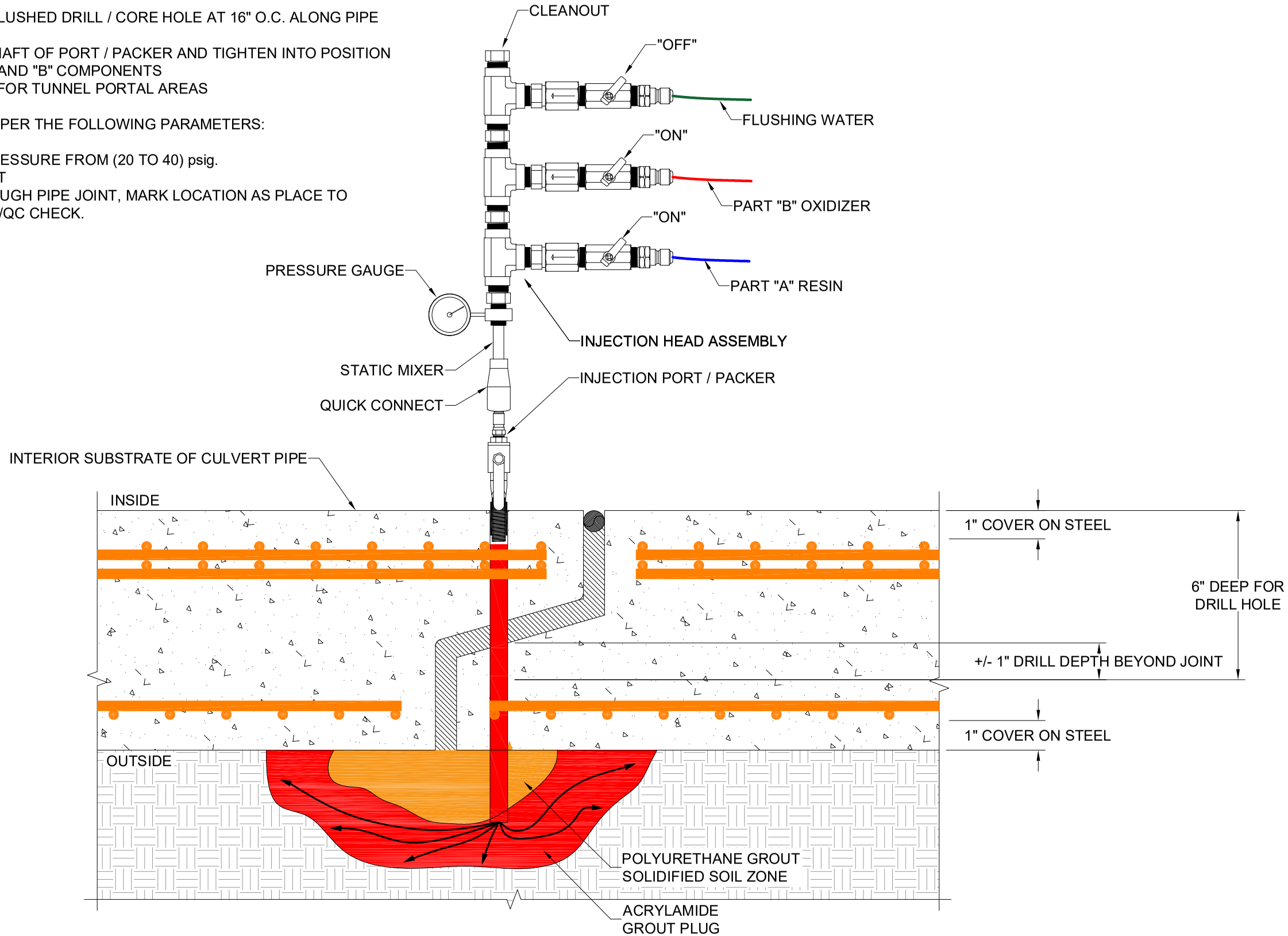
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 4B

1. INSERT INJECTION PORT INTO WATER FLUSHED DRILL / CORE HOLE AT 16" O.C. ALONG PIPE CIRCUMFERENCE
2. USE PLASTIC COUPLER ON TAPERED SHAFT OF PORT / PACKER AND TIGHTEN INTO POSITION
3. MIX UP ACRYLAMIDE GROUT PARTS "A" AND "B" COMPONENTS
4. NOTE SPECIAL GROUT FORMULATIONS FOR TUNNEL PORTAL AREAS
5. SET UP CHEMICAL GROUT EQUIPMENT
6. START INJECTING ACRYLAMIDE GROUT PER THE FOLLOWING PARAMETERS:
   - 6.1. USE 40% LIQUID AV-100 ON "A" SIDE
   - 6.2. PUMP ACRYLAMIDE GROUT AT A PRESSURE FROM (20 TO 40) psig.
   - 6.3. PUMP 3 GALLONS PER 16" O.C. PORT
7. IF ACRYLAMIDE GROUT LEAKS UP THROUGH PIPE JOINT, MARK LOCATION AS PLACE TO RE-INJECT POLYURETHANE GROUT. QA/QC CHECK.



5 ACRYLAMIDE GROUT, JOINT INJECTION

ACRYLAMIDE INJECTION, QA/QC CHECK

Scale 1-1/2"=1'-0"

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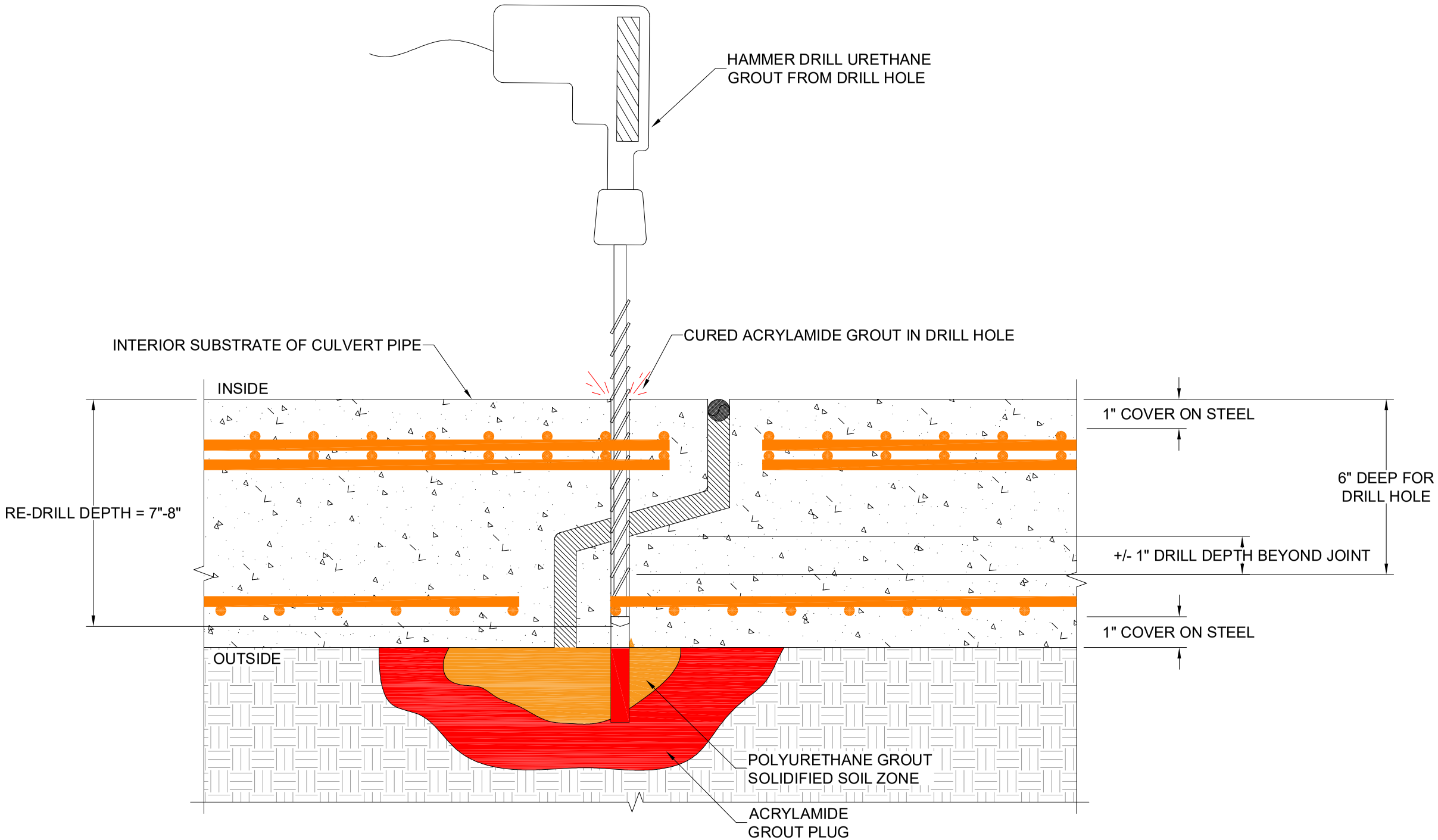
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 5B

1. AFTER 1 HOUR, ACRYLAMIDE GROUT SHOULD BE CURED ENOUGH TO RE-DRILL INJECTION HOLES.
2. ENSURE DRILLING DEPTH IS ROUGHLY 7 TO 8 INCHES.



6 ACRYLAMIDE GROUT, JOINT INJECTION
RE-DRILLING ACRYLAMIDE GROUT HOLES

Scale 1-1/2"=1'-0"

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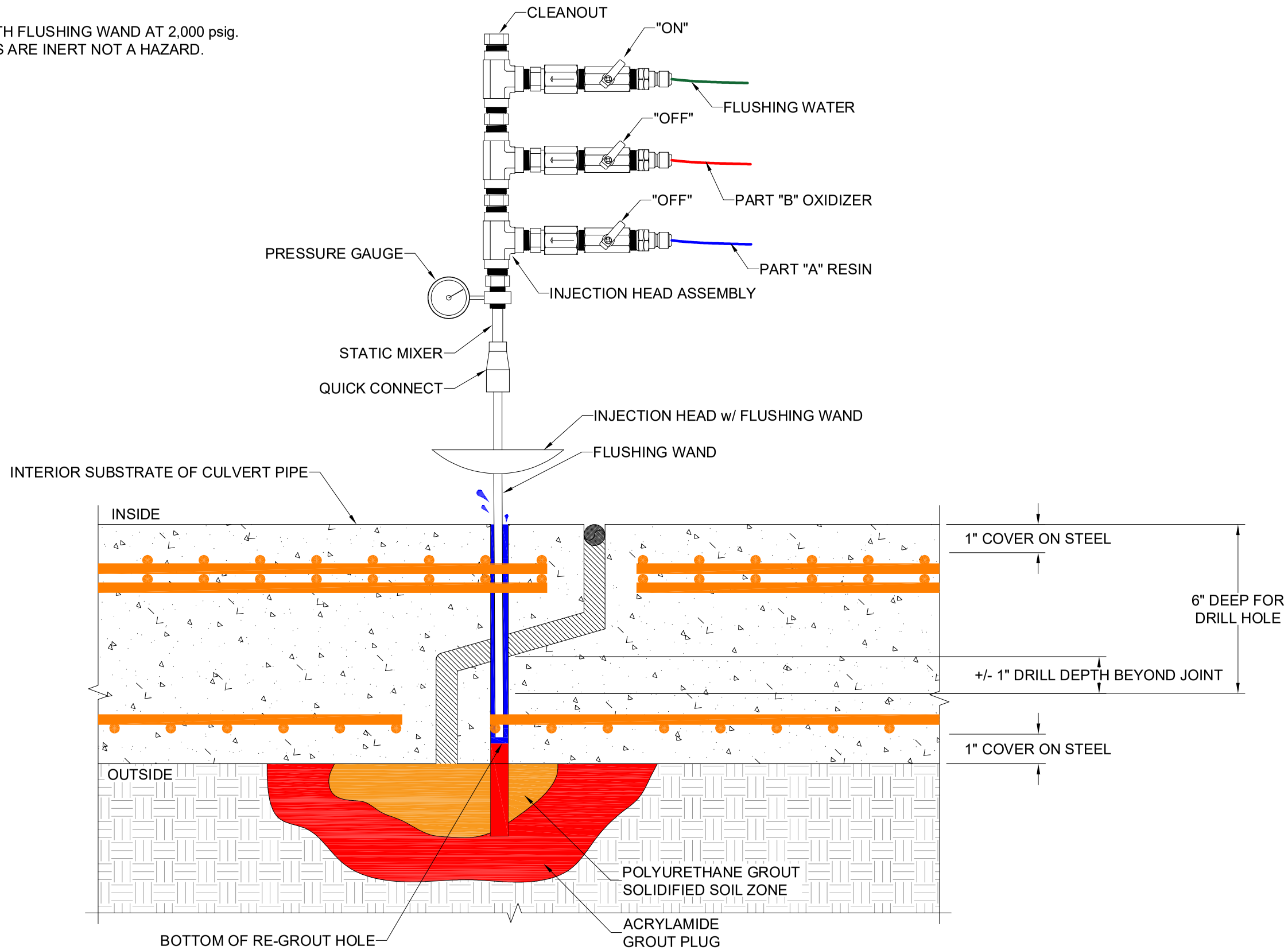
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 6B

1. FLUSH DRILL HOLES AT EACH JOINT WITH FLUSHING WAND AT 2,000 psig.
2. CURED ACRYLAMIDE GROUT PARTICLES ARE INERT NOT A HAZARD.



7 ACRYLAMIDE GROUT, JOINT INJECTION
DRILL HOLE FLUSHING

Scale 1-1/2"=1'-0"

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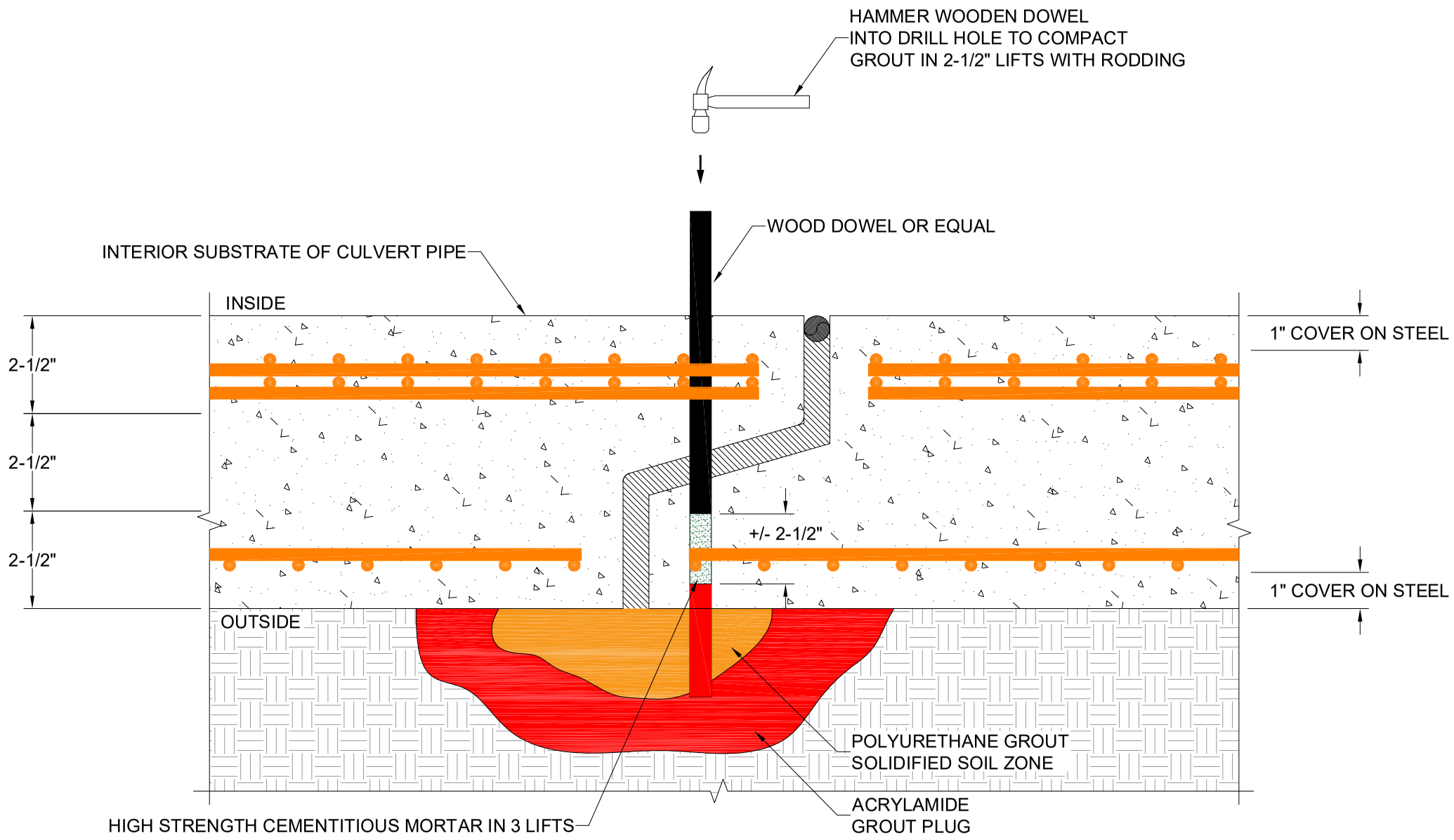
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 7B

1. SELECT A HIGH STRENGTH CEMENTITIOUS CONCRETE MORTAR MIX.
2. MIX REPAIR MORTAR PER MANUFACTURERS INSTRUCTIONS
3. PLACE MORTAR IN DRILL HOLE AND COMPACT WITH WOOD DOWEL IN 3 LIFTS, APPROXIMATELY 2-1/2" PER LIFT.
4. FLUSH MORTAR AT PIPE SURFACE.



8 ACRYLAMIDE GROUT, JOINT INJECTION

1st LIFT OF HIGH STRENGTH MORTAR

Scale 1-1/2"=1'-0"

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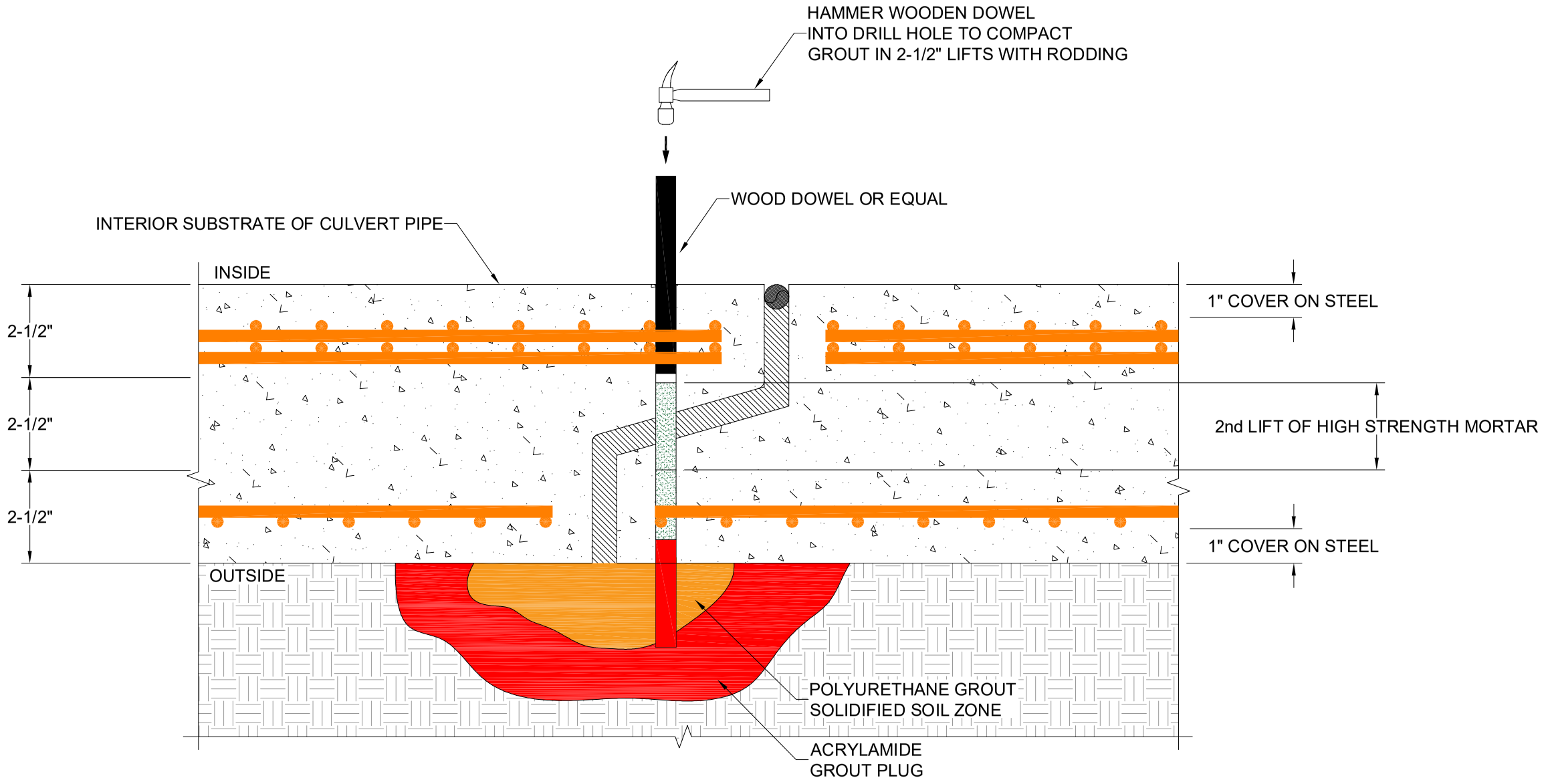
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 8B

1. REPEAT PROCESS OF FILLING DRILL HOLE AND RODDING (COMPACTION).



9 ACRYLAMIDE GROUT, JOINT INJECTION
2nd LIFT OF HIGH STRENGTH MORTAR

Scale 1-1/2"=1'-0"

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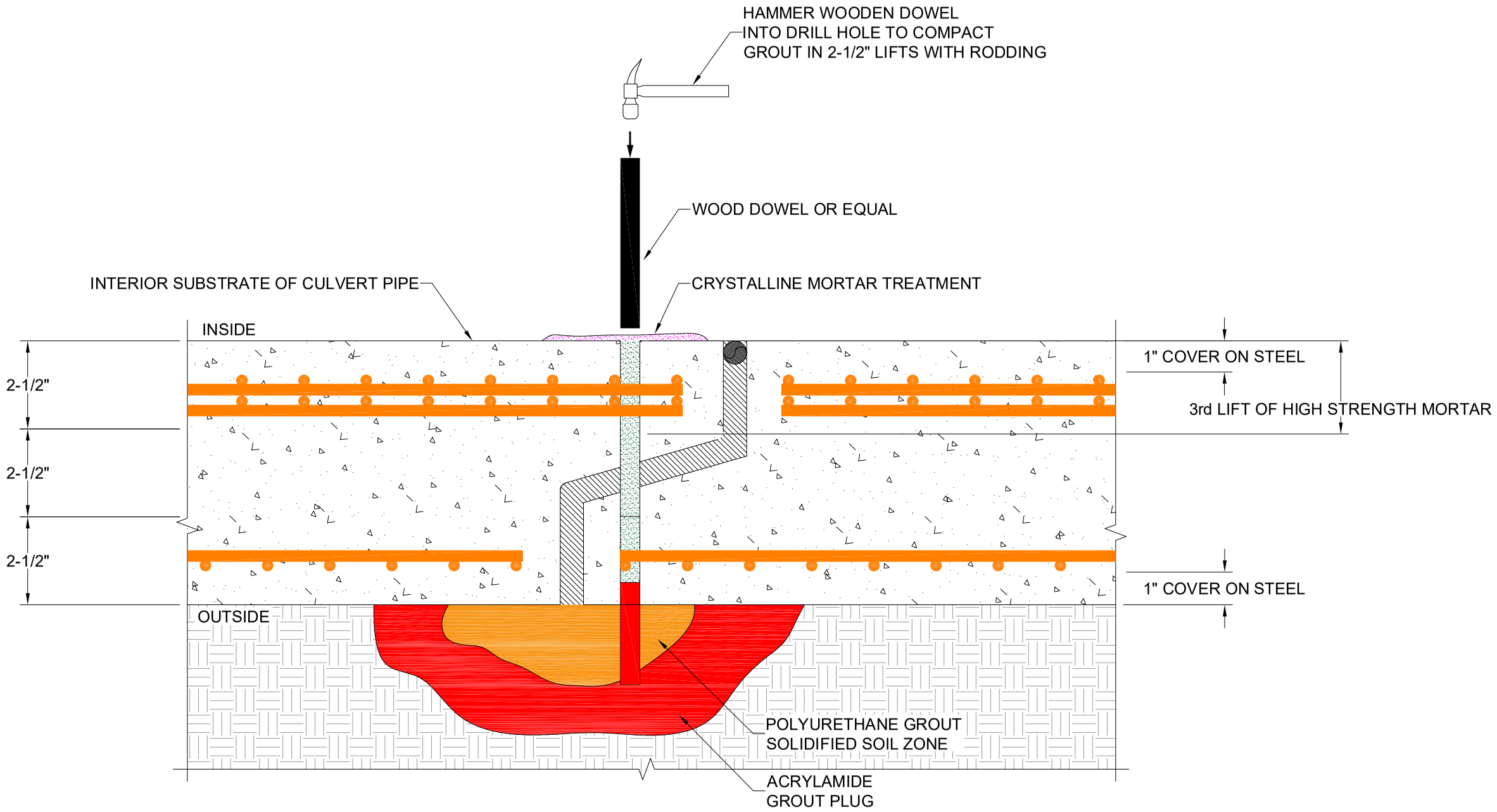
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 9B

1. UPON COMPLETION OF 3rd LIFT WITH HIGH STRENGTH MORTAR, INSTALL A +/- (4" X 4") SLURRY COAT OVER PATCH OF CRYSTALLINE WATERPROOFING (WP-4)



10 ACRYLAMIDE GROUT, JOINT INJECTION

3rd LIFT OF HIGH STRENGTH MORTAR FILL

Scale 1-1/2"=1'-0"

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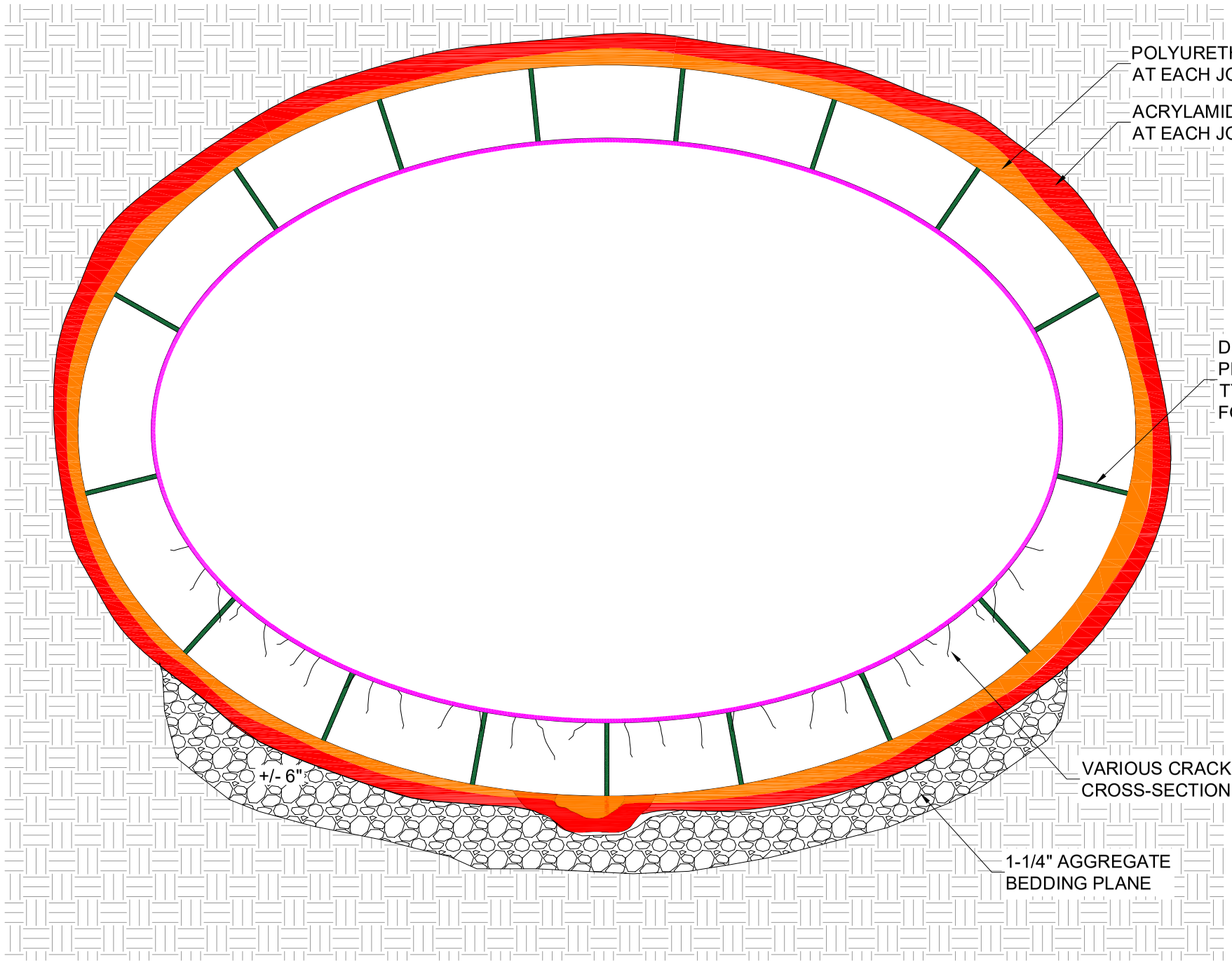
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 10B



11 DRILL HOLE LAYOUT AT +/- 16" O.C. AT CONCRETE PIPE JOINTS

ACRYLAMIDE GROUT PLUG AROUND PERIMETER OF PIPE JOINTS

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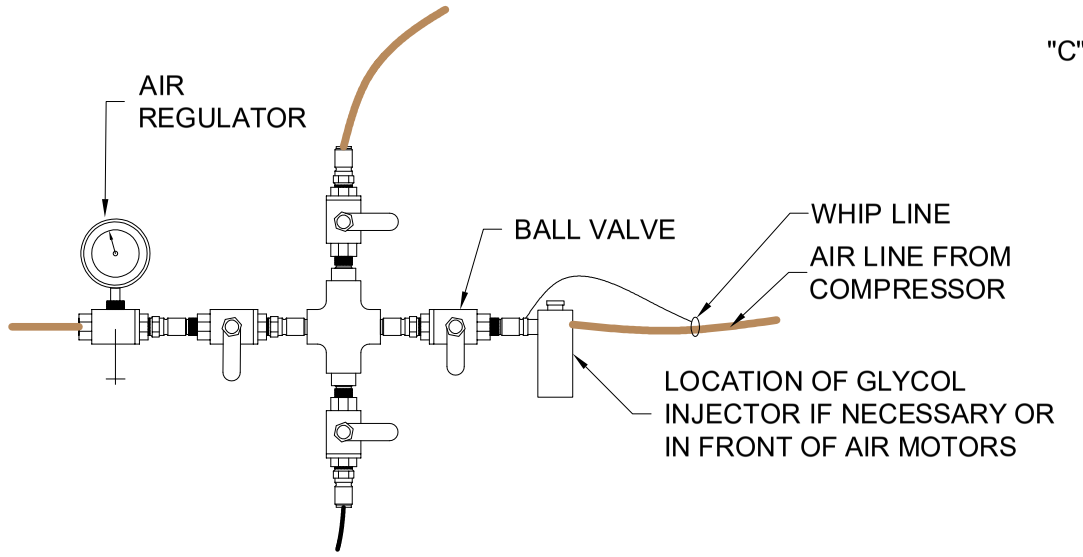
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RAYMOND ROAD CULVERT PIPE RESTORATION

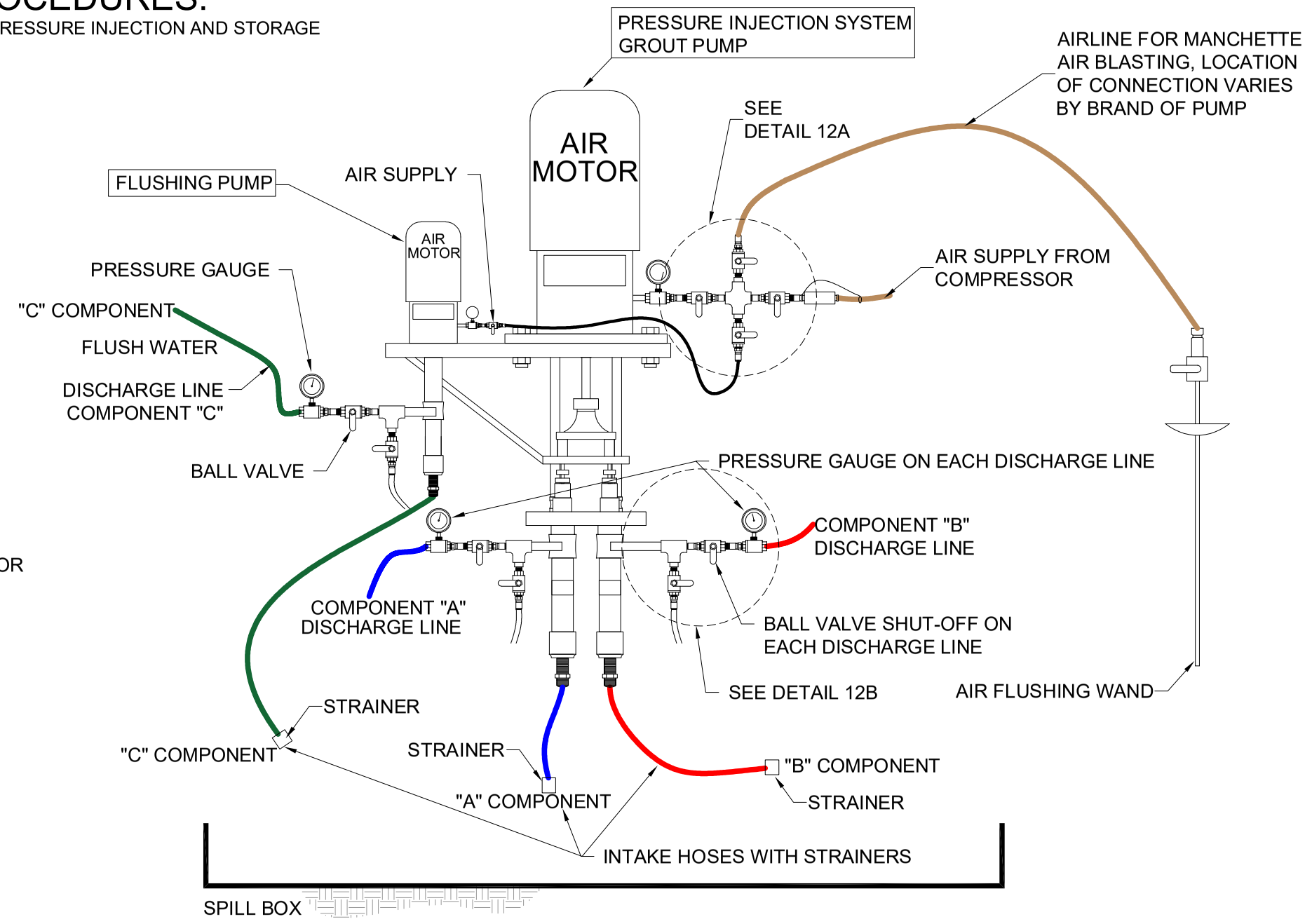
SHEET: 11B

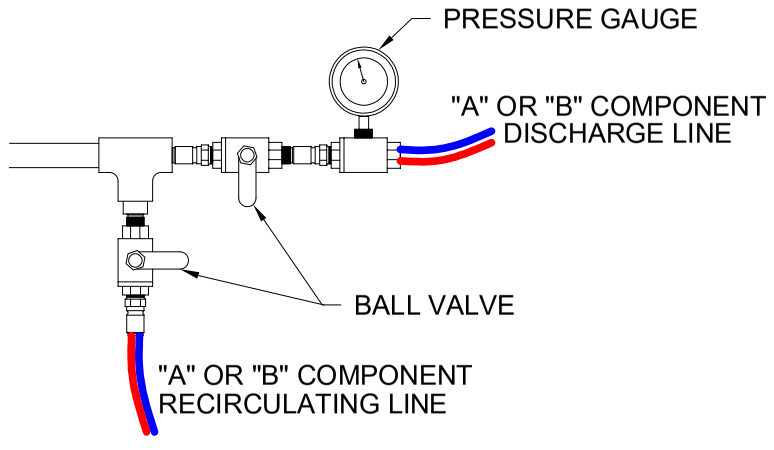
ACRYLAMIDE GROUT EQUIPMENT AND PROCEDURES:

EQUIPMENT SETUP FOR CHEMICAL GROUT SYSTEM (CGS) - CLEANING, FLUSHING, PRESSURE INJECTION AND STORAGE



12A AIR LINE SET-UP





12B DETAIL OF DISCHARGE AND RE-CIRCULATING LINES

12 ACRYLAMIDE GROUT, JOINT INJECTION

GROUT & FLUSHING PUMP SET-UP & COMPONENTS
GROUT PUMP NOT SHOWN FOR CLARITY

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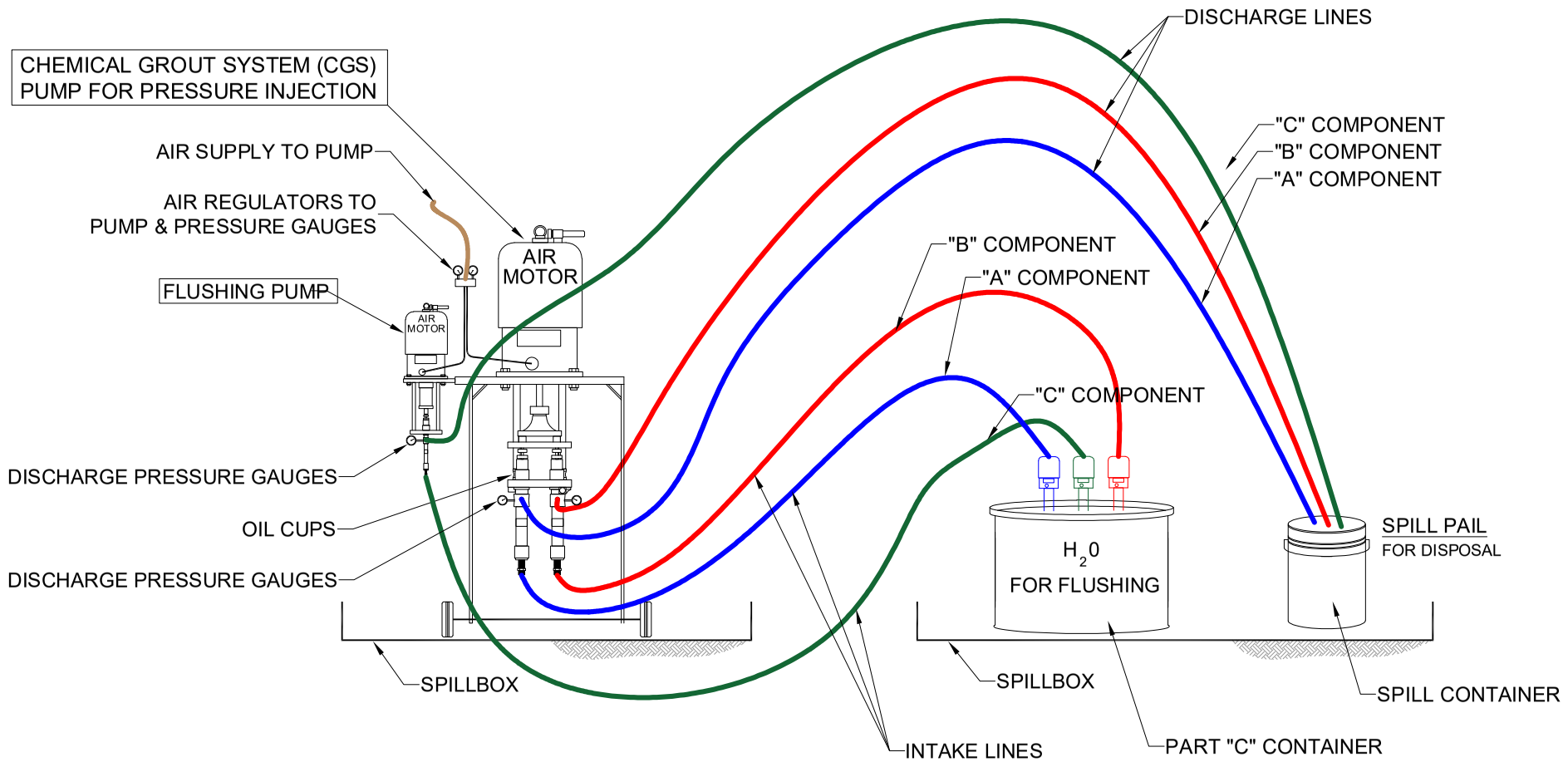
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 12B

1. SET PUMP ON / WITHIN SPILL BOX WITH TEAR RESISTANT MEMBRANE, RAISED ON SIDES
2. ATTACH AIR COMPRESSOR HOSE TO AIR LINE INTAKE ON PRESSURE INJECTION PUMP WITH APPROVED FITTING AND ANTI-WHIP LINE
3. INSTALL ETHYLENE GLYCOL IN LUBRICATOR IF COLD TEMPERATURES ARE PRESENT OR CONSTANT PUMPING IS REQUIRED
4. FILL PART "C" CONTAINER WITH CLEAN WATER
5. PLACE INTAKE LINE FROM FLUSHING PUMP "C" COMPONENT AND BOTH "A" & "B" COMPONENT PRESSURE INJECTION PUMP INTAKE LINES OF CHEMICAL GROUT SYSTEM (CGS) INTO PART "C" CONTAINER
6. PLACE ALL THREE DISCHARGE LINES IN SPILL PAIL ("A" + "B" + "C")
7. TURN CHEMICAL GROUT SYSTEM (CGS) PUMP ON AT LOW SPEED AND PRESSURE, ENSURE ALL THREE LINES DISCHARGE LIQUIDS INTO SPILL PAIL
8. CIRCULATE WATER THROUGH SYSTEM UNTIL ALL OIL FROM STORAGE IS FLUSHED OUT
9. CHECK TO ENSURE RATIO OF "A" & "B" COMPONENTS IS EQUAL OR WITHIN 10% OF EACH OTHER, SEE SHEET 23B

* NOTE:
- RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY
- PUMP IS USUALLY STORED WITH VEGETABLE OIL IN SYSTEM.
- THIS IS NON-HAZARDOUS AND CAN EASILY BE DISPOSED.



13 ACRYLAMIDE GROUT, JOINT INJECTION

GROUT PUMP FLUSHING OF STORAGE OIL FROM SYSTEM
GROUT PUMP PREPERATION

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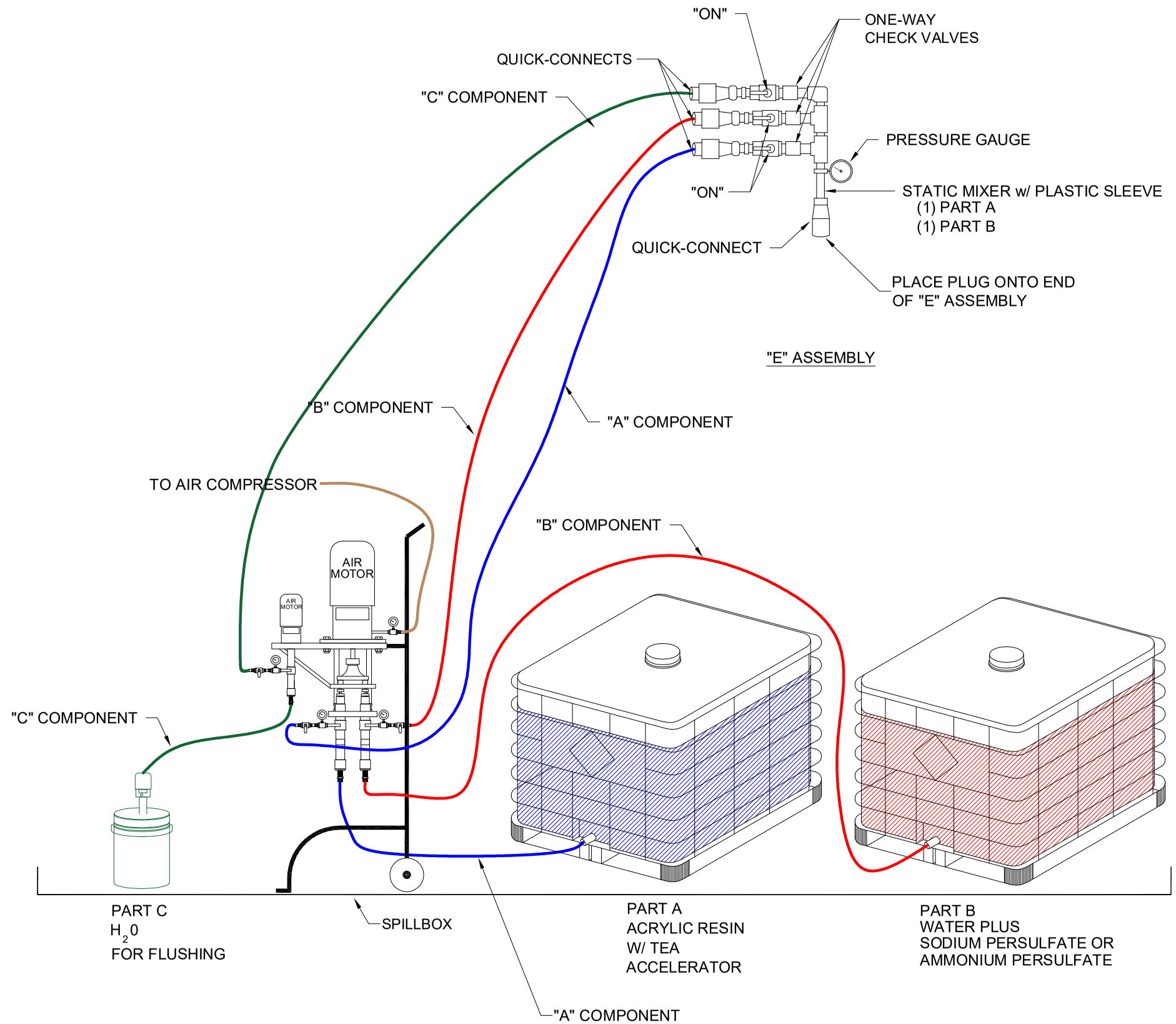
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RAYMOND ROAD CULVERT PIPE RESTORATION

1. PUT "PLUG" ONTO END OF "E" ASSEMBLY INJECTION GUN AND TURN PRESSURE UP TO 500 psig, ENSURE ALL FITTINGS ARE LEAK-FREE
2. MAKE ADJUSTMENTS WHERE NECESSARY IF LEAKAGE AT MECHANICAL CONNECTIONS OCCUR



14 ACRYLAMIDE GROUT, JOINT INJECTION

GROUT PUMP PRESSURE TESTING

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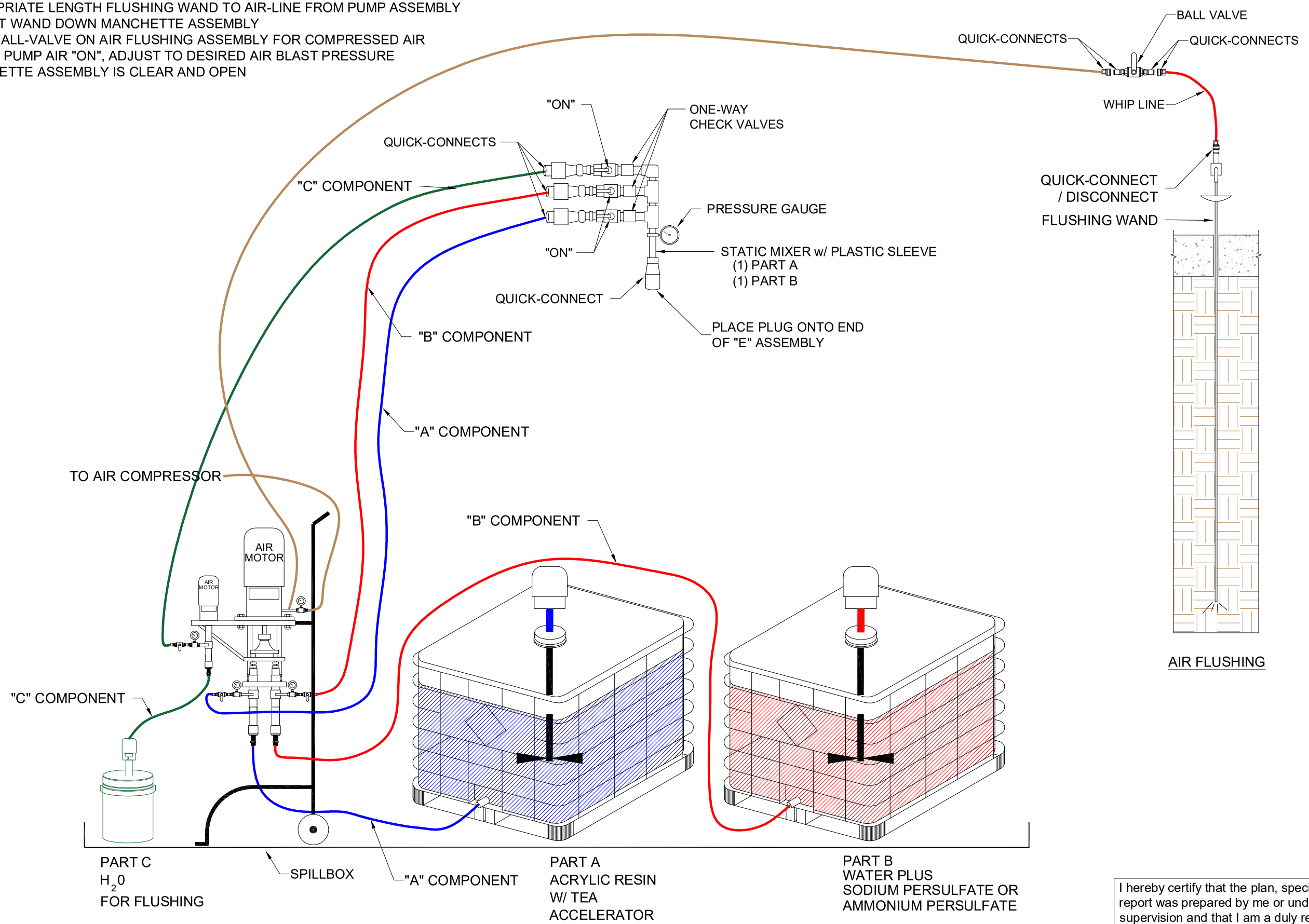
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 14B

AIR FLUSHING DRILL HOLES:

1. ATTACH APPROPRIATE LENGTH FLUSHING WAND TO AIR-LINE FROM PUMP ASSEMBLY
2. PLACE AIR BLAST WAND DOWN MANCHETTE ASSEMBLY
3. SLOWLY OPEN BALL-VALVE ON AIR FLUSHING ASSEMBLY FOR COMPRESSED AIR
4. TURN FLUSHING PUMP AIR "ON", ADJUST TO DESIRED AIR BLAST PRESSURE
5. ENSURE MANCHETTE ASSEMBLY IS CLEAR AND OPEN



AIR FLUSHING

15 ACRYLAMIDE GROUT, JOINT INJECTION

CLASSIC SET-UP FOR AIR FLUSHING MANCHETTES PRIOR TO GROUTING
NOTE: RE-CIRCULATING LINES NOT SHOWN FOR CLARITY

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

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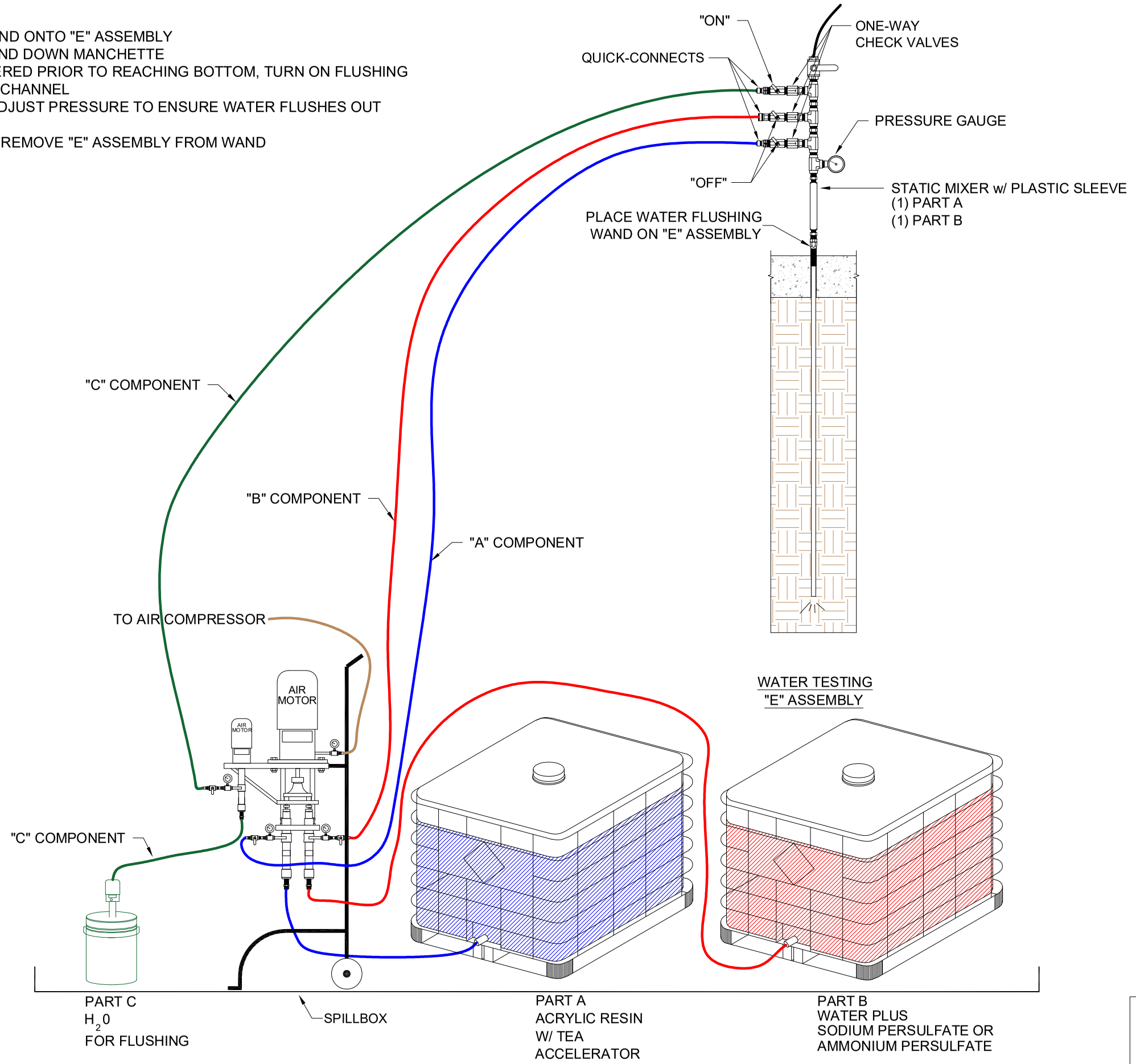
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 15B

WATER FLUSHING MANCHETTE:

1. PLACE WATER FLUSHING WAND ONTO "E" ASSEMBLY
2. PLACE WATER FLUSHING WAND DOWN MANCHETTE
3. IF RESISTANCE IS ENCOUNTERED PRIOR TO REACHING BOTTOM, TURN ON FLUSHING WATER PRESSURE TO OPEN CHANNEL
4. TURN FLUSHING PUMP ON, ADJUST PRESSURE TO ENSURE WATER FLUSHES OUT MANCHETTE ASSEMBLY
5. TURN FLUSHING PUMP OFF - REMOVE "E" ASSEMBLY FROM WAND



16 ACRYLAMIDE GROUT, JOINT INJECTION

CLASSIC SET-UP FOR WATER FLUSHING MANCHETTES PRIOR TO GROUTING
NOTE: RE-CIRCULATING LINES NOT SHOWN FOR CLARITY

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 16B

20% SOLUTION GROUT MADE WITH 40% CONCENTRATION OF LIQUID ACRYLAMIDE

"A" COMPONENT MIXING

1. POSITION 40% ACRYLAMIDE RESIN TOTE ON SPILL PAD (265 GALS)
2. OPEN LID ON TOTE
3. ADD 1 PAIL (50 LBS) OF TEA ACCELERATOR TO TOTE
4. ADD 1/4 to 1/3 CUP OF BLUE DYE TO TOTE
5. PLACE PADDLE IN "A" RESIN TOTE AND SLOWLY MIX FOR 5 MINUTES
6. MEASURE TEMPERATURE OF "A" COMPONENT RESIN
7. HEAT OR COOL IF NECESSARY
8. PLACE LID BACK ON TOTE UNTIL READY FOR USE

"B" COMPONENT MIXING

1. POSITION OXIDIZER TOTE AND FILL WITH 260 GALLONS OF CLEAN WATER
2. ADD 1 PAIL (50 LBS) OF WHITE POWDER (AMMONIUM PERSULFATE) TO WATER
3. ADD 1/4 to 1/3 CUP OF RED DYE TO OXIDIZER TOTE
4. PLACE PADDLE IN "B" RESIN TOTE AND SLOWLY MIX FOR 10 MINUTES
5. MEASURE TEMPERATURE OF "B" COMPONENT FLUID
6. HEAT OR COOL IF NECESSARY
7. PLACE LID BACK ON TOTE UNTIL READY FOR USE

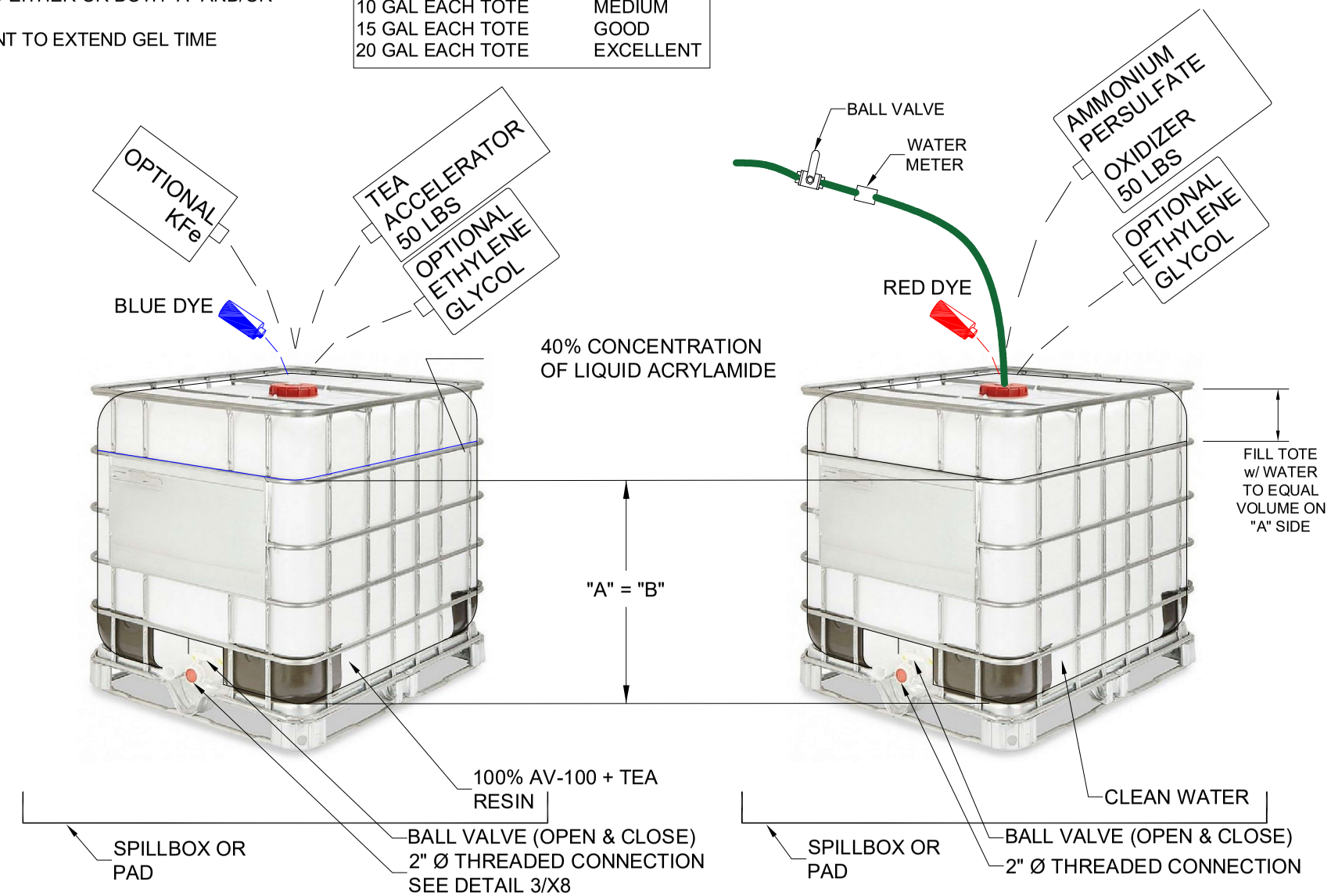
GENERAL NOTES:

A. AV-100 IS PURCHASED IN 40% CONCENTRATION OF ACRYLAMIDE IN WATER
B. ETHYLENE GLYCOL CAN BE ADDED TO EITHER OR BOTH "A" AND/OR "B" COMPONENT
C. KFe CAN BE ADDED TO "A" COMPONENT TO EXTEND GEL TIME

KFe RETARDER @ 70 ° F, MIX	
1-2 oz. / TOTE	10 MIN.
3-5 oz. / TOTE	20 MIN.
6-9 oz. / TOTE	30 MIN.
10-13 oz. / TOTE	40 MIN.
14-17 oz. / TOTE	50 MIN.
18-21 oz. / TOTE	60 MIN.
+/- 2 lbs. / TOTE	+/- 2 HRS

ADDITION OF ETHYLENE GLYCOL
GROUT STABILIZATION (FOR EXPANSION & SHRINKAGE CONTROL)

5 GAL EACH TOTE	LOW
10 GAL EACH TOTE	MEDIUM
15 GAL EACH TOTE	GOOD
20 GAL EACH TOTE	EXCELLENT



17A "A" COMPONENT MIXING

"A" RESIN TOTE
98% AV-100 RESIN + 2% TEA ACCELERATOR

17B "B" COMPONENT MIXING

"B" RESIN TOTE
98% WATER + 2% AMMONIUM PERSULFATE

17 ACRYLAMIDE GROUT, JOINT INJECTION

MIXING A & B COMPONENTS

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By: Brent Anderson

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7954 Highway 65 NE
Fridley, MN 55432
Phone: 612-363-9580
Fax: 763-784-1590

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 17B

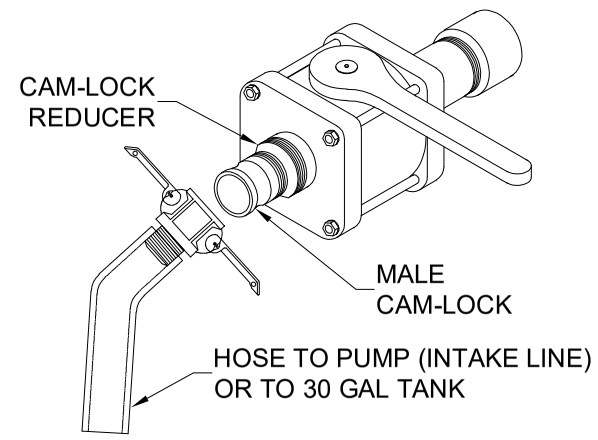
20% SOLUTION GROUT MADE WITH 40% CONCENTRATION OF LIQUID ACRYLAMIDE

"A" COMPONENT MIXING

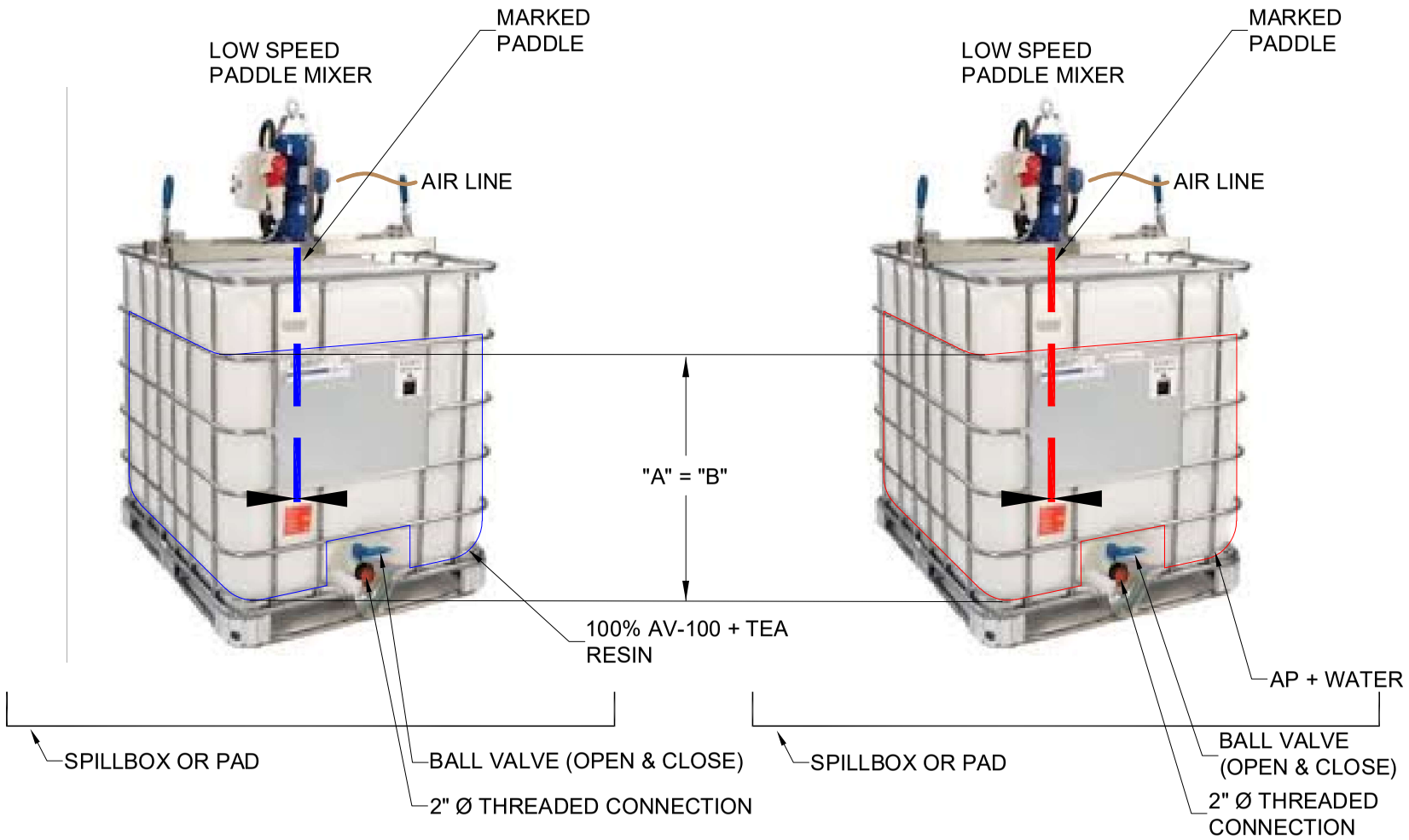
1. PLACE LID BACK ON TOTE UNTIL READY FOR USE
2. MARK "A" RESIN PADDLE WITH BLUE LABEL OR TAPE TO ENSURE AGAINST CROSS-CONTAMINATION IN "B" COMPONENT
3. HOOK UP LINE FROM COMPRESSOR TO AIR-OPERATED AGITATOR
4. AGITATE LIQUID AT LOW SPEED TO ENSURE BLENDED MIXTURE
5. HOOKUP 2" BALL VALVE w/ NPT TO TOTE DISCHARGE
6. HOOKUP GROUT PUMP INTAKE TO TOTES w/ THREADED HOSE CONNECTIONS

"B" COMPONENT MIXING

1. MARK "B" RESIN PADDLE WITH RED LABEL OR TAPE TO ENSURE AGAINST CROSS-CONTAMINATION IN "A" COMPONENTS
2. FILL TOTE TO AN EQUAL VOLUME AS ON "A" SIDE
3. HOOK UP LINE FROM COMPRESSOR TO AIR-OPERATED AGITATOR
4. AGITATE LIQUID AT LOW SPEED TO ENSURE BLENDED MIXTURE
5. HOOKUP 2" BALL VALVE W/ NPT TO TOTE DISCHARGE
6. HOOKUP GROUT PUMP INTAKE TO TOTES W/ THREADED HOSE CONNECTIONS



3 2" BALL VALVE w/ NPT



18A "A" COMPONENT MIXING

"A" RESIN TOTE
98% AV-100 RESIN + 2% TEA ACCELERATOR

18B "B" COMPONENT MIXING

"B" RESIN TOTE
98% WATER + 2% AMMONIUM PERSULFATE

18 ACRYLAMIDE GROUT, JOINT INJECTION

MATERIAL READY FOR DISCHARGE

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 18B

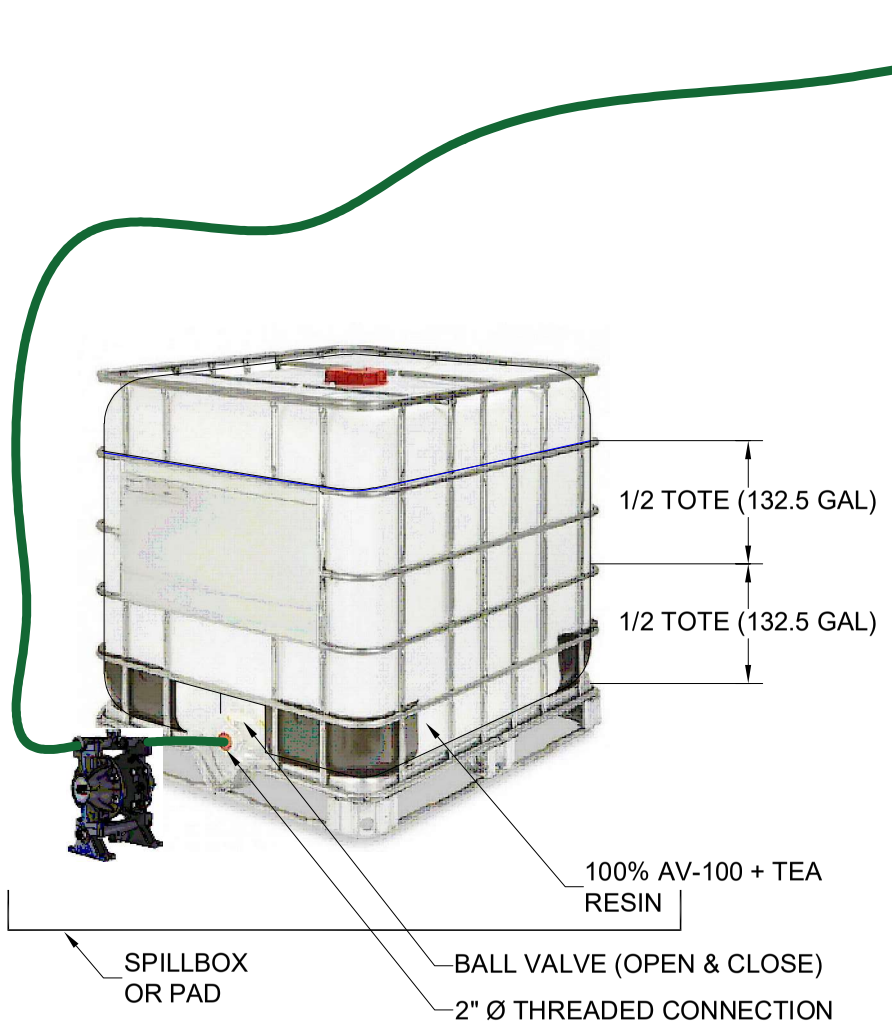
10% SOLUTION GROUT MADE WITH 20% CONCENTRATION OF LIQUID ACRYLAMIDE

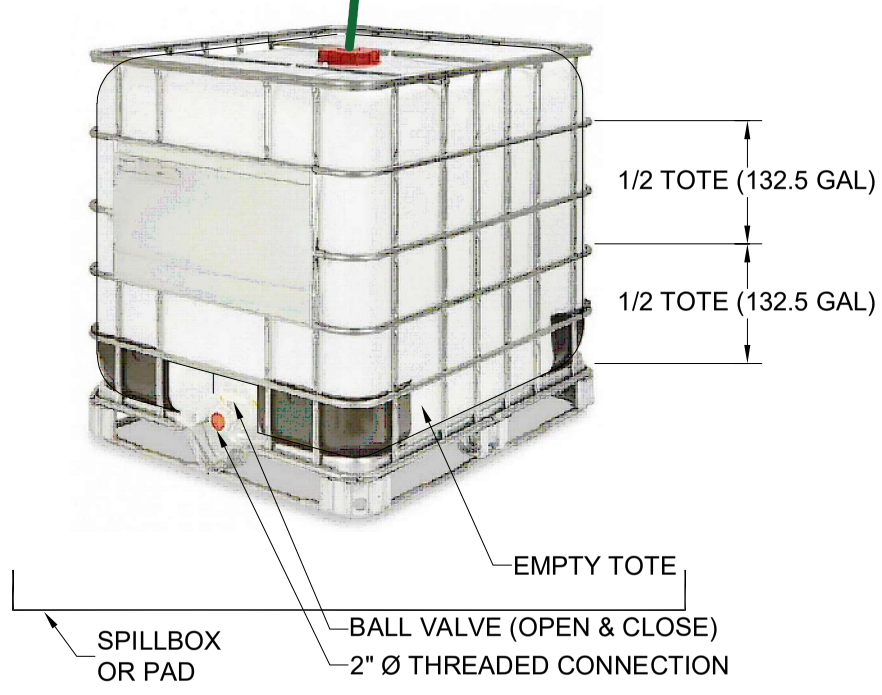
"A" COMPONENT PROPORTIONING

1. POSITION FULL TOTE (2,300 LBS, 265 GALS, 8.66 LBS/GAL), 40% CONCENTRATION, ACRYLAMIDE RESIN ON SPILL PAD
2. PLACE 2" BALL VALVE w/NPT FITTING ONTO DISCHARGE VALVE OF TOTE
3. CONNECT DIAPHRAGM PUMP INTAKE LINE ONTO 2" Ø BALL VALVE w/NPT FITTING
4. PLACE DIAPHRAGM HOSE FROM DIAPHRAGM PUMP INTO EMPTY TOTE ON "B" SIDE, NOTE THAT THIS MATERIAL WILL BE EXTRA "A" SIDE/COMPONENT

"A" COMPONENT PROPORTIONING

1. PLACE CLEAN (WATERBLAST INTERIOR OF TOTE) TOTE ON "B" SIDE OR COMPONENT LOCATION ON SPILLPAD / SPILLBOX
2. ENSURE DISCHARGE VALVE IS WATERTIGHT, SHUT, SECURE AND OPERABLE IF NEEDED
3. PLACE DIAPHRAGM DISCHARGE HOSE INTO TOTE TOP AND FILL TO 1/2 FULL LOCATION (132.5 GAL)
4. PLACE LID BACK ON TOTE UNTIL READY FOR USE





19A "A" COMPONENT PROPORTIONING

"A" RESIN TOTE
98% AV-100 RESIN + 2% TEA ACCELERATOR

19B "B" COMPONENT PROPORTIONING

"B" RESIN TOTE
98% WATER + 2% AMMONIUM PERSULFATE

19 ACRYLAMIDE GROUT, JOINT INJECTION

PROPORTIONING FOR 20% CONCENTRATION

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 19B

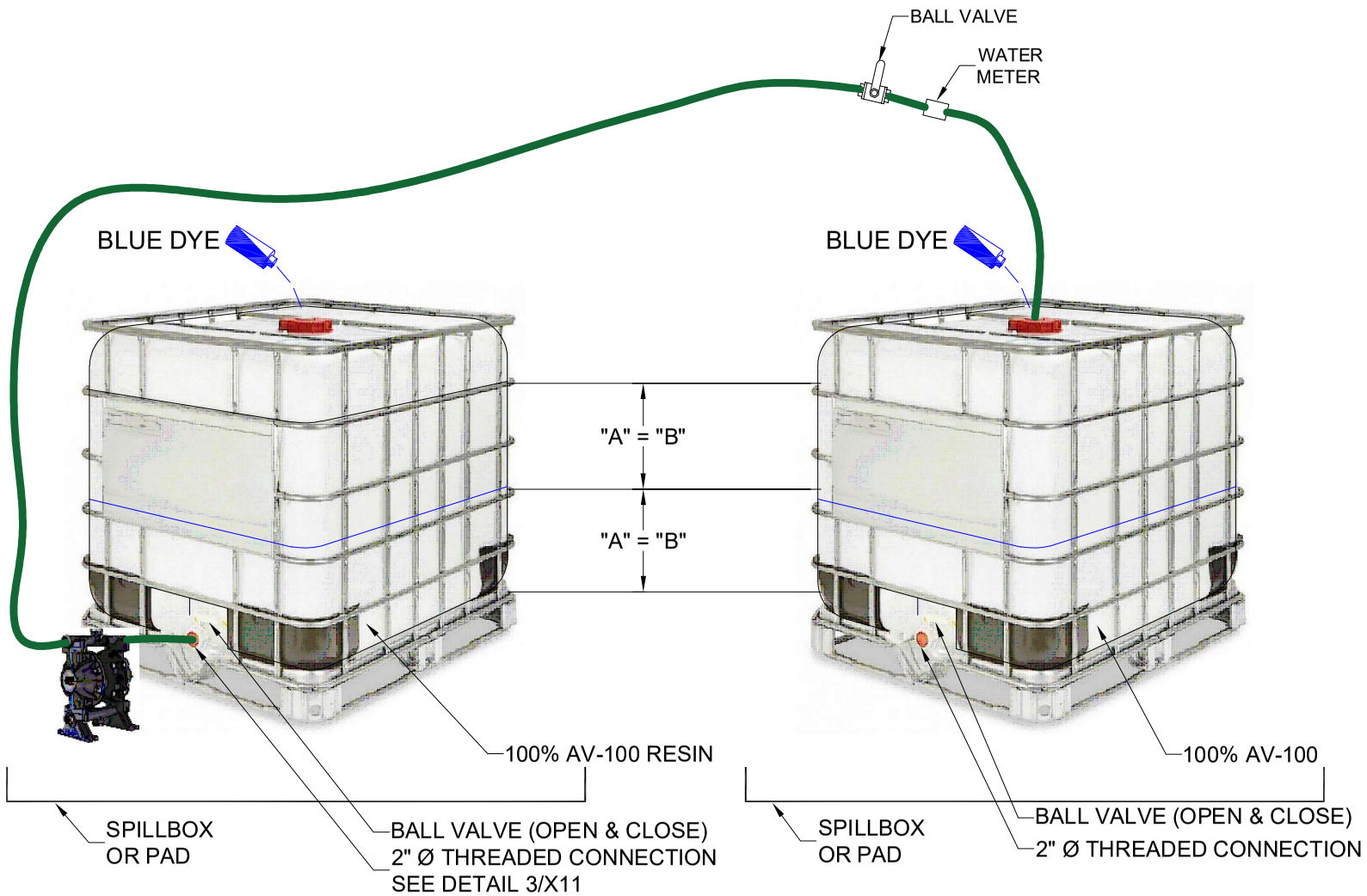
10% SOLUTION GROUT MADE WITH 20% CONCENTRATION OF LIQUID ACRYLAMIDE

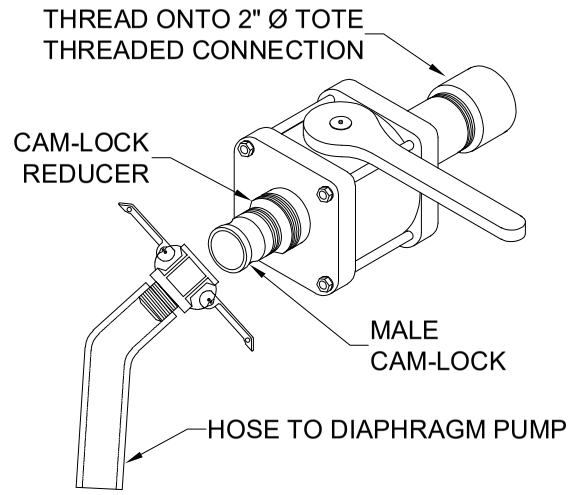
"A" COMPONENT PROPORTIONING

1. PUMP ACRYLAMIDE (40% CONC.) IN FULL TOTE TILL IT IS 1/2 FULL OR EMPTY (132.5 GAL) INTO OTHER TOTE ON "B" SIDE. NOTE THIS MATERIAL WILL BE EXTRA "A" SIDE/COMPONENT
2. UPON COMPLETION, EACH TOTE WILL CONTAIN 132.5 GALLONS AND BE HALF FULL OR EMPTY
3. MARK THIS TOTE AS 132.5 GAL OF 40% CONCENTRATION OF LIQUID ACRYLAMIDE

"A" COMPONENT PROPORTIONING

1. PLACE DIAPHRAGM DISCHARGE HOSE INTO TOTE TOP AND FILL TO 1/2 FULL LOCATION (132.5 GAL)
2. PLACE LID BACK ON TOTE UNTIL READY FOR USE





20C 2" BALL VALVE w/ NPT

20A "A" COMPONENT PROPORTIONING

"A" RESIN TOTE
100% AV-100 RESIN

20B "B" COMPONENT PROPORTIONING

"B" RESIN TOTE
100% AV-100 RESIN

20 ACRYLAMIDE GROUT, JOINT INJECTION

PROPORTIONING FOR 20% SOLUTION, ADDING DYE

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 20B

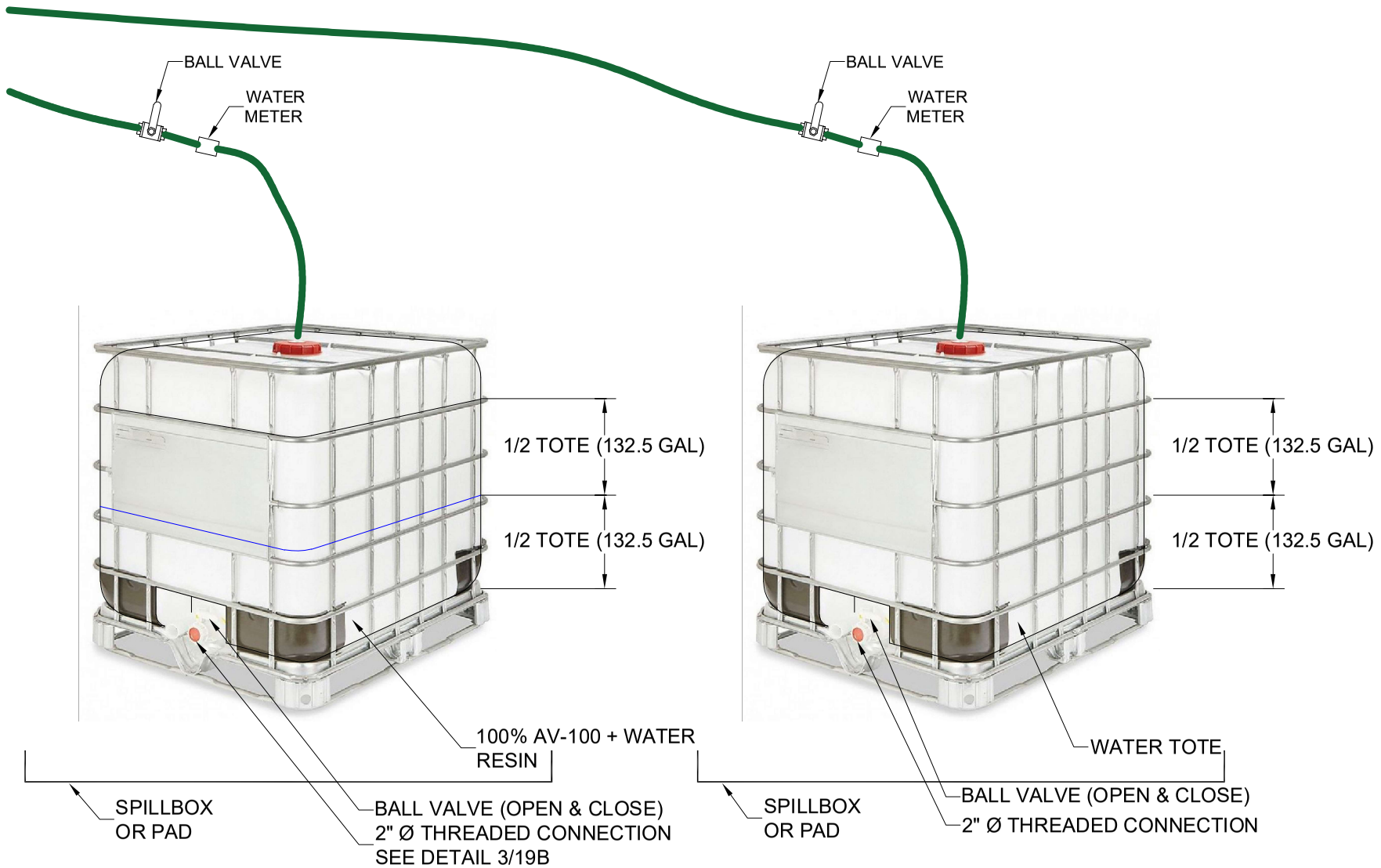
10% SOLUTION GROUT MADE WITH 20% CONCENTRATION OF LIQUID ACRYLAMIDE

"A" COMPONENT PROPORTIONING

1. PLACE 1/2 TOTE (132.5 GAL) ON SPILL PAD
2. FILL TOTE w/ 132.5 GALLONS OF CLEAN WATER TO (265 GAL)

"B" COMPONENT PROPORTIONING

1. PLACE CLEAN EMPTY TOTE ON SPILL PAD
2. PLACE CLEAN (WATERBLAST INTERIOR OF TOTE) TOTE ON "B" SIDE OR COMPONENT LOCATION ON SPILLPAD / SPILLBOX
3. ENSURE DISCHARGE VALVE IS WATERTIGHT, SHUT, SECURE AND OPERABLE IF NEEDED
4. FILL TOTE TO 260 GAL OF CLEAN WATER



21A "A" COMPONENT PROPORTIONING
"A" RESIN TOTE
50% AV-100 RESIN + 50% WATER

21B "B" COMPONENT PROPORTIONING
"B" RESIN TOTE
50% WATER

21 ACRYLAMIDE GROUT, JOINT INJECTION
ADDING WATER FOR PROPORTIONING

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 21B

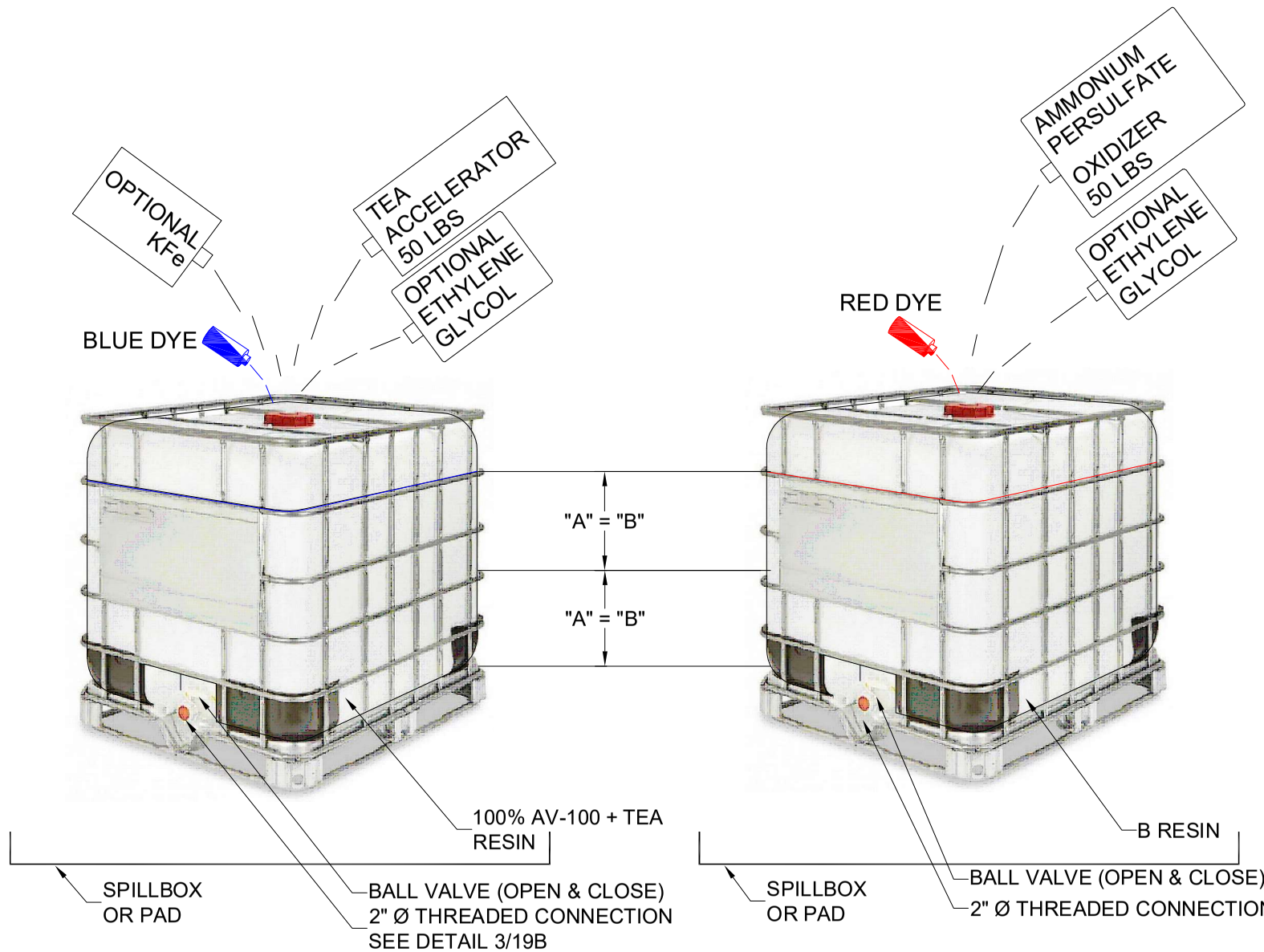
10% SOLUTION GROUT MADE WITH 20% CONCENTRATION OF LIQUID ACRYLAMIDE

"A" COMPONENT PROPORTIONING

1. ADD 1/4 to 1/3 CUP OF BLUE DYE TO TOTE
2. ADD 50 LBS (5 GALS) OF TEA, TRIETHANOLOMINE TO TOTE
3. ADD ETHYLENE GLYCOL AS REQUIRED BY DESIGN
4. ADD KFe TO EXTEND GEL-TIME BY DESIGN
5. AGITATE LIQUID

"B" COMPONENT PROPORTIONING

1. ADD 1/4 to 1/3 CUP OF RED DYE TO TOTE
2. ADD 50 LBS OF AMMONIUM PERSULFATE TO TOTE OF WATER
3. ADD ETHYLENE GLYCOL AS REQUIRED BY DESIGN
4. AGITATE LIQUID



22A "A" COMPONENT PROPORTIONING

"A" RESIN TOTE
49% AV-100 RESIN + 49% WATER + 2% TEA ACCELERATOR

22B "B" COMPONENT PROPORTIONING

"B" RESIN TOTE
98% WATER + 2% AMMONIUM PERSULFATE

22 ACRYLAMIDE GROUT, JOINT INJECTION

ADDING ADDITIONAL COMPONENTS TO MIX

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 22B

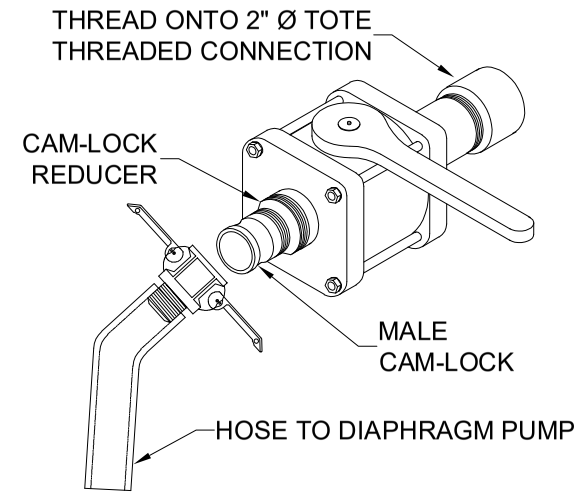
10% SOLUTION GROUT MADE WITH 20% CONCENTRATION OF LIQUID ACRYLAMIDE

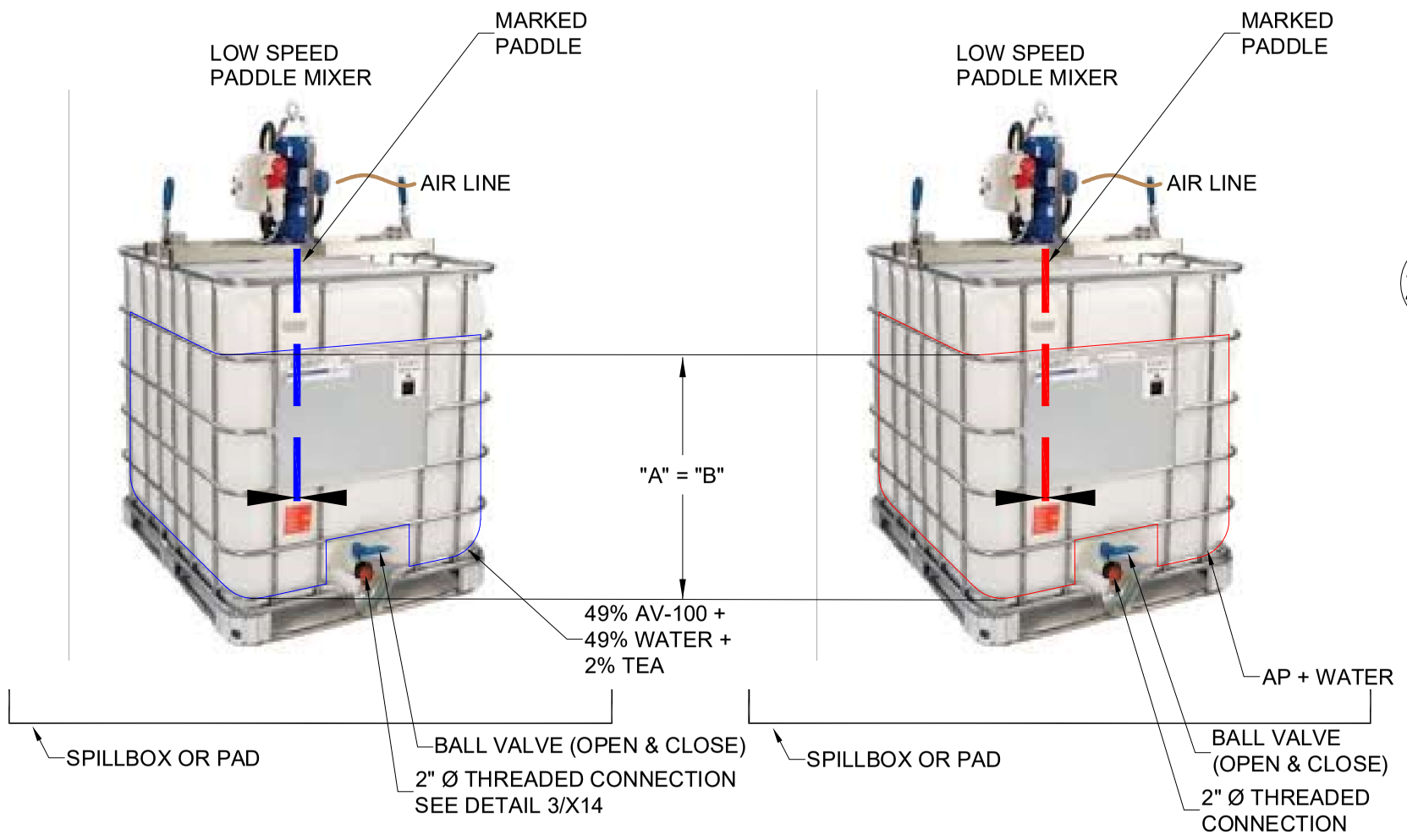
"A" COMPONENT MIXING

1. PLACE LID BACK ON TOTE UNTIL READY FOR USE
2. MARK "A" RESIN PADDLE WITH BLUE LABEL OR TAPE TO ENSURE AGAINST CROSS-CONTAMINATION IN "B" COMPONENT
3. HOOK UP LINE FROM COMPRESSOR TO AIR-OPERATED AGITATOR
4. AGITATE LIQUID AT LOW SPEED TO ENSURE BLENDED MIXTURE
5. HOOKUP 2" BALL VALVE w/ NPT TO TOTE DISCHARGE
6. HOOKUP GROUT PUMP INTAKE TO TOTES w/ THREADED HOSE CONNECTIONS

"B" COMPONENT MIXING

1. MARK "B" RESIN PADDLE WITH RED LABEL OR TAPE TO ENSURE AGAINST CROSS-CONTAMINATION IN "A" COMPONENTS
2. FILL TOTE TO AN EQUAL VOLUME AS ON "A" SIDE
3. HOOK UP LINE FROM COMPRESSOR TO AIR-OPERATED AGITATOR
4. AGITATE LIQUID AT LOW SPEED TO ENSURE BLENDED MIXTURE
5. HOOKUP 2" BALL VALVE W/ NPT TO TOTE DISCHARGE
6. HOOKUP GROUT PUMP INTAKE TO TOTES W/ THREADED HOSE CONNECTIONS





23C 2" BALL VALVE w/ NPT

23A "A" COMPONENT MIXING

"A" RESIN TOTE
49% AV-100 RESIN + 49% WATER + 2% TEA ACCELERATOR

23B "B" COMPONENT MIXING

"B" RESIN TOTE
98% WATER + 2% AMMONIUM PERSULFATE

23 ACRYLAMIDE GROUT, JOINT INJECTION

MATERIAL READY FOR DISCHARGE

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

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1	1/9/2020	REVISIONS	TB

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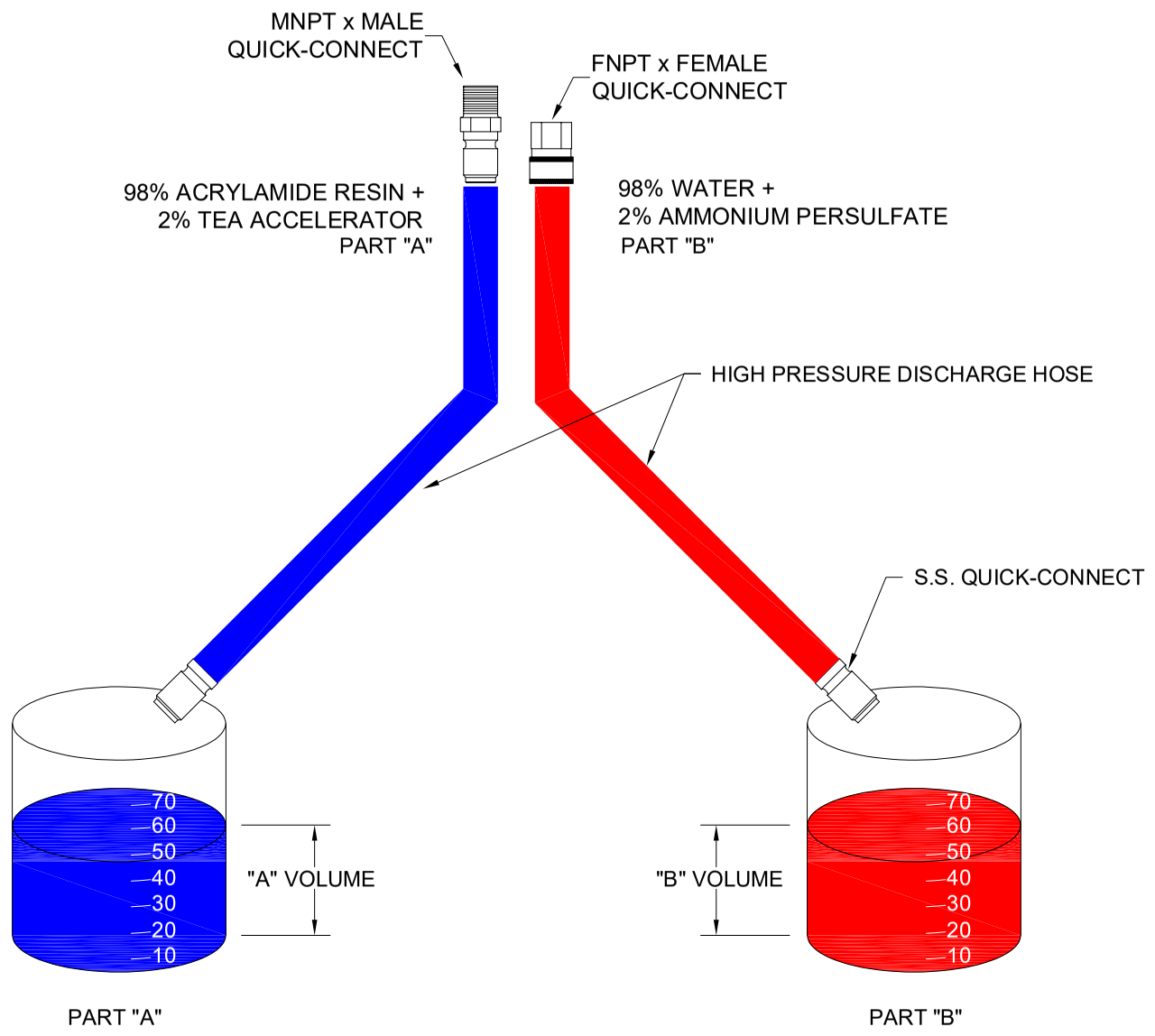
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Phone: 612-363-9580
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 23B

1. PRIOR TO PUMPING:
   1.1. DISCONNECT "E" OR "F" ASSEMBLY
   1.2. PUMP PARTS "A" & "B" INTO MEASURING CUPS TO ENSURE PROPER 1-TO-1 RATIO, TOLERANCE MAY BE 10% EITHER WAY
   1.3. ADJUST PUMP STROKE LENGTH IF NOT IN RATIO OF 1-TO-1
2. RATIO BALANCE CAN BE INFLUENCED BY PARTICLES OR DEBRIS BUILD UP IN VALVES OF PUMP



24 ACRYLAMIDE GROUT, JOINT INJECTION

QA / QC, 1-to-1 RATIO CHECK

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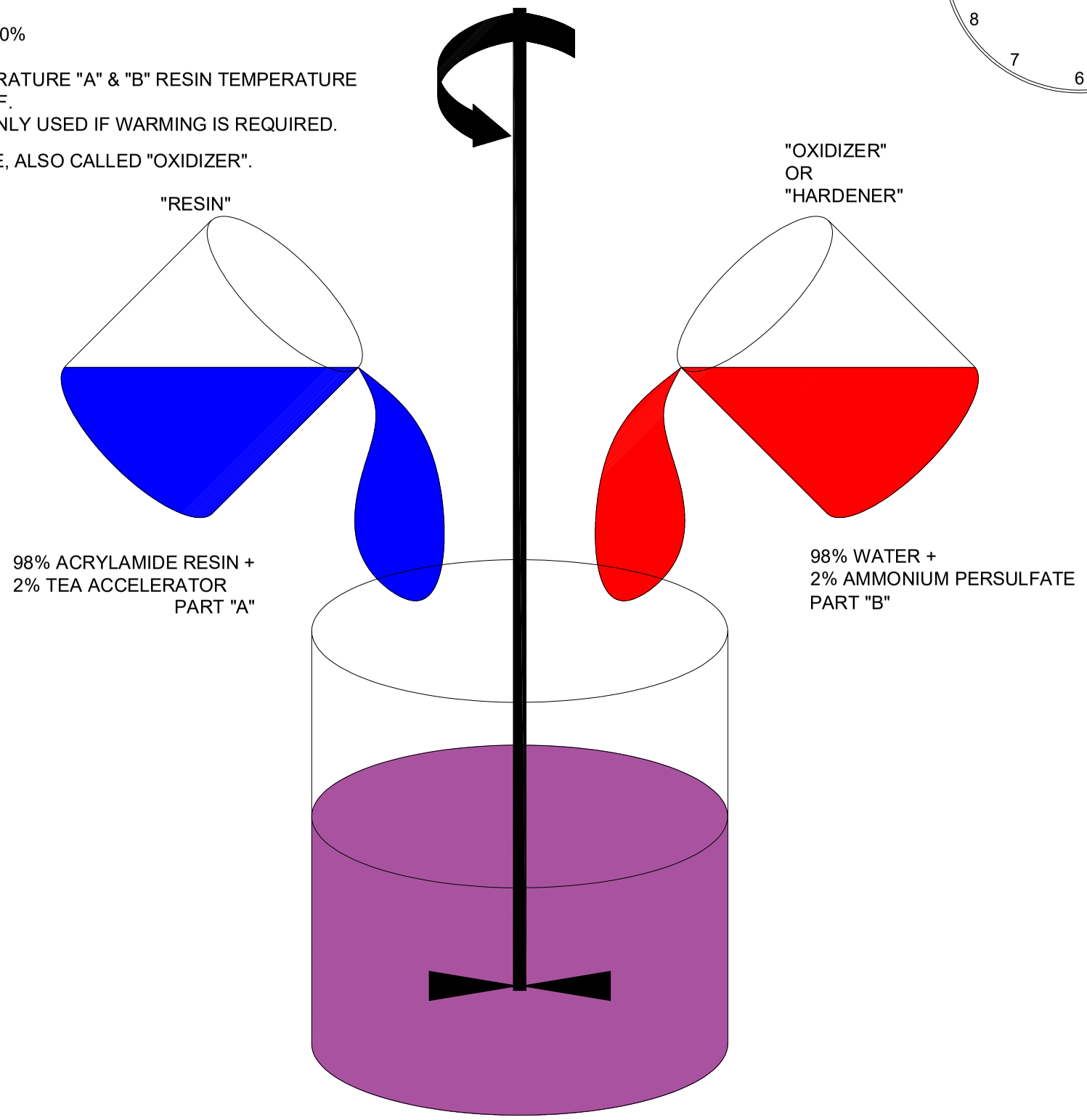
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 24B

1. COLLECT EQUAL VOLUME "A" & "B" COMPONENTS AND MIX TOGETHER, NOTE START TIME.
2. AFTER SHORT PERIOD (30 SECONDS TO 3 MINUTES) GROUT VISCOSITY INCREASES.
3. RATHER QUICKLY GROUT SOLIDIFIES INTO A SOLID MASS. NOTE GEL TIME.
4. IF GEL TIME IS TOO SHORT:
   - 4.1. REDUCE TEA BY 20% INTO PART "A"
   - 4.2. REDUCE HARDENER IN PART "B" BY 20%.
   - 4.3. MEASURE NEW GEL TIME.
5. IF GEL TIME IS TOO LONG:
   - 5.1. INCREASE TEA BY 20% INTO PART "A"
   - 5.2. INCREASE HARDENER IN PART "B" BY 20%
   - 5.3. MEASURE NEW GEL TIME
6. GEL-TIME IS INFLUENCED BY FLUID TEMPERATURE "A" & "B" RESIN TEMPERATURE TO THIS CAN BE VARIED FROM 40° TO 120° F.
7. PAIL AND/OR DRUM HEATERS ARE COMMONLY USED IF WARMING IS REQUIRED.

* HARDENER IS CALLED AMMONIUM PERSULFATE, ALSO CALLED "OXIDIZER".





GEL TIME INFLUENCED BY:

1. TEMPERATURE OF LIQUIDS "A" & "B"
2. pH OF WATER ON "B" SIDE
3. IRON CONTENT IN WATER IN "B" SIDE
4. CONCENTRATIONS OF ACCELERATOR AND OXIDIZER IN TOTES

25 ACRYLAMIDE GROUT, JOINT INJECTION

GEL TIME CHECK

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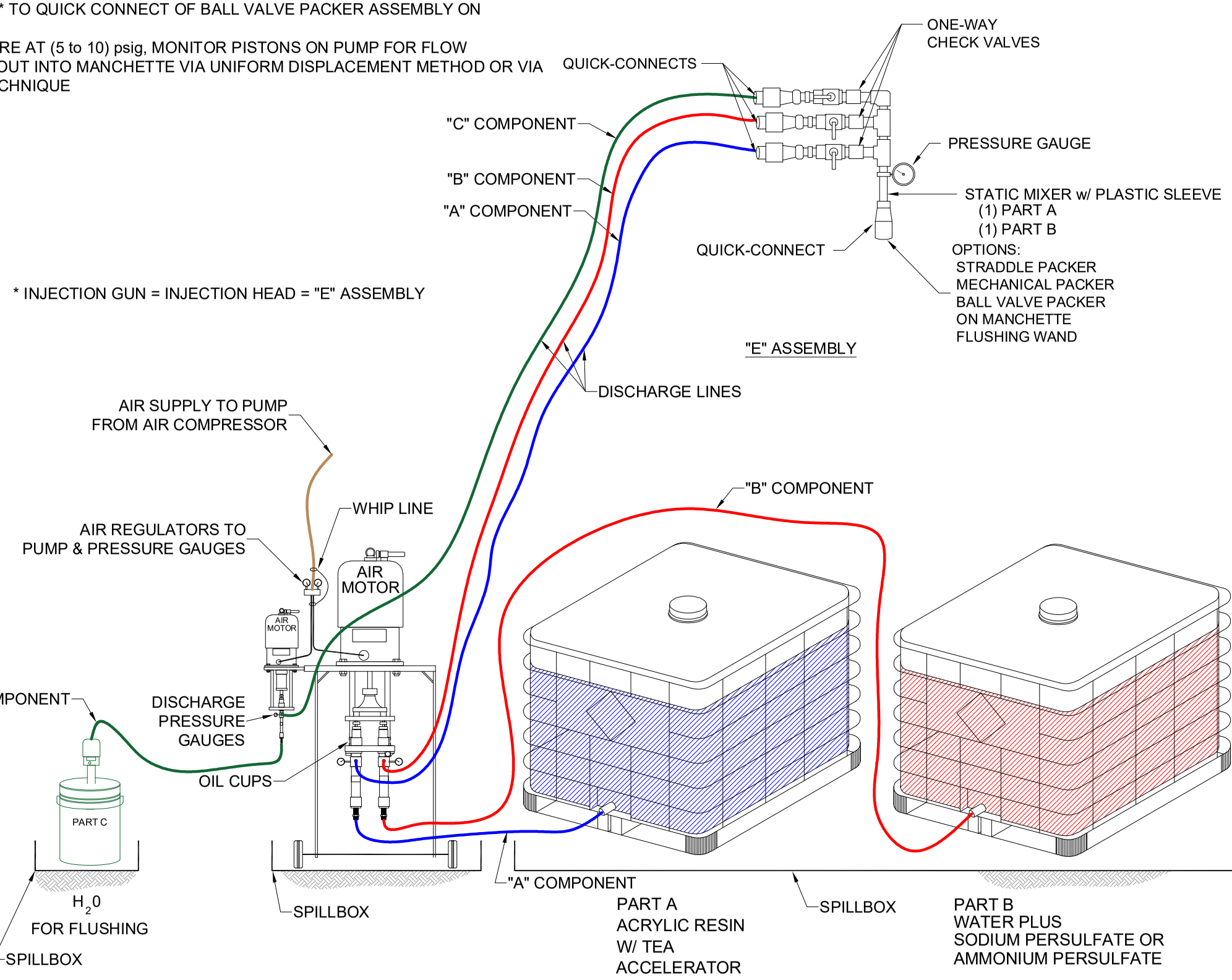
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 25B

1. REFER TO SHEET 24B AND 25B, FOR GEL-TIME CUP TEST, AND RATIO CHECK
2. NOTE: STATIC MIXER NEEDS TO BE FLUSHED WITH WATER PRIOR TO GEL-TIME REACTION
3. TURN ON AIR PRESSURE TO CHEMICAL GROUT SYSTEM PUMP, TURN OFF AIR PRESSURE TO FLUSHING PUMP
4. REGULATE AIR PRESSURE TO OBTAIN A STEADY FLOW OF MATERIAL THROUGH INJECTION GUN*
5. HOOK UP INJECTION HEAD* TO QUICK CONNECT OF BALL VALVE PACKER ASSEMBLY ON MANCHETTE
6. START INJECTION PRESSURE AT (5 to 10) psig, MONITOR PISTONS ON PUMP FOR FLOW
7. DISCHARGE SOLUTION GROUT INTO MANCHETTE VIA UNIFORM DISPLACEMENT METHOD OR VIA BOTTOM-UP GROUTING TECHNIQUE

* INJECTION GUN = INJECTION HEAD = "E" ASSEMBLY



* NOTE - RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY

26 ACRYLAMIDE GROUT, JOINT INJECTION PUMPING

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JOB NO.

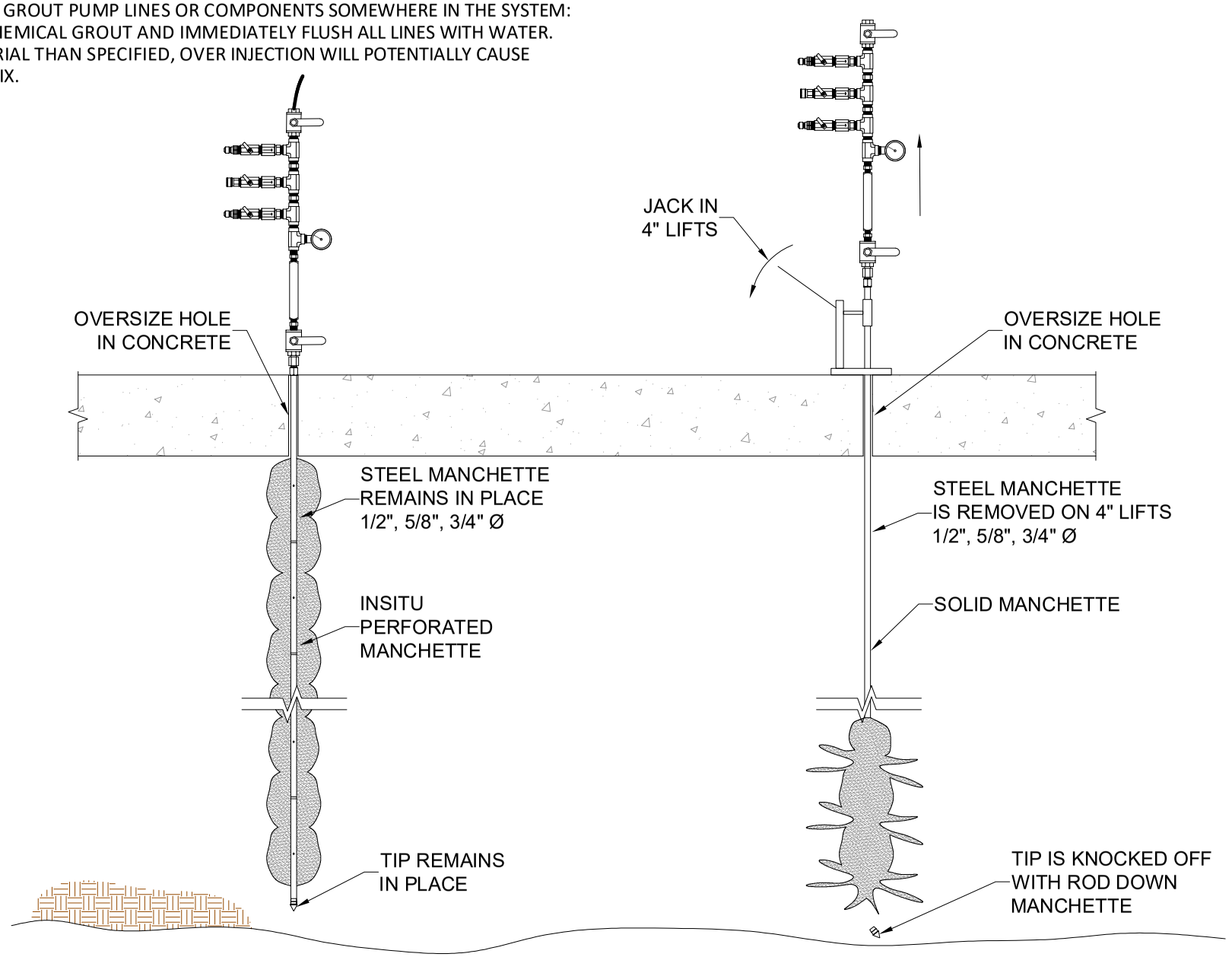
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 26B

1. TWO CLASSIC METHODS OF MANCHETTE INJECTION ARE:
   1.1. UNIFORM DISPURSEMENT GROUTING
   1.2. BOTTOM-UP GROUTING
2. CONTINUE PUMPING UNTIL SPECIFIED GROUT QUANTITY IS DELIVERED INTO POSITION;
   2.1. IF PRESSURE GAUGE SPIKES UP DURING PUMPING, ONE OF THE FOLLOWING ITEMS HAS OCCURRED:
      2.1.1. THE CHEMICAL GROUT HAS SUDDENLY GELLED AND CURED IN THE MANCHETTE SLEEVE, CONSIDER THIS A "DEAD" HOLE,
         2.1.1.1. MOVE TO NEXT MANCHETTE AND SPEED UP THE INJECTION RATE,
         2.1.1.2. IF PLUGGING CONTINUES IN MANCHETTE, NOTE AS "DEAD" HOLE AND CHANGE FORMULATION TO LONGER GEL TIME OF "A" AND "B" COMPONENTS, AND
         2.1.1.3. NEW INJECTION HOLES WILL BE REQUIRED NEXT TO THE "DEAD" HOLES.
      2.1.2. THE SOIL ZONE IS FULL AND CANNOT TAKE MORE GROUT,
         2.1.2.1. IF GROUTING CONTINUES UNDER HIGHER PRESSURES, SOIL FRACKING WILL OCCUR AND SOIL UPLIFT MAY START.
      2.1.3. THERE IS A PLUG IN THE GROUT PUMP LINES OR COMPONENTS SOMEWHERE IN THE SYSTEM:
         2.1.3.1. STOP INJECTING CHEMICAL GROUT AND IMMEDIATELY FLUSH ALL LINES WITH WATER.
   2.2. DO NOT INJECT MORE MATERIAL THAN SPECIFIED, OVER INJECTION WILL POTENTIALLY CAUSE FRACKING OF THE SOIL MATRIX.
   2.3. IF UNREACTED CHEMICAL GROUT COMES TO THE SURFACE OTHER THAN IMMEDIATELY AT THE MANCHETTE PENETRATION INTO THE SOIL, NOTE THE FOLLOWING
      2.3.1. THE SOIL ZONE IS FULL AND CANNOT TAKE MORE GROUT,
         2.3.1.1. IF GROUTING CONTINUES UNDER HIGHER PRESSURES, SOIL FRACKING WILL OCCUR AND SOIL UPLIFT MAY START.
      2.3.2. THERE IS A PLUG IN THE BOTTOM PART OF THE MANCHETTE AND ALL GROUT IS BEING DISBURSED CLOSE TO THE SURFACE,
         2.3.2.1. IMMEDIATELY FLUSH MANCHETTE WITH WATER AND RUN FLUSHING WAND DOWN MANCHETTE TO ENSURE IT IS OPEN TO THE BOTTOM.



27A UNIFORM PLACEMENT

27B BOTTOM-UP GROUTING
PUMPING

27 ACRYLAMIDE GROUT, JOINT INJECTION
TYPES OF MANCHETTE INJECTION

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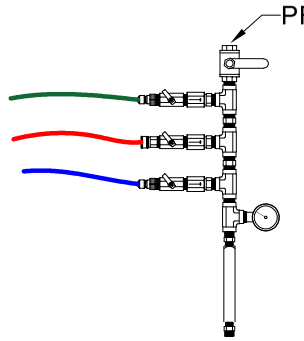
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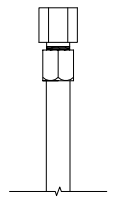
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 27B

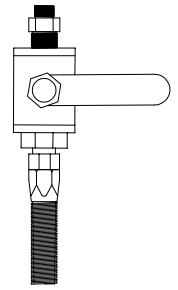
1. UPON COMPLETION OF PRESSURE INJECTION OPERATIONS, FLUSH PUMPS WITH DETERGENT/SOAP AND WATER INTO SPILL PAIL
2. ENSURE THE FOLLOWING ITEMS ARE FLUSHED OUT:
   - 2.1. PUMP INTAKE LINES, DISCHARGE LINES, AND RECIRCULATING LINES
   - 2.2. E-ASSEMBLY
   - 2.3. FERRULE FITTINS ON MANCHETTES
   - 2.4. REMOVABLE PACKERS



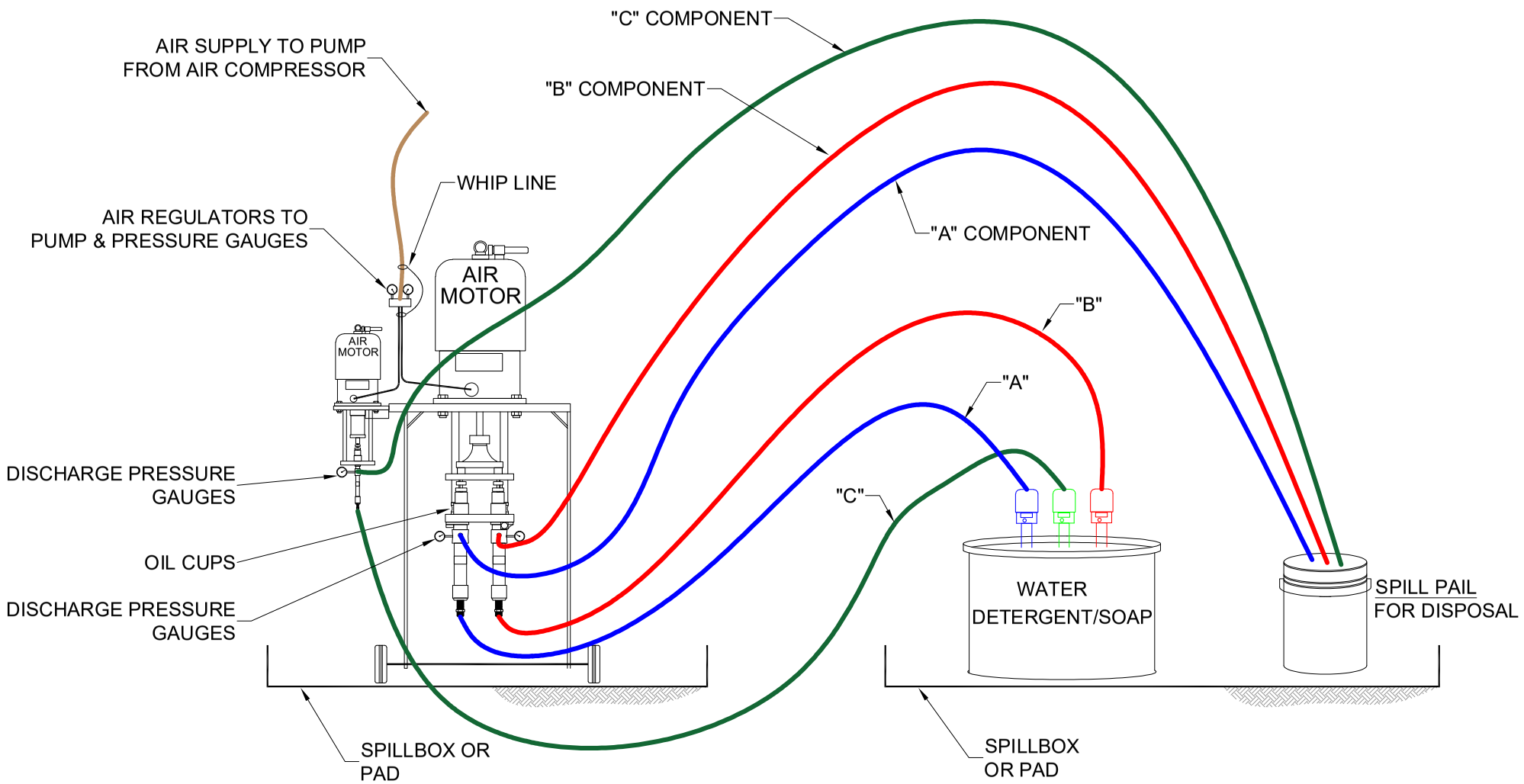
28A E-ASSEMBLY



28B FERRULE FITTINGS



28C REMOVABLE PACKERS



28 ACRYLAMIDE GROUT, JOINT INJECTION

DETERGENT WATER FLUSHING GROUT PUMP
GROUT PUMP CLEANUP
NOTE: RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY

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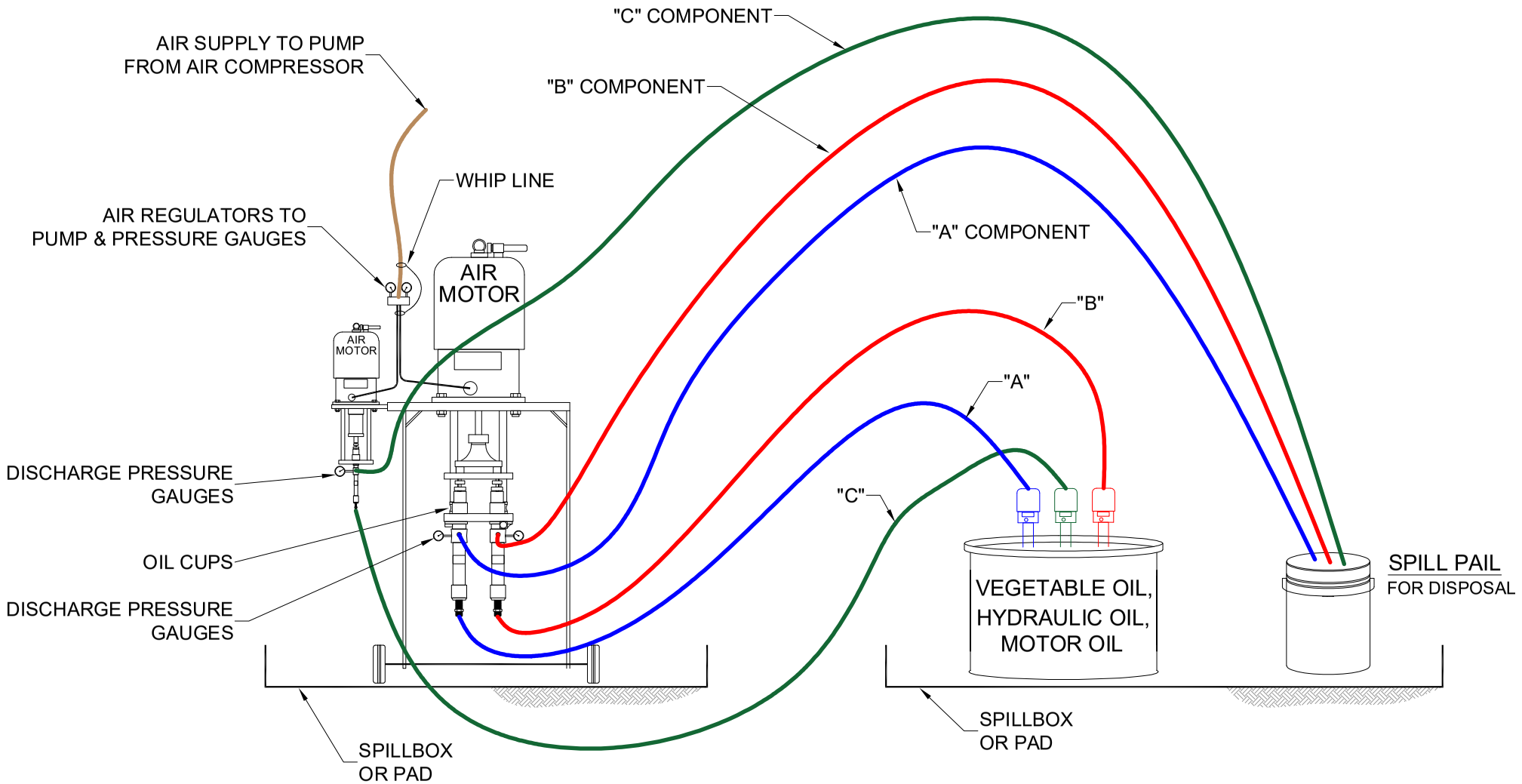
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 28B

1. AFTER FLUSHING w/ DETERGENT AND WATER, PUMP VEGETABLE, OR MOTOR OIL IN (CHEMICAL GROUT SYSTEMS (CGS) PRESSURE INJECTION PUMP AND ATTACHED FLUSHING PUMP) SYSTEM FOR STORAGE OR UNTIL NEXT USAGE.



29 ACRYLAMIDE GROUT, JOINT INJECTION

OIL INDUCTION, PREPARING FOR STORAGE

NOTE: RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY

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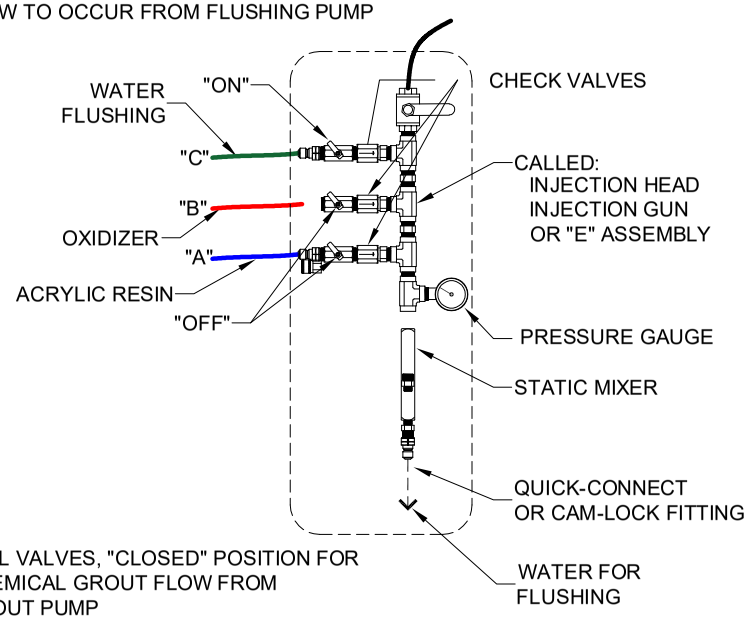
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 29B

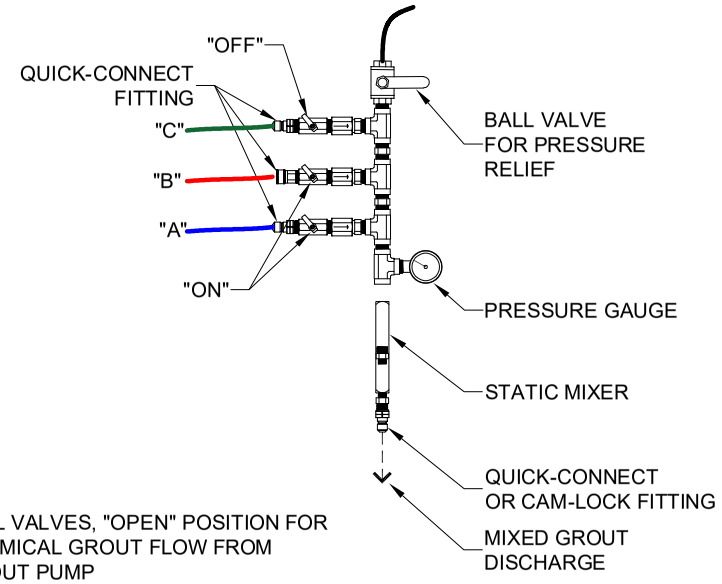
WATER FLUSHING LINE IN OPEN POSITION, MEANING PRESSURIZED WATER FLOW TO OCCUR FROM FLUSHING PUMP



BALL VALVES, "CLOSED" POSITION FOR CHEMICAL GROUT FLOW FROM GROUT PUMP

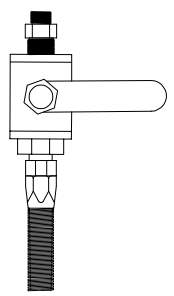
"E" ASSEMBLY, FLUSHING OPERATION

WATER FLUSHING LINE IN CLOSED, MEANING NO WATER FLOW FROM FLUSHING PUMP

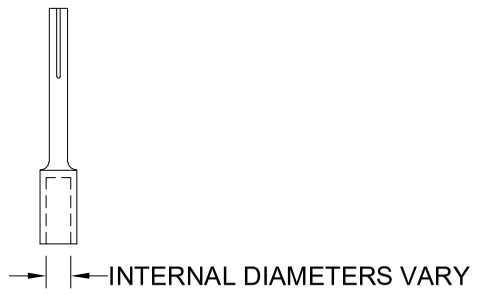


BALL VALVES, "OPEN" POSITION FOR CHEMICAL GROUT FLOW FROM GROUT PUMP

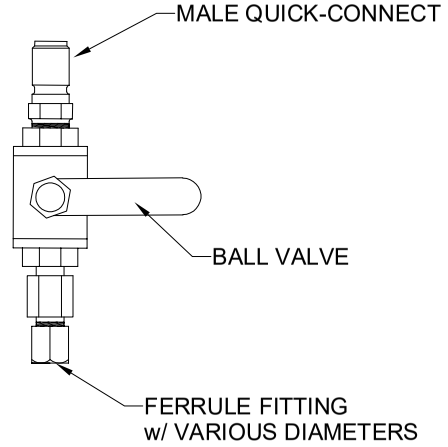
"E" ASSEMBLY, GROUTING OPERATION



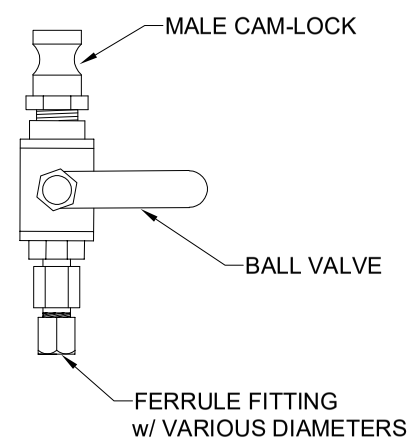
REMOVABLE PACKER



MANCHETTE DRIVER
w/ VARIOUS INTERNAL DIAMETERS



QUICK-CONNECT / BALL VALVE / FERRULE



CAM / BALL VALVE / FERRULE

30 ACRYLAMIDE GROUT, JOINT INJECTION
EQUIPMENT HARDWARE & ACCESSORIES

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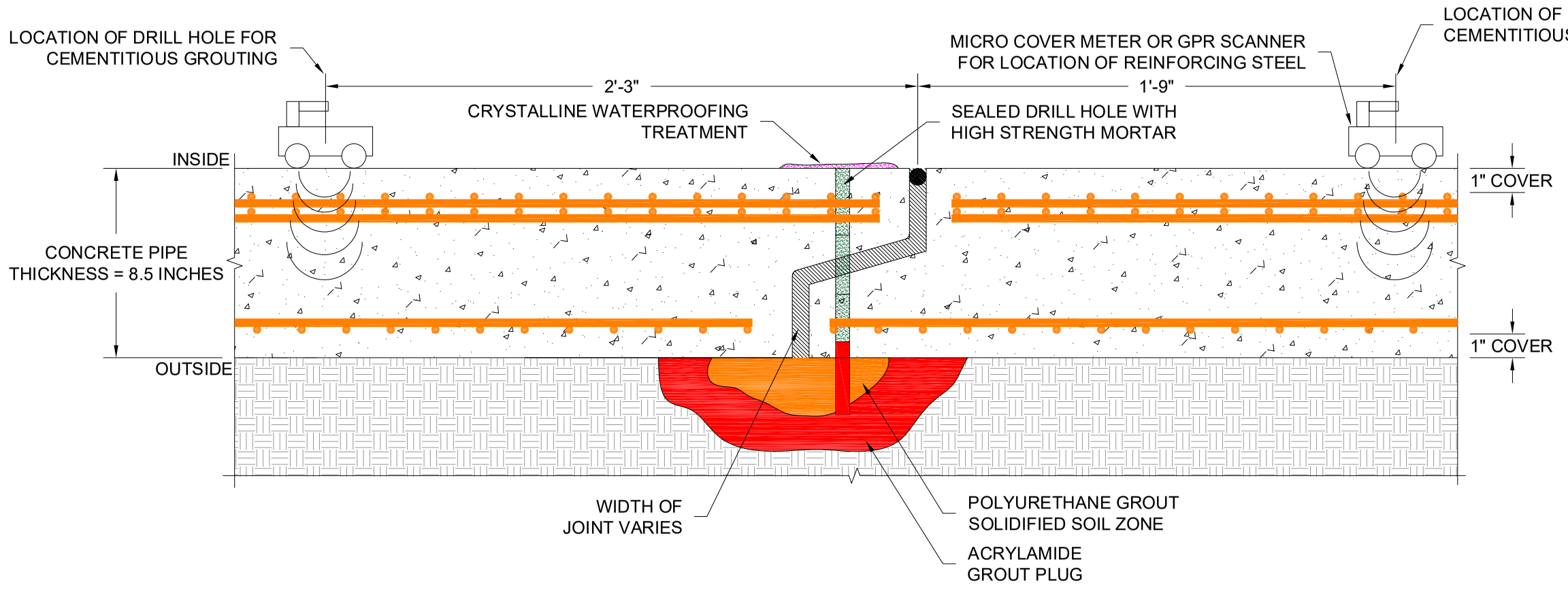
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 30B

GENERAL CONDITIONS:

1. EXAMINE TUNNEL MANHOLES AND PORTALS FOR ACCESS AND EGRESS, OBSERVE MANHOLE COVERS DIMENSIONS FOR OBSTRUCTIONS:
   - 1.1. COORDINATE SAFETY PLAN TO INCLUDE MANAGEMENT OF MANCHETTE TOPS TO AVOID TRIP HAZARDS TO TRADESMEN
   - 1.2. COORDINATE ACCESS/EGREE PLAN IN CASE OF HIGH WATER, EXCESS CARBON DIOXIDE, LACK OF LIGHTING AND/OR OTHER ISSUES THAT MAY REQUIRE UNPLANNED EVACUATION OF CULVERT PIPE
   - 1.3. COORDINATE WORKING TIMES TO ENSURE STORM WATER DRAINAGE DOES NOT INTERFERE WITH GROUTING OPERATIONS BEYOND MANAGED WATER RE-ROUTING
   - 1.4. COORDINATE EYEWASH STATIONS FOR POTENTIAL CONTAMINANTS DURING GROUTING
   - 1.5. COORDINATE ELECTRICAL AND COMPRESSED AIR SUPPLY FOR GROUTING EQUIPMENT
   - 1.6. ENSURE PROJECT TEAM IS COORDINATED WITH WEATHER FORECASTS AND CURRENT CONDITIONS
   - 1.7. ENSURE WATER DIVERSION PLAN IS APPROVED BY OWNER
   - 1.8. FOLLOW ALL OSHA REQUIREMENTS FOR CONFINED SPACE WORK
   - 1.9. ENSURE:
     - 1.9.1. PROPER & ADEQUATE LIGHTING & ELECTRICAL SUPPLY
     - 1.9.2. PROPER & ADEQUATE FRESH AIR-SUPPLY
     - 1.9.3. PROPER & ADEQUATE AIR QUALITY MONITORING
     - 1.9.4. PROPER & ADEQUATE EYE WASH STATIONS ARE SETUP
   - 1.10. IDENTIFY ALL BURIED UTILITIES WITHIN IMMEDIATE GROUT ZONE AREA.
   - 1.11. IDENTIFY STORM OR SANITARY SEWER PIPES WITHIN 10 FEET OF GROUT ZONE, AND ESTABLISH SOME CRITERIA TO MONITOR EXISTING PIPING DURING CHEMICAL GROUTING TO ENSURE NO STRAY GROUT MIGRATION OCCURS.

1. CLEAN DRY SUBSTRATES IN GROUT ZONE
2. USE GPR OR EQUAL TO LOCATE STEEL REINFORCING
3. MARK DRILL / CORE LOCATIONS ON CONCRETE SUBSTRATE AS FOLLOWS:
   - 3.1. LOCATE DRILL / CORE HOLES 1'-9" FROM JOINT ON ONE SIDE AND 2'-3" ON THE OTHER SIDE,
   - 3.2. LOCATE DRILL / CORE HOLES AS SHOWN ON DETAIL 2C.



1 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION
PREPERATION, LOCATION OF STEEL REINFORCING

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"F" SERIES DRAWINGS	1F-6F	Section 03 64 23 Epoxy Resin Crack Injection	WP-6
"G" SERIES DRAWINGS	1G-4G	Section 07 13 56 Thermoplastic Sheet Strip Seals	WP-7

GENERAL NOTES:
1. STEEL REINFORCING VARIES AT LOCATIONS IN CULVERT PIPE.

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Fridley, MN 55432
Phone: 612-363-9580
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RAYMOND ROAD CULVERT PIPE RESTORATION

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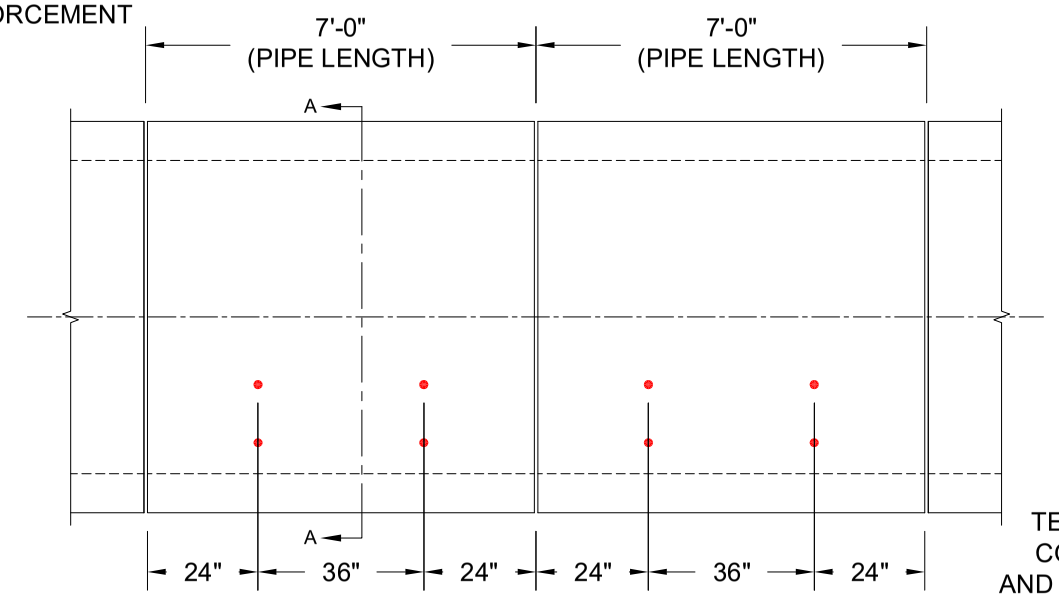
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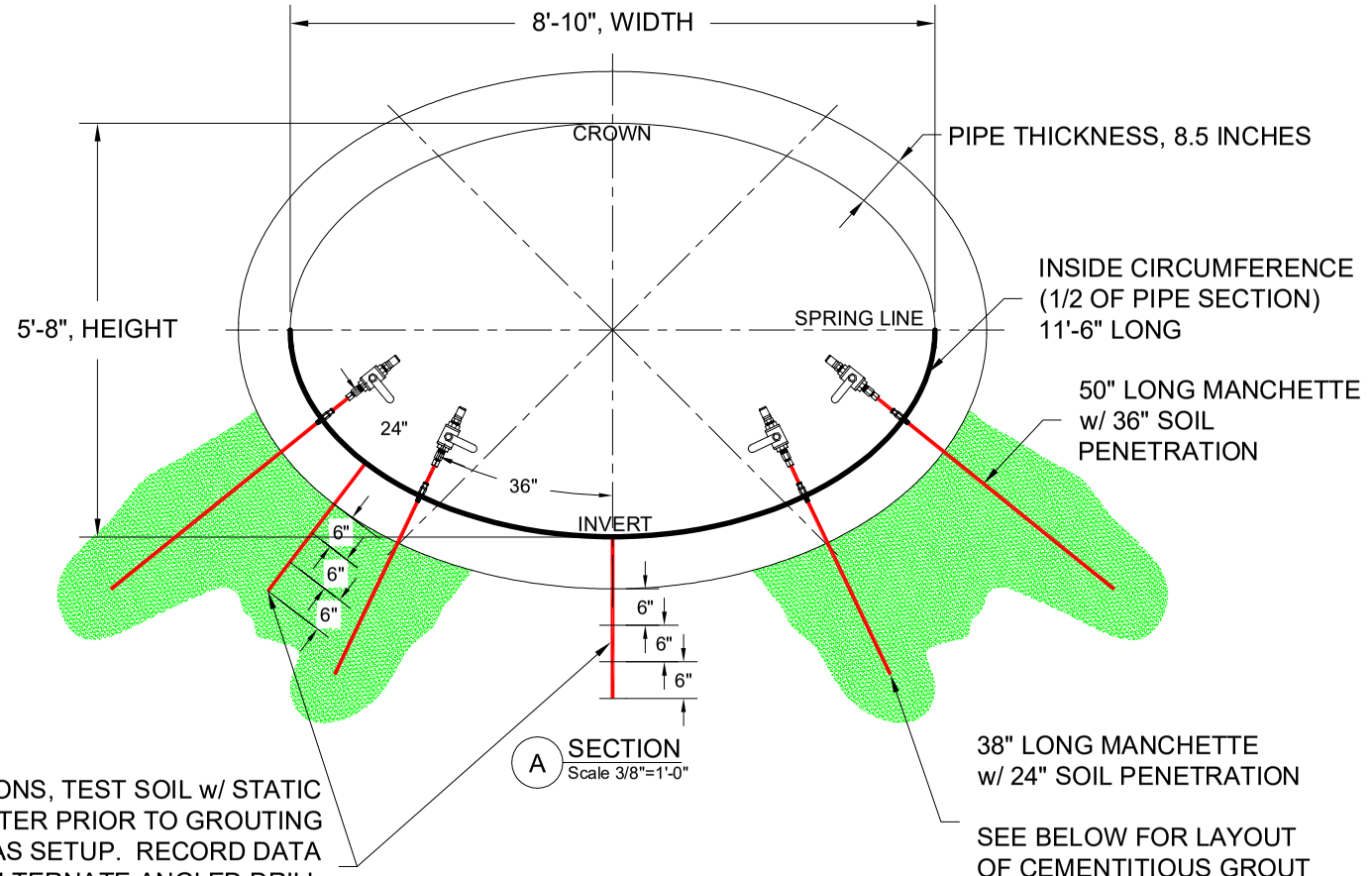
SHEET: 1C

ULTRA-FINE CEMENTITIOUS GROUTING

1. MARK GROUT HOLE LOCATIONS FOR DRILLING AS SHOWN ON THE PLANS
   - 1.1. CEMENTITIOUS GROUT HOLES SHALL BE LOCATED AT TUNNEL HAUNCH AREAS (ON EACH SIDE OF INVERT)
   - 1.2. DRILL HOLES SHALL BE LOCATED AT 36" AND 60" TRANSVERSE AND CIRCUMFERENTIALLY FROM INVERT ON EACH SIDE
   - 1.3. DRILL HOLES SHALL BE ADDITIONALLY LOCATED @ 24" FROM EACH END PIPE
   - 1.4. USE GPR OR SIMILAR METHODS FOR LOCATING STEEL REINFORCING BARS/GRIDS/MESH IN CONCRETE CULVERT PRIOR TO DRILLING
   - 1.5. DRILL HOLES CAN BE ADJUSTED 4 INCHES IN ANY DIRECTION TO AVOID STEEL REINFORCEMENT

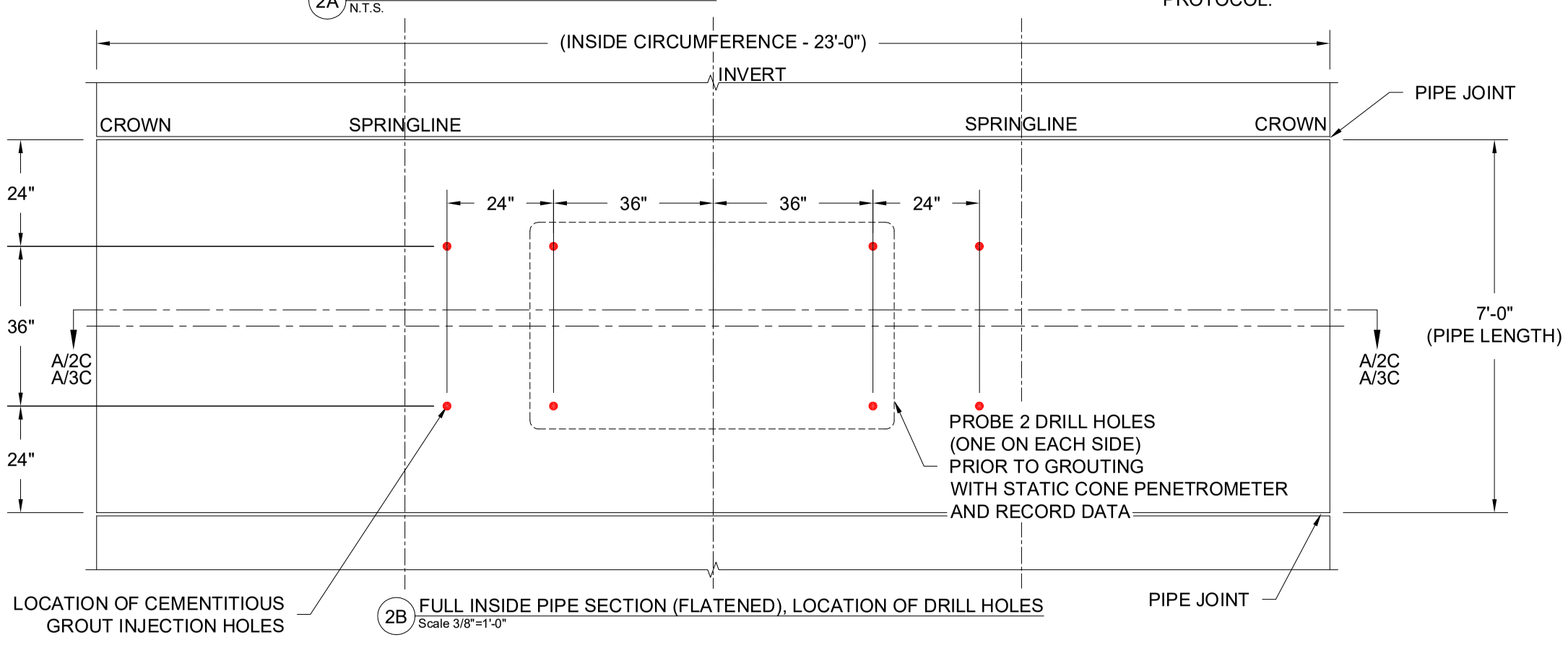


TEST HOLE LOCATIONS, TEST SOIL w/ STATIC CONE PENETROMETER PRIOR TO GROUTING AND AFTER GROUT HAS SETUP. RECORD DATA ON SOIL IMPROVEMENT. ALTERNATE ANGLED DRILL HOLE TESTING. SEE SHEET 4C FOR MOCKUP PROTOCOL.



A SECTION
Scale 3/8"=1'-0"

2A ELEVATION, LOCATION OF DRILL HOLES
N.T.S.



2B FULL INSIDE PIPE SECTION (FLATENED), LOCATION OF DRILL HOLES
Scale 3/8"=1'-0"

2 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION
DRILL HOLE LOCATIONS

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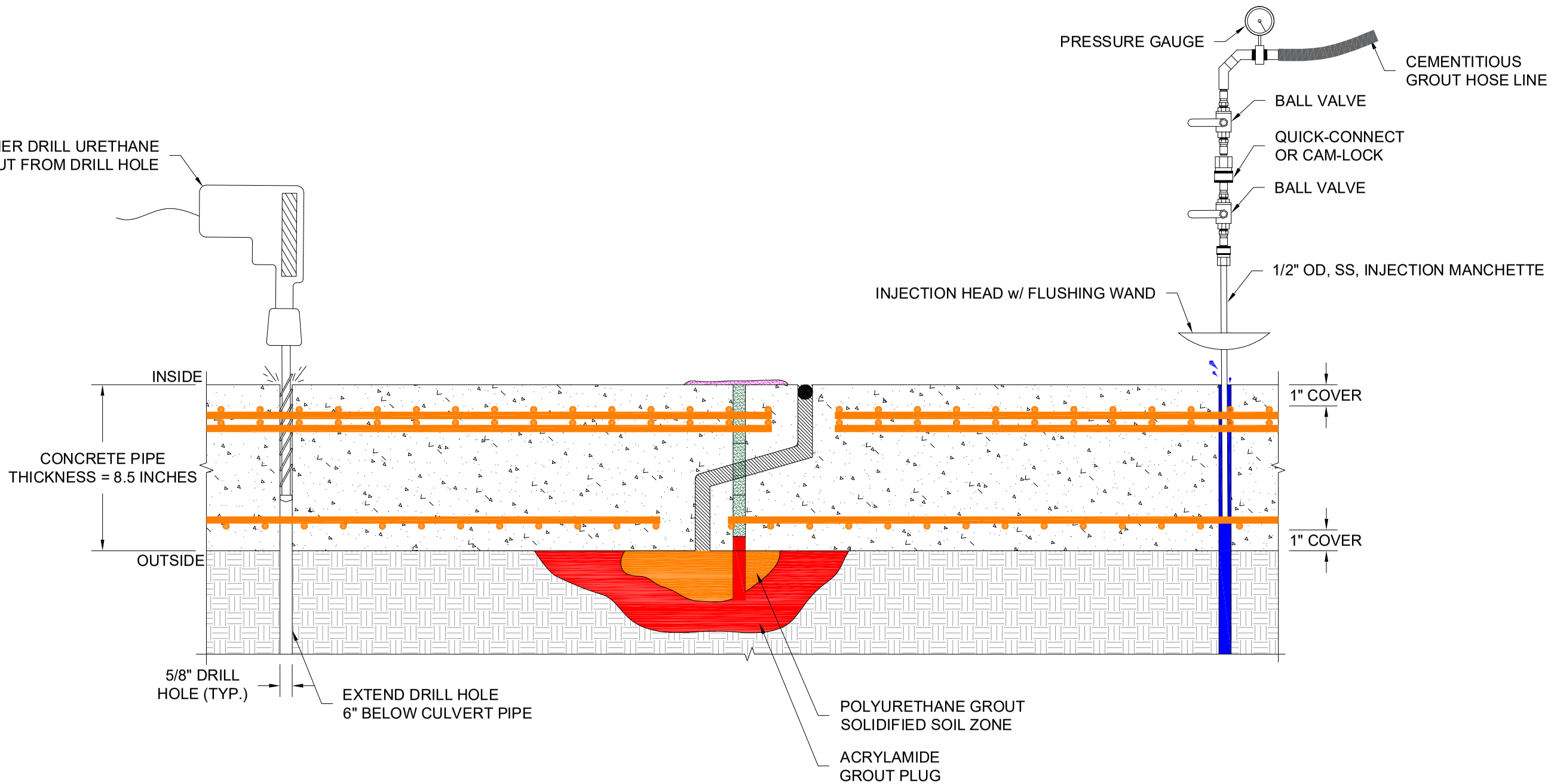
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BDA Associates, LLC.
7864 Highway 65 NE
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 2C

1. DRILL 3/4" Ø HOLES THROUGH CONCRETE PIPE WITH PROGRESSING LENGTH BITS AS REQUIRED TO A DEPTH AS NOTED ON THE PLANS
   1.1. COLLECT DRILLING DEBRIS AND SOIL PARTICLES VIA VACUUM AROUND DRILL HOLES, AND
   1.2. AIR OR WATERBLAST DRILL HOLE SIDES TO CLEAN, ENSURE OSHA SILICA DUST PROTOCOLS ARE FOLLOWED
2. PENETRATE DRILL 6" BELOW PIPE EXTERIOR, INTO SOIL
3. FLUSH DRILL / CORE HOLE WITH PRESSURIZED WATER.



3 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION

DRILL HOLE & WATER FLUSHING DRILL HOLES

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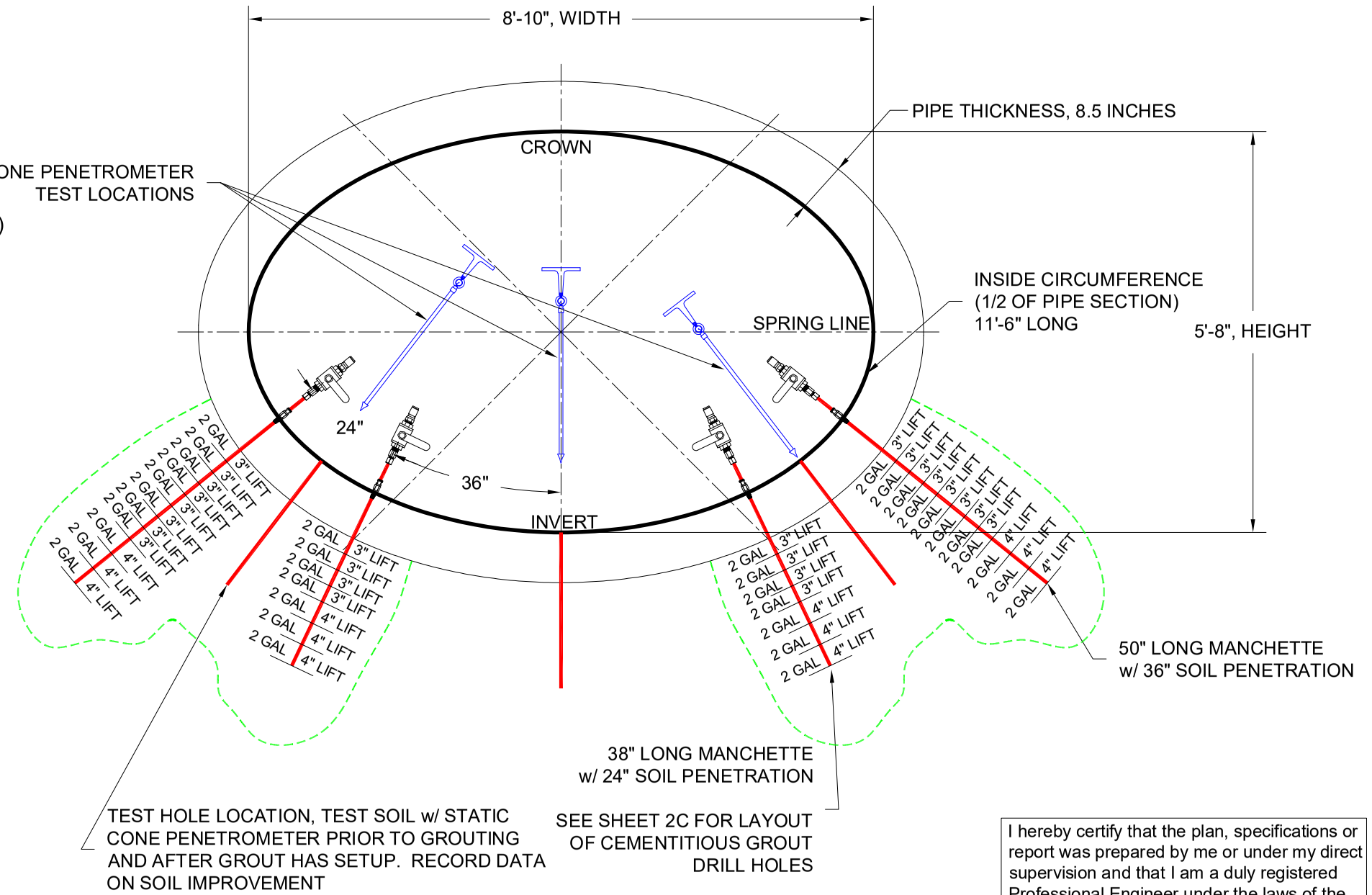
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 3C

1. INSERT STATIC CONE PENETROMETER DOWN DRILL HOLE 36 INCHES CIRCUMFERENTIALLY OFF INVERT, (24-INCH-DEEP GROUT ZONE) AND MEASURE RESISTANCE AT 12 INCH AND 18 INCH DEPTHS, RECORD DATA ON SPREADSHEET
2. INSERT PLASTIC SLEEVE ON TAPERED SHAFT OF "JA" PACKER AND SECURE INTO POSITION AT DRILL HOLE, ENSURE RUBBER O-RING IS IN PLACE AND NOT SEVERELY WORN OR DAMAGED
3. PLACE METAL DRIVE TIP ON 1/2" Ø MANCHETTE
4. PLACE 1/2" Ø MANCHETTE INTO "JA" PACKER AND ALIGN WITH DRILL HOLE
5. DRIVE 1/2" Ø SOLID MANCHETTE, WITH STEEL TIP, WITH HAMMER-DRILL DRIVING TOOL OR BY HAND PRESSURE
6. IF RESISTANCE IS ENCOUNTERED DUE TO BOULDERS, COBBLES, OR COARSE AGGREGATE BACKFILL, USE SOLID STEEL ROD OR 3/8" HAMMER-DRILL BIT TO CLEAR PASSAGE
7. DRIVE MANCHETTES TO DEPTHS SHOWN, 24 INCHES INTO SOIL-CLOSEST TO INVERT, 36 INCHES INTO SOIL FARTHEST FROM INVERT. NOTE THE FOLLOWING:
   - 7.1. MANCHETTE LENGTH OF 24 INCHES INTO SOIL, 8.5 INCHES THRU CONCRETE PIPE SECTION, 5.5 INCHES INTERIOR EQUATES TO 38 INCHES LONG
   - 7.2. MANCHETTE LENGTH OF 36 INCHES INTO SOIL, 8.5 INCHES THRU CONCRETE PIPE SECTION, 5.5 INCHES INTERIOR EQUATES TO 50 INCHES LONG
8. UPON COMPLETION OF THE MANCHETTES, DROP PLUNGING ROD DOWN MANCHETTES TO ENSURE NO DEBRIS HAS FILLED TUBE IF GROUNDWATER CONDITIONS EXIST
9. USE FLUSHING WAND TO CLEAN MANCHETTE IF FILLED WITH SOIL DEBRIS
10. TUBES FILLED WITH SOIL PARTICLES, DRILL DEBRIS, OR CHEMICAL GROUT SHALL BE FLUSHED WITH WATER TO CLEAN PRIOR TO MICROFINE CEMENT GROUTING INJECTION
11. KNOCK OF STEEL TIP ON SOLID MANCHETTES ONLY
12. INSTALL FERRULE/BALL-VALVE HARDWARE CONSISTS OF CAM-LOCK INJECTION HEAD, BALL-VALVE, AND FERRULE FITTING ASSEMBLY
13. PRE-INJECT OR FLUSH MANCHETTE WITH FRESH WATER (1 TO 2 GALLONS) TO A PRESSURE OF 25 psig TO ENSURE GROUT ACCEPTANCE AND INTERIOR LEAKAGE DOES NO OCCUR

MOCK-UP FOR CEMENTITIOUS GROUT TESTING

1. MOCK-UP TEST SECTION:
   - 1.1. TEST TWO (2) PIPE SECTIONS (APPROXIMATELY 14 LINEAL FEET) AS DESCRIBED BELOW BEFORE GROUTING REMAINDER OF ELLIPTICAL CONCRETE CULVERT PIPE.
   - 1.2. TEST SECTION TO VERIFY IF BEDDING CONDITIONS MEETS A TYPE II OR TYPE III CONDITION PER THE AMERICAN PIPE ASSOCIATION, DESIGN MANUAL.
   - 1.3. TEST HOLES BEFORE GROUTING TO VERIFY POTENTIAL SOIL TYPE, THICKNESS AND RELATIVE COMPACTION OF FILL MATERIAL.
   - 1.4. TEST HOLES AFTER GROUTING TO VERIFY THAT GROUT HAS PENETRATED OR FRACTURED SOIL AND MADE IT MORE COMPACT.
   - 1.5. TEST HOLES SHOULD VERIFY THAT HAUNCH SOILS ARE MORE COMPACT THAN SOIL AT THE INVERT (6 O'CLOCK POSITION).
   - 1.6. TEST TO VERIFY GROUT TYPE, MIX RATIO AND QUANTITY OF GROUT PUMP TO INCREASE HAUNCH COMPACTION, HOWEVER NOTE THAT INVERT AREA TO BE LESS COMPACT THEN HAUNCH AREAS.
   - 1.7. TEST ALL 8 HOLES BEFORE GROUTING.
   - 1.8. TEST 6 NEW HOLES AFTER GROUTING.
   - 1.9. TEST WITH STATIC CONE PENETROMETER TO VERIFY IT ADEQUATELY TESTS FOR SOIL RESISTANCE.
   - 1.10. TEST IN THE PRESENCE OF A QUALIFIED ENGINEER.
   - 1.11. QUALIFIED ENGINEER TO APPROVE GROUTING OF MOCK-UP TEST SECTION HAS MET ABOVE REQUIREMENTS, BEFORE GROUTING REMAINDER CULVERT PIPES.
   - 1.12. QUALIFIED ENGINEER TO SET TESTING REQUIREMENTS FOR REMAINDER OF PIPE TO BE GROUTED. AS A MINIMUM EACH PIPE MUST HAVE 1 TEST HOLE IN THE HAUNCH AND 1 TEST HOLE AT THE 6 O'CLOCK FLOOR POSITION.



4 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION
SECTION, TESTING AND PRESCRIBED GROUT QUANTITIES

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By: Brent Anderson

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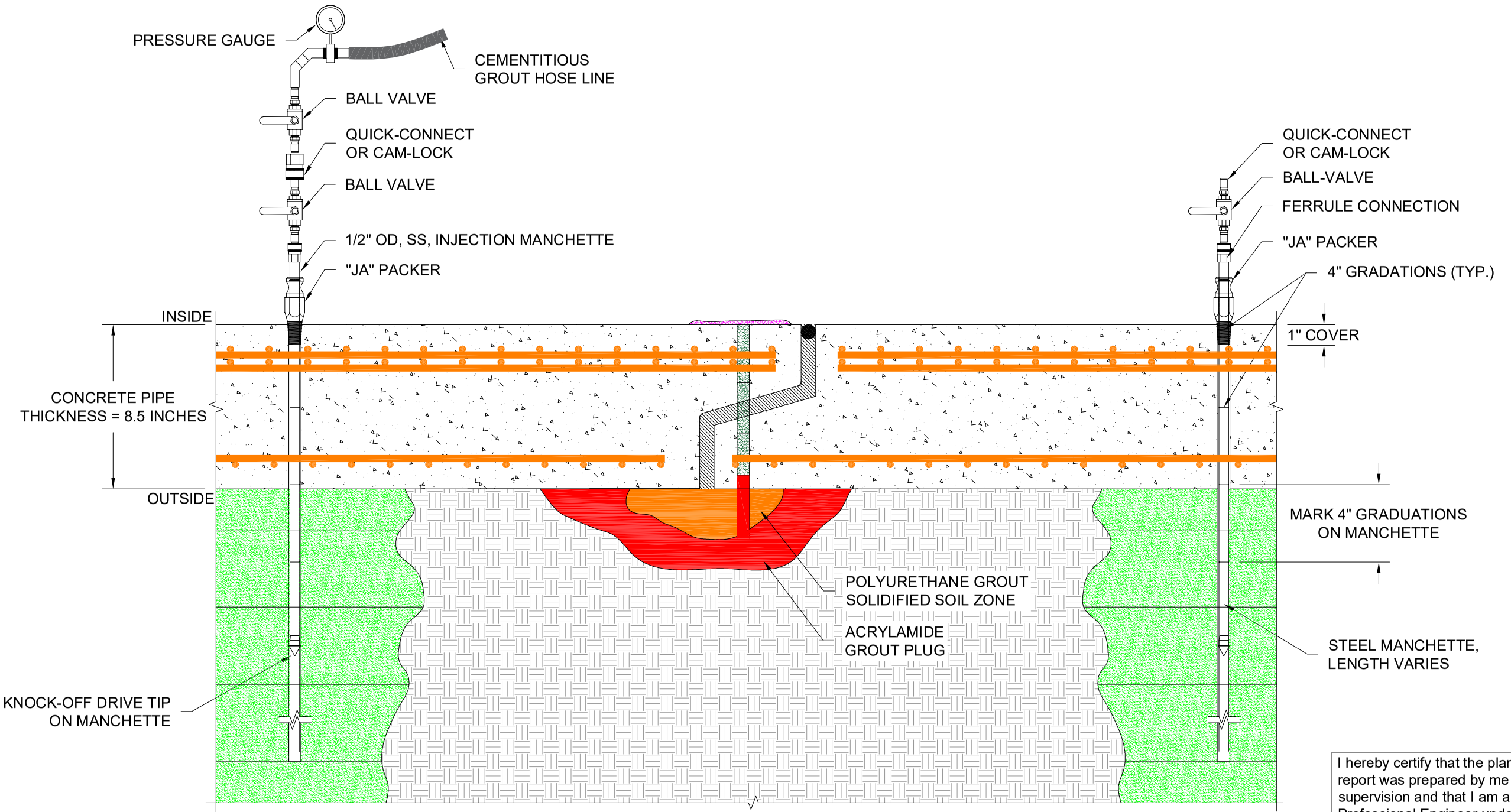
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 4C

1. SETUP COLLOIDAL MIXER IN HEATED ENCLOSURE
2. PLACE GRADATIONS AT 3" AND 4" O.C. ON INJECTION MANCHETTE AND SHOW ON SHEET 4C
3. PUSH INJECTION MANCHETTE (24" to 36") INCHES INTO THE UNDERLYING SOIL, AS SHOWN ON PAGES 4C.
4. REMOVE TIP AT END OF MANCHETTE BY RODDING.
5. ATTACH CEMENTITIOUS INJECTION HEAD TO MANCHETTE.
6. MIXING CEMENTITIOUS GROUT:
   - 6.1. FOLLOW MANUFACTURER'S INSTRUCTIONS FOR SETUP OF COLLOIDAL MIXER
   - 6.2. THE FOLLOWING INSTRUCTIONS SHALL BE INSTITUTED FOR CEMENTITIOUS GROUT FORMULATION:
     - 6.2.1. PROVIDE A WATER-TO-CEMENTITIOUS RATIO OF 0.6 BY WEIGHT
     - 6.2.2. PROVIDE 3.2 GALLONS OF WATER PER 44-POUND BAG OF MICRO/ULTRA-FINE CEMENT
     - 6.2.3. ADD SUPERPLASTICIZER PER MANUFACTURER'S RECOMMENDATIONS
     - 6.2.4. THE YIELD OF THESE SPECIFICATIONS SHOULD APPROXIMATE 5.4 GALLONS OF PUMPABLE CEMENTITIOUS GROUT PER BAG
     - 6.2.5. USE COLD WATER IN LIEU OF WARM WATER FOR MIXING TO IMPROVE FLOWABILITY
     - 6.2.6. DO NOT ADD FLYASH, LINE OR SILICA POWDER TO MIX
   - 6.3. SUFFICIENTLY MIX MICRO/ULTRA-FINE CEMENT AND WATER TO A "CREAM-LIKE" CONSISTENCY WITHOUT LUMPS
   - 6.4. INJECT MICRO/ULTRA-FINE CEMENT GROUT AS FOLLOWS:
     - 6.4.1. MIX AND PROPORATION MICRO/ULTRA-FINE CEMENT GROUT IN A COLLOIDAL MIXER PER MANUFACTURER'S INSTRUCTIONS,
     - 6.4.2. DISBURSE CEMENTITIOUS GROUT INTO GROUT PUMP,
     - 6.4.3. PUMP CEMENTITIOUS GROUT AT A RATE OF 1/2 GALLON PER MINUTE INTO MANCHETTE, DO NOT EXCEED THIS RATE OF INJECTION. INJECTION RATES IN EXCESS OF 1/2 GALLON PER MINUTE POTENTIALLY WILL INDUCE FRACKING PLANES IN SOIL GROUT ZONE
     - 6.4.4. IF INJECTION GROUT RATE INCREASES TO 1/4 GALLON PER MINUTE, AT MAXIMUM ALLOWABLE GROUT PRESSURE, FOR FIVE (5) CONSECUTIVE MINUTES, REFUSAL CRITERIA ARE MET AND MOVE TO NEXT MANCHETTE



5 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION
INJECTION PROCEDURE

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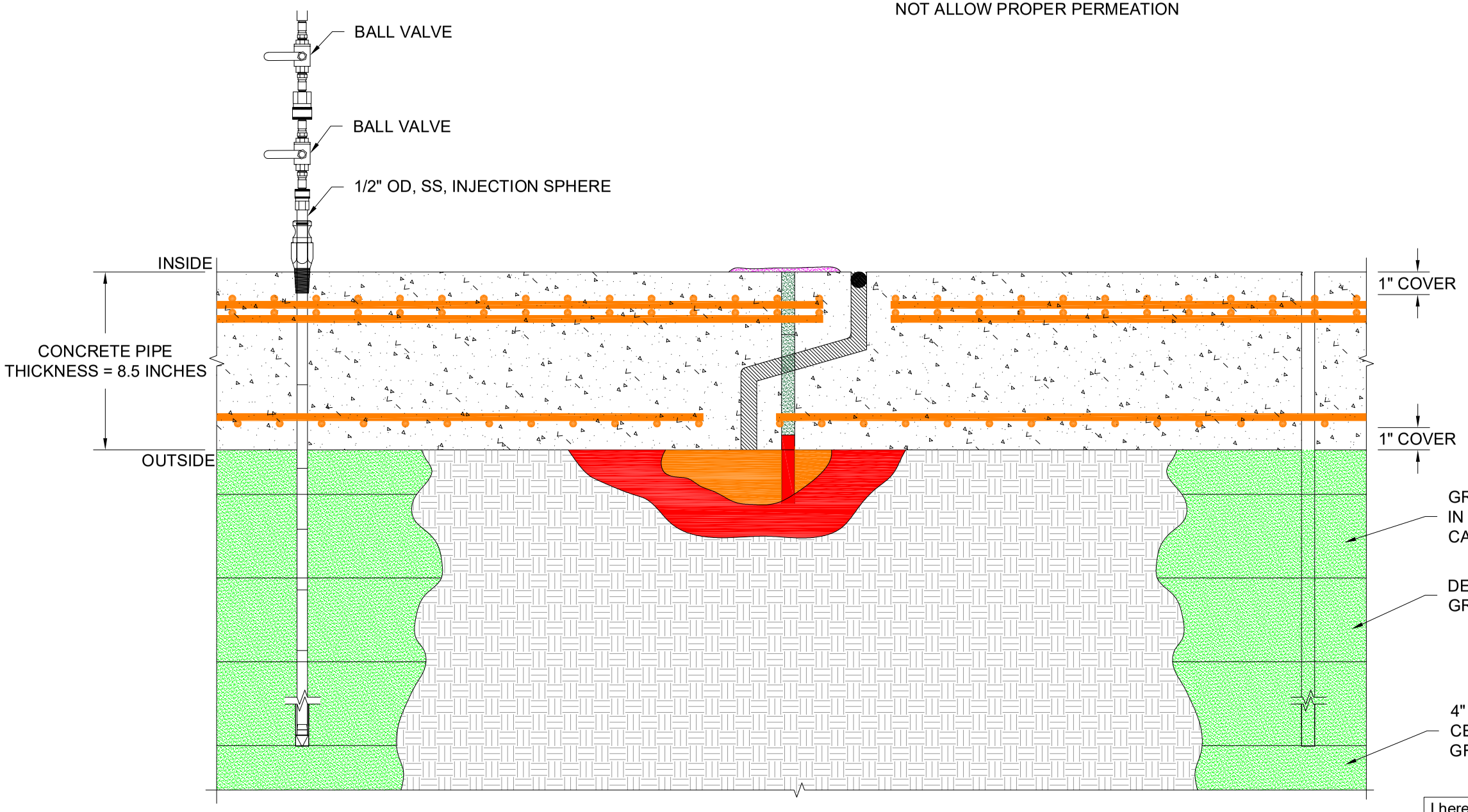
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 5C

1. WHEN SOIL GROUTING LAST LIFT OF BOTH 38" AND 50" MANCHETTES (i.e. WITHIN THREE (3) INCHES OF ELLIPTICAL CONCRETE PIPE EXTERIOR), PROCEED AS FOLLOWS:
   - 1.1. PUMP THE DESIGNATED 2-GALLON PER 3" LIFT AT A RATE OF 1/2 GALLON PER MINUTE
   - 1.2. NOTE THE PUMPING GROUT PRESSURE, IF IT DOES NOT EXCEED 30 psig, GROUTING ON THIS LIFT TILL REFUSAL IS MET
   - 1.3. NOTE THAT EXCESSIVE SOIL VOIDS, OR LOW COMPACTION MATERIAL EXISTS AND IS PRESENT, IN THESE AREAS; DOCUMENT ADDITIONAL GROUT INJECTED IN MANCHETTE
2. INJECT CEMENTITIOUS GROUT INTO EACH MANCHETTE AS FOLLOWS AT SPACINGS SHOWN ON DRAWINGS,
   - 2.1. 38" MANCHETTE SHALL BE GROUTED AS FOLLOWS:
     - 2.1.1. INJECT 8-GALLONS PER FOOT FOR 2 FEET:
       - 2.1.1.1. 2-GALLONS PER 4" LIFTS FOR 12 INCHES, AND
       - 2.1.1.2. 2-GALLONS PER 3" LIFTS FOR 12 INCHES,
       - 2.1.1.3. WHICH EQUATES TO 16 GALLONS PER MANCHETTE
   - 2.2. 50" MANCHETTE SHALL BE GROUTED AS FOLLOWS:
     - 2.2.1. INJECT 8-GALLONS PER FOOT FOR 3 FEET:
       - 2.2.1.1. 2-GALLONS PER 4" LIFTS FOR 12 INCHES, AND
       - 2.2.1.2. 2-GALLONS PER 3" LIFTS FOR 24 INCHES,
       - 2.2.1.3. WHICH EQUATES TO 24 GALLONS PER MANCHETTE
3. MICRO/ULTRA-FINE CEMENT GROUTING PROCEDURES:
   - 3.1. MICRO/ULTRA-FINE CEMENT GROUT INJECTION PRESSURE VARIATION SHALL BE BETWEEN (10 to 30) psig, GROUT PRESSURE SHALL NOT EXCEED 40 psig
     - 3.1.1. PERFORM CEMENTITIOUS GROUTING VIA BOTTOM-UP PROCEDURES, THE FIRST LIFT IS FARTHEST FROM THE CONCRETE PIPE EXTERIOR.
     - 3.1.2. GROUTING WITH 38" LONG MANCHETTES SHALL BE DONE WITH EIGHT (8) 3" LIFTS,
       - 3.1.2.1. THE LAST LIFT (No. 8, CLOSES TO PIPE) SHALL CONTINUE UNTIL GROUT PRESSURE EXCEEDS 30 psig TO ENSURE ANY BACKFILL VOIDS IN HAUNCH AREAS ARE FILLED
     - 3.1.3. GROUTING WITH 50" LONG MANCHETTES SHALL BE DONE WITH TWELVE (12) 3" LIFTS,
       - 3.1.3.1. THE LAST LIFT (No. 12, CLOSEST TO PIPE) SHALL CONTINUE UNTIL GROUT PRESSURE EXCEEDS 30 psig TO ENSURE ANY BACKFILL VOIDS IN HAUNCH AREAS ARE FILLED
   - 3.2. PUMP MICRO/ULTRA-FINE CEMENT GROUT AT A RATE NOT TO EXCEED 1/2 GALLON PER MINUTE,
     - 3.2.1. NOTE - PUMPING IN-EXCESS-OF 1/2 GALLON PER MINUTE WILL FRACK THE SOIL LAYERS AND NOT ALLOW PROPER PERMEATION



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By: Brent Anderson

6 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION

INJECTION PROCEDURE

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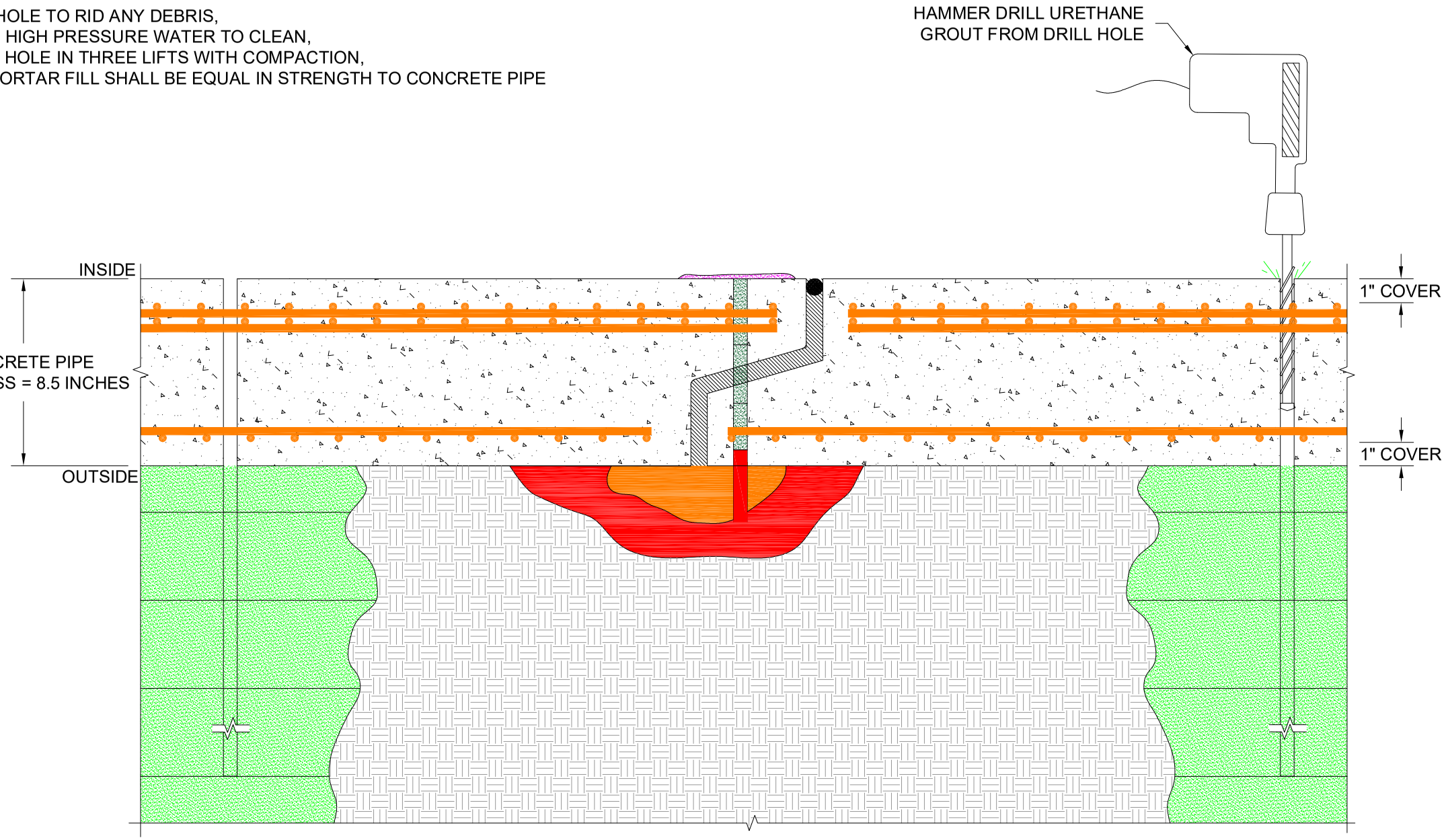
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 6C

1. AFTER REMOVAL OF MANCHETTE FROM "JA" PACKER, PLACE CAM-LOCK CAP ON PACKER, OR AN OPTIONAL PROCEDURE IS TO REMOVE PACKER AND PLUG WITH WOOD DOWEL
2. AFTER 3-5 DAYS OF CEMENTITIOUS GROUT CURES, DRILL TWO (2) 3/4" Ø HOLES AS SHOWN ON PLANS TO TEST GROUTED SOIL ZONE
   - 2.1. PERFORM STATIC CONE PENETROMETER AT 12" OR 18" DEPTHS
   - 2.2. GOAL TO ACHIEVE 25% INCREASE IN SOIL STRENGTH FROM CEMENTITIOUS GROUTING
   - 2.3. IF SOIL STRENGTH IS NOT ACHIEVED, CONTACT EDR FOR MODIFIED GROUTING PROCEDURES
3. MANCHETTE DISMANTLING:
   - 3.1. ALLOW GROUT TO GEL/SET/CURE/HARDEN AND THEN REMOVE BALL-VALVE "JA" HARDWARE,
   - 3.2. RE-DRILL GROUT HOLE TO RID ANY DEBRIS,
   - 3.3. FLUSH HOLE WITH HIGH PRESSURE WATER TO CLEAN,
   - 3.4. DRY-PACK GROUT HOLE IN THREE LIFTS WITH COMPACTION,
   - 3.5. CEMENT BASED MORTAR FILL SHALL BE EQUAL IN STRENGTH TO CONCRETE PIPE



7 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION

RE-DRILL GROUT FROM DRIL HOLE

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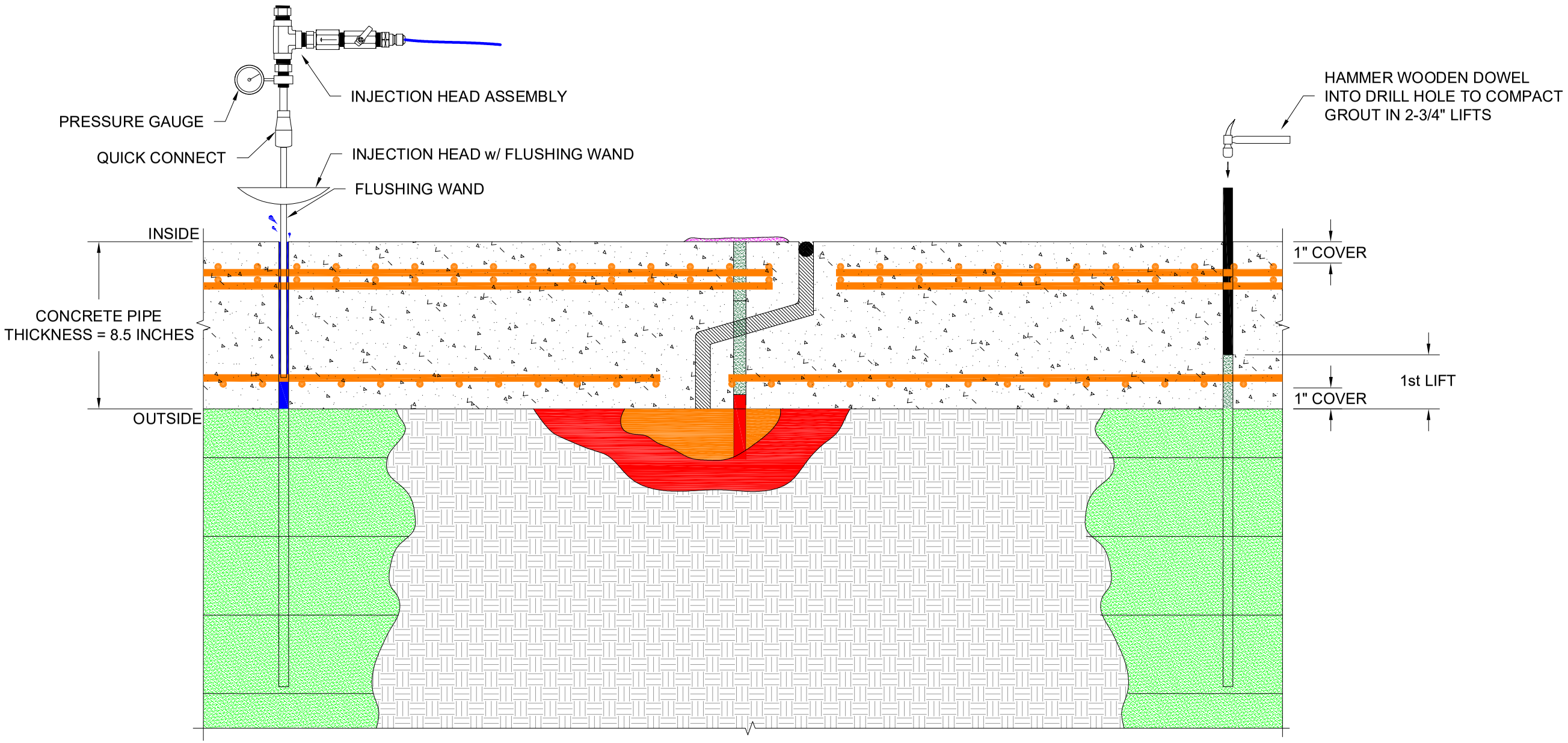
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 7C

1. FLUSH DRILL / CORE HOLE AFTER INITIAL SET.
2. USE ROD TO COMPACT GROUT IN 3" LIFTS IN EACH DRILL / CORE HOLE.



8 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION

DRILL HOLE PREPERATION

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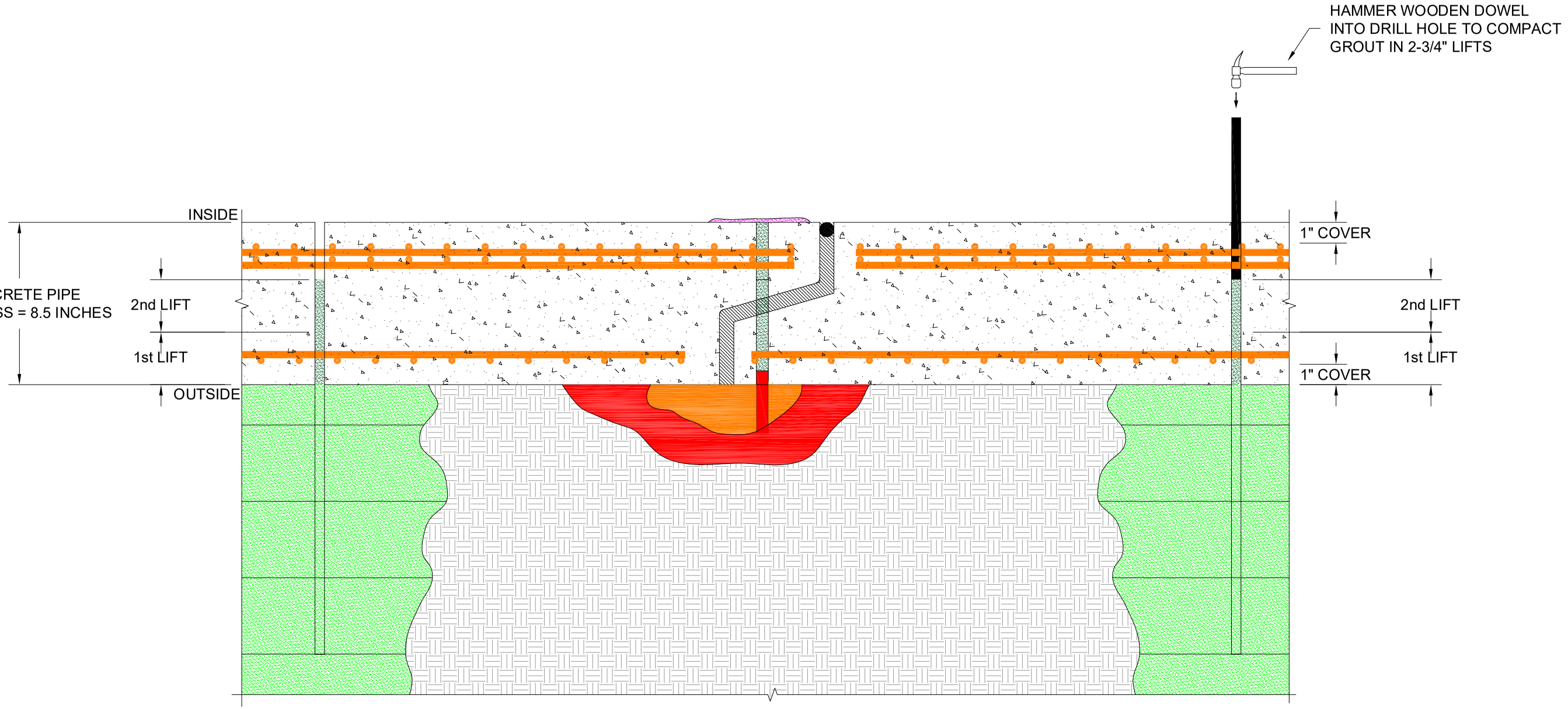
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 8C



9 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION

CEMENTITIOUS MORTAR TO FILL DRILL HOLES

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

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DRN	TB	1/9/2020
CHK	BA	1/9/2020

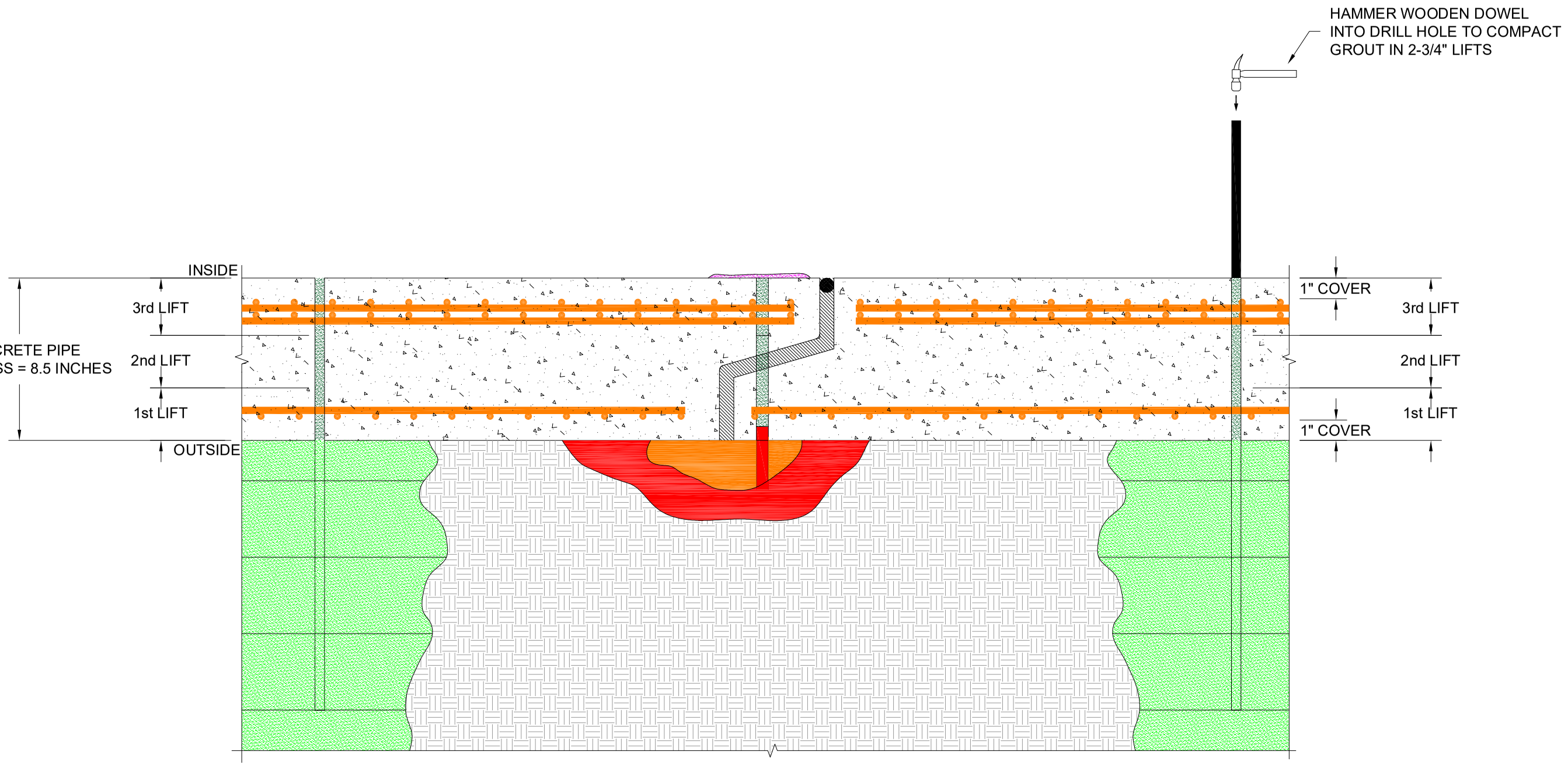
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 9C



10 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION

COMPLETED DRILL HOLE RESTORATION

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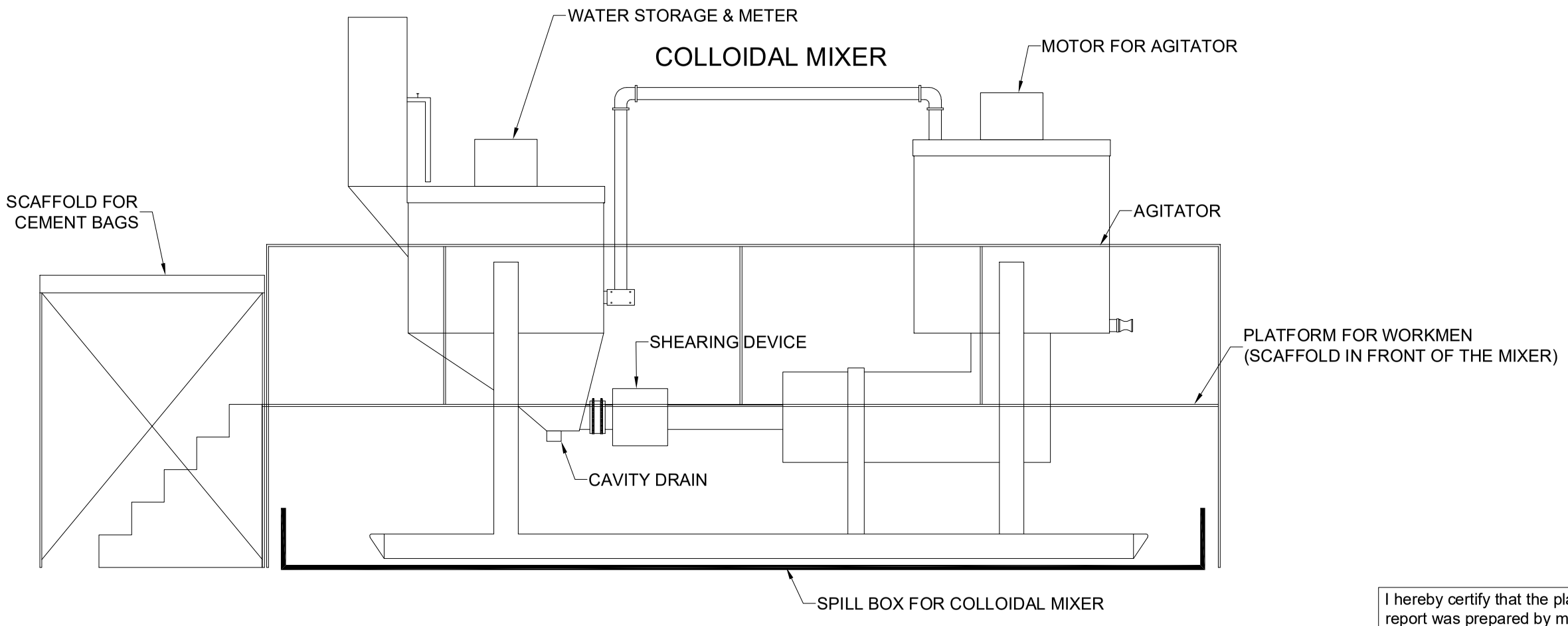
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 10C

MIXING WITH THE COLLOIDAL MIXER AND PUMPING WITH THE ROTOR -STATOR PUMP:

ENSURE COLLOIDAL MIXER IS PREPARED:

1. CHOOSE A LOCATION FOR THE COLLOIDAL MIXER WHERE FORKLIFT ACCESS IS APPROPRIATE TO MOVE PALLETS OF CEMENT BAGS INTO POSITION.
2. PLACE SPILL BOX / PAD UNDER COLLOIDAL MIXER AND ROTOR-STATOR PUMP. SOME CONTRACTORS PLACE LEVEL PAD UNDER SCAFFOLD AS WELL.
3. LEVEL MIXER WITH WOOD BLOCKS AND / OR METAL SHIMS ON SPILL PAD. IT IS RECOMMENDED TO ELEVATE THE COLLOIDAL MIXER HIGH ENOUGH TO ENSURE THE DISCHARGE PIPE ON THE AGITATOR TANK IS ABOUT 4 INCHES HIGHER THAN THE ROTOR-STATOR CAVITY BOX.
4. MOST CONTRACTORS WANT TO BUILD A SCAFFOLD ABOUT TWO FEET HIGH TO FACILITATE EASE OF WORKING. SOME CONTRACTORS BUILD A SCAFFOLD 4 FEET HIGH ON THE COLLOIDAL MIXER END NEAR THE SHEAR TANK, TO ACCOMMODATE ACCESS TO THE CEMENT BAGS.
5. SPRAY FORM-RELEASE AGENT, OIL, OR SIMILAR ON COLLOIDAL MIXER AND ROTOR-STATOR PUMP TO AID IN CLEANUP.
6. FILL OIL RESERVOIR BASIN FOR AIR MOTORS WITH MARVEL AIR TOOL OIL OR EQUAL.
7. GREASE ALL ZERK FITTINGS (4 THUS ON MACHINE) AND FILL GREASE RESERVOIR.
8. ENSURE DRAIN CAP PLACED ON BOTTOM OF SHEARING / MIXING TANK IS SECURE.
9. ENSURE STRAINER IS CLEAN BETWEEN SHEARING / MIXING TANK AND AGITATION TANK.
10. HOOK UP COMPRESSED AIR FITTING TO MIXER.
11. ADD 5-GAL. OF WATER TO SYSTEM.
12. TURN ON SYSTEM, MOVE LEVELS BACK AND FORTH TO UNDERSTAND OPERATIONAL PROTOCOL. YOU WILL NOT DAMAGE ANYTHING BY LEVER OPERATION AS-LONG-AS JUST WATER IS IN THE SYSTEM.
    - 12.1. LEVER FORWARD - DISCHARGE TO AGITATION TANK.
    - 12.2. LEVER BACKWARD - RECIRCULATING GROUT THROUGH HIGH SHEAR MIXER.
    - 12.3. NOTE THE BALL VALVE LEVER TO START AND STOP THE AGITATION TANK.
13. NOTE THAT THE OIL LIBERATOR SHOULD BE SUPPLYING AIR WITH OIL TO THE TWO AIR MOTORS ON THE MACHINE. CHECK OIL LEVELS EVERY 4 HOURS.
14. THEN DISCHARGE THE WATER TO THE AGITATOR TANK.
15. TURN ON AGITATOR BLADE IN THE TANK.
16. THEN DISCHARGE WATER OUT OF THE TANK INTO THE ROTOR STATOR CAVITY BOX.
17. PUMP WATER TO THE END OF THE HOSE.
18. ONE CAN RE-USE DISCHARGE WATER IF IT'S CLEAN AND CONTAINS NO DEBRIS.



11 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION

COLLOIDAL MIXER SET-UP & OPERATION

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7654 Highway 65 NE
Fax: 763-784-1590
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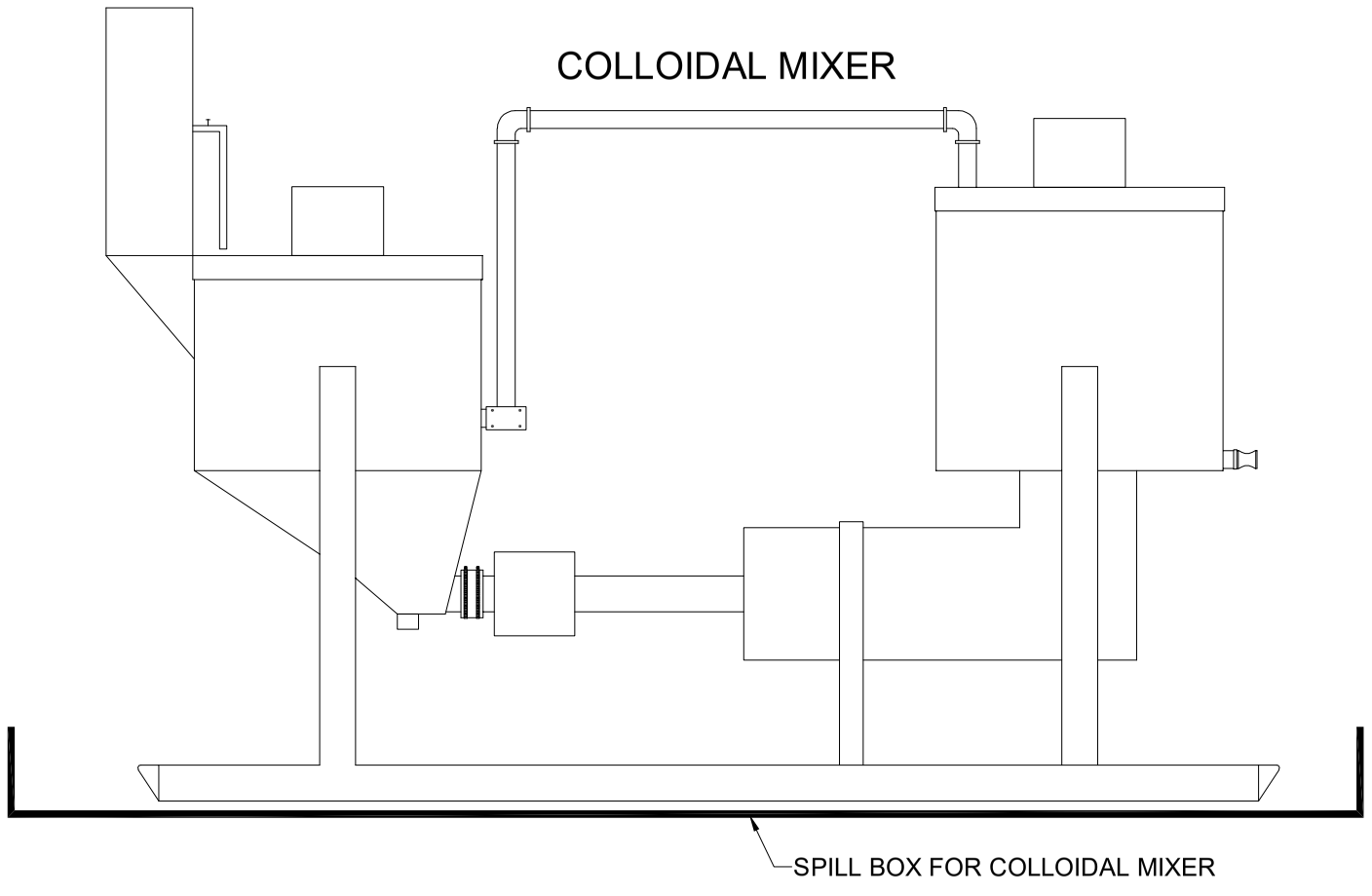
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 11C

1. ADD 12 GAL. OF POTABLE WATER TO COLLOIDAL MIXER,
2. ADD 7 oz. UNIT OF SUPERPLASTIZER,
3. ADD 44 POUND BAG OF ULTRAFINE CEMENT,
4. CIRCULATE WATER THRU HIGH SHEAR DEVICE,
5. SLOWLY ADD 2nd BAG OF MICROFINE CEMENT,
6. SLOWLY ADD 3rd BAG OF MICROFINE CEMENT,
7. SLOWLY ADD 4th BAG OF MICROFINE CEMENT,
8. ADD 1 GAL. OF WATER
9. YOU SHOULD HAVE APPOXIMATELY 27 GALLONS OF FLOWABLE GROUT.
10. ENSURE ALL LOOSE CEMENT POWDER IS IN MIX, CAREFULLY SCRAPE TOP / SIDES OF SHEAR TANK.
11. WARM WATER WILL INCREASE DEMAND FOR ADDITIONAL WATER.
12. COLD WATER WILL DECREASE DEMAND FOR ADDITIONAL WATER.
13. ALLOW TO RE-CIRCULATE FOR THREE MINUTES OR MORE.
14. DISCHARGE GROUT TO AGITATION TANK THRU STRAINER, MONITOR STRAINER FOR LUMPS.
15. LUMPS IN GROUT INDICATES LONGER MIXING TIME REQUIRED THRU HIGH SHEAR DEVICE.
16. LUMPS CAN BE DISPOSED IN TRASH.
17. REPEAT PROCESS BASED ON DEMAND.
18. NOTE - ONCE EVERY TWO HOURS, USE 4000 PSI WATER BLASTER TO FLUSH OUT BOTTOM OF HIGH SHEAR MIXING TANK AND CAVITY BOX OF ROTOR-STATOR PUMP, THE FLUSH WATER CAN BE RECYCLED AND USED FOR MIXING.
19. NOTE - ONCE EVERY FOUR HOURS, RUN SPONGES THROUGH HOSES FOR FLUSHING, THIS WILL HELP AVOID PLUGGING.

CLEAN-UP OF COLLOIDAL MIXER:

1. FLUSH COPIOUS AMOUNTS OF WATER THRU MIXING TANK.
2. DISCHARGE TO AGITATION TANK AND CIRCULATE.
3. USE 4000 PSI POWER WASHER (WATER-BLASTER) TO CLEAN MIXING TANK THOROUGHLY.
4. POWER WASH ALL RESIDUE ON INSIDE AND OUTSIDE OF MIXING TANK.
5. DISCHARGE TO AGITATION TANK.
6. POWER WASH STRAINER.
7. DISCHARGE AGITATOR TANK WATER TO PLASTIC STORAGE TANK OR DRUMS.
8. POWER WASH INSIDE AND OUTSIDE OF AGITATOR TANK.
9. DISCHARGE AGITATOR TANK WATER TO PLASTIC STORAGE TANK OR DRUMS.
10. DISCHARGE WATER FROM STORAGE TANK OR DRUMS. THEY CAN BE USED FOR MIXING WATER THE SAME OR FOLLOWING DAY.
11. TAKE CAP OFF OF THE BOTTOM OF THE MIXING TANK, ENSURE IT IS CLEAN.
12. SPRAY TANK WITH FORM RELEASE AGENT.



12 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION

COLLOIDAL SET-UP & OPERATION

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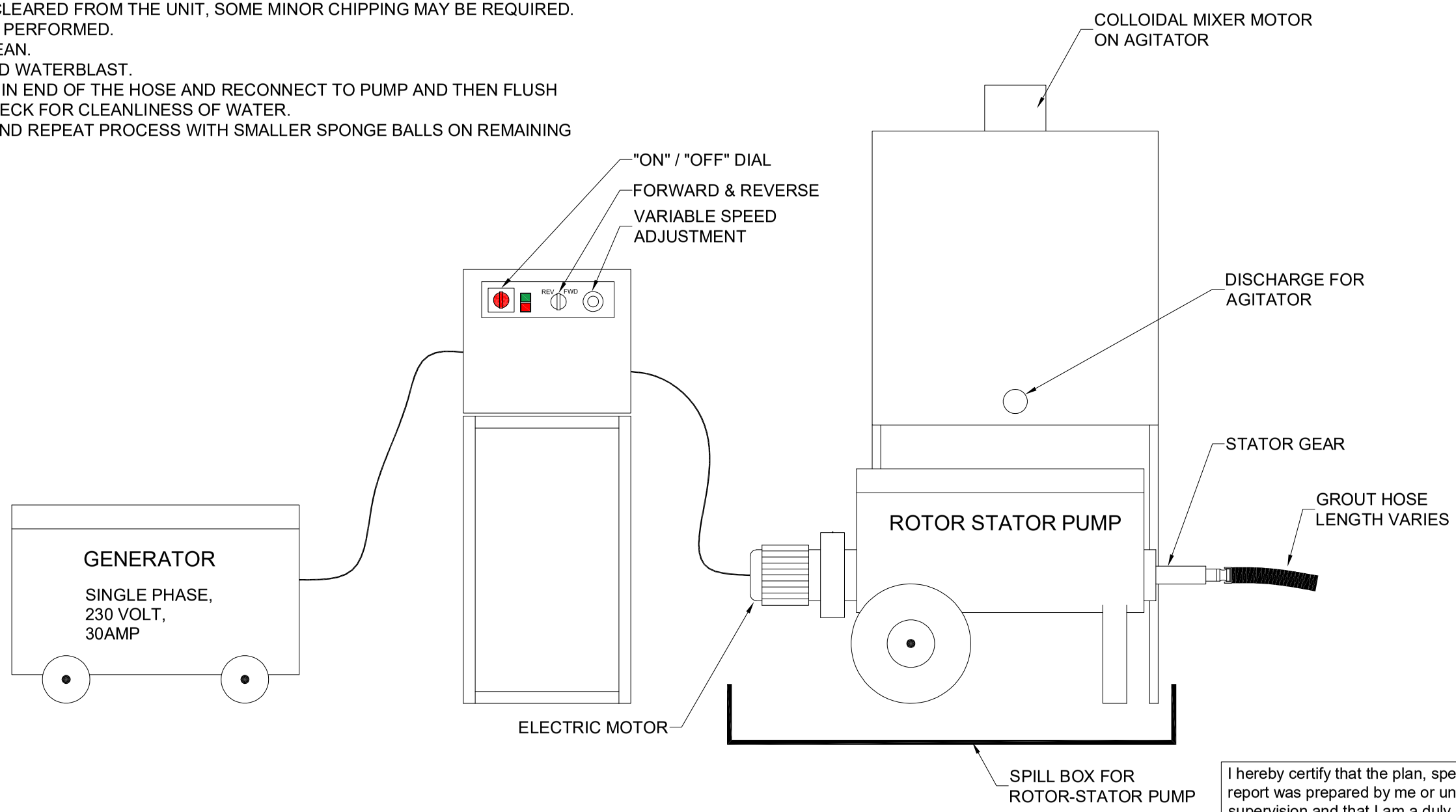
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 12C

1. ROTOR-STATOR PUMP OPERATES AT 230 VOLT, 30 AMP., SINGLE PHASE, ELECTRIC CIRCUIT.
2. COORDINATE WITH PLANT PERSONNEL TO ACCOMMODATE SUCH A HOOK-UP.
3. THERE SHOULD BE 100 LINEAL FEET OF ELECTRICAL LINE SUPPLIED BY STRUCTURAL TECHNOLOGIES.
4. CHECK TO ENSURE THE PLUG ENDS WILL MATCH THE SERVICE.
5. ASSEMBLE THE ROTOR-STATOR PUMP BOX CAVITY TO THE ELECTRICAL MOTOR AND ROTOR-STATOR PUMP.
   - 5.1. THIS IS DONE WITH THE WEDGES.
   - 5.2. ENSURE THE AUGER IS PROPERLY POSITIONED INTO PLACE AT EACH END.
   - 5.3. GREASE THE XERK FITTINGS ON THE CAVITY BOX TILL GREASE EXTRUDES FROM SIDES.
6. SITUATE THE ELECTRICAL CONTROL BOX FOR ROTOR-STATOR PUMP A FEW FEET (5 - 10) AWAY FROM THE PUMP.
7. PLUG IN THE PUMP MOTOR TO THE CONTROL BOX, PLUS IN SERVICE TO THE CONTROL BOX.
8. TURN ON DIAL TO THE RIGHT, PRESS THE GREEN BUTTON TO START.
9. REGULATE SPEED OF AUGER.
10. HOOK UP HOSES FROM ROTOR-STATOR PUMP TO MANCHETTES.

CLEAN-UP OF ROTOR-STATOR PUMP:

1. ENSURE ALL HARDENED GROUT IS CLEARED FROM THE UNIT, SOME MINOR CHIPPING MAY BE REQUIRED.
2. BE SURE UNIT IS OFF IF CHIPPING IS PERFORMED.
3. FLUSH WITH WATER TILL UNIT IS CLEAN.
4. DISCONNECT CAM-LOCK FITTING AND WATERBLAST.
5. PLACE APPROPRIATE SPONGE BALL IN END OF THE HOSE AND RECONNECT TO PUMP AND THEN FLUSH BALL THROUGH THE LINE TWICE, CHECK FOR CLEANLINESS OF WATER.
6. DISCONNECT THE CLEANED HOSE AND REPEAT PROCESS WITH SMALLER SPONGE BALLS ON REMAINING HOSE IF USED.



13 CEMENTITIOUS GROUT, HAUNCH AREA INJECTION

ROTOR STATOR PUMP SET-UP & OPERATION

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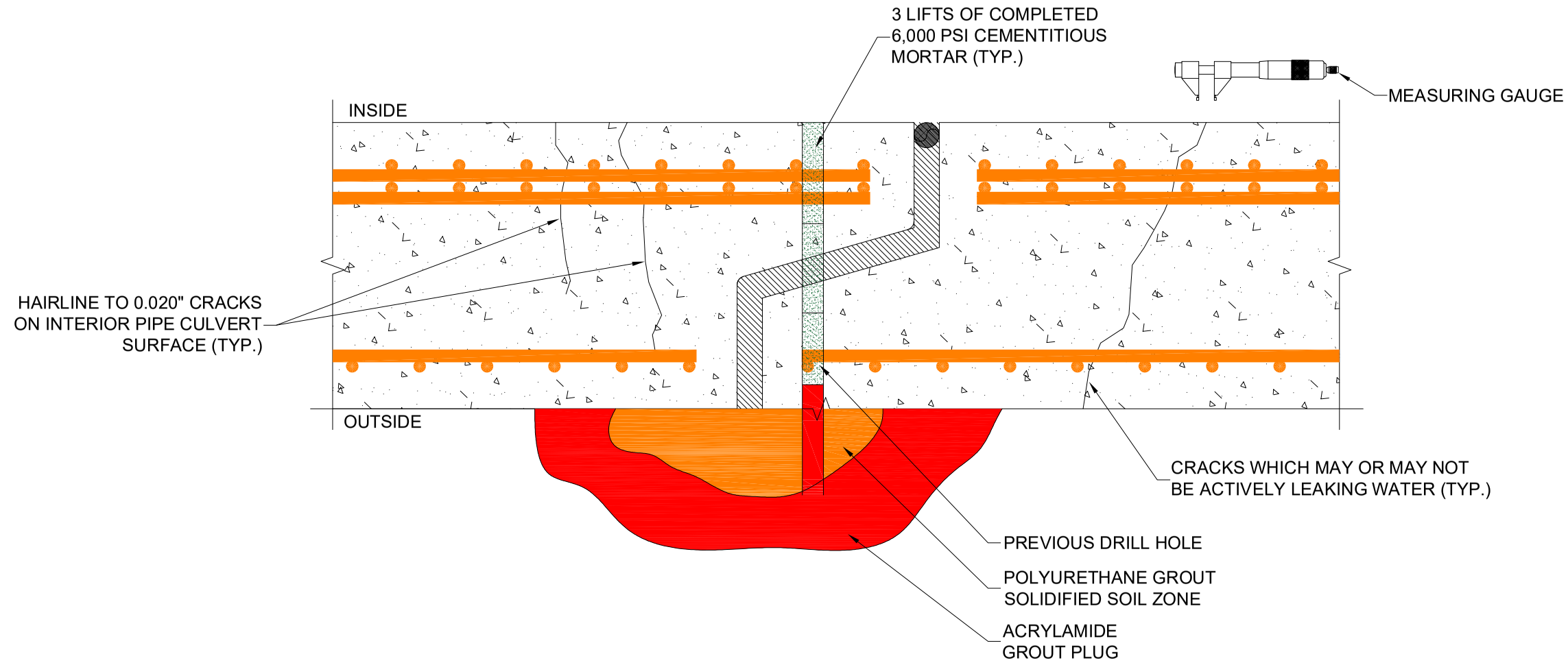
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 13C

GENERAL CONDITIONS:

1. COORDINATE SAFETY PLAN TO INCLUDE MANAGEMENT OF MANCHETTE TOPS TO AVOID TRIP HAZARDS TO TRADESMEN
2. COORDINATE ACCESS/EGREE PLAN IN CASE OF HIGH WATER, EXCESS CARBON DIOXIDE, LACK OF LIGHTING AND/OR OTHER ISSUES THAT MAY REQUIRE UNPLANNED EVACUATION OF CULVERT PIPE
3. COORDINATE WORKING TIMES TO ENSURE STORM WATER DRAINAGE DOES NOT INTERFERE WITH GROUTING OPERATIONS BEYOND MANAGED WATER RE-ROUTING
4. ENSURE PROJECT TEAM IS COORDINATED WITH WEATHER FORECASTS AND CURRENT CONDITIONS
5. ENSURE WATER DIVERSION PLAN IS APPROVED BY OWNER
6. FOLLOW ALL OSHA REQUIREMENTS FOR CONFINED SPACE
7. ENSURE:
   - 7.1. PROPER & ADEQUATE LIGHTING & ELECTRICAL SUPPLY
   - 7.2. PROPER & ADEQUATE FRESH AIR-SUPPLY
   - 7.3. PROPER & ADEQUATE AIR QUALITY MONITORING
   - 7.4. PROPER & ADEQUATE EYE WASH STATIONS ARE SETUP

1. MEASURE WIDTH OF ALL CRACKS:
2. NOTE THE FOLLOWING:
   - 2.1. CRACKS LESS THAN 0.021 INCHES (21 MILS) SHALL BE SURFACE TREATED WITH CRYSTALLINE WATERPROOFING
   - 2.2. CRACKS GREATER THAN 0.021 INCHES AND LESS THAN 0.040 INCHES (40 MILS) SHALL BE INJECTED WITH POLYACRYLATE GROUT
   - 2.3. CRACKS GREATER THAN 0.040 INCHES (40 MILS) SHALL BE INJECTED WITH EPOXY RESIN



1 CRYSTALLINE WATERPROOF TREATMENT

HAIRLINE TO 20 MIL CRACKS IN CONCRETE PIPE, EXISTING CONDITIONS

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"B" SERIES DRAWINGS	1B-30B	Section 03 64 20 Acrylamide Grout Joint Injection, Soil Solidification	WP-2
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GENERAL NOTES:

1. STEEL REINFORCING VARIES AT LOCATIONS IN CULVERT PIPE.

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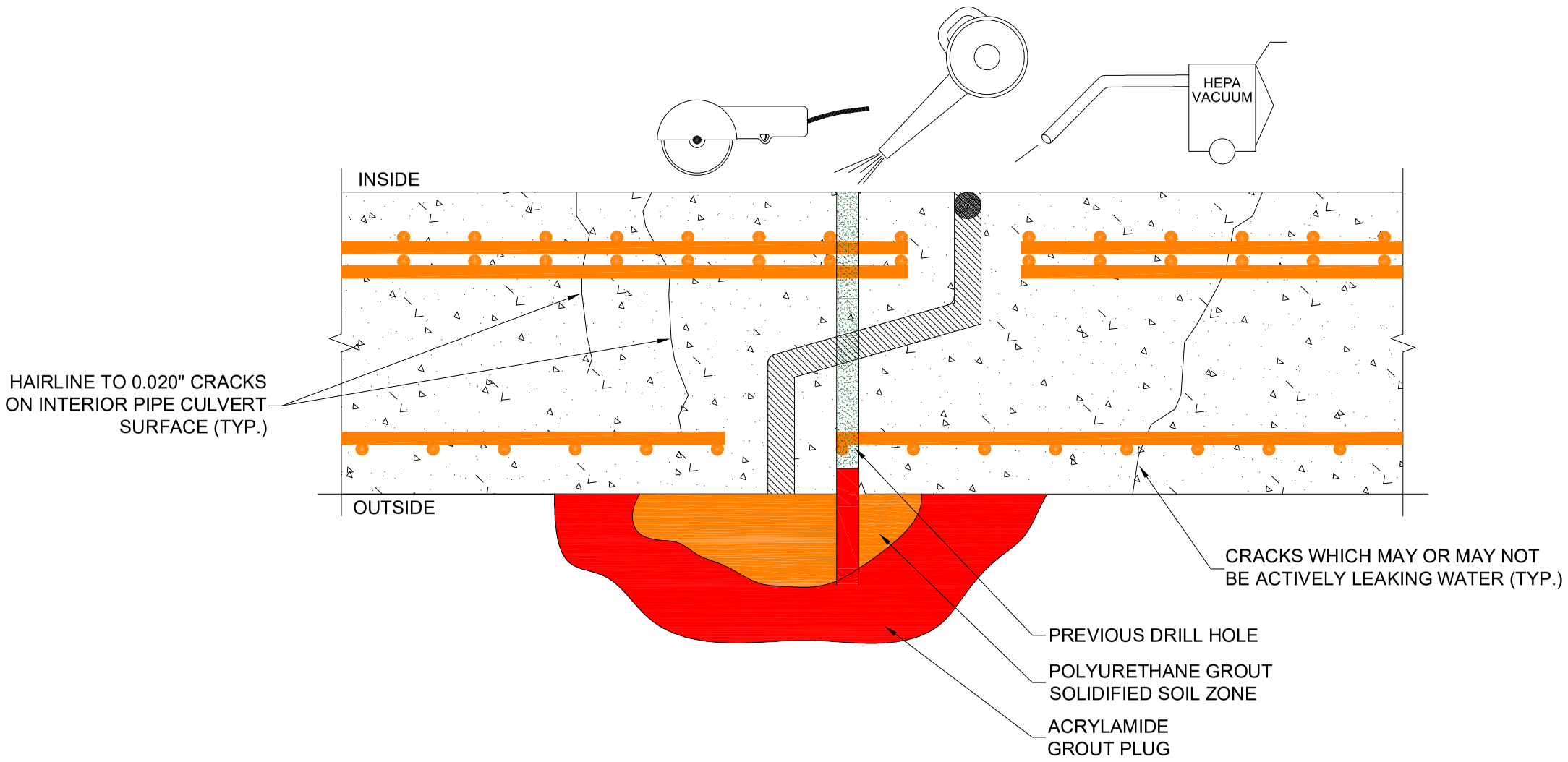
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 1D

1. MEASURE WIDTH OF ALL CRACKS:
2. NOTE THE FOLLOWING:
   2.1. CRACKS LESS THAN 0.021 INCHES (21 MILS) SHALL BE SURFACE TREATED WITH CRYSTALLINE WATERPROOFING
   2.2. CRACKS GREATER THAN 0.020 INCHES AND LESS THAN 0.040 INCHES (40 MILS) SHALL BE INJECTED WITH POLYACRYLATE GROUT
   2.3. CRACKS GREATER THAN 0.040 INCHES (40 MILS) SHALL BE INJECTED WITH EPOXY RESIN



2 CRYSTALLINE WATERPROOF TREATMENT

HAIRLINE TO 20 MIL CRACKS IN CONCRETE PIPE, SURFACE PREPERATION

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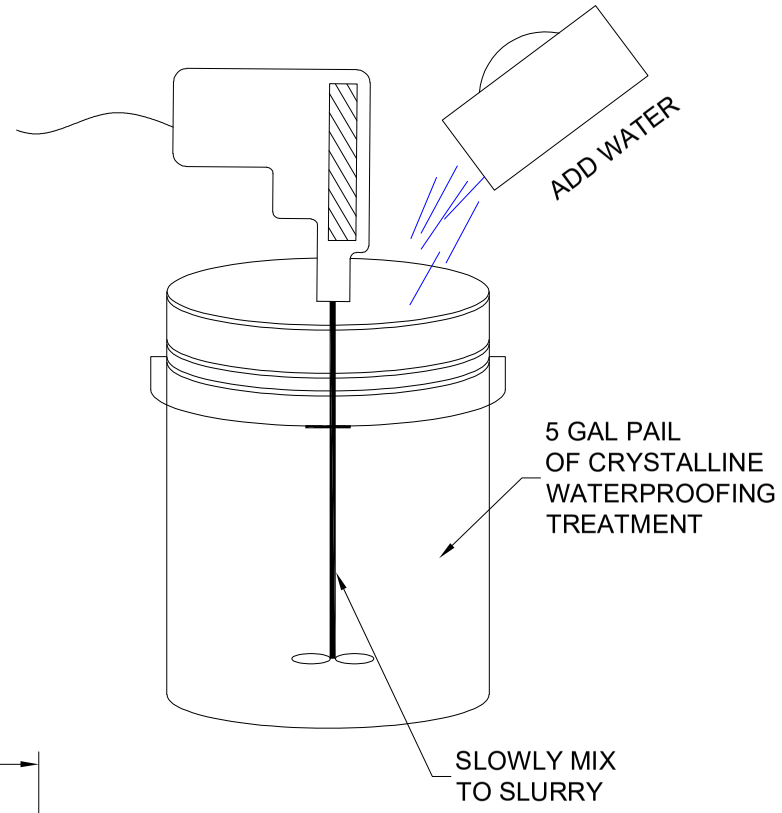
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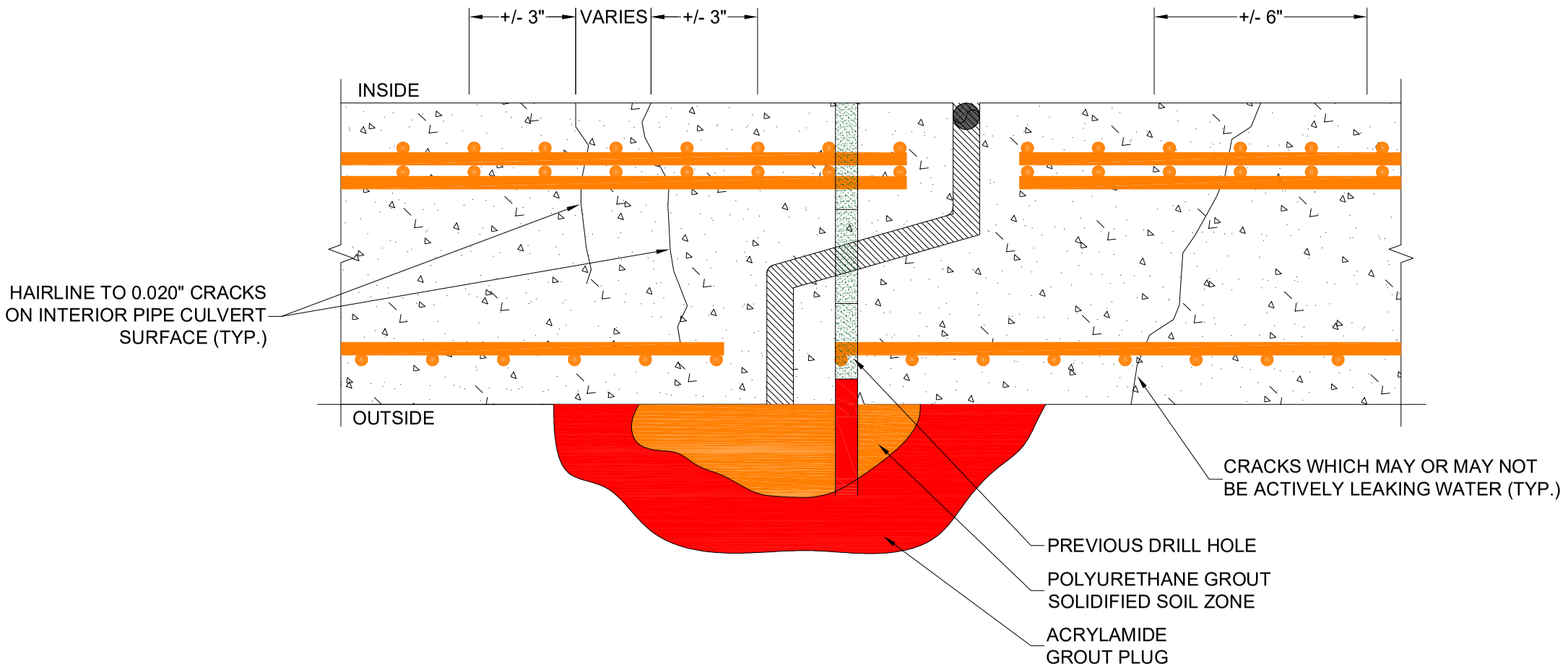
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 2D

1. MIX CRYSTALLINE WATERPROOFING SLURRY PER MANUFACTURER'S DIRECTIONS





3 CRYSTALLINE WATERPROOF TREATMENT

HAIRLINE TO 20 MIL CRACKS IN CONCRETE PIPE, MIXING INSTRUCTIONS

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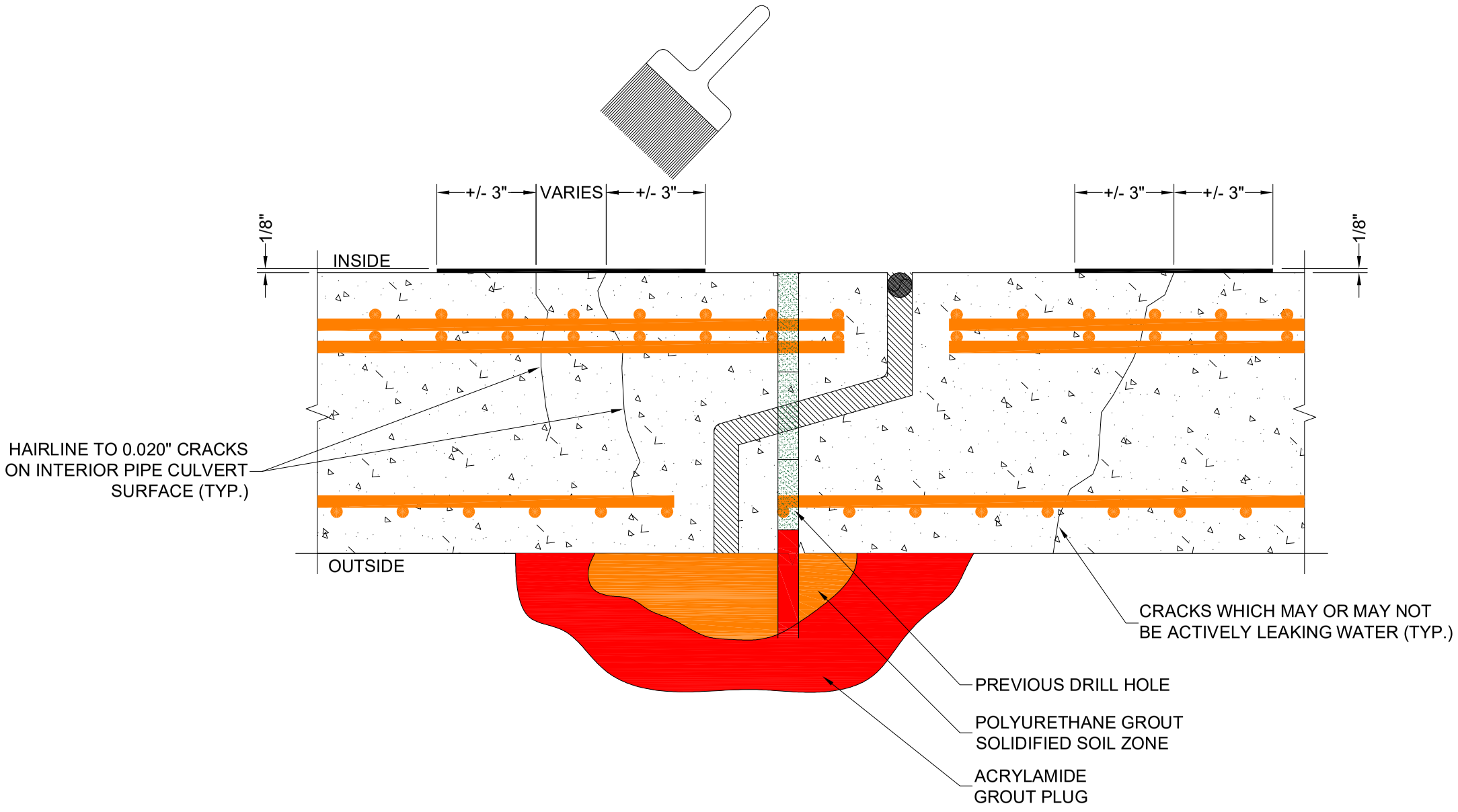
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 3D

1. APPLY 2 SLURRY COATS OF CRYSTALLINE WP APPROXIMATELY 3" ON EACH SIDE OF CRACKS LESS THAN 0.021 INCHES (21 MILS)
2. ALLOW 3 HOURS BETWEEN +/- 1/16" COATS
3. KEEP MOIST FOR 3 DAYS OR SPRAY CURING COMPOUND ON SURFACE



4 CRYSTALLINE WATERPROOF TREATMENT

HAIRLINE TO 20 MIL CRACKS IN CONCRETE PIPE, TREATMENT APPLICATION

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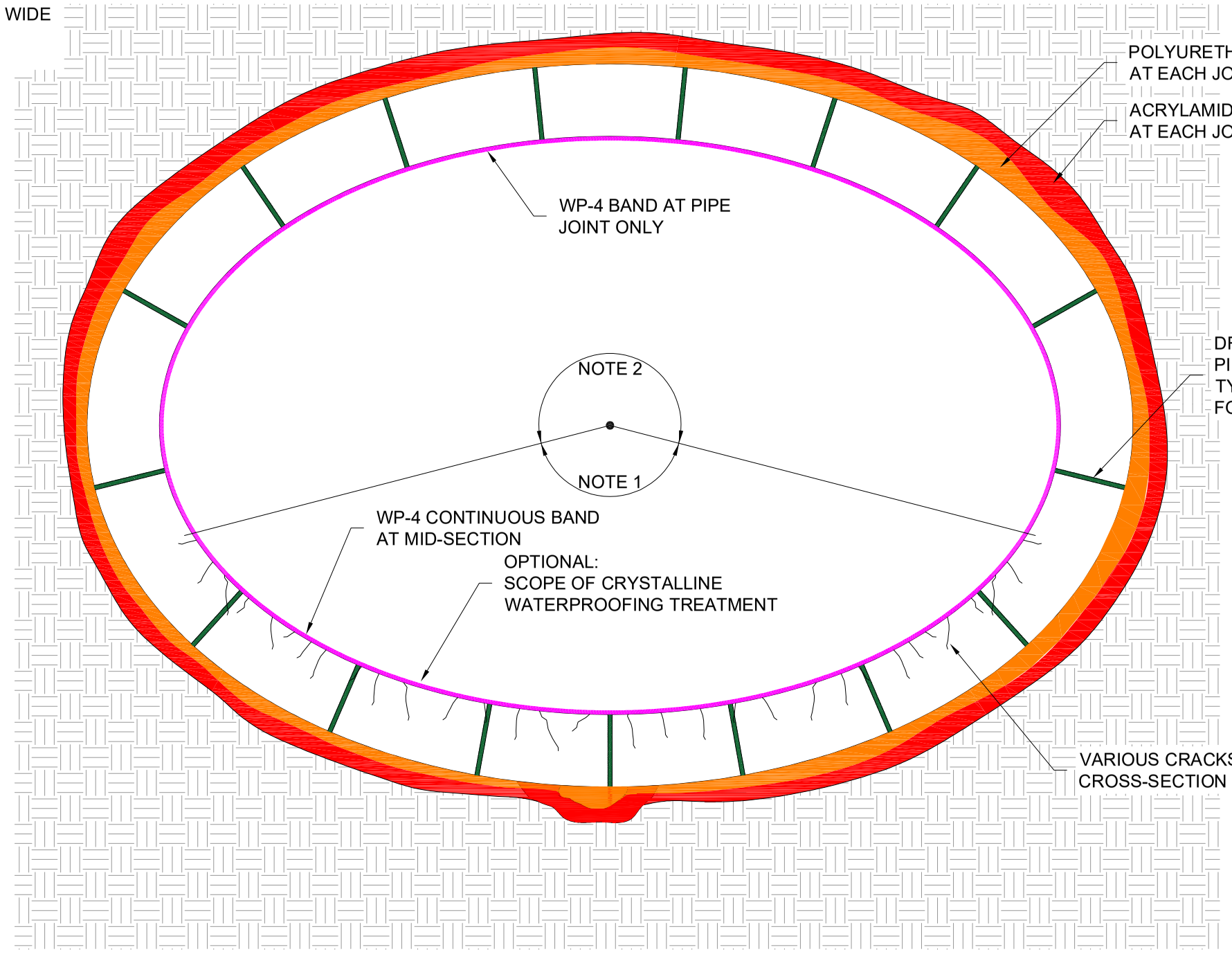
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 4D

NOTE 1: CONTRACTOR OPTION TO TREAT 62" WIDE ZONE AT EACH SIDE OF INVERT WITH WP-4 IN LEIU OF 6"x6" SPOT TREATMENT ALL PENETRATIONS AND CRACKS.

NOTE 2: CONTRACTOR OPTION TO PLACE 6" WIDE STRIP OR BAND OF WP-4 FROM SPRINGLINE ACROSS CROWN.



5 OPTIONAL SCOPE OF CRYSTALLINE WATERPROOFING TREATEMENT @ JOINT
TREATMENT AT PIPE INVERT & HAUNCH AREAS

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

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1	1/9/2020	REVISIONS	TB

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1/9/2020	1/9/2020	1/9/2020	

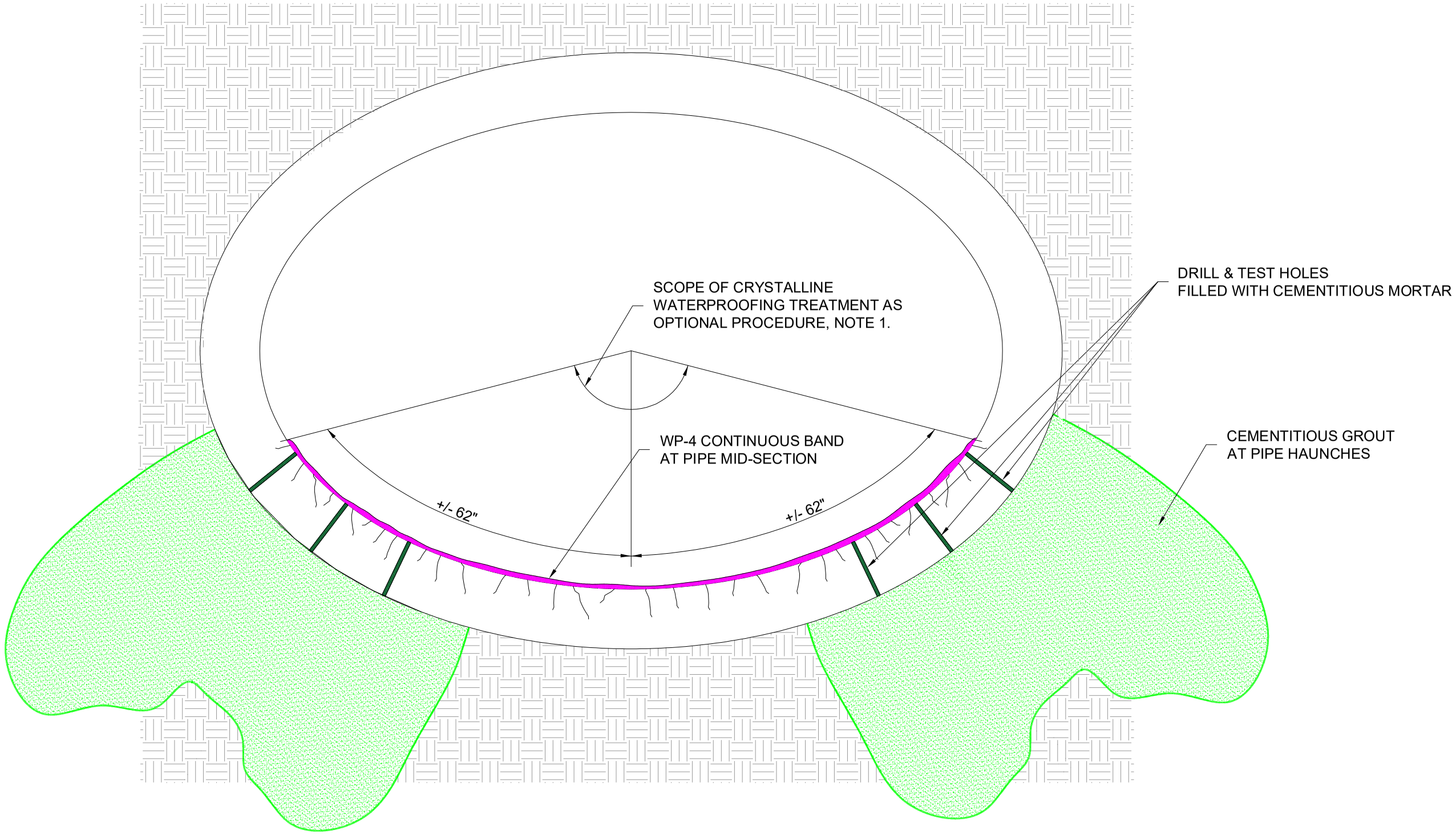
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Fax: 763-784-1590
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 5D

NOTE 1: CONTRACTOR OPTION TO TREAT 62" WIDE ZONE AT EACH SIDE OF INVERT WITH WP-4 IN LEIU OF 6"x6" SPOT TREATMENT AT ALL DRILL HOLES AND BANDING AT ALL CRACKS.



6 OPTIONAL SCOPE OF CRYSTALLINE WATERPROOFING TREATEMENT @ MID-SECTION

TREATMENT AT PIPE INVERT & HAUNCH AREAS

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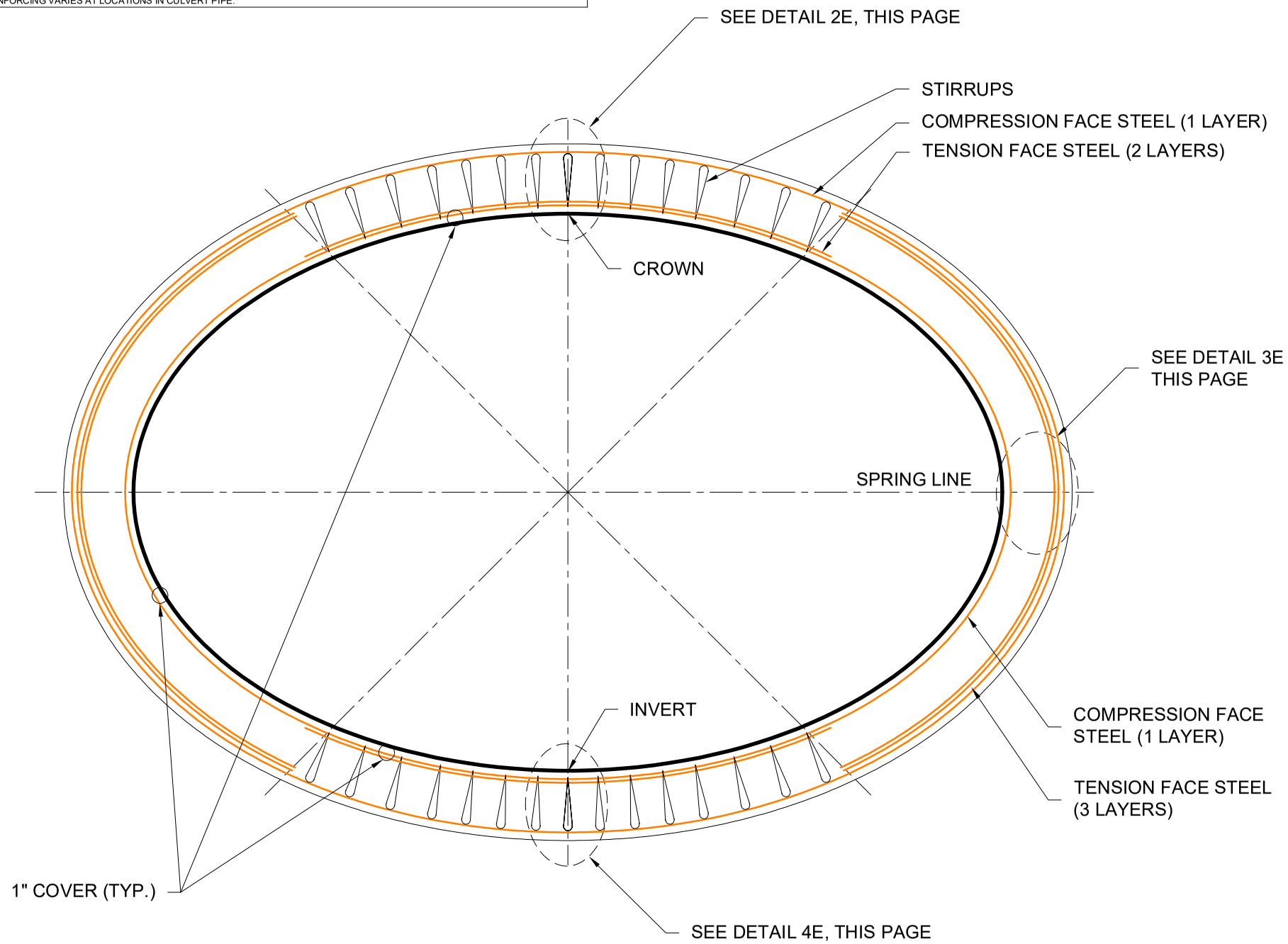
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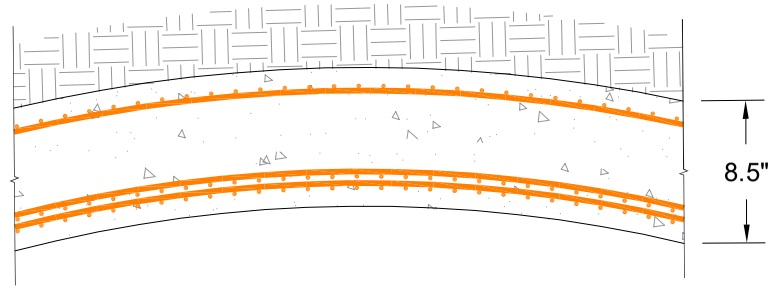
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 6D

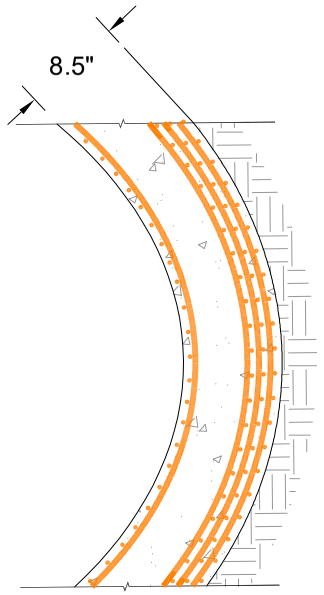
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TYPICAL REINFORCEMENT DRAWINGS	2-4		
TYPICAL PIPE JOINT CONDITIONS	5-9		
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GENERAL NOTES:			
1. STEEL REINFORCING VARIES AT LOCATIONS IN CULVERT PIPE.			



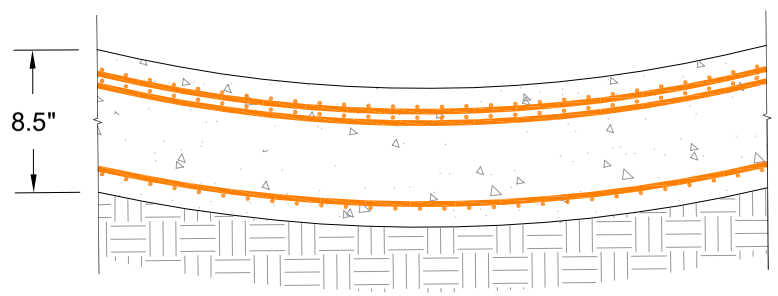
A PIPE END VIEW
Scale 1/2"=1'-0"



2E DETAIL
Scale 1/2"=1'-0"



3E DETAIL
Scale 1/2"=1'-0"



4E DETAIL
Scale 1/2"=1'-0"

1 POLYACRYLATE GROUT, CRACK INJECTION
FOR CRACK INJECTION BETWEEN (0.021 to 0.039) INCHES (21 to 39) MILS

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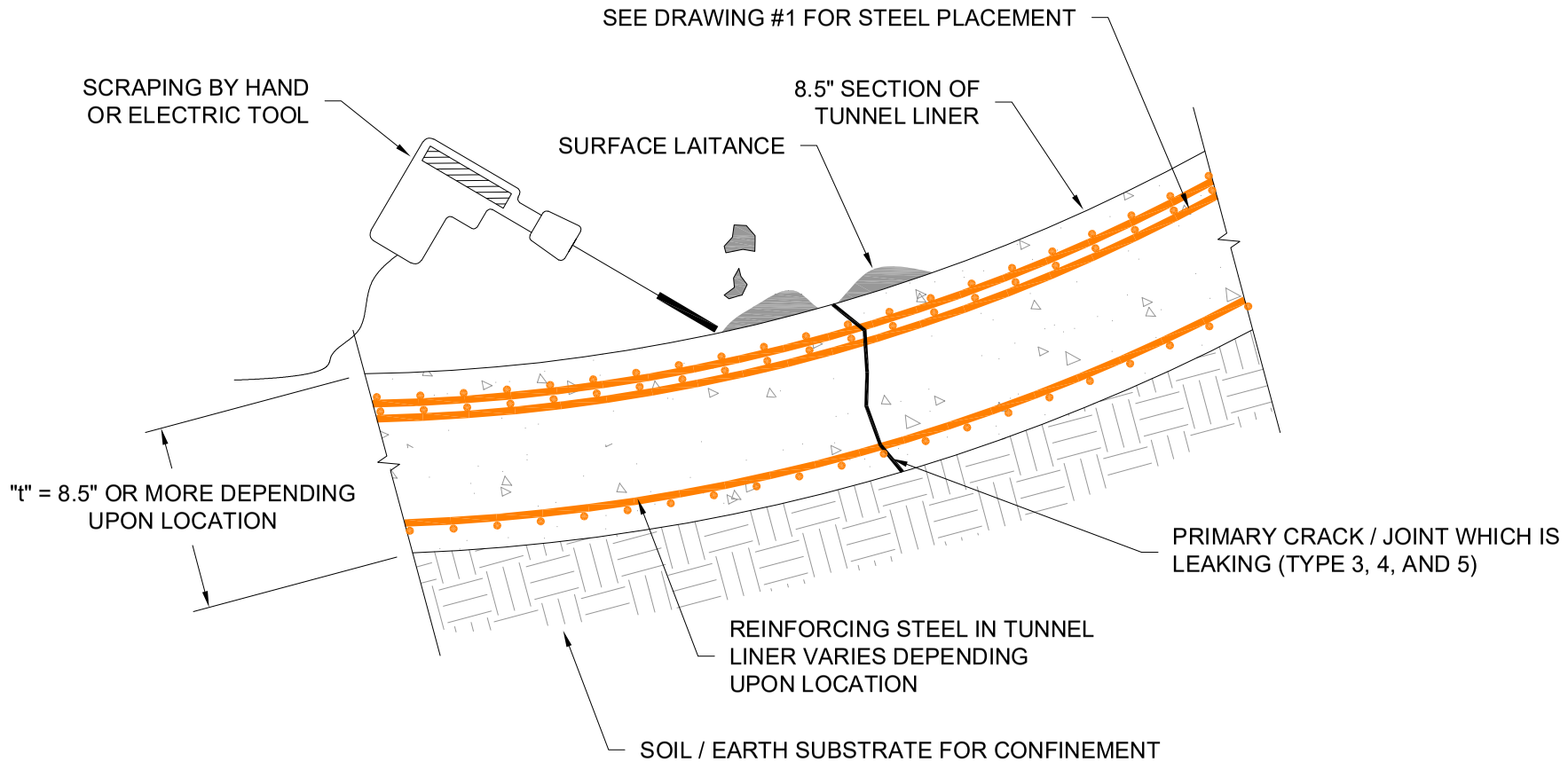
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 1E

1. ENSURE APPROPRIATE PPE IS BEING WORN BY ALL TRADES
2. SCRAPE, CHIP OR GRIND SURFACE CLEAN AS SURFACE PREPERATION
3. CHAIN DRAG OR SOUND AREA OF CONCRETE WITH ACOUSTIC IMPACT AROUND THE CRACK FOR DELAMINATIONS, ABOUT 8 INCHES OUT ON BOTH SIDES (BY OTHERS IF DEEMED NECESSARY)
4. LOCATE STEEL REINFORCING BAR, AND EMBEDDED COMMODITIES WITH GPR OR SIMILAR AND MARK ON SUBSTRATE
5. MARK LOCATIONS OF 5/8 INCH Ø DRILL HOLES FOR CRACK INTERCEPTION
   - 5.1. PERPENDICULAR TO CRACK LENGTH, MARK DRILL HOLE LOCATION (4-5) INCHES OUT [(t/2) = x]
   - 5.2. PARALLEL TO CRACK LENGTH, MARK OUT DRILL HOLE LOCATIONS ON ALTERNATING SIDES OF CRACK, (6-8) INCHES ON CENTER
   - 5.3. DRILL HOLE LOCATIONS CAN ALTERNATE IN DIRECTION, OR FROM ONE SIDE ONLY

DEGREES OF WATER LEAKAGE:

TYPE 1: COLOR CHANGE (DARKER) DUE TO SURFACE MOISTURE CONTENT
TYPE 2: WET TO TOUCH, SURFACE DAMPNESS, NO SUSTAINED TRAIL
TYPE 3: WEEPS & SEEPAGE, SUSTAINED TRAIL OF WETNESS
TYPE 4: CONTINUOUS DRIPPING, VISIBLE SURFACE FLOW
TYPE 5: GUSHING FLOW FROM HYDROSTATIC PRESSURE



2 POLYACRYLATE GROUT, CRACK INJECTION

INJECTION INTO CRACKS / PREPERATION

Key:

t = WALL / SLAB THICKNESS
1/3t = INTERCEPTION ZONE IN CRACK SECTION
x = MIN. DISTANCE FROM DRILL HOLE TO CRACK SHALL BE BETWEEN t/2 +/- (t/6)
⊖ = DRILL ANGLE TO SUBSTRATE SHALL TYPICALLY BE 45° AND CAN VARY +/- 15°
y = DRILL HOLE DIAMETER CAN BE 1/4", 3/8", 1/2", 5/8", AND 3/4"
t/2 = CENTERLINE OF ELEMENT
w = CRACK WIDTH
z = SPACING OF DRILL HOLES ALONG CRACK LENGTH SHALL BE BETWEEN t/2 to 2/3t

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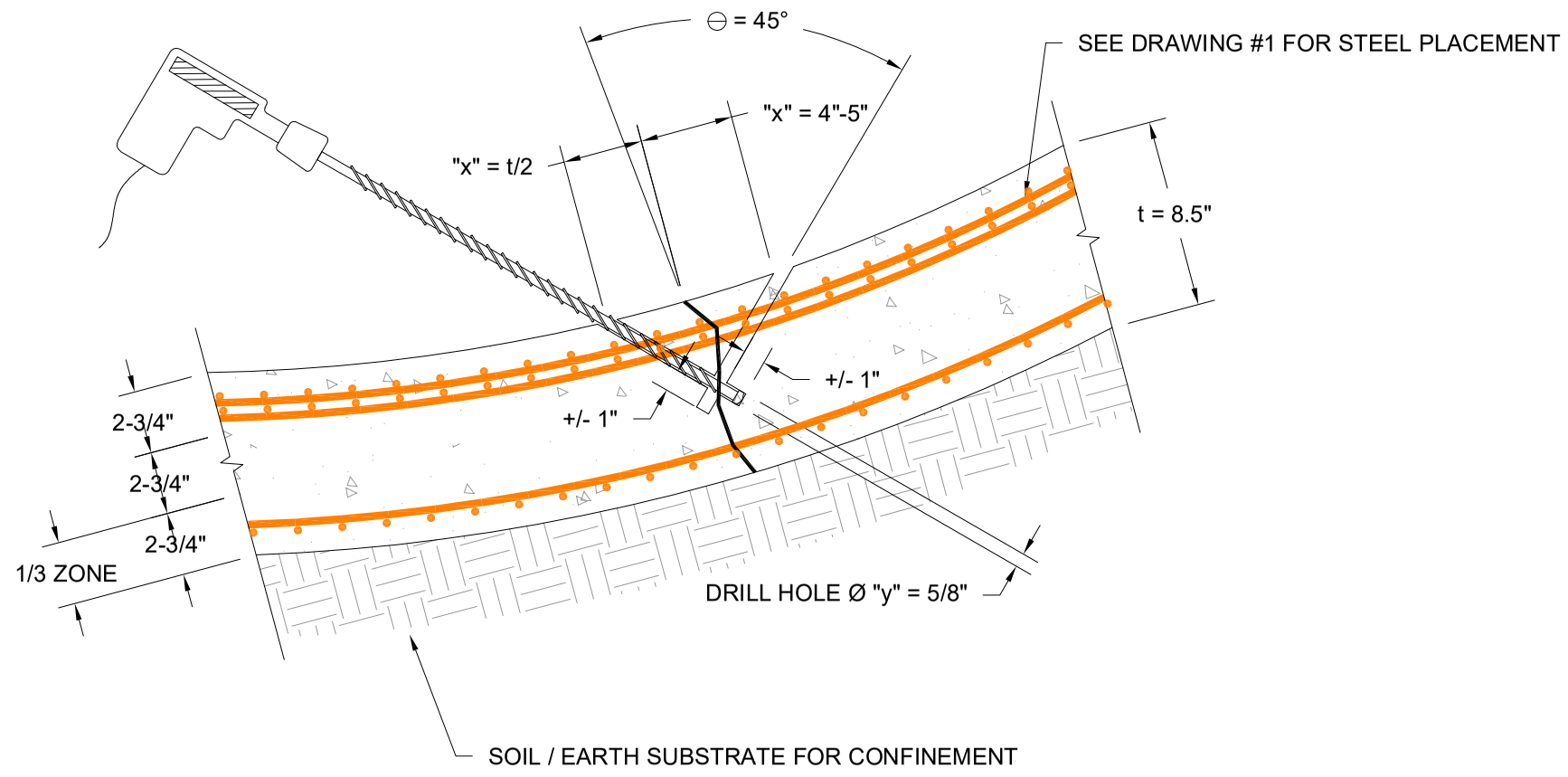
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 2E

1. ENSURE APPROPRIATE PPE IS BEING WORN BY ALL TRADES
2. MARK SPOTS FOR HAMMER DRILLING ALONG CRACK / JOINT LENGTH
3. DRILL HOLE LOCATIONS SHALL BE 4" to 5" OUT, ON EACH SIDE OF CRACK, APPROXIMATELY (6 to 8) INCHES ON CENTER. CAN USE ALTERNATING PATTERN. "x" = 6", z = 8" to 10".
4. BASED ON A DRILL ANGLE OF 45° FROM SURFACE OF CONCRETE, DRILL TO A DEPTH WHEREBY DRILL BIT EXTENDS PAST CRACK / JOINT, TYPICALLY BY +/- 1".
5. DIAGONAL DRILL DEPTH SHALL BE APPROXIMATELY 10".

DEGREES OF WATER LEAKAGE:

TYPE 1: COLOR CHANGE (DARKER) DUE TO SURFACE MOISTURE CONTENT
TYPE 2: WET TO TOUCH, SURFACE DAMPNESS, NO SUSTAINED TRAIL
TYPE 3: WEEPS & SEEPAGE, SUSTAINED TRAIL OF WETNESS
TYPE 4: CONTINUOUS DRIPPING, VISIBLE SURFACE FLOW
TYPE 5: GUSHING FLOW FROM HYDROSTATIC PRESSURE



3 POLYACRYLATE GROUT, CRACK INJECTION

INJECTION INTO CRACKS / DRILL PROCEDURE

Key:

t = WALL / SLAB THICKNESS
1/3t = INTERCEPTION ZONE IN CRACK SECTION
x = MIN. DISTANCE FROM DRILL HOLE TO CRACK SHALL BE BETWEEN t/2 +/- (t/6)
⊖ = DRILL ANGLE TO SUBSTRATE SHALL TYPICALLY BE 45° AND CAN VARY +/- 15°
y = DRILL HOLE DIAMETER CAN BE 1/4", 3/8", 1/2", 5/8", AND 3/4"
t/2 = CENTERLINE OF ELEMENT
w = CRACK WIDTH
z = SPACING OF DRILL HOLES ALONG CRACK LENGTH SHALL BE BETWEEN t/2 to 2/3t

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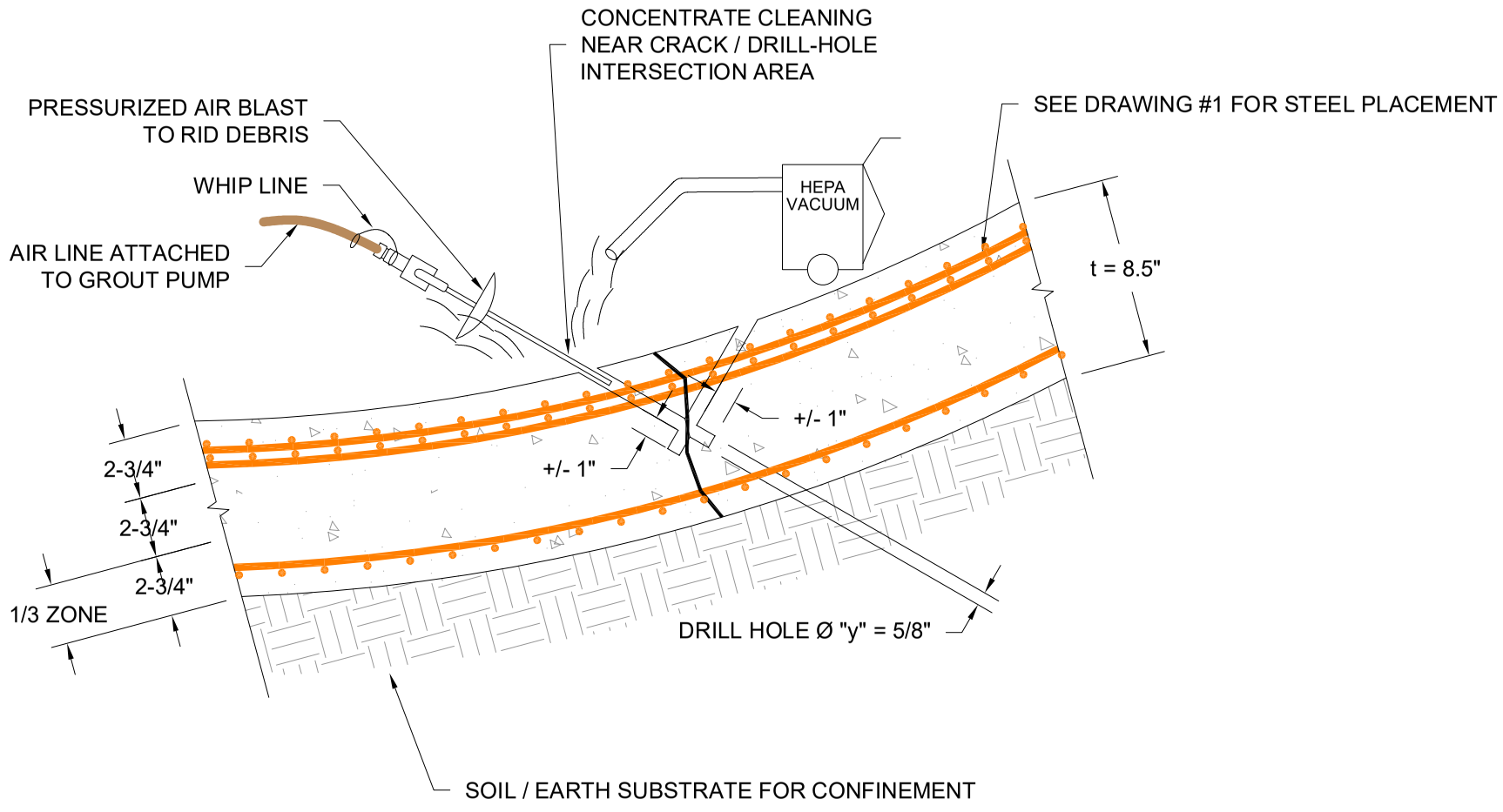
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 3E

1. AFTER HAMMER-DRILLING HOLE, USE AIR PRESSURIZED WAND TO RID DUST AND DEBRIS. FOLLOW OSHA STANDARDS FOR DUST CONTROL
2. BLOW COMPRESSED AIR DOWN DRILL HOLE TO RID HOLE OF DRILLING DEBRIS
3. VACUUM PROCEDURES CAN BE USED IN LIEU OF COMPRESSED AIR FLUSHING
4. SET-UP AND ACTIVATE WATER FLUSHING AND CHEMICAL GROUT SYSTEM (CGS) PRESSURE INJECTION PUMPS, SEE PAGES 7E-17E.

DEGREES OF WATER LEAKAGE:

TYPE 1: COLOR CHANGE (DARKER) DUE TO SURFACE MOISTURE CONTENT
TYPE 2: WET TO TOUCH, SURFACE DAMPNESS, NO SUSTAINED TRAIL
TYPE 3: WEEPS & SEEPAGE, SUSTAINED TRAIL OF WETNESS
TYPE 4: CONTINUOUS DRIPPING, VISIBLE SURFACE FLOW
TYPE 5: GUSHING FLOW FROM HYDROSTATIC PRESSURE



4 POLYACRYLATE GROUT, CRACK INJECTION

INJECTION INTO CRACKS / CRACK FLUSHING

t = WALL / SLAB THICKNESS
1/3t = INTERCEPTION ZONE IN CRACK SECTION
x = MIN. DISTANCE FROM DRILL HOLE TO CRACK SHALL BE BETWEEN t/2 +/- (t/6)
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t/2 = CENTERLINE OF ELEMENT
w = CRACK WIDTH
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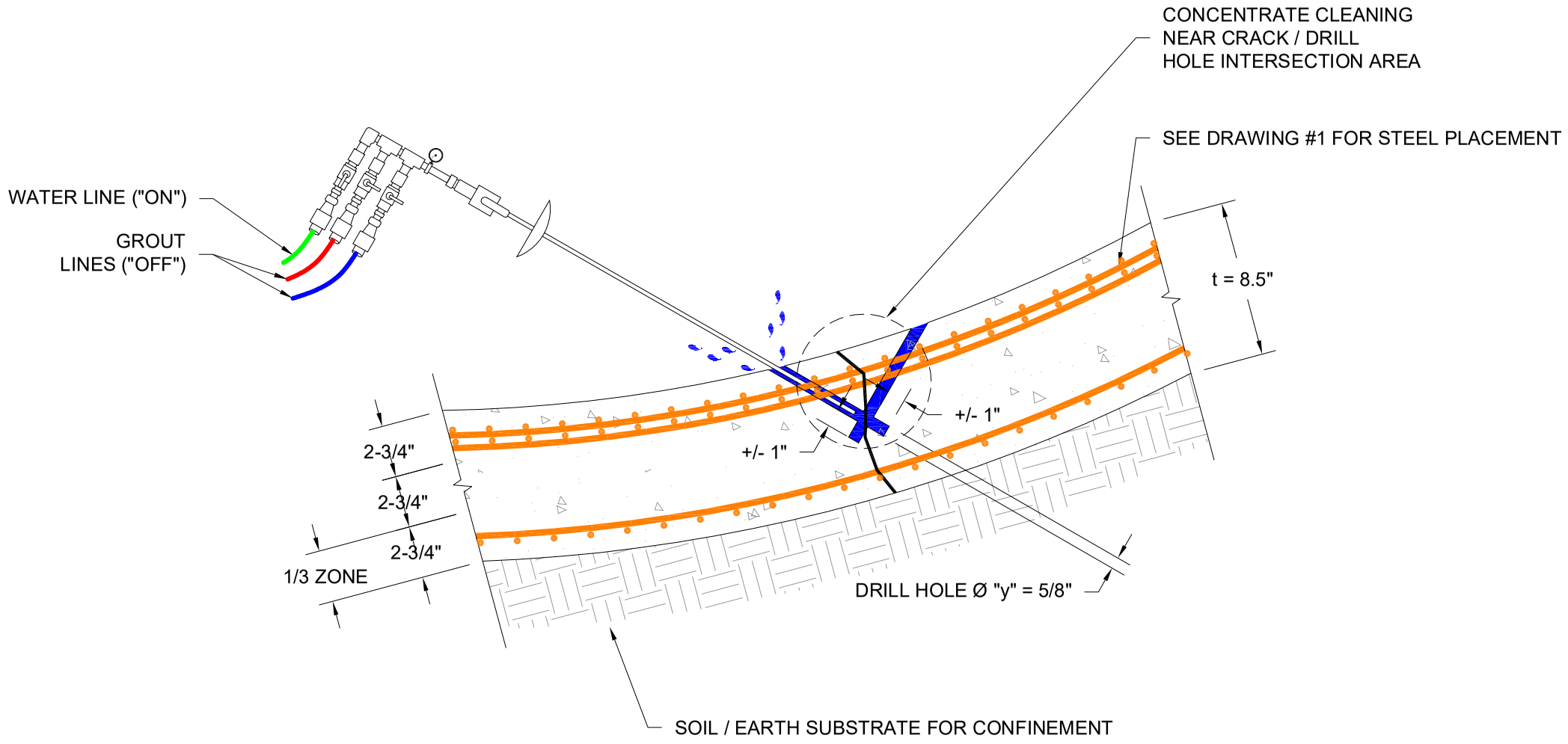
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 4E

1. AFTER AIR-BLASTING DRILL HOLE IS COMPLETED, ATTACH WATER FLUSING WAND TO "E" ASSEMBLY AND WATER BLAST DRILL HOLE TO RID FURTHER DEBRIS, CONCENTRATE CLEANING EFFORTS NEAR CRACK INTERCEPTION AREA
2. WATER PRESSURE FROM FLUSHING PUMP CAN VARY FROM (500 TO 1000) psig FOR CLEANING PURPOSES OF DRILL HOLE

DEGREES OF WATER LEAKAGE:

TYPE 1: COLOR CHANGE (DARKER) DUE TO SURFACE MOISTURE CONTENT
TYPE 2: WET TO TOUCH, SURFACE DAMPNESS, NO SUSTAINED TRAIL
TYPE 3: WEEPS & SEEPAGE, SUSTAINED TRAIL OF WETNESS
TYPE 4: CONTINUOUS DRIPPING, VISIBLE SURFACE FLOW
TYPE 5: GUSHING FLOW FROM HYDROSTATIC PRESSURE



5 POLYACRYLATE GROUT, CRACK INJECTION

INJECTION INTO CRACKS / CRACK CLEANING PROCEDURE

t = WALL / SLAB THICKNESS
1/3t = INTERCEPTION ZONE IN CRACK SECTION
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z = SPACING OF DRILL HOLES ALONG CRACK LENGTH SHALL BE BETWEEN t/2 to 2/3t

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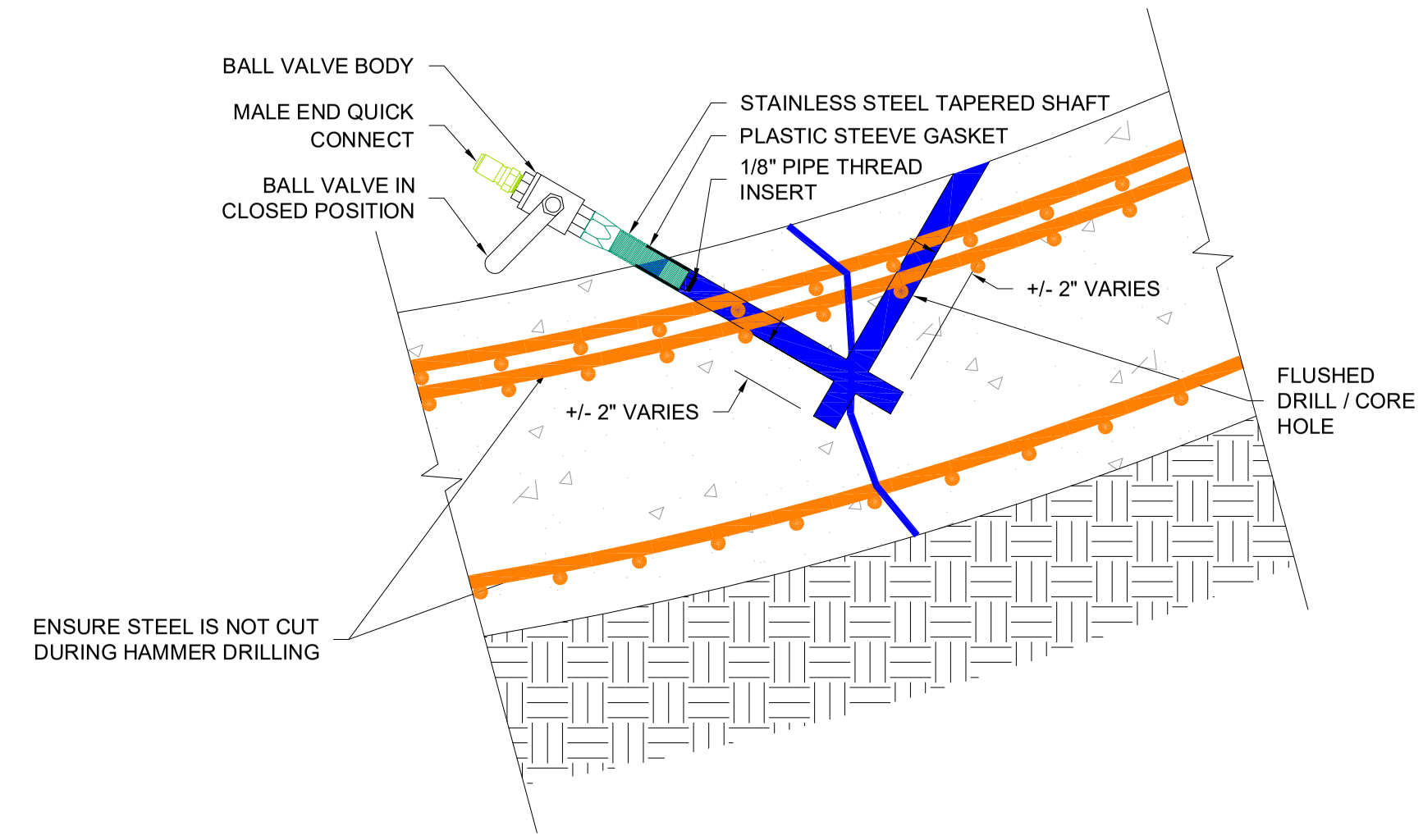
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 5E

1. PLACE PLASTIC SLEEVE ON BALL VALVE PACKER TAPERED SHAFT PRIOR TO PLACEMENT INTO 5/8" Ø DRILL HOLE
2. SPIN TAPERED SHAFT INTO DRILL HOLE TO ENSURE A WATERTIGHT FIT
3. ADJUST TIGHTNESS OF PACKER PRIOR TO PRESSURIZED WATER FLUSHING

DEGREES OF WATER LEAKAGE:

TYPE 1: COLOR CHANGE (DARKER) DUE TO SURFACE MOISTURE CONTENT
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TYPE 5: GUSHING FLOW FROM HYDROSTATIC PRESSURE



6 POLYACRYLATE GROUT, CRACK INJECTION

INJECTION INTO CRACKS / PACKER PLACEMENT

t = WALL / SLAB THICKNESS
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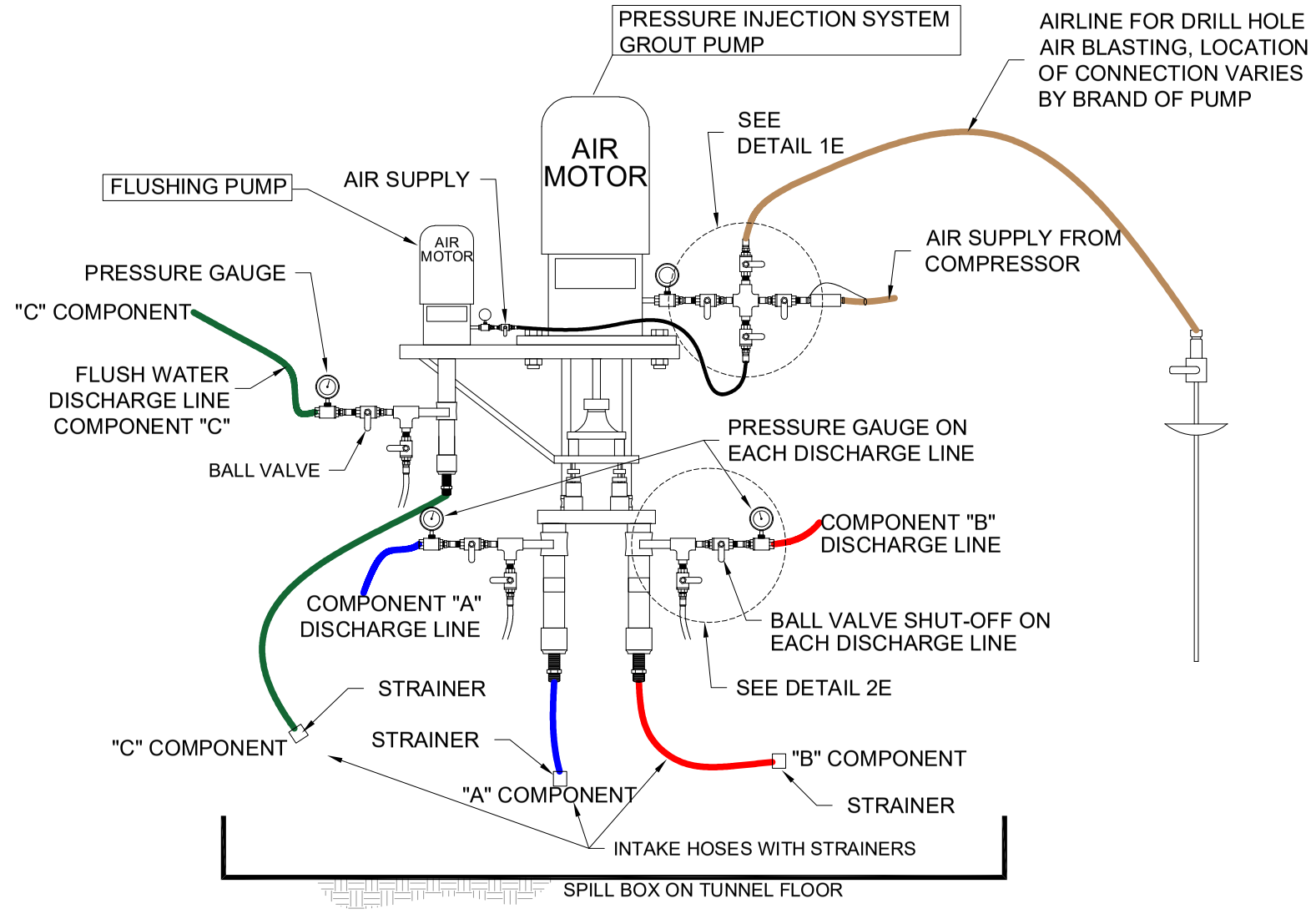
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 6E

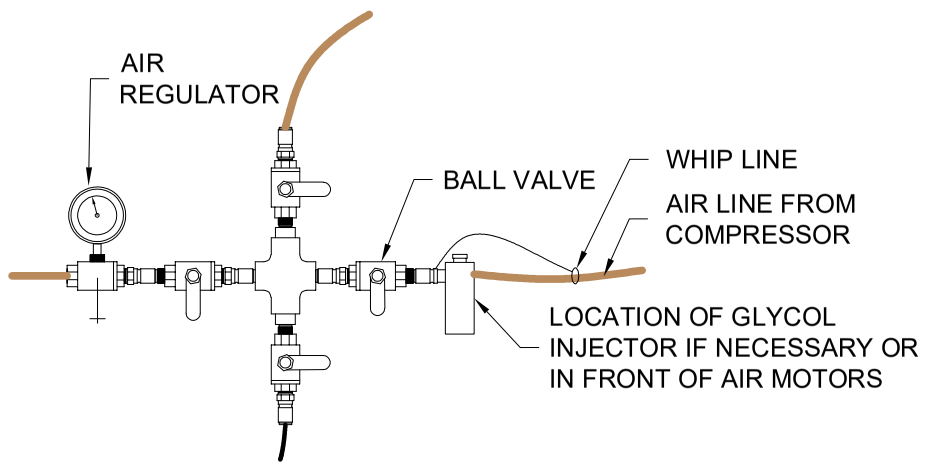
POLYACRYLATE GROUT EQUIPMENT AND PROCEDURES:

EQUIPMENT SETUP FOR CHEMICAL GROUT SYSTEM (CGS) - CLEANING, FLUSHING, PRESSURE INJECTION AND STORAGE

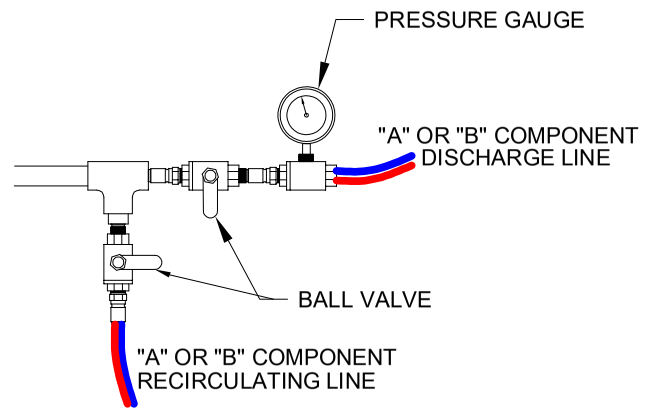


7 POLYACRYLATE GROUT, CRACK INJECTION

GROUT & FLUSHING PUMP SET-UP & COMPONENTS
NOTE: GROUT PUMP NOT SHOWN FOR CLARITY



1E AIR LINE SET-UP



2E DETAIL OF DISCHARGE AND RE-CIRCULATING LINES

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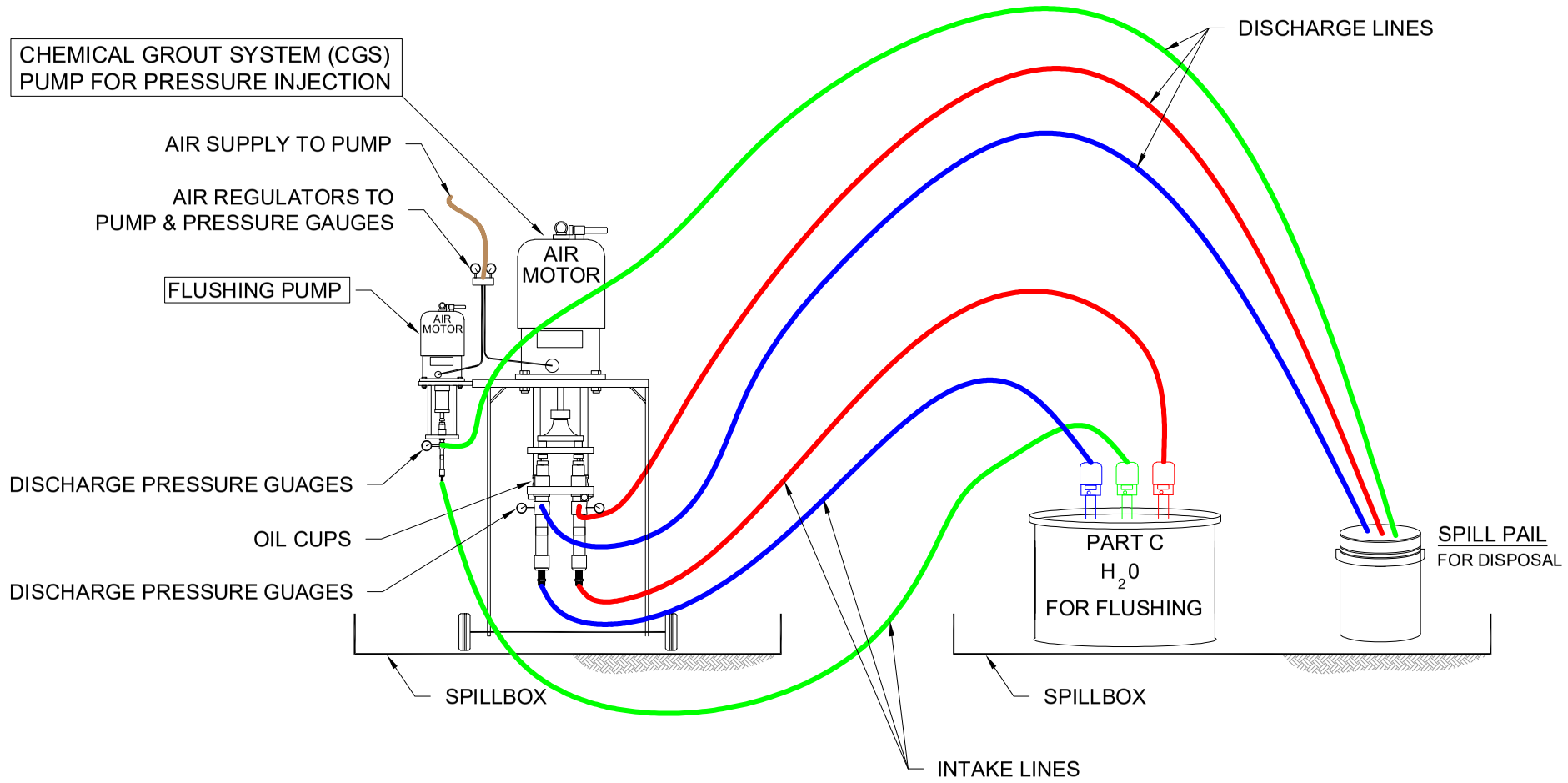
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 7E

1. SET PUMP ON / WITHIN SPILL BOX WITH TEAR RESISTANT MEMBRANE, RAISED ON SIDES
2. ATTACH AIR COMPRESSOR HOSE TO AIR LINE INTAKE ON PRESSURE INJECTION PUMP WITH APPROVED FITTING AND ANTI-WHIP LINE
3. INSTALL ETHYLENE GLYCOL LUBRICATOR IF COLD TEMPERATURES ARE PRESENT OR CONSTANT PUMPING IS REQUIRED
4. FILL PART "C" CONTAINER WITH CLEAN WATER
5. PLACE INTAKE LINE FROM FLUSHING PUMP AND BOTH "A" & "B" COMPONENT PRESSURE INJECTION PUMP LINE OF CHEMICAL GROUT SYSTEM (CGS) INTO PART "C" CONTAINER
6. PLACE ALL THREE DISCHARGE LINES IN SPILL PAIL
7. TURN CHEMICAL GROUT SYSTEM (CGS) PUMP ON AT LOW SPEED AND PRESSURE, ENSURE ALL THREE LINES DISCHARGE LIQUIDS INTO SPILL PAIL
8. CIRCULATE WATER THROUGH SYSTEM UNTIL ALL OIL FROM STORAGE IS FLUSHED OUT OF THE SYSTEM
9. CHECK TO ENSURE RATIO OF "A" & "B" COMPONENTS IS EQUAL OR WITHIN 10% OF EACH OTHER, SEE SHEET 12E
10. PUT INJECTION HEAD ("E" ASSEMBLY) ONTO (USE QUICK CONNECT FITTINGS) DISCHARGE LINES AND CLOSE BALL-VALVES, ENSURE NO LEAKAGE EXISTS AT HIGH FLUID PRESSURE
11. MAKE ADJUSTMENTS WHERE NECESSARY IF LEAKAGE AT MECHANICAL CONNECTIONS OCCUR



* NOTE:
- RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY
- PUMP IS USUALLY STORED WITH VEGETABLE OIL IN SYSTEM. THIS IS NON-HAZARDOUS AND CAN EASILY BE DISPOSED OF.

8 POLYACRYLATE GROUT, CRACK INJECTION
PUMP FLUSHING OR STORAGE OIL OUT FROM SYSTEM
GROUT PUMP PREPERATION

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

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1	1/9/2020	REVISIONS	TB

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DRN	TB	1/9/2020
CHK	BA	1/9/2020

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Fridley, MN 55432
Phone: 612-363-9580
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 8E

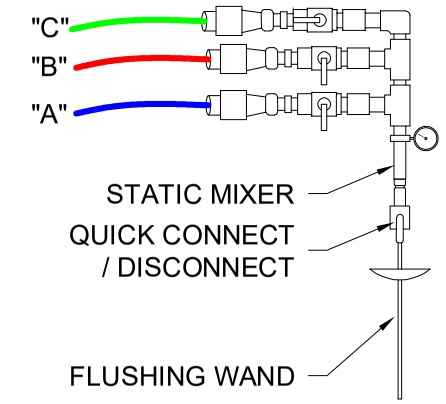
WATER FLUSHING DRILL HOLES:

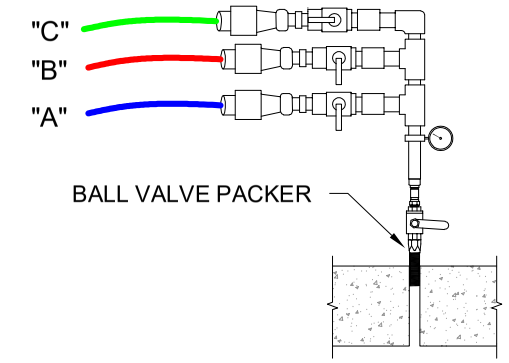
1. OPEN BALL VALVE ON "E" ASSEMBLY FOR COMPONENT "C", WATER
2. CLOSE BALL VALVES ON "E" ASSEMBLY FOR COMPONENTS "A" & "B", CHEMICAL GROUT
3. PLACE WATER BLAST WAND ON "E" ASSEMBLY
4. TURN FLUSHING PUMP "ON", ADJUST TO DESIRED WATER BLAST PRESSURE
5. PLACE FLUSHING WAND DOWN DRILL HOLE TO FLUSH DRILLING DEBRIS FROM HOLE

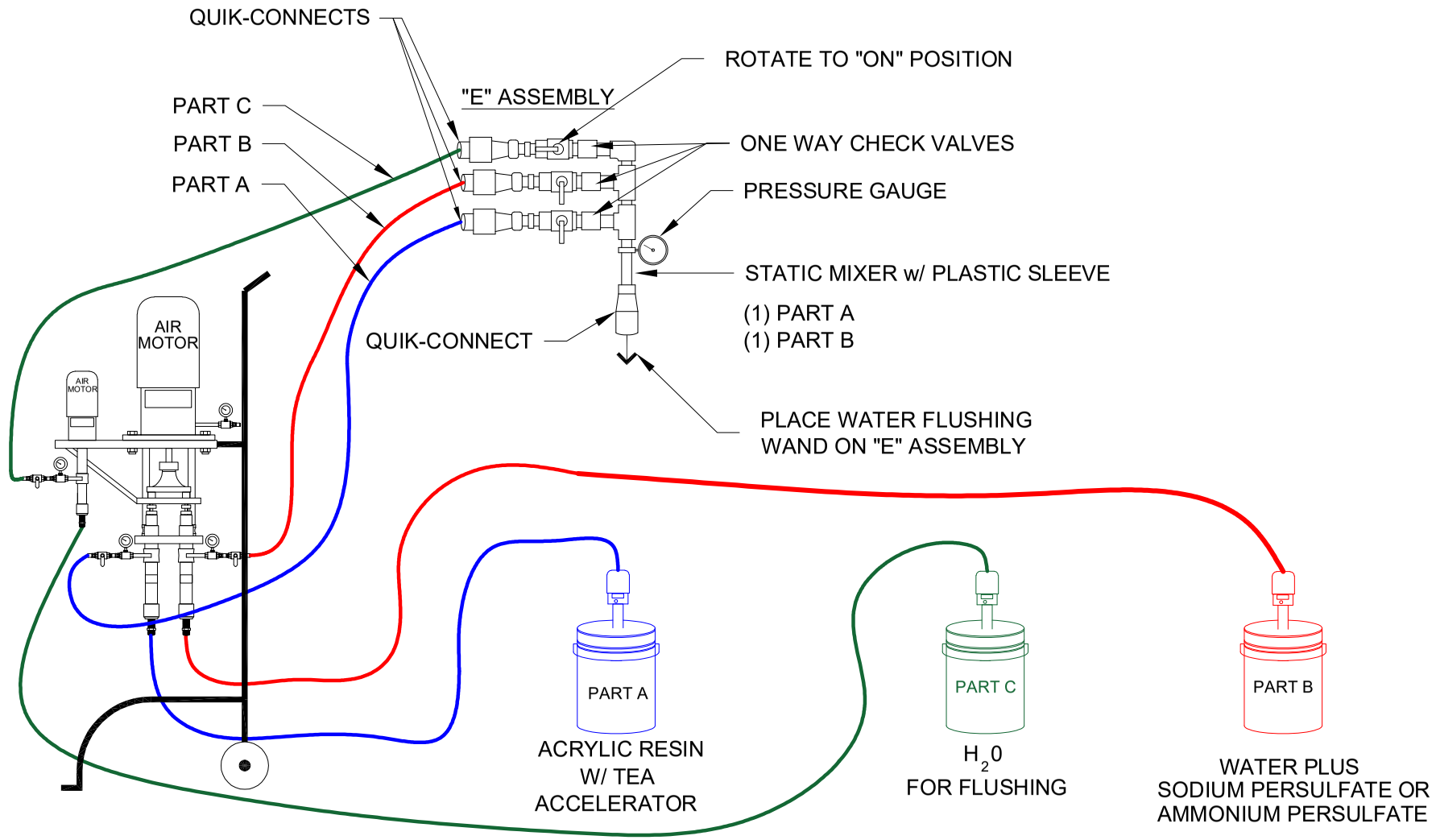
WATER FLUSHING CRACK:

1. REMOVE WATER BLAST WAND FROM "E" ASSEMBLY
2. PLACE BALL-VALVE PACKER ON DRILL HOLE, SECURE & TIGHTEN
3. PLACE "E" ASSEMBLY ON BALL VALVE PACKER
4. TURN FLUSHING PUMP ON, ADJUST PRESSURE TO ENSURE WATER FLUSHES OUT CRACK 6" ON EACH SIDE OF DRILL HOLE
5. TURN FLUSHING PUMP OFF - REMOVE "E" ASSEMBLY FROM PACKER

"E" ASSEMBLY







9 POLYACRYLATE GROUT, CRACK INJECTION

CLASSIC SET-UP FOR FLUSHING GROUT & PUMPING WATER FOR CRACK / JOINT FLUSHING
NOTE: RE-CIRCULATING LINES NOT SHOWN FOR CLARITY
NOTE: SPILL BOX NOT SHOWN FOR CLARITY

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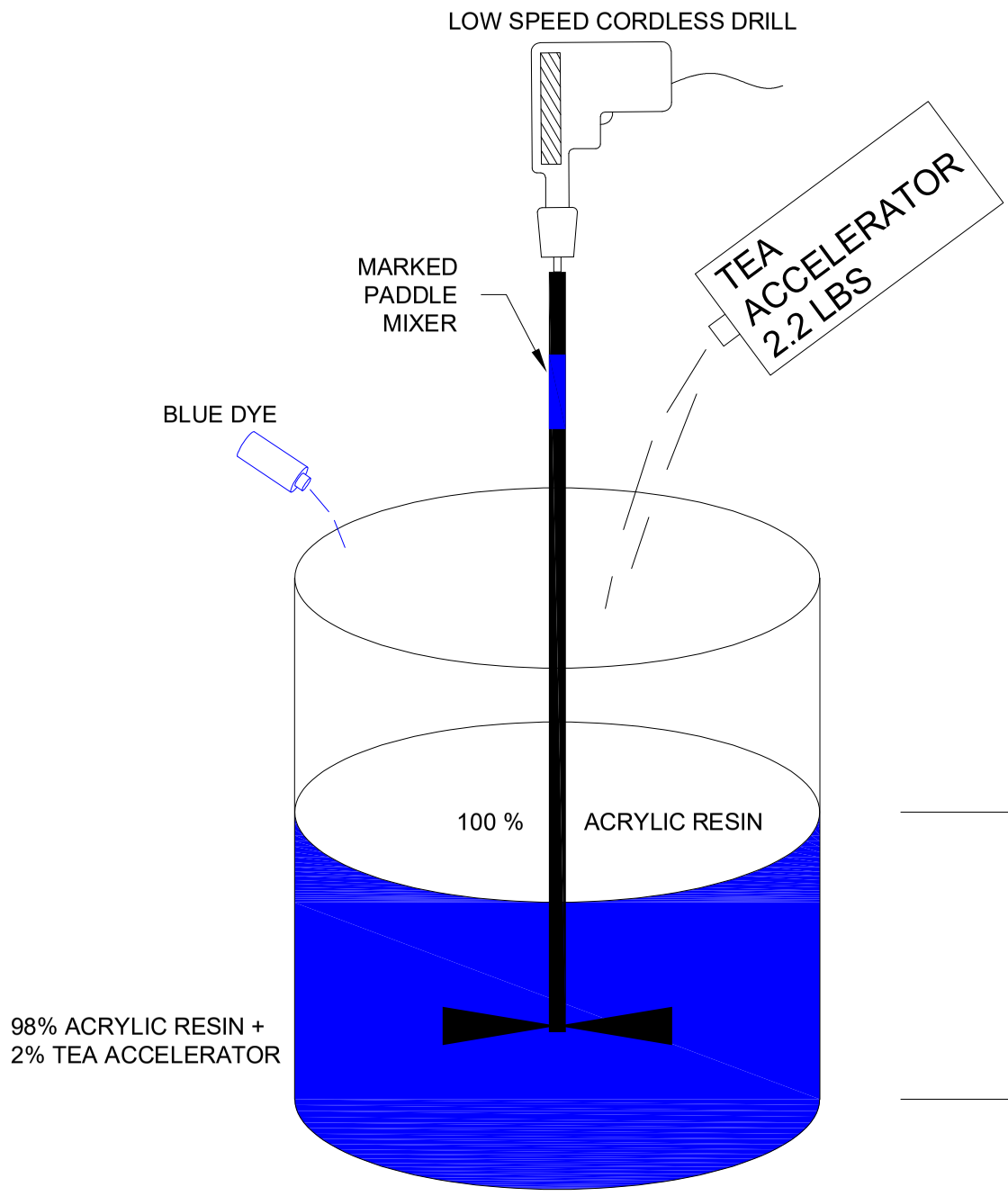
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 9E

"A" COMPONENT MIXING

1. POSITION 100% ACRYLIC RESIN PAIL ON SPILL PAD
2. OPEN LID ON RESIN PAIL
3. ADD 1 BOTTLE (2.2 LBS) OF BLUE ACCELERATOR TO RESIN PAIL
4. ADD 3-4 TEASPOONS OF BLUE DYE TO RESIN PAIL
5. PLACE PADDLE IN "A" RESIN PAIL AND SLOWLY MIX FOR 2 MINUTES
6. MEASURE TEMPERATURE OF "A" COMPONENT RESIN
7. HEAT OR COOL IF NECESSARY
8. PLACE LID BACK ON PAIL UNTIL READY FOR USE
9. MARK "A" RESIN PADDLE WITH BLUE LABEL OR TAPE TO ENSURE AGAINST CROSS-CONTAMINATION IN "B" COMPONENT

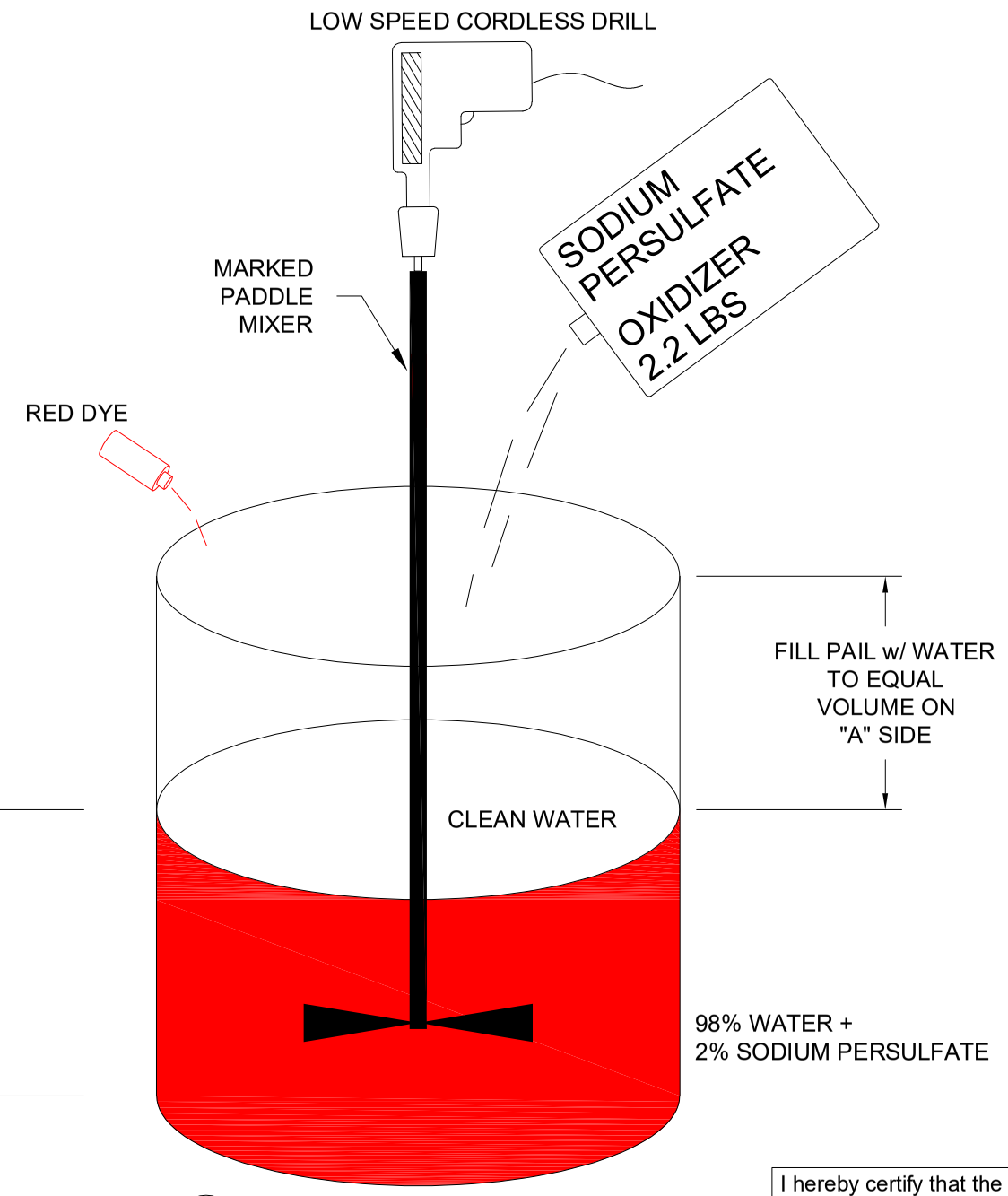


10A "A" COMPONENT MIXING
"A" RESIN PAIL

"A" + "B" EQUAL

"B" COMPONENT MIXING

1. POSITION OXIDIZER PAIL AND FILL WITH 4 GALLONS OF CLEAN WATER
2. ADD 1 BAG (2.2 LBS) OF WHITE POWDER (SODIUM PERSULFATE) TO WATER
3. ADD 2-3 TEASPOONS OF RED DYE TO OXIDIZER PAIL
4. PLACE PADDLE IN "B" RESIN PAIL AND SLOWLY MIX FOR 2 MINUTES
5. MEASURE TEMPERATURE OF "B" COMPONENT FLUID
6. HEAT OR COOL IF NECESSARY
7. PLACE LID BACK ON PAIL UNTIL READY FOR USE
8. MARK "B" RESIN PADDLE WITH RED LABEL OR TAPE TO ENSURE AGAINST CROSS-CONTAMINATION IN "A" COMPONENTS
9. FILL PAIL TO AN EQUAL VOLUME AS ON "A" SIDE



10B "B" COMPONENT MIXING
"B" RESIN PAIL

10 POLYACRYLATE GROUT, CRACK INJECTION
MIXING / FORMULATING A&B COMPONENTS

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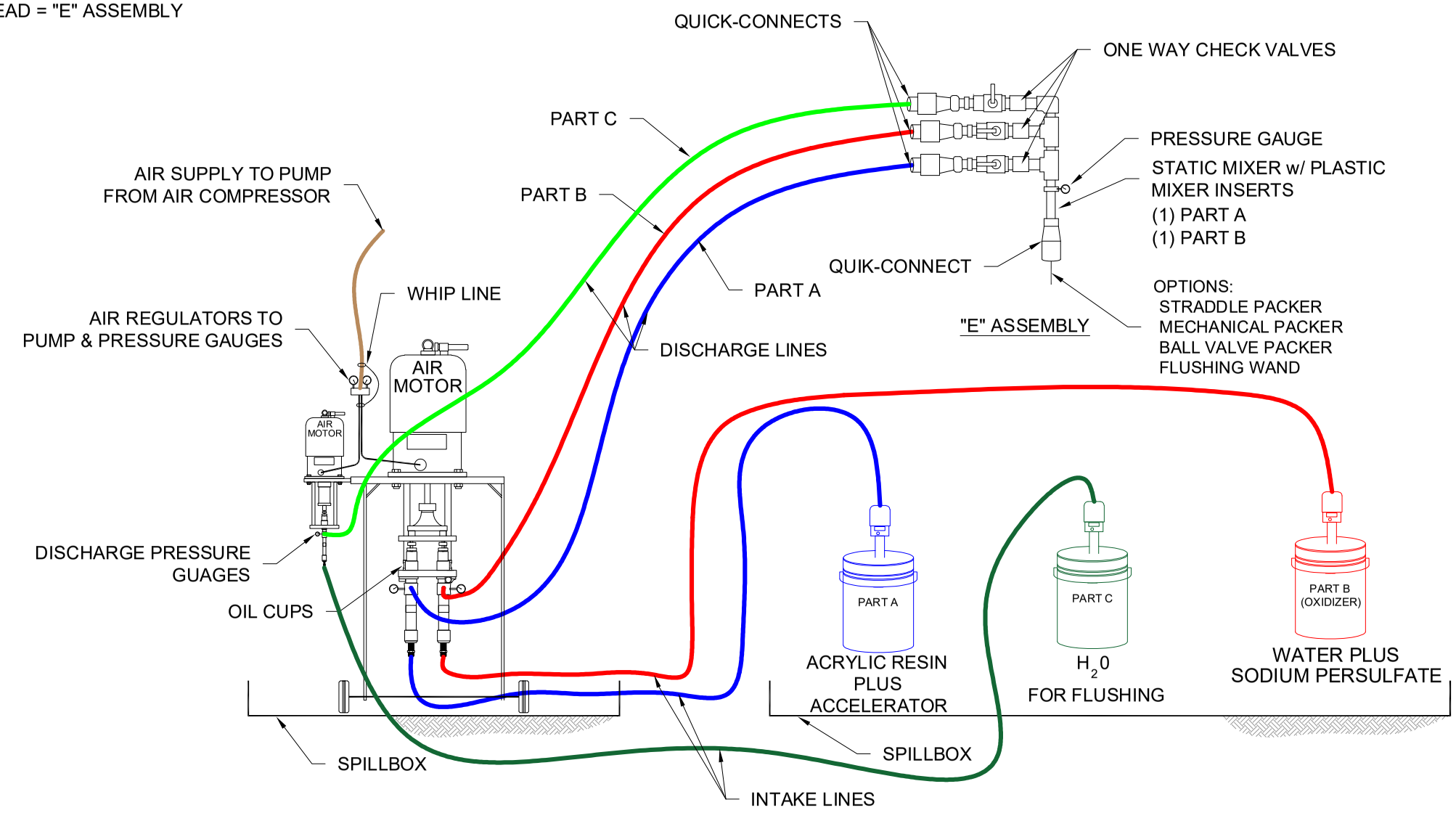
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 10E

1. REFER TO SHEET 12 AND 13, FOR GEL-TIME CUP TEST, AND RATIO CHECK
2. NOTE: STATIC MIXER NEEDS TO BE FLUSHED WITH WATER PRIOR TO GEL-TIME REACTION
3. TURN ON AIR PRESSURE TO CHEMICAL GROUT SYSTEM PUMP, TURN OFF AIR PRESSURE TO FLUSHING PUMP
4. REGULATE AIR PRESSURE TO OBTAIN A STEADY FLOW OF MATERIAL THROUGH INJECTION GUN*
5. HOOK UP INJECTION HEAD* TO QUICK CONNECT OF BALL VALVE PACKER ASSEMBLY
6. START INJECTION PRESSURE AT (100-200) psig, MONITOR PISTONS ON PUMP FOR FLOW
7. CONTINUE PUMPING UNTIL MIXED GROUT EXTENDS HALF WAY TO EACH ADJACENT PORT
8. IF RESISTANCE TO CHEMICAL GROUT FLOW DOES NOT ALLOW PISTON MOVEMENT, INCREASE PRESSURE TO AIR MOTOR ON CHEMICAL GROUT SYSTEM (CGS) PRESSURE INJECTION PUMP IN 100 psig INCREMENTS UNTIL FLOW OCCURS
9. DO NOT EXCEED 700 psig AT DISCHARGE PRESSURE GAUGES
10. IF CHEMICAL GROUT DOES NOT CONTINUE TO FLOW, REMOVE "E" ASSEMBLY FROM PACKER, FLUSH LINE WITH WATER, REPEAT PROCESS OF DRILLING NEW DRILL HOLE IN VICINITY OF "DEAD HOLE". NOTE THAT THIS SHOULD NOT OCCUR BECAUSE THE HOLE WAS TESTED WITH WATER PREVIOUSLY.
11. MOVE TO NEXT PACKER ASSEMBLY.

* INJECTION GUN = INJECTION HEAD = "E" ASSEMBLY



* NOTE - RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY

11 POLYACRYLATE GROUT, CRACK INJECTION

CHEMICAL GROUT INJECTION OPERATION / PLUMBING

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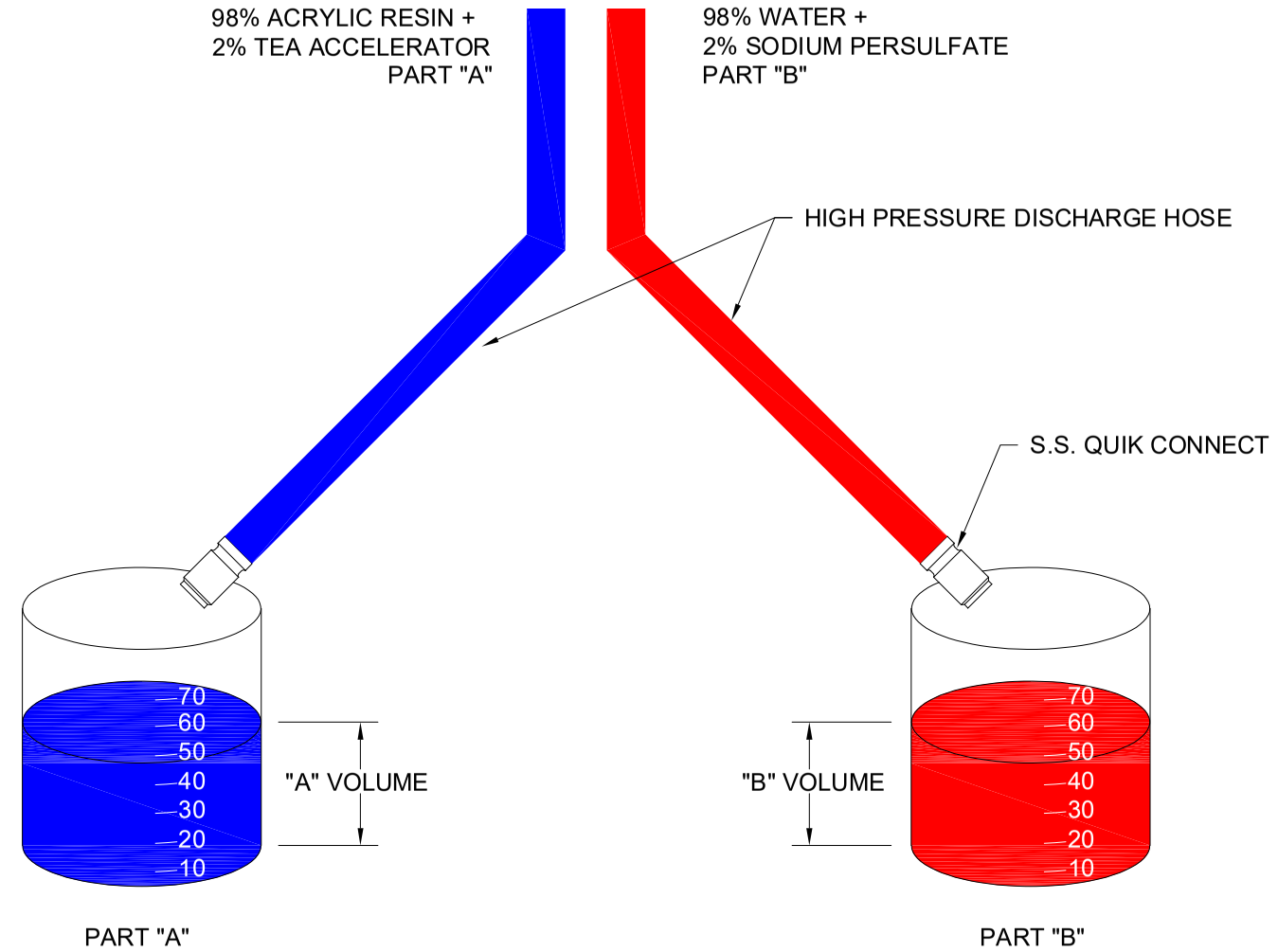
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 11E

1. PRIOR TO PUMPING:
   1.1. DISCONNECT "E" OR "F" ASSEMBLY
   1.2. PUMP PARTS "A" & "B" INTO MEASURING CUPS TO ENSURE PROPER 1-TO-1 RATIO, TOLERANCE MAY BE 10% EITHER WAY
   1.3. ADJUST PUMP STROKE LENGTH IF NOT IN RATIO OF 1-TO-1
2. RATIO BALANCE CAN BE INFLUENCED BY PARTICLES OR DEBRIS BUILD UP IN VALVES OF PUMP



12 POLYACRYLATE GROUT, CRACK INJECTION
QA / QC, 1-to-1 RATIO CHECK

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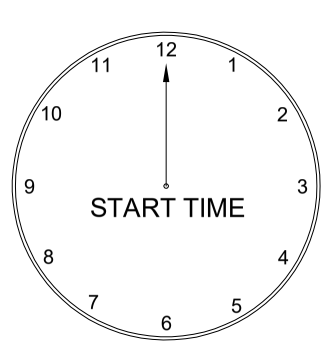
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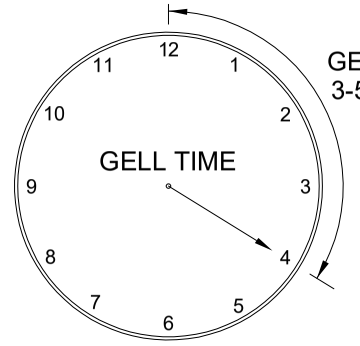
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 12E

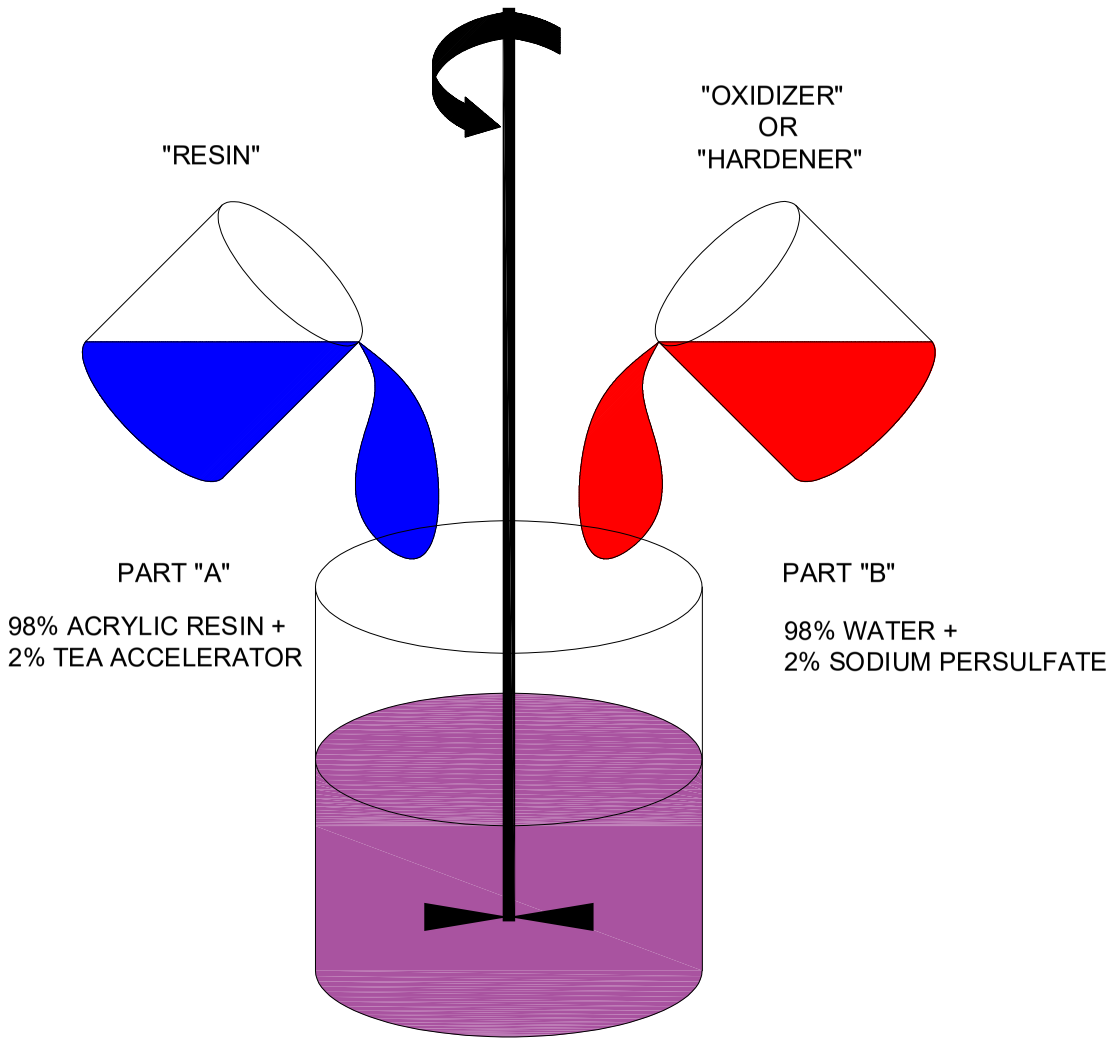
1. TAKE "A" & "B" COMPONENTS AND MIX TOGETHER, NOTE START TIME.
2. AFTER SHORT PERIOD (30 SECONDS TO 3 MINUTES) GROUT VISCOSITY INCREASES.
3. RATHER QUICKLY GROUT SOLIDIFIES INTO A SOLID MASS. NOTE GEL TIME.
4. IF GEL TIME IS TOO SHORT:
   - 4.1. REDUCE TEA BY 20% INTO PART "A"
   - 4.2. REDUCE HARDENER IN PART "B" BY 20%.
   - 4.3. MEASURE NEW GEL TIME.
5. IF GEL TIME IS TOO LONG:
   - 5.1. INCREASE TEA BY 20% INTO PART "A"
   - 5.2. INCREASE HARDENER IN PART "B" BY 20%
   - 5.3. MEASURE NEW GEL TIME
6. GEL-TIME IS INFLUENCED BY FLUID TEMPERATURE "A" & "B" RESIN TEMPERATURE CAN BE VARIED FROM 40° TO 120° F.
7. PAIL AND/OR DRUM HEATERS ARE COMMONLY USED IF WARMING IS REQUIRED.

* HARDENER IS CALLED SODIUM PERSULFATE, ALSO CALLED "OXIDIZER".





GEL-TIME
3-5 MINUTES



GEL TIME INFLUENCED BY:

1. TEMPERATURE OF LIQUIDS "A" & "B"
2. pH OF WATER ON "B" SIDE
3. IRON CONTENT IN WATER IN "B" SIDE
4. CONCENTRATIONS OF ACCELERATOR AND OXIDIZER IN PAILS

13 POLYACRYLATE GROUT, CRACK INJECTION
GEL TIME CHECK

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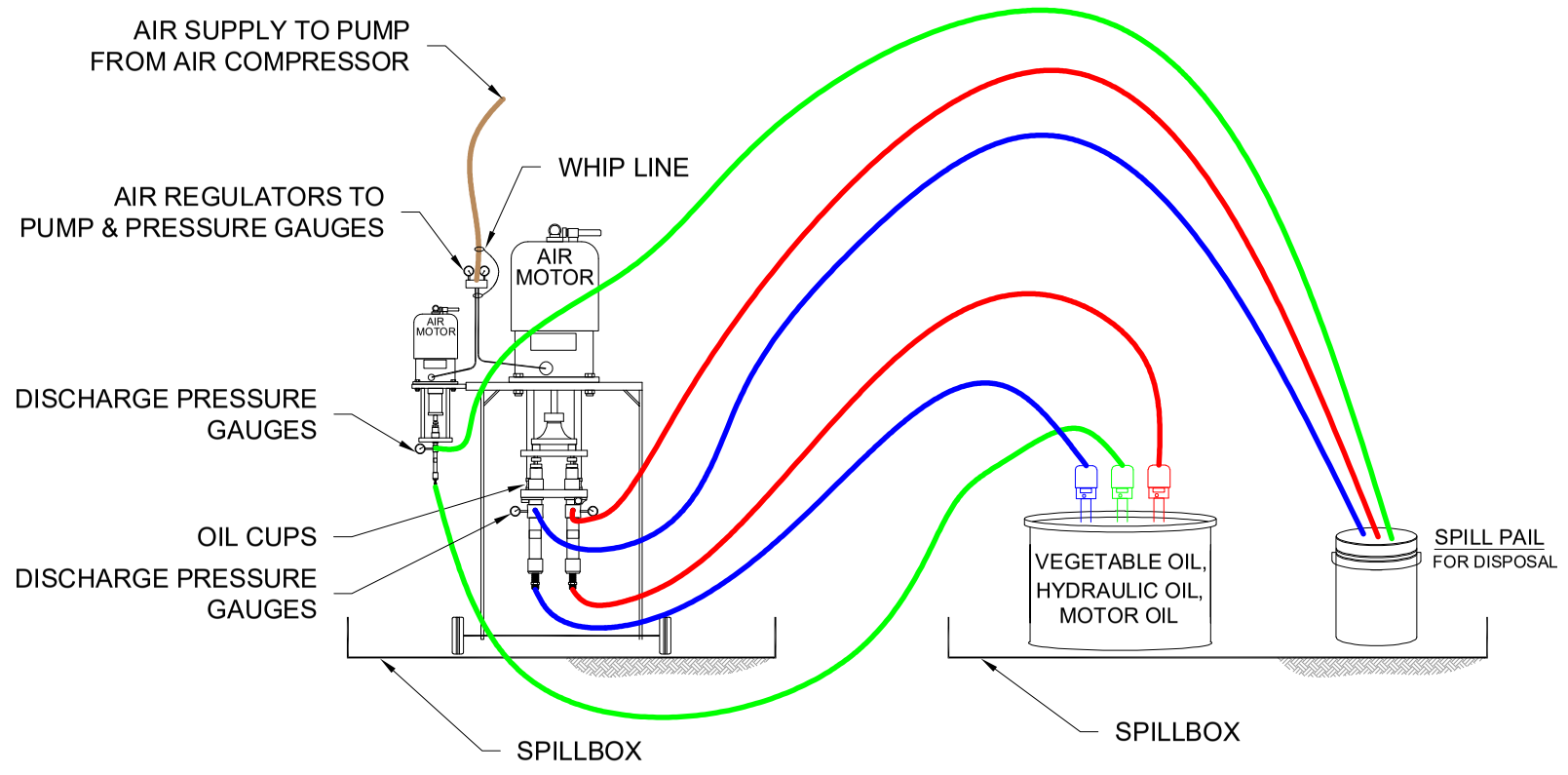
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 13E

1. UPON COMPLETION OF PRESSURE INJECTION OPERATIONS, FLUSH PUMPS (CHEMICAL GROUT SYSTEMS (CGS) PRESSURE INJECTION PUMP AND ATTACHED FLUSHING PUMP) WITH DETERGENT/SOAP AND WATER INTO SPILL PAIL
2. AFTER FLUSHING, PUMP VEGETABLE, OR MOTOR OIL IN (CHEMICAL GROUT SYSTEMS (CGS) PRESSURE INJECTION PUMP AND ATTACHED FLUSHING PUMP) SYSTEM FOR STORAGE AND UNTIL NEXT USAGE.



* NOTE - RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY

14 POLYACRYLATE GROUT, CRACK INJECTION

FLUSHING GROUT PUMP AND PREPARING FOR STORAGE
GROUT PUMP CLEANUP

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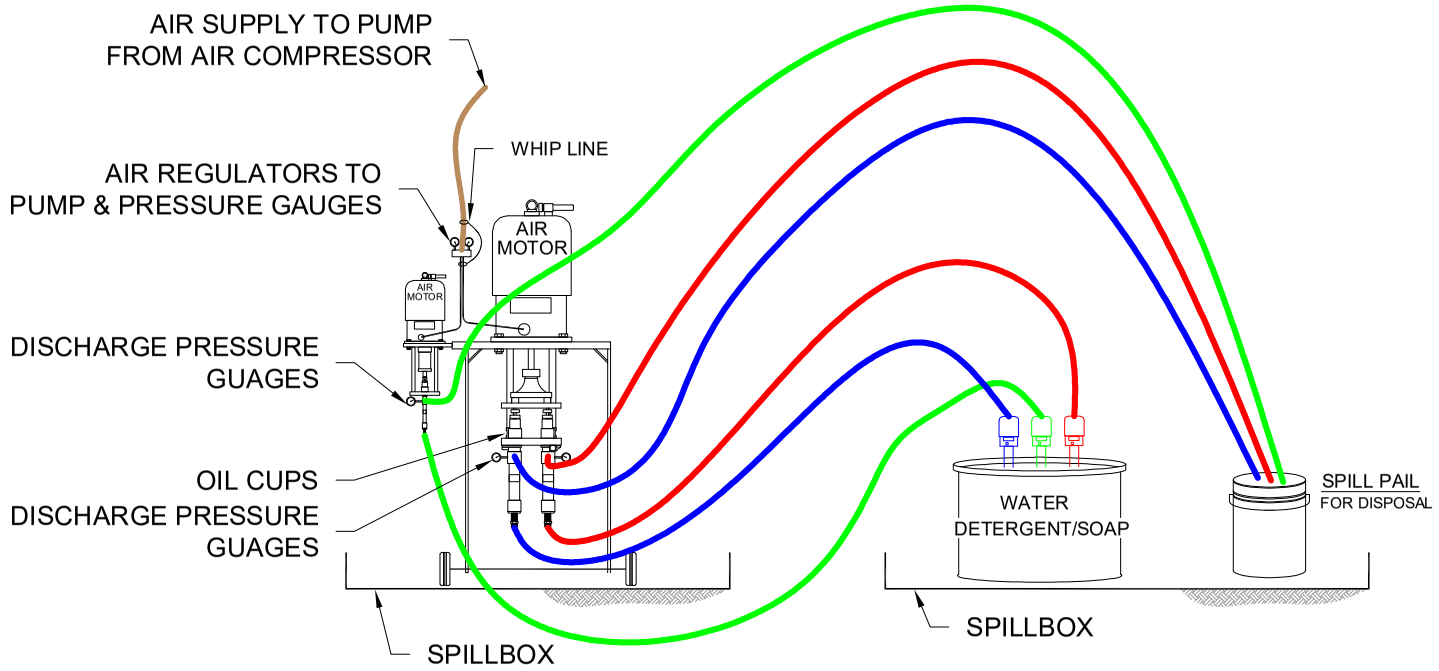
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 14E

1. UPON COMPLETION OF PRESSURE INJECTION OPERATIONS, FLUSH PUMPS (CHEMICAL GROUT SYSTEMS (CGS) PRESSURE INJECTION PUMP AND ATTACHED FLUSHING PUMP) WITH DETERGENT/SOAP AND WATER INTO SPILL PAIL
2. AFTER FLUSHING, PUMP VEGETABLE, OR MOTOR OIL IN (CHEMICAL GROUT SYSTEMS (CGS) PRESSURE INJECTION PUMP AND ATTACHED FLUSHING PUMP) SYSTEM FOR STORAGE AND UNTIL NEXT USAGE.



* NOTE - RE-CIRCULATING DISCHARGE LINES NOT SHOWN FOR CLARITY

15 POLYACRYLATE GROUT, CRACK INJECTION
FLUSHING GROUT PUMP AND PREPARING FOR STORAGE
GROUT PUMP CLEANUP

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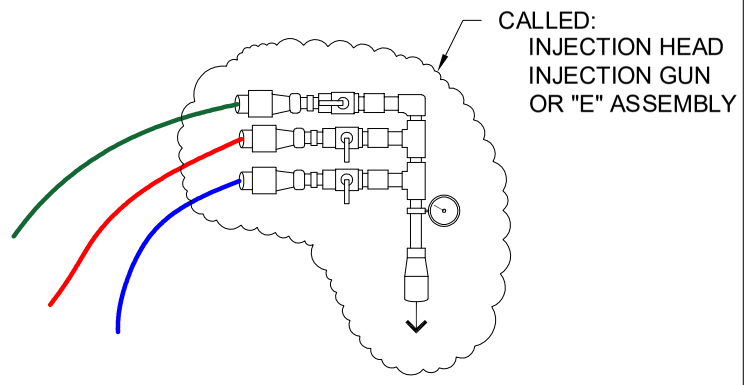
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 15E

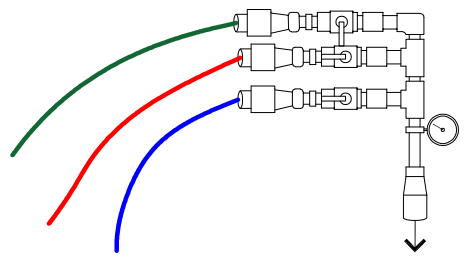
WATER FLUSHING LINE IN OPEN POSITION, MEANING PRESSURIZED WATER FLOW TO OCCUR FROM FLUSHING PUMP



BALL VALVES, CLOSED POSITION FOR CHEMICAL GROUT FLOW FROM GROUT PUMP

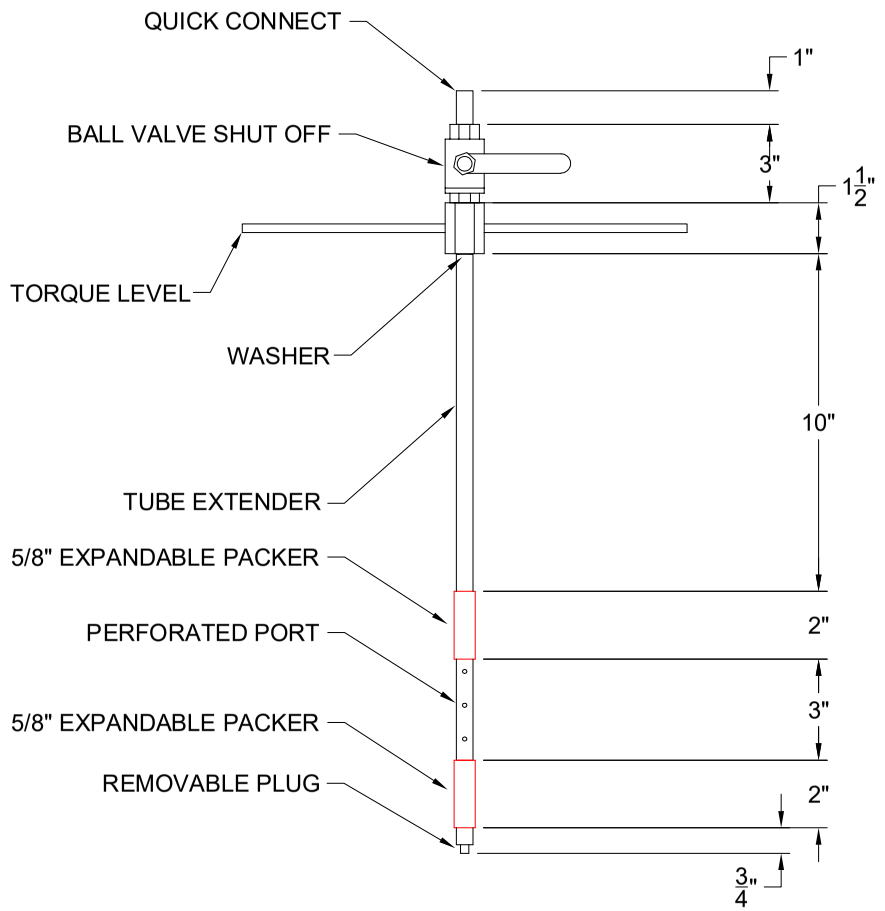
"E" ASSEMBLY

WATER FLUSHING LINE IN CLOSED POSITION, MEANING NO WATER FLOW FROM FLUSHING PUMP

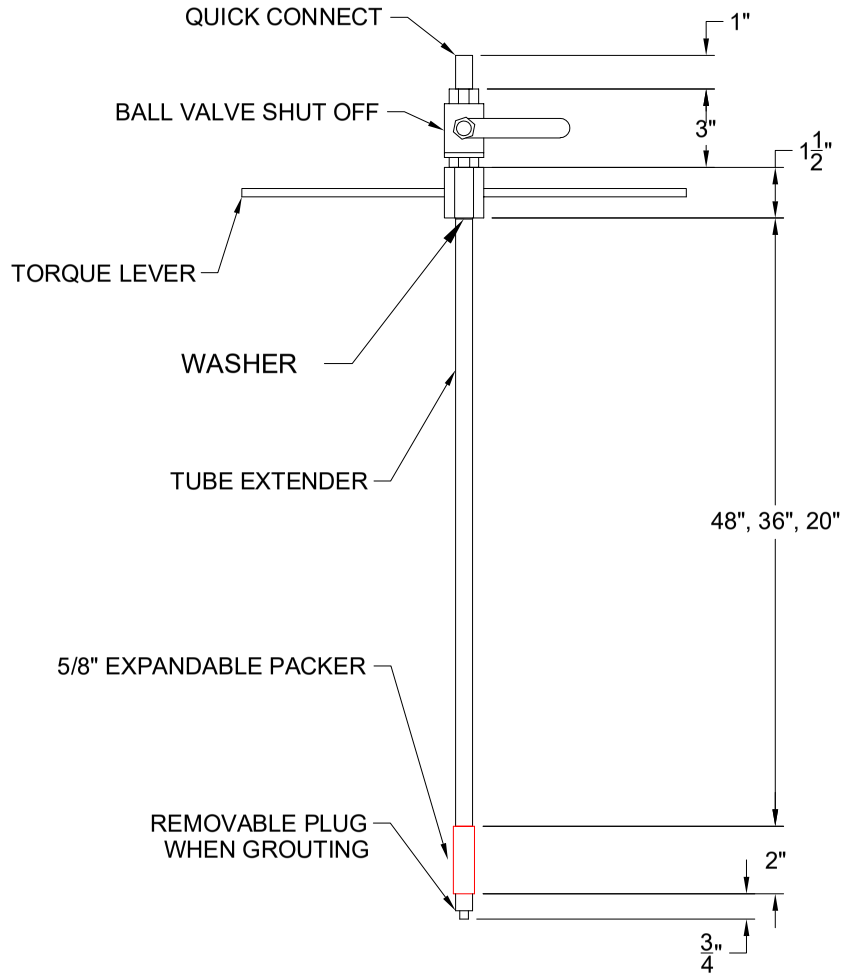


BALL VALVES, OPEN POSITION FOR CHEMICAL GROUT FLOW FROM GROUT PUMP

"E" ASSEMBLY



STRADDLE MECHANICAL PACKER



18" MECHANICAL PACKER

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16 POLYACRYLATE GROUT, CRACK INJECTION
EXAMPLES OF GROUTING ACCESSORIES

NO.	DATE	REVISIONS	BY
1	1/9/2020		TB

DES	BA	1/9/2020
DRN	TB	1/9/2020
CHK	BA	1/9/2020

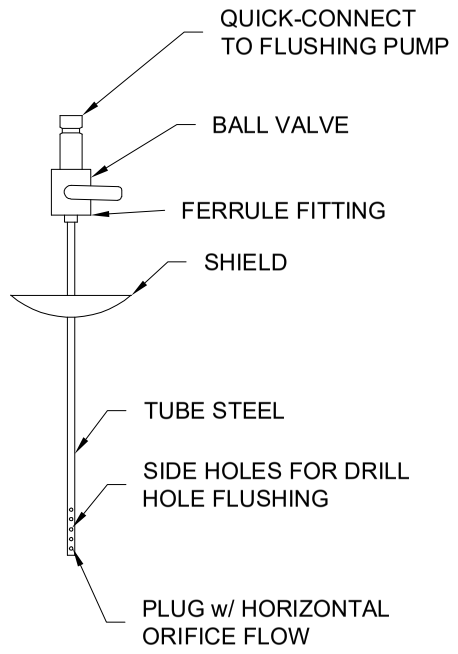
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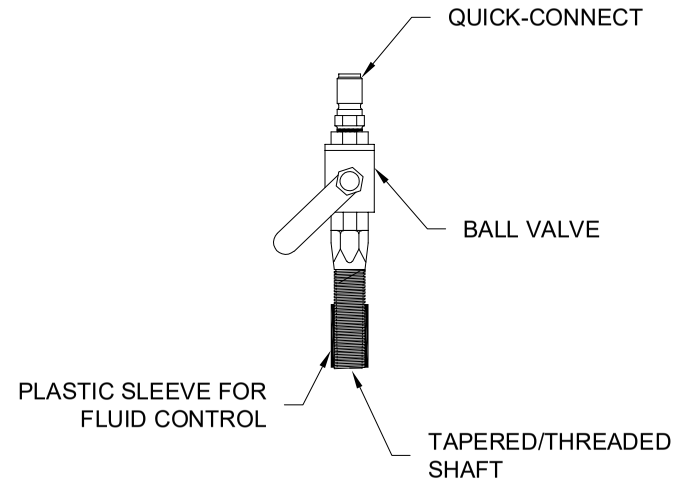
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RAYMOND ROAD CULVERT PIPE RESTORATION

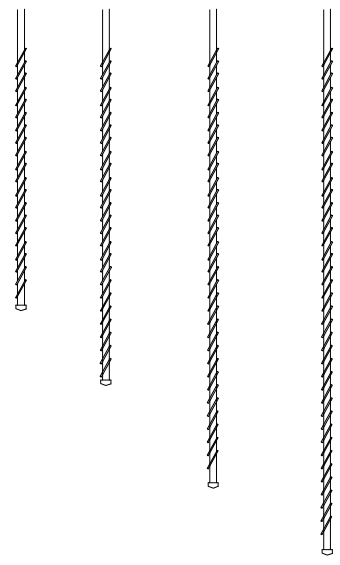
SHEET: 16E



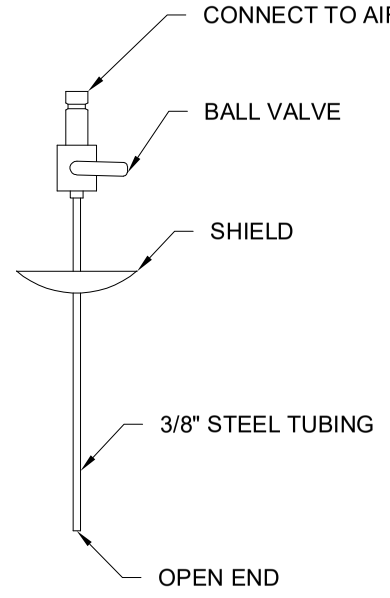
DRILL HOLE FLUSHING WAND



(TSBV) PACKER
TAPERED SHAFT, BALL VALVE (TSBV)



DRILL BITS OF VARIOUS LENGTHS & DIAMETERS



AIR FLUSHING WAND FOR
INITIAL DRILL HOLE CLEANING

17 POLYACRYLATE GROUT, CRACK INJECTION
EXAMPLES OF GROUTING ACCESSORIES

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

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DES	BA	1/9/2020
DRN	TB	1/9/2020
CHK	BA	1/9/2020

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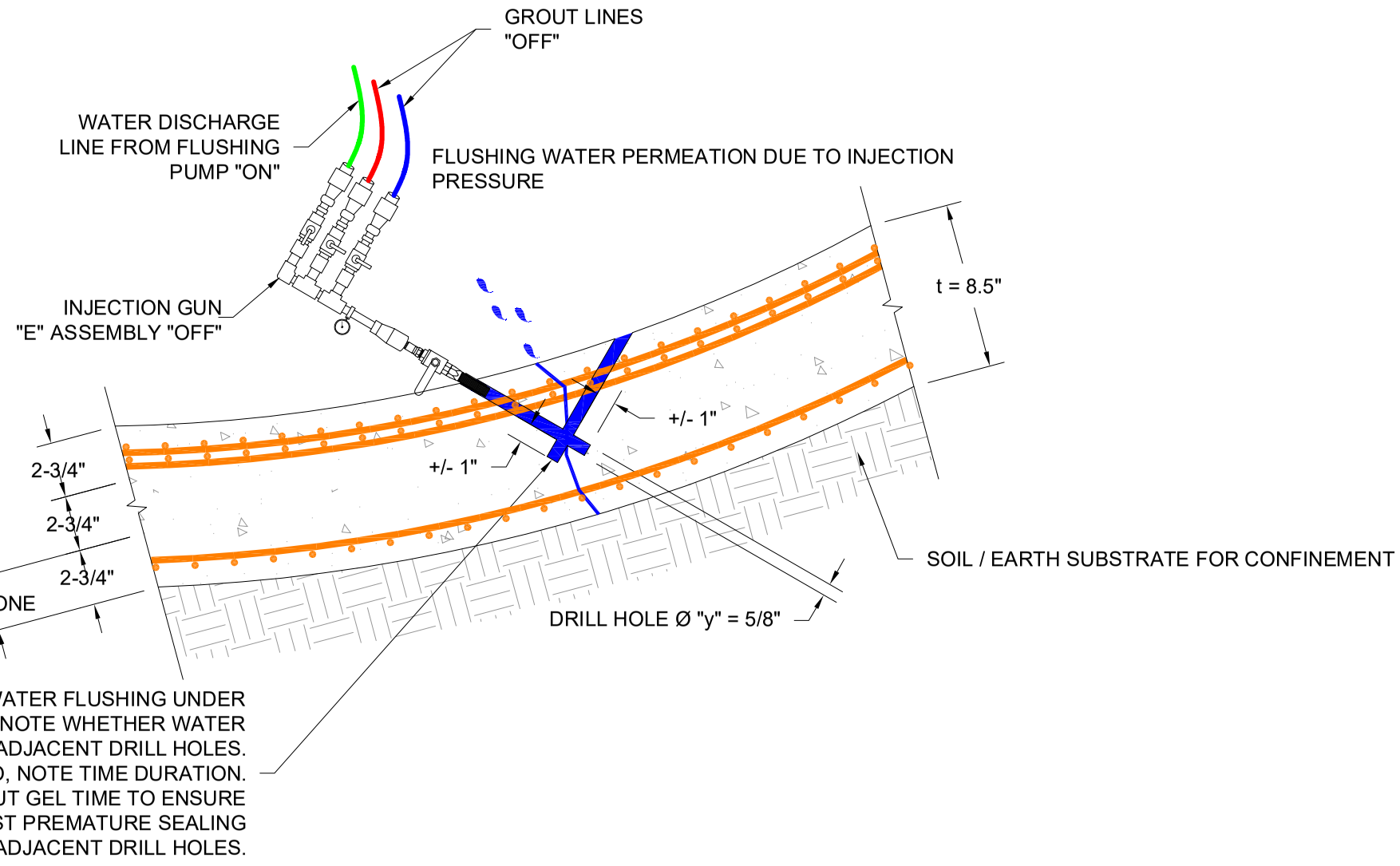
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 17E

1. PLACE BALL VALVE WITH QUICK-CONNECT, PACKER INTO DRILL HOLE AND TIGHTEN
2. ENSURE GOGGLES OR FACE-SHIELDS ARE IN PLACE
3. ATTACH "E" ASSEMBLY INJECTION HEAD TO PACKER, ENSURE PACKER IS SECURE
4. START INJECTING WATER FROM WATER FLUSHING PUMP AT 100 psig INTO CRACK, SEE SHEET 11
5. ENSURE WATER PERMEATES FROM CRACK 6 INCHES EACH DIRECTION CENTERED ON DRILL HOLE
6. IF WATER DOES NOT PERMEATE FROM CRACK, INCREASE PRESSURE IN 100 psig INCREMENTS, IF WATER FLUSHING PUMP PRESSURE BUILDS UP TO 700 psig, THE CRACK HAS NOT BEEN INTERCEPTED, EXCESSIVE PRESSURE MAY FRACK THE CONCRETE
7. STOP OPERATIONS, RELIEVE RESIDUAL WATER PRESSURE AND REMOVE INJECTION HEAD FROM PACKER, REMOVE PACKER AND RE-DRILL
8. DRILL DEEPER INTO CROSS-SECTION BECAUSE CRACK WAS NOT PROPERLY INTERCEPTED OR DRILLING DEBRIS HAVE PLUGGED INTERSECTION. REPEAT PROCESS UNTIL FLUSH WATER HAS PERMEATED FROM CRACK
9. HOLES THAT DO NOT ALLOW WATER PENETRATION SHALL BE MARKED AS "DEAD-HOLES"
10. ENSURE ALL DRILL HOLES PERMEATE FLUSHING WATER, CONTINUE FLUSHING WATER FOR 2 MINUTES

DEGREES OF WATER LEAKAGE:

TYPE 1: COLOR CHANGE (DARKER) DUE TO SURFACE MOISTURE CONTENT
TYPE 2: WET TO TOUCH, SURFACE DAMPNESS, NO SUSTAINED TRAIL
TYPE 3: WEEPS & SEEPAGE, SUSTAINED TRAIL OF WETNESS
TYPE 4: CONTINUOUS DRIPPING, VISIBLE SURFACE FLOW
TYPE 5: GUSHING FLOW FROM HYDROSTATIC PRESSURE



Key:

t = WALL / SLAB THICKNESS
1/3t = INTERCEPTION ZONE IN CRACK SECTION
x = MIN. DISTANCE FROM DRILL HOLE TO CRACK SHALL BE BETWEEN t/2 +/- (t/6)
⊖ = DRILL ANGLE TO SUBSTRATE SHALL TYPICALLY BE 45° AND CAN VARY +/- 15°
y = DRILL HOLE DIAMETER CAN BE 1/4", 3/8", 1/2", 5/8", AND 3/4"
t/2 = CENTERLINE OF ELEMENT
w = CRACK WIDTH
z = SPACING OF DRILL HOLES ALONG CRACK LENGTH SHALL BE BETWEEN t/2 to 2/3t

18 POLYACRYLATE GROUT, CRACK INJECTION

INJECTION INTO CRACKS / CRACK CLEANING PROCEDURE

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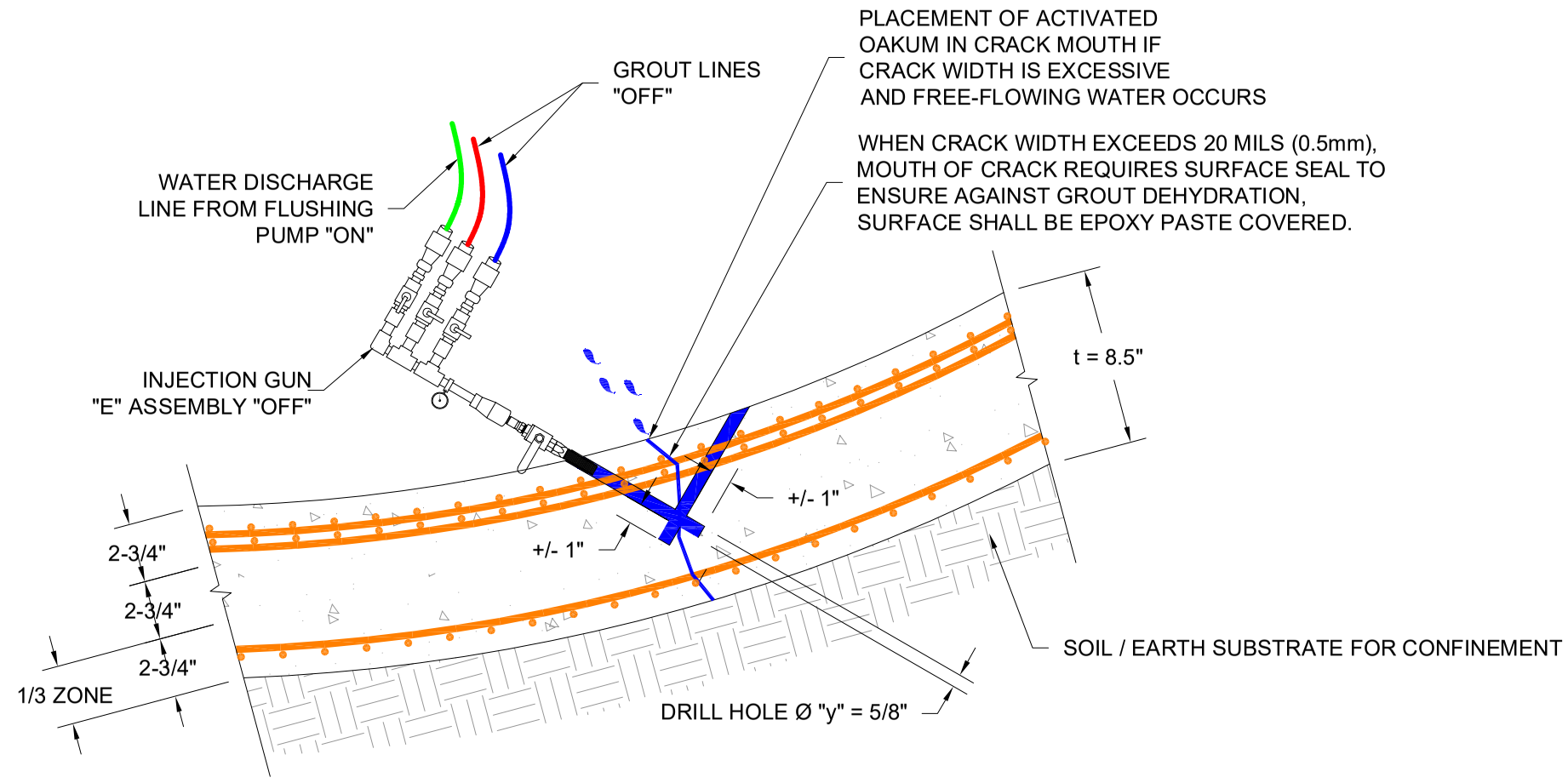
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 18E

1. WEAR PROPER PPE, ENSURE GOGGLES OR FACE-SHIELDS ARE CLEAR AND AVAILABLE FOR USE
2. IN CRACKS WHICH ARE WIDE ENOUGH TO ALLOW VISUALLY, FREE FLOWING WATER, PLACE UN-RAVELED OAKUM INTO MOUTH OF CRACK TO TEMPORARILY STOP THE UN-RESTRICTED FLOW OF WATER
3. OAKUM CAN BE SUPPLEMENTED WITH URETHANE OR POLYACRYLATE GROUT MIXTURE PRIOR TO PLACEMENT IN CRACK

DEGREES OF WATER LEAKAGE:

TYPE 1: COLOR CHANGE (DARKER) DUE TO SURFACE MOISTURE CONTENT
TYPE 2: WET TO TOUCH, SURFACE DAMPNESS, NO SUSTAINED TRAIL
TYPE 3: WEEPS & SEEPAGE, SUSTAINED TRAIL OF WETNESS
TYPE 4: CONTINUOUS DRIPPING, VISIBLE SURFACE FLOW
TYPE 5: GUSHING FLOW FROM HYDROSTATIC PRESSURE



19 POLYACRYLATE GROUT, CRACK INJECTION

INJECTION INTO CRACKS / CRACK CLEANING PROCEDURE
CRACK FLUSHING AND PREPERATION PROCEDURE

Key:

t = WALL / SLAB THICKNESS
1/3t = INTERCEPTION ZONE IN CRACK SECTION
x = MIN. DISTANCE FROM DRILL HOLE TO CRACK SHALL BE BETWEEN t/2 +/- (t/6)
⊖ = DRILL ANGLE TO SUBSTRATE SHALL TYPICALLY BE 45° AND CAN VARY +/- 15°
y = DRILL HOLE DIAMETER CAN BE 1/4", 3/8", 1/2", 5/8", AND 3/4"
t/2 = CENTERLINE OF ELEMENT
w = CRACK WIDTH
z = SPACING OF DRILL HOLES ALONG CRACK LENGTH SHALL BE BETWEEN t/2 to 2/3t

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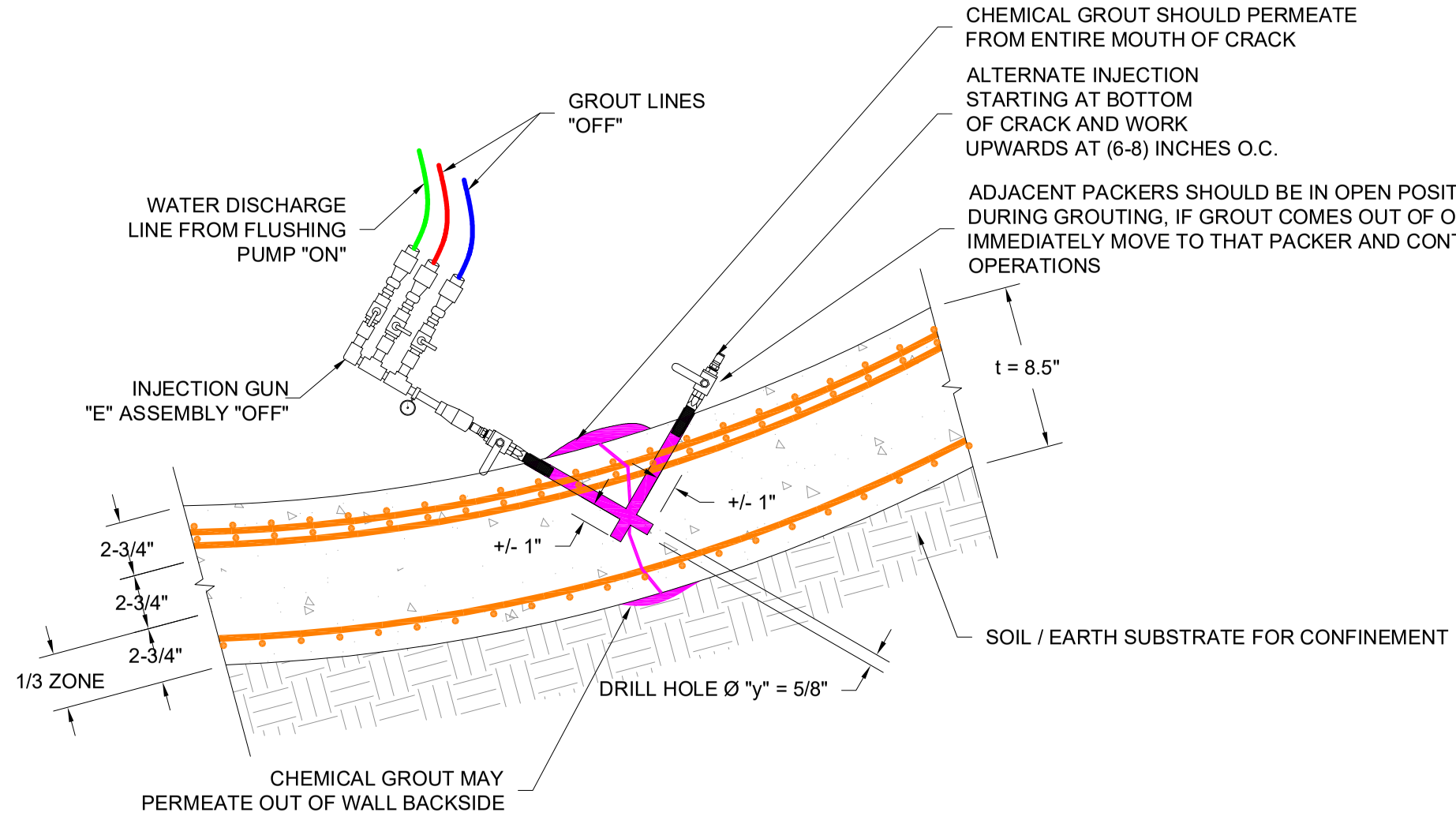
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 19E

1. AFTER CRACK FLUSHING IS COMPLETED, SEE SHEET 11 FOR CHEMICAL GROUT SYSTEM (CGS) PRESSURE INJECTION
2. WEAR PROPER PERSONAL PROTECTIVE EQUIPMENT, ENSURE GOGGLES OR FACE-SHIELDS ARE CLEAR AND AVAILABLE FOR USE
3. ATTACH INJECTION HEAD ON PACKER AT LOWEST POINT ON CRACK LENGTH
4. START CHEMICAL GROUT PRESSURE INJECTION PUMP AT 200 psig, IF SAID PUMP CEASES TO DISPLACE PISTONS, INCREASE PRESSURE IN 100 psi INCREMENTS TILL CHEMICAL GROUT FLOW RESUMES, SEE SHEET 11 AND SIMILAR
5. DO NOT EXCEED 700 psig
6. CONTINUE PUMPING TILL UNREACTED CHEMICAL GROUT FLOWS 6" ABOVE AND BELOW DRILL HOLE MIDPOINT OR SIMILAR
7. ENSURE ITEM # 5 DIRECTLY ABOVE OCCURS PRIOR TO THE CHEMICAL GROUT GEL-TIME MEASURED BY THE CUP TEST, SEE SHEET 12 AND 13
8. ALWAYS FLUSH STATIC MIXER ON INJECTION HEAD PRIOR TO GEL-TIME MEASURED FROM CUP TEST
9. UPON COMPLETION OF #5 ABOVE, DISCONNECT "E" ASSEMBLY FROM PACKER AND CONTINUE UPWARDS ON CRACK, PACKER-TO-PACKER
10. SEE SHEET 14-15 FOR GROUT PUMP CARE

DEGREES OF WATER LEAKAGE:

TYPE 1: COLOR CHANGE (DARKER) DUE TO SURFACE MOISTURE CONTENT
TYPE 2: WET TO TOUCH, SURFACE DAMPNESS, NO SUSTAINED TRAIL
TYPE 3: WEEPS & SEEPAGE, SUSTAINED TRAIL OF WETNESS
TYPE 4: CONTINUOUS DRIPPING, VISIBLE SURFACE FLOW
TYPE 5: GUSHING FLOW FROM HYDROSTATIC PRESSURE



Key:

t = WALL / SLAB THICKNESS
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t/2 = CENTERLINE OF ELEMENT
w = CRACK WIDTH
z = SPACING OF DRILL HOLES ALONG CRACK LENGTH SHALL BE BETWEEN t/2 to 2/3t

20 POLYACRYLATE GROUT, CRACK INJECTION

INJECTION INTO CRACKS / CRACK CLEANING PROCEDURE
CRACK INJECTION PROCEDURE

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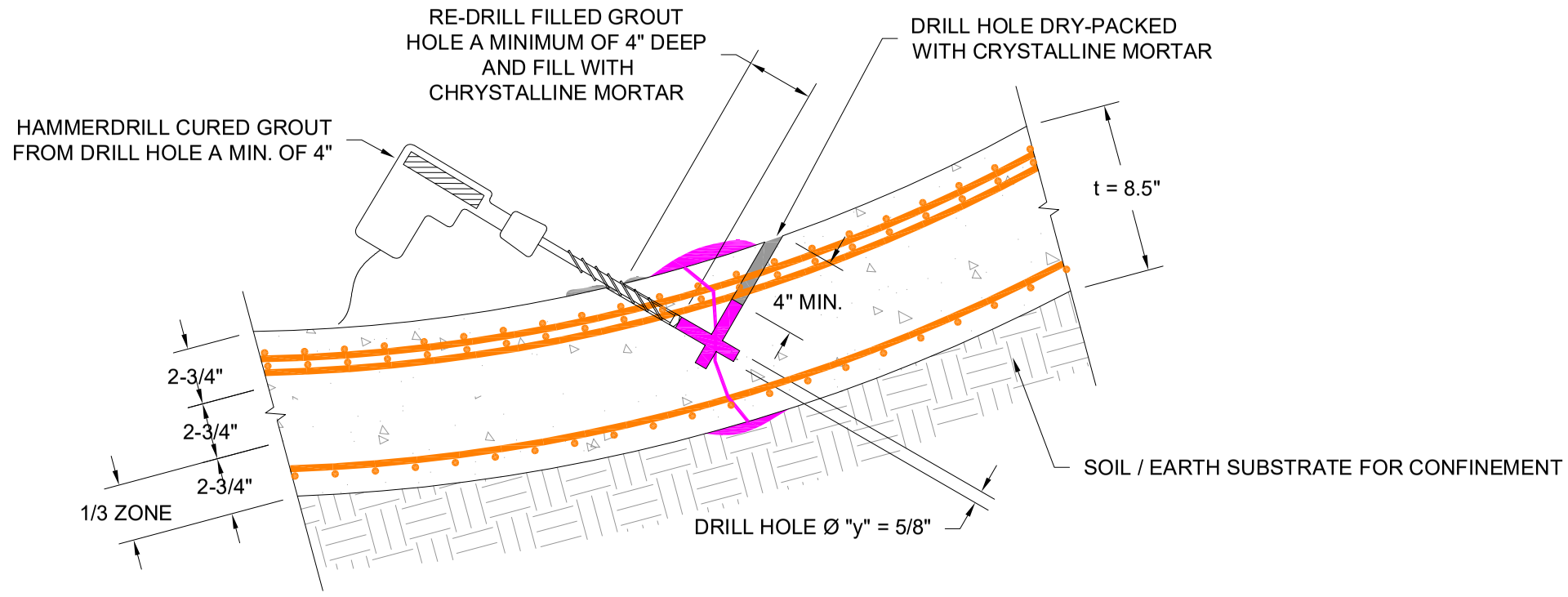
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 20E

1. AFTER COMPLETION OF CHEMICAL GROUT SYSTEM (CGS) PRESSURE INJECTION AND SETTING/GELLING OF CHEMICAL GROUT, REMOVE MECHANICAL PACKER FROM DRILL HOLE
2. RE-DRILL HOLE TO RID CURED GROUT TO A MINIMUM OF 4 INCHES, FLUSH & RINSE WITH CLEAN WATER FROM FLUSHING PUMP
3. MIX BATCH OF CRYSTALLINE MORTAR AND DRY-PACK DOWN DRILL HOLE, IN ACCORDANCE WITH SITE PROCEDURES
4. FLUSH SURFACE WITH MARGIN TROWEL IF EXCESSIVE MORTAR EXISTS

DEGREES OF WATER LEAKAGE:

TYPE 1: COLOR CHANGE (DARKER) DUE TO SURFACE MOISTURE CONTENT
TYPE 2: WET TO TOUCH, SURFACE DAMPNESS, NO SUSTAINED TRAIL
TYPE 3: WEEPS & SEEPAGE, SUSTAINED TRAIL OF WETNESS
TYPE 4: CONTINUOUS DRIPPING, VISIBLE SURFACE FLOW
TYPE 5: GUSHING FLOW FROM HYDROSTATIC PRESSURE



21 POLYACRYLATE GROUT, CRACK INJECTION

INJECTION INTO CRACKS / DRILL HOLE RESTORATION

Key:

t = WALL / SLAB THICKNESS
1/3t = INTERCEPTION ZONE IN CRACK SECTION
x = MIN. DISTANCE FROM DRILL HOLE TO CRACK SHALL BE BETWEEN t/2 +/- (t/6)
⊖ = DRILL ANGLE TO SUBSTRATE SHALL TYPICALLY BE 45° AND CAN VARY +/- 15°
y = DRILL HOLE DIAMETER CAN BE 1/4", 3/8", 1/2", 5/8", AND 3/4"
t/2 = CENTERLINE OF ELEMENT
w = CRACK WIDTH
z = SPACING OF DRILL HOLES ALONG CRACK LENGTH SHALL BE BETWEEN t/2 to 2/3t

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Date: 1/9/2020 Registration No: 23802-6

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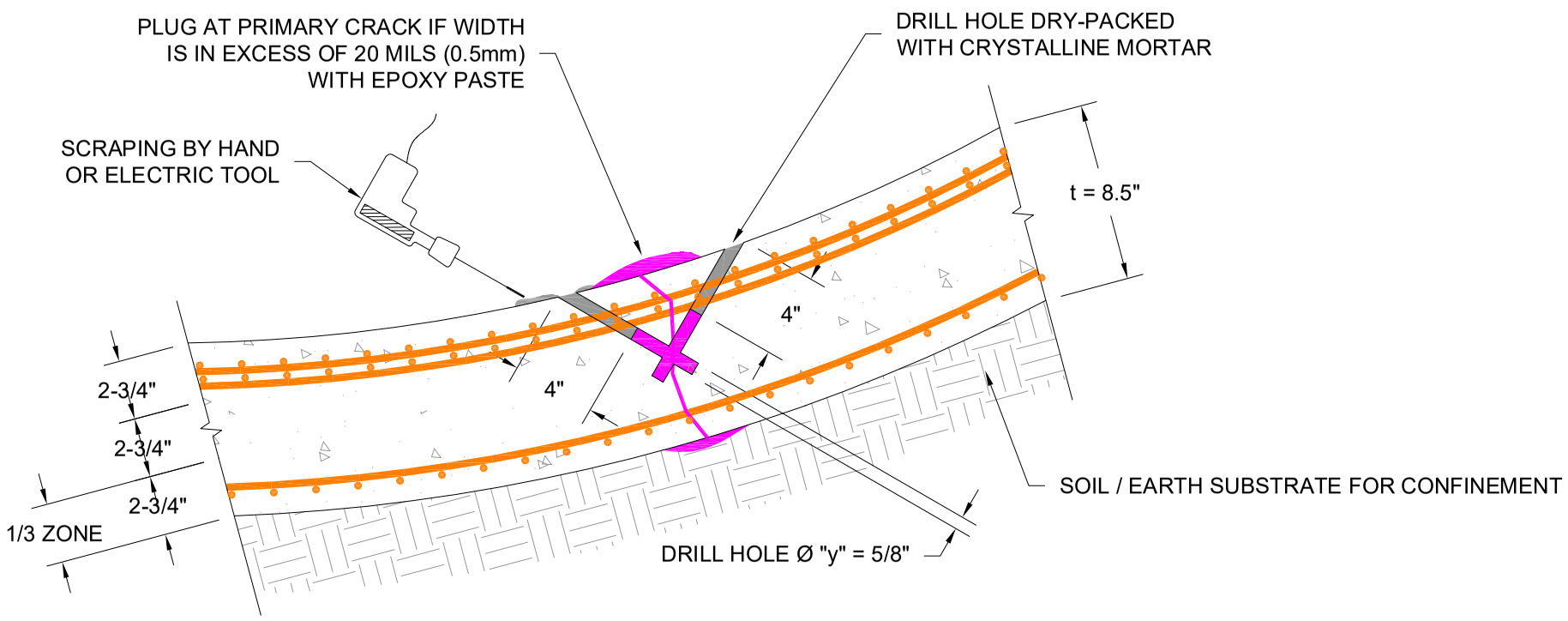
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 21E

1. SCRAPE, CHIP OR GRIND SURFACE CLEAN AND FLUSH PRIOR TO DE-MOBILIZATION
2. CONCRETE IS MONOLITHIC AGAIN

DEGREES OF WATER LEAKAGE:

TYPE 1: COLOR CHANGE (DARKER) DUE TO SURFACE MOISTURE CONTENT
TYPE 2: WET TO TOUCH, SURFACE DAMPNESS, NO SUSTAINED TRAIL
TYPE 3: WEEPS & SEEPAGE, SUSTAINED TRAIL OF WETNESS
TYPE 4: CONTINUOUS DRIPPING, VISIBLE SURFACE FLOW
TYPE 5: GUSHING FLOW FROM HYDROSTATIC PRESSURE



22 POLYACRYLATE GROUT, CRACK INJECTION

INJECTION INTO CRACKS / DRILL HOLE RESTORATION

Key:

t = WALL / SLAB THICKNESS
1/3t = INTERCEPTION ZONE IN CRACK SECTION
x = MIN. DISTANCE FROM DRILL HOLE TO CRACK SHALL BE BETWEEN t/2 +/- (t/6)
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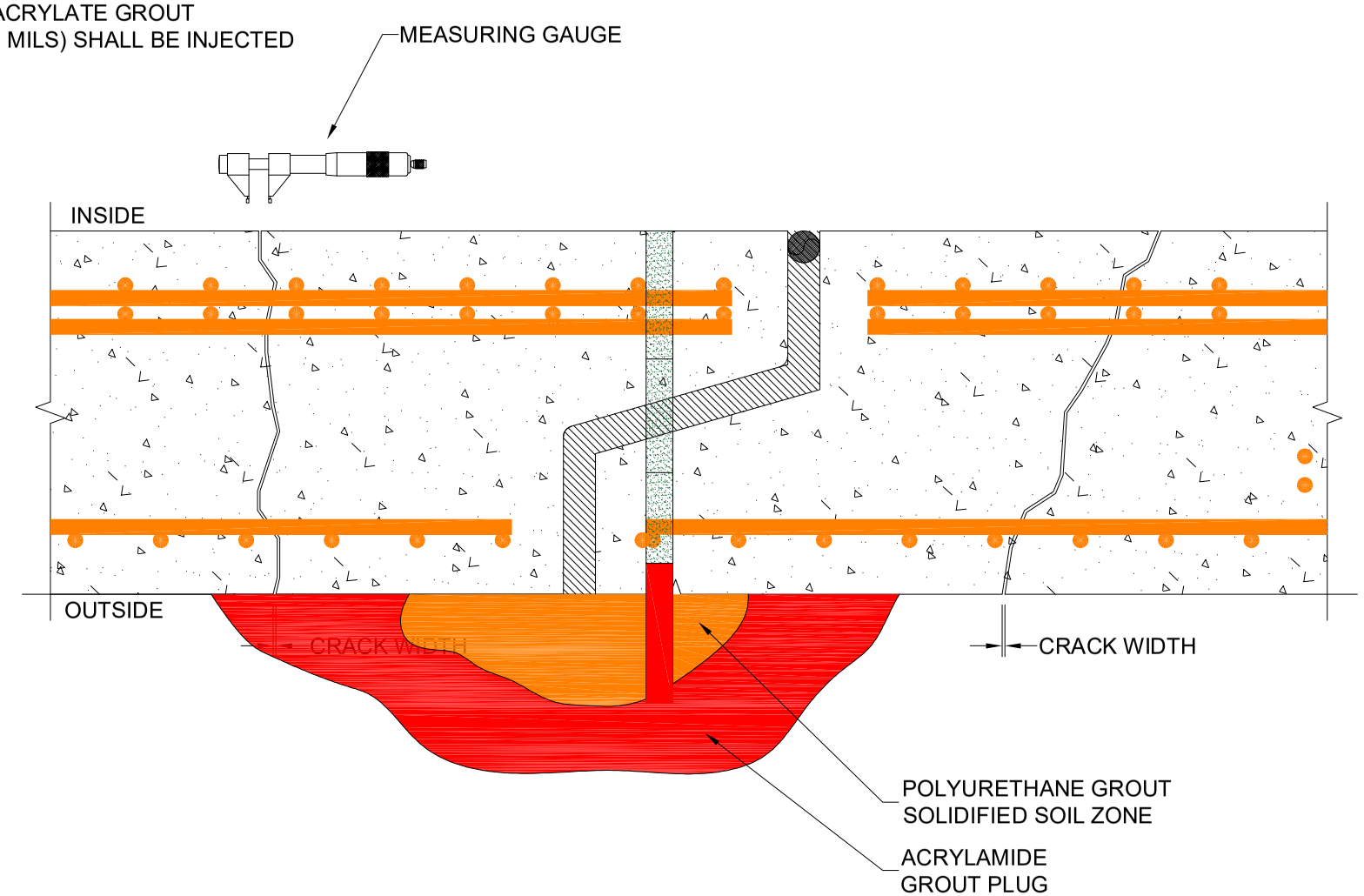
RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 22E

GENERAL CONDITIONS:

1. COORDINATE SAFETY PLAN TO INCLUDE MANAGEMENT OF MANCHETTE TOPS TO AVOID TRIP HAZARDS TO TRADESMEN
2. COORDINATE ACCESS/EGREE PLAN IN CASE OF HIGH WATER, EXCESS CARBON DIOXIDE, LACK OF LIGHTING AND/OR OTHER ISSUES THAT MAY REQUIRE UNPLANNED EVACUATION OF CULVERT PIPE
3. COORDINATE WORKING TIMES TO ENSURE STORM WATER DRAINAGE DOES NOT INTERFERE WITH GROUTING OPERATIONS BEYOND MANAGED WATER RE-ROUTING
4. ENSURE PROJECT TEAM IS COORDINATED WITH WEATHER FORECASTS AND CURRENT CONDITIONS
5. ENSURE WATER DIVERSION PLAN IS APPROVED BY OWNER
6. FOLLOW ALL OSHA REQUIREMENTS FOR CONFINED SPACE
7. ENSURE:
   - 7.1. PROPER & ADEQUATE LIGHTING & ELECTRICAL SUPPLY
   - 7.2. PROPER & ADEQUATE FRESH AIR-SUPPLY
   - 7.3. PROPER & ADEQUATE AIR QUALITY MONITORING
   - 7.4. PROPER & ADEQUATE EYE WASH STATIONS ARE SETUP
8. IDENTIFY ALL BURIED UTILITIES WITHIN IMMEDIATE GROUT ZONE AREA.
9. IDENTIFY STORM OR SANITARY SEWER PIPES WITHIN 10 FEET OF GROUT ZONE, AND ESTABLISH SOME CRITERIA TO MONITOR EXISTING PIPING DURING CHEMICAL GROUTING TO ENSURE NO STRAY GROUT MIGRATION OCCURS.

1. MEASURE WIDTH OF ALL CRACKS:
2. NOTE THE FOLLOWING:
   - 2.1. CRACKS LESS THAN 0.021 INCHES (21 MILS) SHALL BE SURFACE TREATED WITH CRYSTALLINE WATERPROOFING
   - 2.2. CRACKS GREATER THAN 0.020 INCHES AND LESS THAN 0.040 INCHES (40 MILS) SHALL BE INJECTED WITH POLYACRYLATE GROUT
   - 2.3. CRACKS GREATER THAN 0.040 INCHES (40 MILS) SHALL BE INJECTED WITH EPOXY RESIN



1 EPOXY RESIN GROUT, CRACK INJECTION
MEASURING CRACK WIDTHS IN EXCESS OF 40 MILS (0.040")

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"B" SERIES DRAWINGS	1B-30B	Section 03 64 20 Acrylamide Grout Joint Injection, Soil Solidification	WP-2
"C" SERIES DRAWINGS	1C-13C	Section 03 61 10 Ultra-Fine Cement, Soil Stabilization	SS-3
"D" SERIES DRAWINGS	1D-6D	Section 07 16 16 Crystalline Waterproofing	WP-4
"E" SERIES DRAWINGS	1E-22E	Section 03 64 10 Polyacrylate Grout Crack Injection	WP-5
"F" SERIES DRAWINGS	1F-6F	Section 03 64 23 Epoxy Resin Crack Injection	WP-6
"G" SERIES DRAWINGS	1G-4G	Section 07 13 56 Thermoplastic Sheet Strip Seals	WP-7
GENERAL NOTES:			
1. STEEL REINFORCING VARIES AT LOCATIONS IN CULVERT PIPE.			

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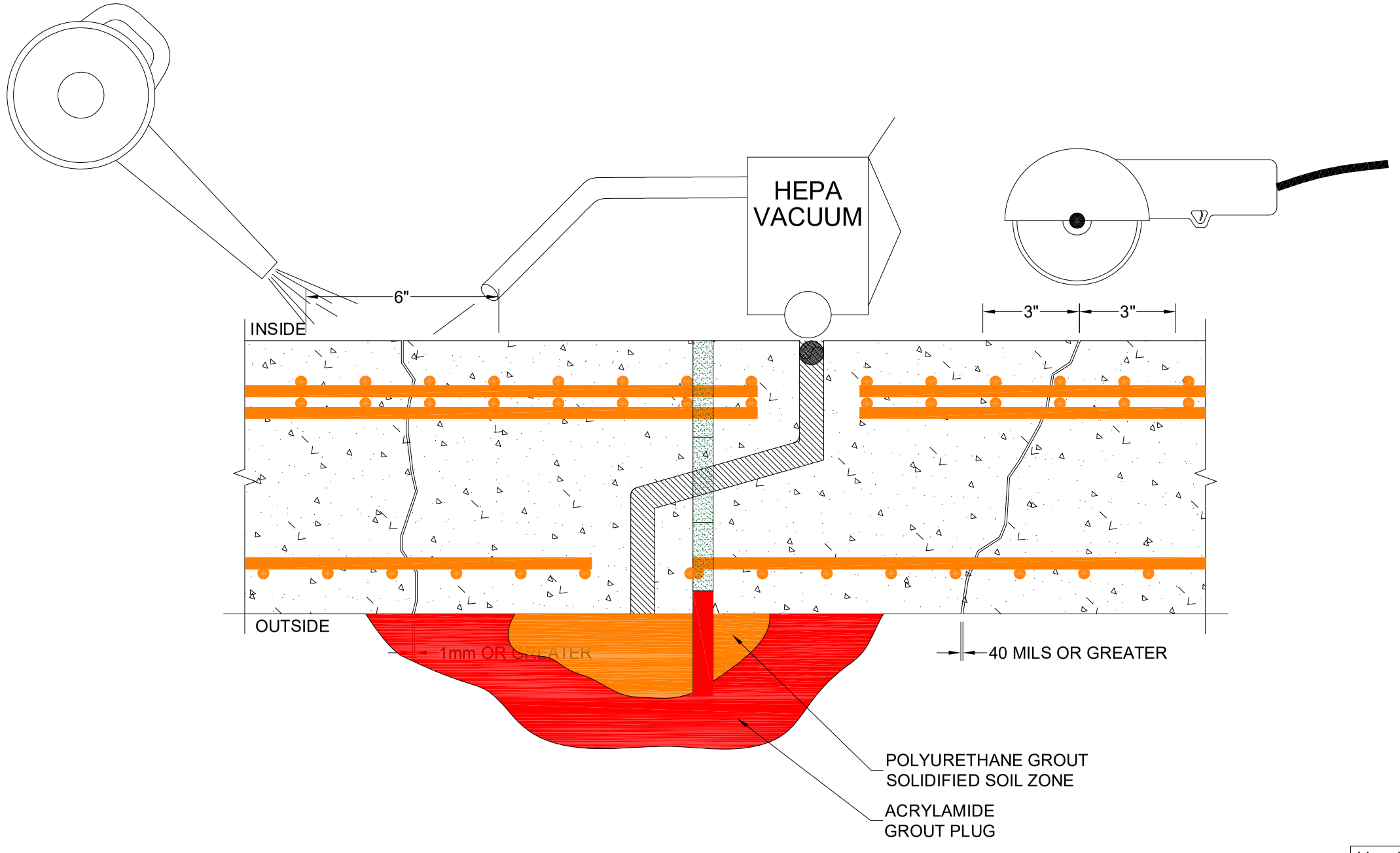
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 1F

1. MEASURE WIDTH OF ALL CRACKS:
2. NOTE THE FOLLOWING:
   2.1. CRACKS LESS THAN 0.021 INCHES (21 MILS) SHALL BE SURFACE TREATED WITH CRYSTALLINE WATERPROOFING
   2.2. CRACKS GREATER THAN 0.020 INCHES AND LESS THAN 0.040 INCHES (40 MILS) SHALL BE INJECTED WITH POLYACRYLATE GROUT
   2.3. CRACKS GREATER THAN 0.040 INCHES (40 MILS) SHALL BE INJECTED WITH EPOXY RESIN



2 EPOXY RESIN GROUT, CRACK INJECTION
SURFACE PREPERATION

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Date: 1/9/2020 Registration No: 23802-6

By: Brent Anderson

NO.	DATE	REVISION	BY
1	1/9/2020	REVISIONS	TB

DES	BA	1/9/2020
DRN	TB	1/9/2020
CHK	BA	1/9/2020

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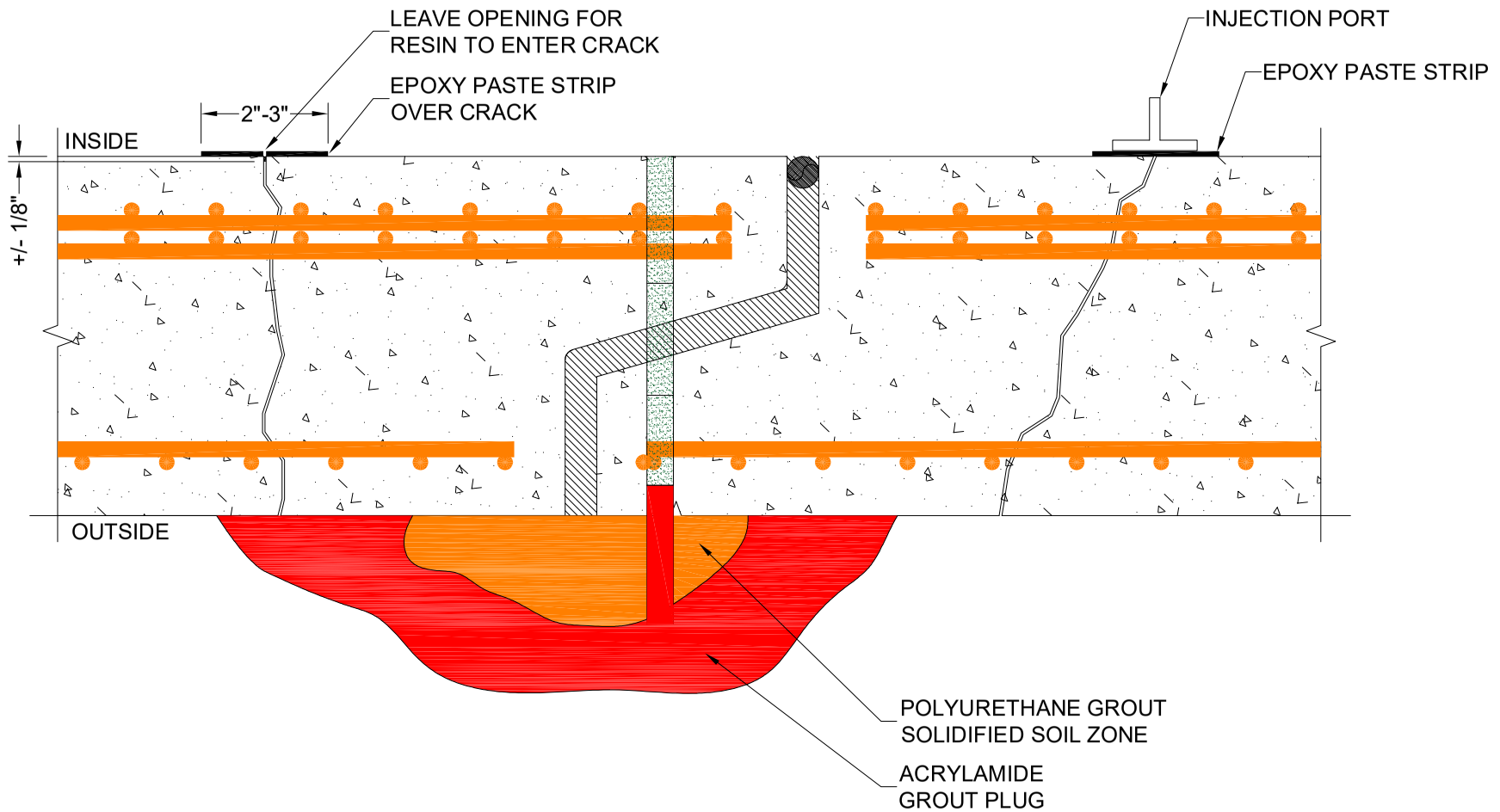
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 2F

1. CENTER EPOXY INJECTION PORTS OVER CONCRETE CRACKS AT 6"-8" O.C.
2. PLACE EPOXY PASTE OVER CRACK APPROXIMATELY 2"-3" WIDE AND 1/8" THICK



3 EPOXY RESIN GROUT, CRACK INJECTION
PLACEMENT OF EPOXY ADHESIVE FOR PORTS

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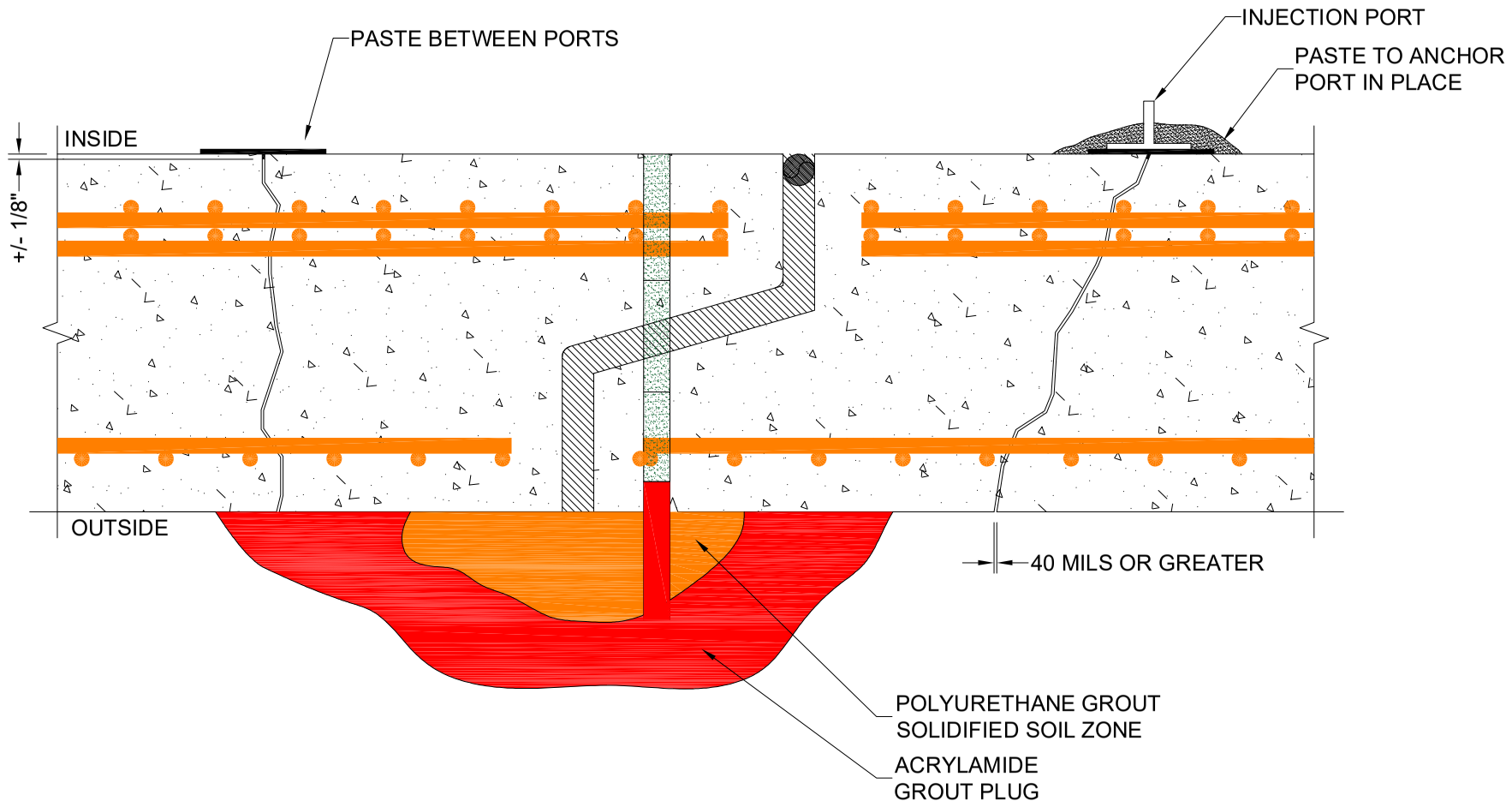
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RAYMOND ROAD CULVERT PIPE RESTORATION

1. PLACE EPOXY PASTE OVER PORT SIDES TO ENSURE AGAINST LEAKAGE.



4 EPOXY RESIN GROUT, CRACK INJECTION

EPOXY PASTE STRIP TO SEAL CRACK MOUTH

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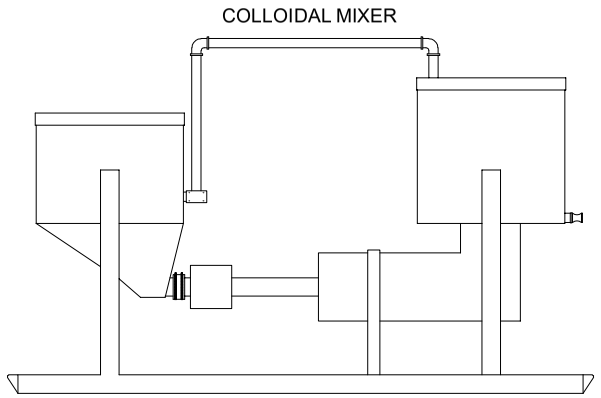
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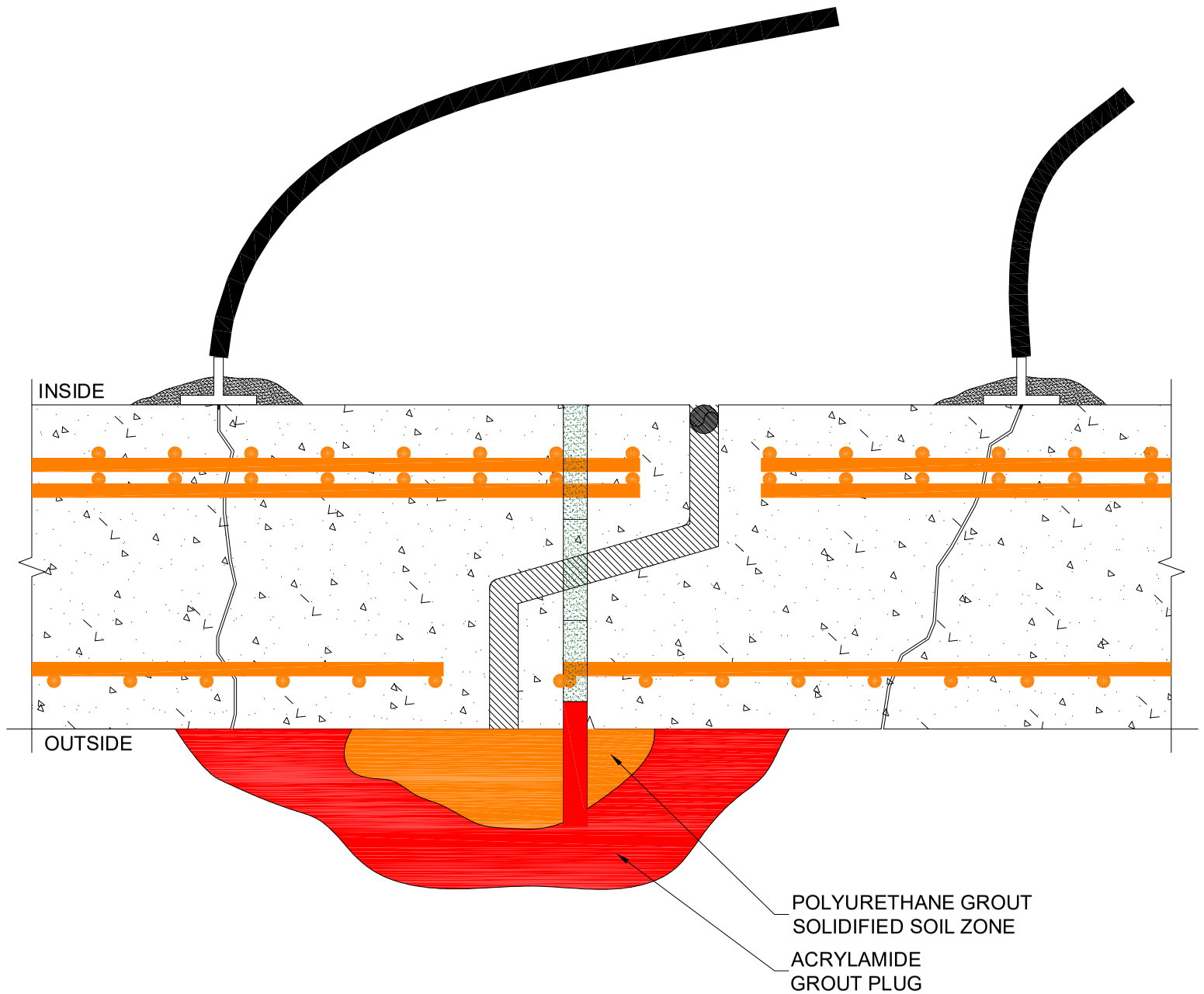
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RAYMOND ROAD CULVERT PIPE RESTORATION

1. ALLOW EPOXY PASTE TO CURE AND HARDEN
2. MIX EPOXY RESIN COMPONENTS "A" & "B" IN PUMP WITH PROPORTIONER
3. PUMP RESIN AT +/- 50 psig AND AT 1/4 GAL PER MINUTE OR LESS
4. WHEN EPOXY FLOWS FROM ADJACENT PORT A MOVE TO NEXT IN LINE
5. CRIMP PORTS AFTER INJECTION

COLLOIDAL MIXER





5 EPOXY RESIN GROUT, CRACK INJECTION

EPOXY RESIN INJECTION

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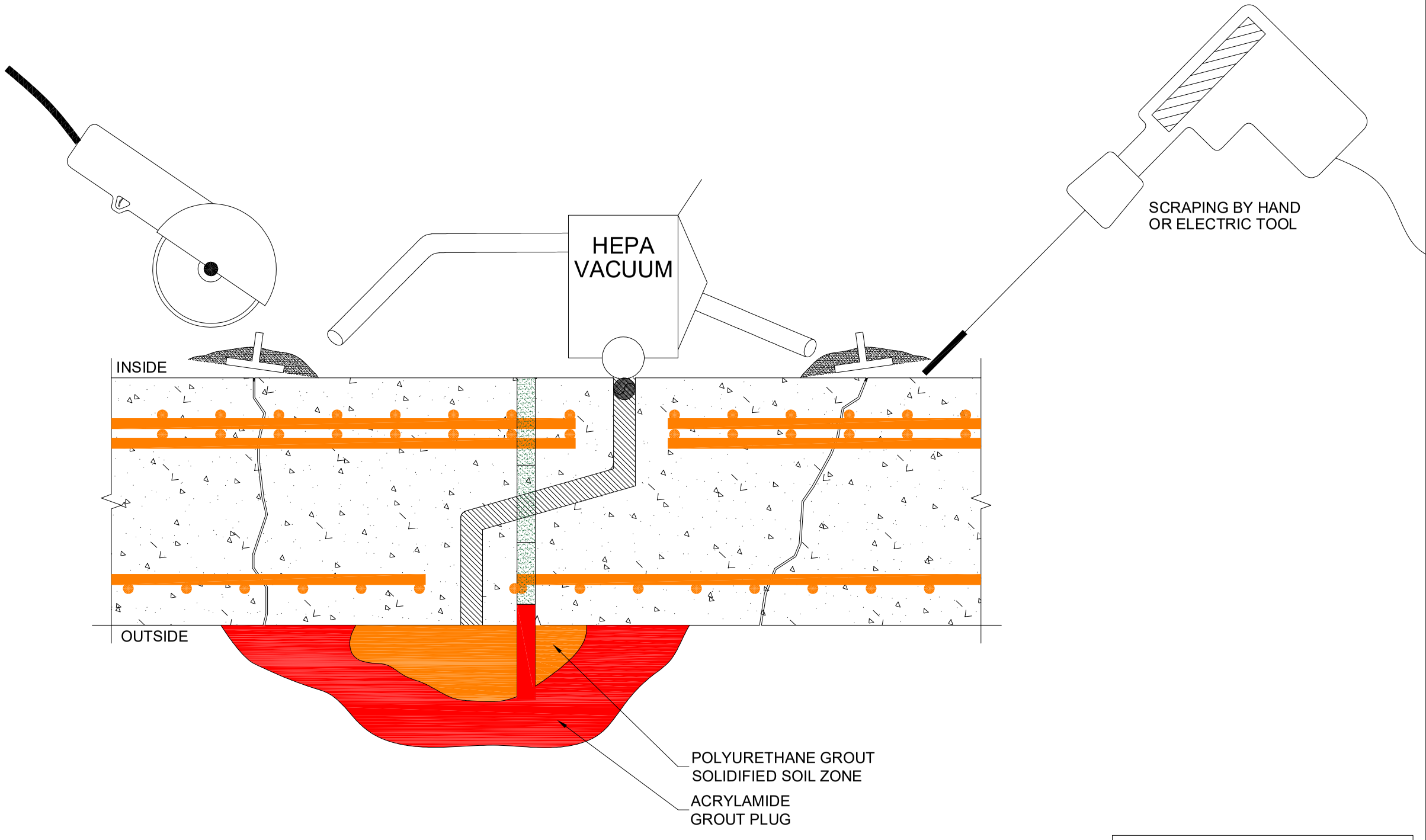
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 5F

1. CHIP AND / OR GRIND EPOXY INJECTION PORTS FROM SURFACE



6 EPOXY RESIN GROUT, CRACK INJECTION
REMOVAL OF SURFACE PORTS

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RAYMOND ROAD CULVERT PIPE RESTORATION

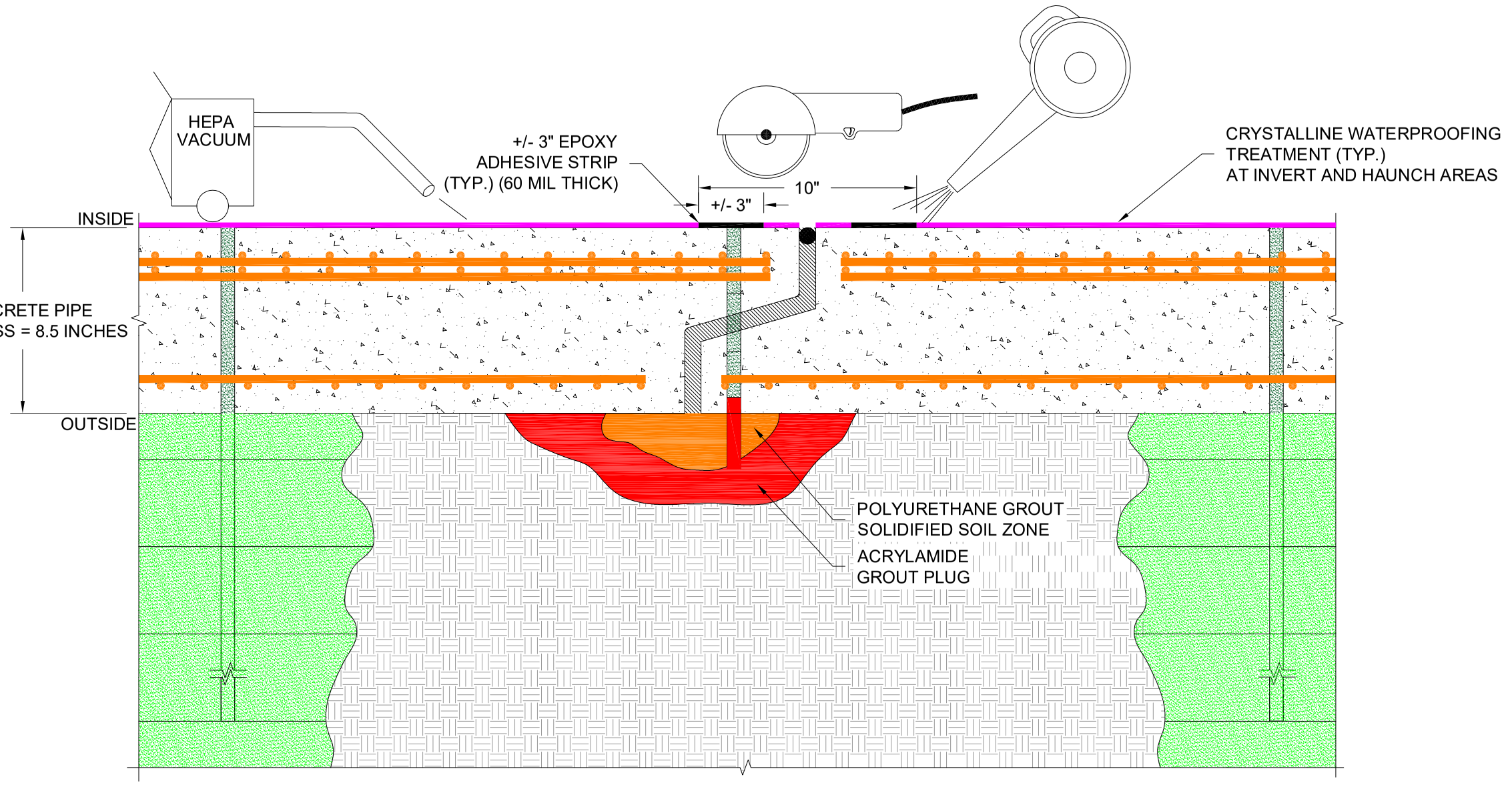
SHEET: 6F

1. CLEAN AND DRY SUBSTRATE AT PIPE FLANGES.
2. REMOVE ANY EXCESS ASPHALT DEBRIS IN 10 INCH WIDE STRIP ZONE.
3. APPLY EPOXY ADHESIVE IN +/- 3" WIDE STRIPS ON EACH SIDE OF JOINT.

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GENERAL NOTES:
1. STEEL REINFORCING VARIES AT LOCATIONS IN CULVERT PIPE.



1 STRIP SEALS, AT JOINTS IN EXCESS OF 1.5 INCHES

SURFACE PREPERATION, APPLICATION OF EPOXY ADHESIVE

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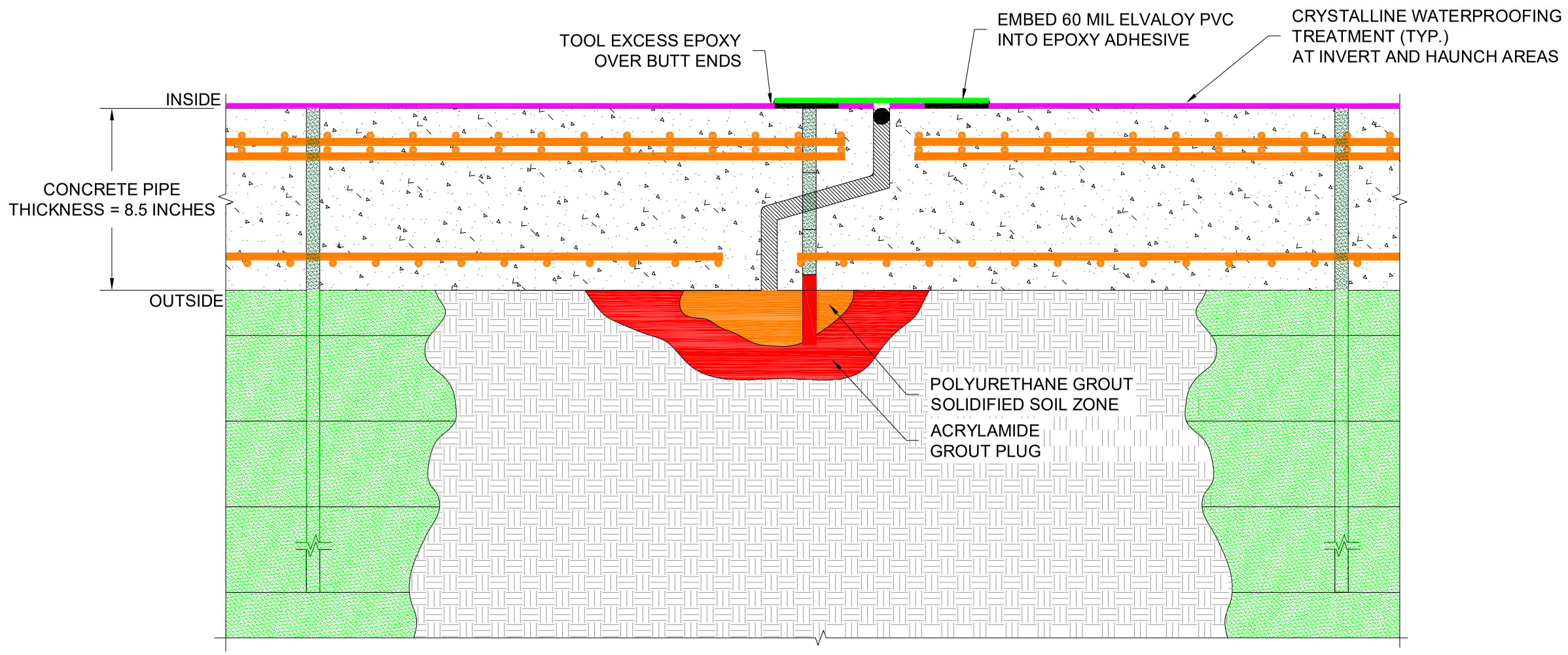
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 1G

1. INSTALL 60mil ELVALOY PVC STRIP INTO EPOXY ADHESIVE
2. PRESS 10 INCH WIDE, 60 mil, ELVALOY PVC STRIP INTO EPOXY ADHESIVE
3. ENSURE 10 INCH WIDE SHEET IS UNIFORMLY EMBEDDED, AND END LAPPED ONTO ITSELF A MINIMUM OF 4 INCHES
4. END LAPS SHALL BE WITHIN 2 LINEAL FEET OF TUNNEL CROWN
5. HEAT WELD LAP
6. TOOL EXCESS EPOXY OVER EDGE OF MEMBRANE



2 STRIP SEALS, AT JOINTS IN EXCESS OF 1.5 INCHES

MEMBRANE EMBEDMENT INTO EPOXY ADHESIVE

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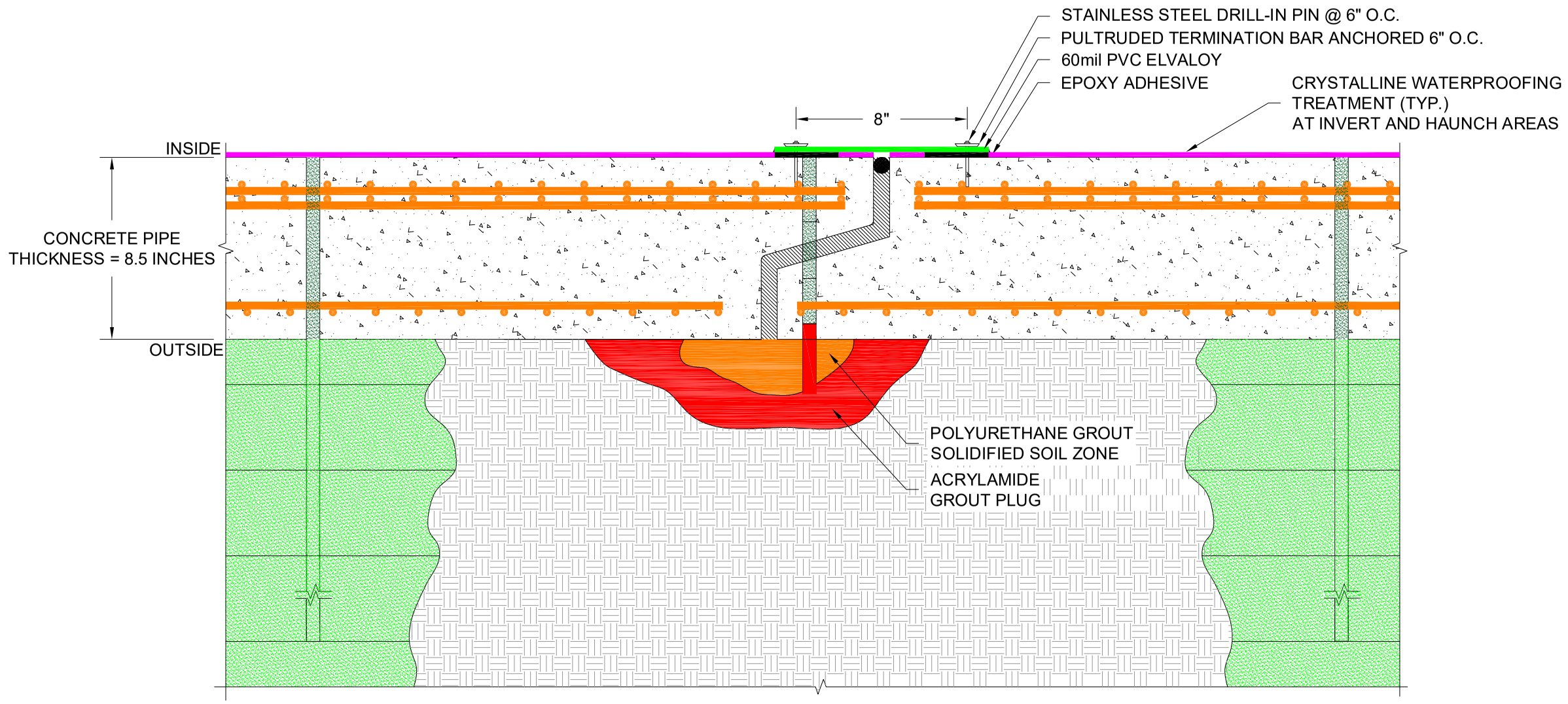
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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 2G

1. INSTALL TERMINATION BAR (STAINLESS OR PULTRUDED FIBERGLASS) AT 6" O.C. DRILL -IN PINS.



3 STRIP SEALS, AT JOINTS IN EXCESS OF 1.5 INCHES
TERMINATION BAR APPLICATION

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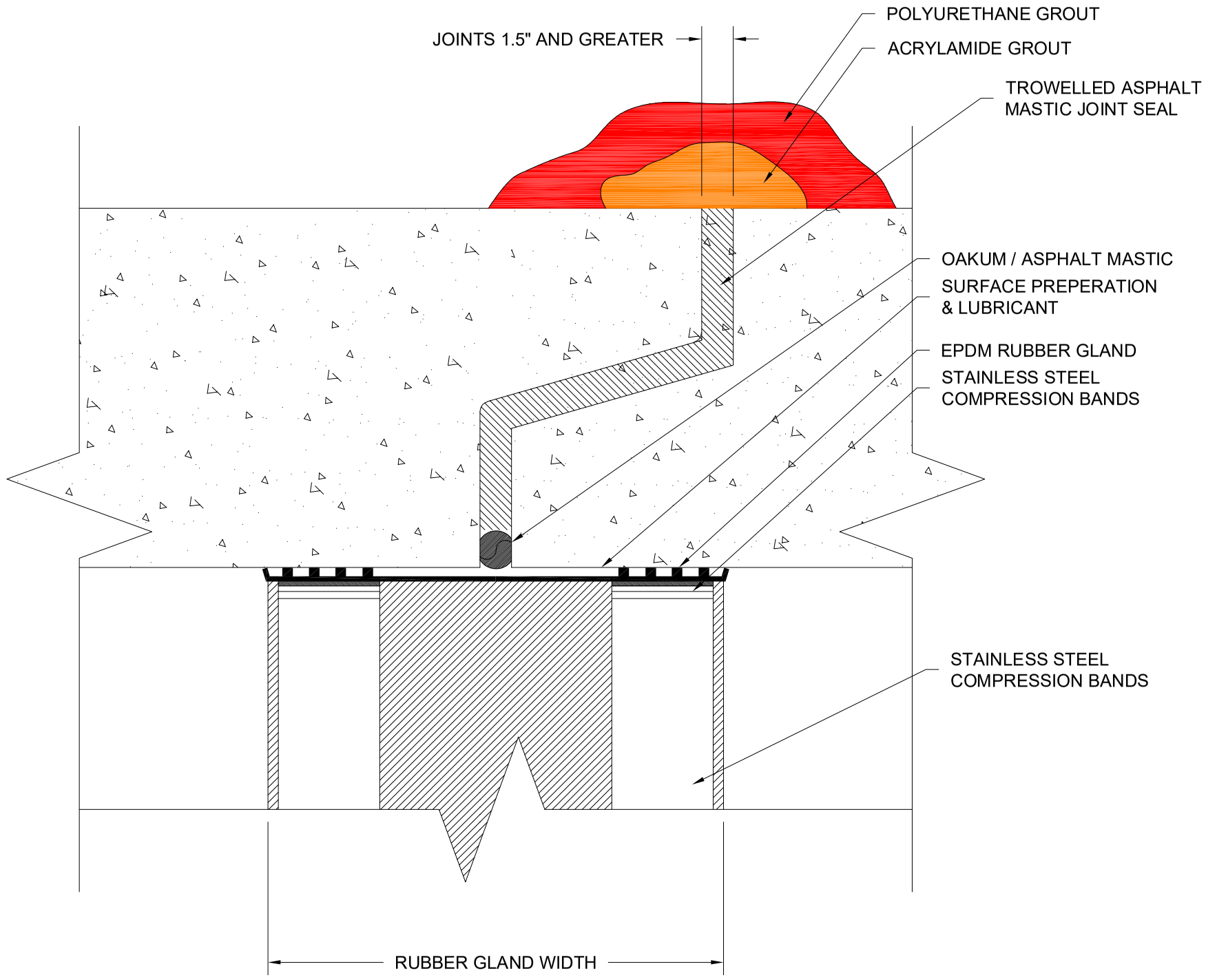
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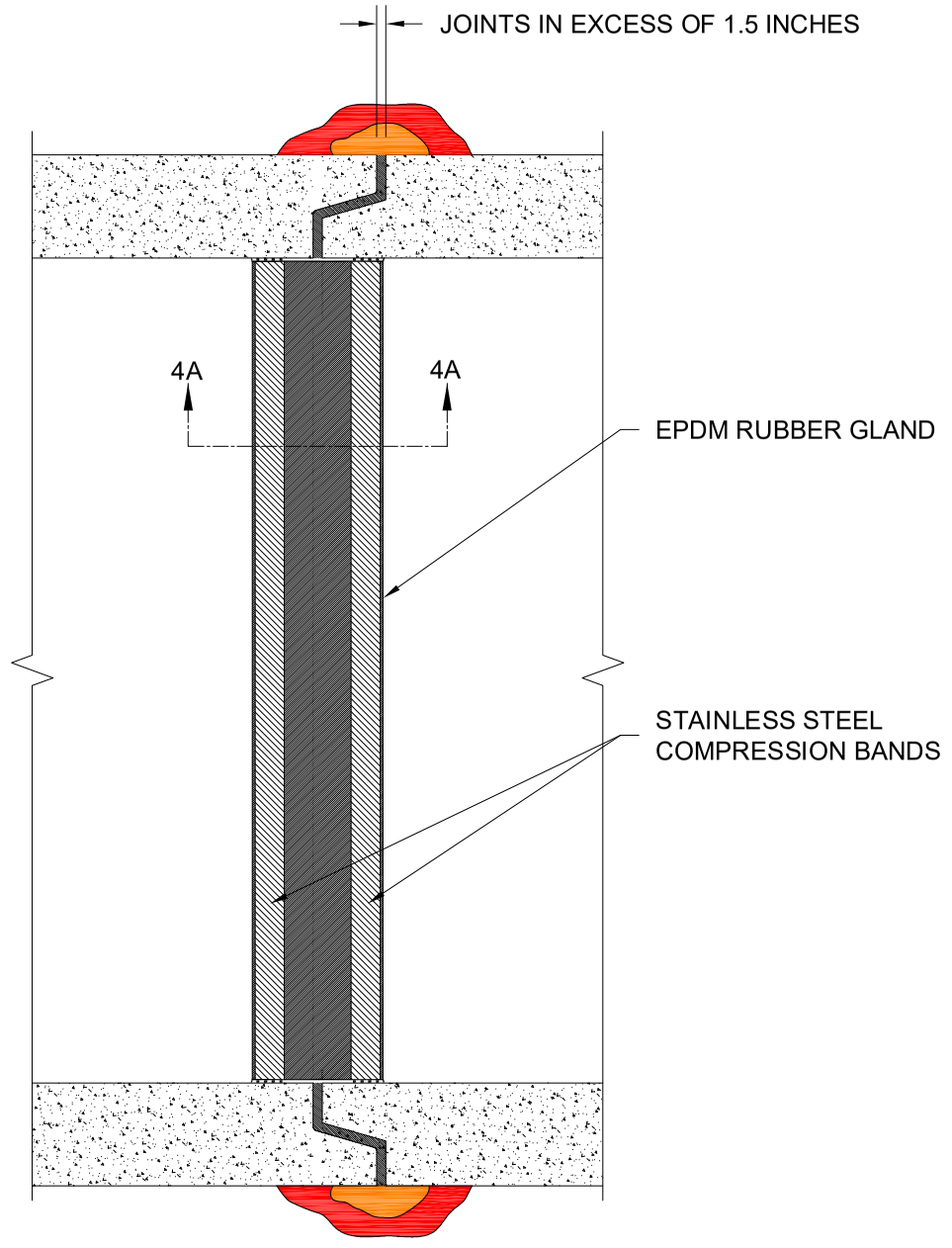
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RAYMOND ROAD CULVERT PIPE RESTORATION



4A SECTION OF INTERIOR JOINT SEAL
INTERIOR JOINT SEAL COMPONENTS



4B ELEVATION OF INTERIOR JOINT SEAL
INTERNAL JOINT SEALING SYSTEM (STANDARD)

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RAYMOND ROAD CULVERT PIPE RESTORATION

SHEET: 4G