

**ADDENDUM NO. 1  
FOR  
ALKALI SEWER REHABILITATION**

**DOWNRIVER UTILITY WASTEWATER AUTHORITY  
WYANDOTTE, MICHIGAN**

**ADDENDUM ISSUE DATE: MAY 14, 2020**

**INTENT:**

This Addendum is issued prior to receipt of Bids to provide for certain changes to the Specifications and the Plans, as herein specified, and is hereby made a part of the Contract Documents and shall take into consideration in preparing the Bid. All other conditions remain the same.

The Bidder shall acknowledge the receipt of this Addendum on the Bid Form, where indicated.

The following items constitute the Addendum and are described in detail.

**CLARIFICATIONS:**

1. Meeting notes from the Pre-bid meeting are included with this Addendum.
2. Videos from the sewer inspection conducted in the fall of 2018 can be downloaded for viewing at the following links:

MH6-12: <https://ohm.filegenius.com/downloadPublic/fsuhs4b2li5nncb>

MH6-12A: <https://ohm.filegenius.com/downloadPublic/v7q871zyi8ptcw7>

**CHANGES in the SPECIFICATIONS BOOK:**

**Section 02707 Spin Cast Geopolymer Pipe (Issued)**

Replace Section 02707 Spin Cast Geopolymer Pipe in its entirety with the new section issued with this addendum.

**End of Addendum No. 1**

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Bloomfield Hills, MI 48302  
248-454-6300

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**Grand Rapids**  
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**Jackson**  
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**Kalamazoo**  
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**Lansing**  
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**PRE-BID MEETING NOTES  
ALKALI SEWER REHABILITATION  
DOWNRIVER UTILITY WASTEWATER AUTHORITY**

Date: May 13, 2020

Time: 10:00 AM

Meeting Held: Via Conference Call

HRC Job No. 20191063.07

**I. Agenda**

- ≡ Brief Introductions of Structure of Ownership and Operators of System
- ≡ Roll Call of Attendees
- ≡ Key Dates
- ≡ Project Summary
- ≡ Review Instructions to Bidders and Proposal Forms
- ≡ Addendum 1 – Issued in a couple days including specification change on geopolymer system
- ≡ Open to Questions & Answers

**II. Introductions**

Hubbell, Roth & Clark are the engineers for the project and Bill Davis (HRC) led the meeting discussion. The DUWA System Manager is OHM Advisors. Veolia operates the wastewater treatment plant and collection system for DUWA.

**III. Roll Call of Attendees**

- ≡ Inland Waters Pollution Control, Lloyd Lambrich
- ≡ Benchmark Construction, Mike Duffy
- ≡ Xylem Dewatering Solutions, Amy Veselsky
- ≡ GeoTree Solutions, David Keaffaber
- ≡ Veolia, Mike Tapp
- ≡ OHM Advisors, Lambrina Tercala
- ≡ HRC, Bill Davis

**IV. Key Dates**

- ≡ Optional Pre-Bid today May 13, 2020 at 10:00 AM
- ≡ Question deadline is May 20, 2020 at 5 PM – all questions must be presented in written format
- ≡ Bids are due May 29, 2020 at 2:00 PM - deliver to OHM Advisors as indicated on proposal form
- ≡ Award & Notice to Proceed are anticipated for mid-June 2020
- ≡ Substantial Completion – 150 calendar days from NTP (mid November 2020)
- ≡ Final Completion - 60 calendar days from Substantial Completion (January 2020)

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## V. Project Summary

- ≡ Rehabilitate approximately 450 LF of 60-inch diameter brick sanitary sewer in Wyandotte, MI
- ≡ Sewer was inspected in Fall 2018 and the results of the inspection are included in Appendix A of the project specifications.
- ≡ Drawing C1 presents Scope of Work
  - Construct new gate chamber over existing 72-inch tunnel sewer
  - Modify MH C4-18 (located on adjacent system; operated by SWRDDD). The SWRDDD will accept dry weather flow to allow work to occur within the 60-inch sewer
  - Contractor shall design, furnish, operate temporary flow bypass to divert flow from new gate chamber to SWRDDD system at MH C4-18. Once the bypass system is constructed and tested, then the existing 60-inch sewer will be cleaned, debris removed, and prepared for geopolymer lining.
  - Once sewer is cleaned and prepared the geopolymer lining system will be installed.
  - Two manholes on either end of lining reach will be lined with same geopolymer material as the sewer.
  - Construct a new sewer vent near downstream MH 6-12.
  - Once all work is complete, the bypass system can be shut down, and removed.
  - Gate chamber will be brought to final condition and restoration and cleanup of site can occur.
- ≡ All work is being done in a residential area and contractor needs to minimize noise and odors. The City of Wyandotte has dictated operating hours for bypass system and this information is presented in the in the project documents.

## VI. Instructions to Bidders (00120) & Bid Forms (00300)

- ≡ Section 00120 – Instructions to Bidders contains information on completing bid. This section should be reviewed and followed.
  - Specifically, Items 12 & 13 list the forms that are required to be submitted with the bid
  - Additional forms can be submitted by the low bidder after the bid as indicated
- ≡ Section 00300 Bid Forms were reviewed
  - Deliver to OHM Advisors
  - 5% bid bond required
  - Time of completion – 150 days for substantial completion
  - There are liquidated damages in the amount \$1,250 per calendar day for not meeting completion times
  - Bids remain firm for 180 days
  - DUWA is using WIFIA funds to finance this project – as such all Federal crosscutters must be met, including Davis-Bacon prevailing wages, American Iron and Steel Act, etc. Current wage determination is included the contract book and will be further assessed and re-issued in future Addendum if necessary.
- ≡ Walk through
  - No project walk through is scheduled
  - All work is within public right of way and Bidders are encouraged to visit site

## VII. Addendum No. 1

- ≡ This addendum will be issued is couple of days
- ≡ The geopolymer lining specification is being revised. It will name Quadex GeoKrete as an approved manufacturer for the Spin Cast Geopolymer Pipe lining.
- ≡ Questions and responses will be included – formal response require a written question to be submitted

## VIII. Closing Remarks

- ≡ If COVID changes things, we will adjust accordingly. DUWA seeks to complete work safely and get sewer back in service, in good condition as quickly as possible.

## IX. Questions

- ≡ Participants were asked to submit all questions in writing via email by May 20, 2020 at 5:00 PM to: Bill Davis at wdavis@hrcengr.com
- ≡ Inland Waters Pollution Control asked the following questions:
  1. Have you considered adding cement grouting pay items to deal with infiltration?  
Answer: Will review. Send question via email.
  2. There are many loose bricks in the existing sewer – consider hand chipping or removal of old bricks that are not adhered very good?  
Answer: Loose bricks need to be removed; must satisfy manufacturer’s surface preparation requirements to allow product to adhere to good substrate and perform as intended.
  3. IWPC has video of previously completed inspection since IWPC complete inspection; can DUWA share video with others so they have the same knowledge?  
Answer: DUWA and HRC will work on posting video of previously completed sewer inspection to website.

SECTION 02707

SPIN-CAST GEOPOLYMER PIPE

PART 1 GENERAL

1.1 SUMMARY

- A. This section specifies a Spin-Cast Geopolymer Pipe (SCGP) that provides for the rehabilitation of existing sanitary sewer pipelines, channels and manholes, structural coating, using an approved structural geopolymer lining system. This Specification covers the general requirements for the referenced specifications, liner manufacturer and installer qualifications, submittal and guaranty guidelines, materials, pre-installation and installation procedures, and testing. The liner may be spin cast or hand sprayed to various pipe surfaces including: brick, concrete, corrugated metal, clay tile, and various other compatible materials.
- B. Furnish all labor, materials, equipment and incidentals required to install the monolithic geopolymer sewer pipe and manhole lining system and appurtenances as specified herein. The lining system shall be used to rehabilitate the interior of all designated sewer pipelines or manholes.
- C. The manhole lining system shall consist of a geopolymer coat applied to the cleaned and prepared surfaces.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM C-33 – Standard Specification for Concrete Aggregates.
  - 2. ASTM C-39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
  - 3. ASTM C-78 – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading). (Note: ASTM C293 – Standard Test method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading) – Is not a substitute test for the more conservative ASTM C78, ASTM C293 provides flexural strengths significantly higher than ASTM C78 due to relaxed loading conditions which are not appropriate for this type of structural repair).
  - 4. ASTM C-109 – Standard Test method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in Cube Specimens).
  - 5. ASTM C-172 – Standard Practice for Sampling Freshly Mixed Concrete.
  - 6. ASTM C-267 – Standard Test methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes.
  - 7. ASTM C-469 – Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
  - 8. ASTM C-496 – Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
  - 9. ASTM C-666 – Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.

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10. ASTM C-801 – Standard Test Method for Time of Setting of Hydraulic Cement Mortar by Modified Vicat Needle.
  11. ASTM C-882 (Type II or Type V) – Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete By Slant Shear.
  12. ASTM C-1090 – Standard Test Method for measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout.
  13. ASTM F-2414 - Standard Practice for Sealing Sewer Manholes Using Chemical Grouting.
  14. ASTM F-2551 – Standard Practice for Installing a Protective Cementitious Liner System in Sanitary Sewer Manholes.
- B. American Concrete Institute (ACI):
1. ACI 305R-99 Hot Weather Concreting
  2. ACI 306R-88 Cold Weather Concreting
  3. ACI Certified Concrete Field-Testing Technician, Level 1
- C. National Association of Sewer Service Companies:
1. NASSCO Pipeline Assessment & Certification Program (PACP)
- D. Occupational Safety and Health Administration (OSHA):
1. Regulations Standard – 29 CFR

Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

### 1.3 SUBMITTALS

- A. Product Data:
1. Submit Manufacturer’s product data and installation instructions. Include required substrate preparation, on-site quality assurance recommendations and a list all materials to be used.
- B. Certifications:
1. Manufacturer shall submit a letter of certification that the product meets or exceeds all technical and packaging requirements.
  2. Manufacturer shall submit original third-party verification that materials meet physical properties specified for design at 24hr and 28 day, minimally ASTM C-78, ASTM C-39 or C-109, ASTM C-882, and ASTM C-1090. Further Manufacture shall submit original third-party verification of test data for ASTM C-666 testing for samples cured 28 days and subjected to 300 cycles.
  3. Manufacturer shall submit original third-party verification of material formulation via XRF (X-ray Fluorescence) data as detailed in the material section.
  4. Submit Manufacturer's certifications that materials have been approved for the installation conditions shown on the Drawings and as specified herein.
  5. Submit Manufacturer’s Materials Warranty certificate.
  6. Submit Installer’s warranty certificate.
  7. Submit Installer’s job history and reference certificate.
- C. Qualifications:

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1. The Contractor performing the work shall be fully qualified, experienced and equipped to complete this work expeditiously, in a satisfactory manner, and shall be an approved installer of the geopolymer lining system as certified and licensed by the Manufacturer.
  2. The Manufacturer shall submit documentation and verifiable references for installation the proposed lining system in a minimum of 100 vertical linear feet for manhole qualifications.
  3. The Manufacturer shall submit documentation and verifiable references for installation the proposed lining system in a minimum of 5000 linear feet of large diameter (>36 inch) horizontal pipe for pipeline qualifications.
  4. The Contractor shall submit a certified statement from the Manufacturer certifying them as a certified and/or licensed installer of the liner.
  5. The Contractor shall also be capable of providing crews as needed to complete this work without undue delay.
  6. The Geopolymer Installer must submit a work plan showing how the work shall be scheduled and coordinated.
  7. The Owner reserves the right to approve or disapprove the Contractor, based on the submitted qualifications.
- D. Liner Thickness Design Calculations:
1. Submit liner design thickness calculations using the design parameters given in this specification.
- E. Post-lining tapes and logs:
1. Submit copies of the cure logs for all work.
- F. CCTV Post-Rehab Video:
1. Submit CCTV video showing the rehabilitated sewer and manholes.
- 1.4 DELIVERY, STORAGE AND HANDLING
- A. Delivery of Materials:
1. Deliver material in Manufacturer's original unopened and undamaged packages.
  2. Clearly identify Manufacturer, brand name, contents and stock number on each package.
  3. Packages showing indications of damage that may affect condition of contents are not acceptable.
- B. Storage of Materials:
1. Store in original packaging under protective cover and protect from damage.
  2. Store all materials at temperatures recommended by manufacturer.
  3. Stack containers/bags in accordance with manufacturer's recommendations.
- C. Handling of Materials:
1. Handle materials in such a manner as to prevent damage to products or finishes.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS and PRODUCTS

- A. GeoSpray® & GeoSpray® AMS  
GreenTree Solutions a division of ClockSpring|NRI  
David Keaffaber (317) 306-6595  
[www.clockspring.com](http://www.clockspring.com)
- B. Quadex® GeoKrete®  
Vortex Companies  
Matthew Richards (914) 512-7713  
[mrichards@vortexcompanies.com](mailto:mrichards@vortexcompanies.com)
- C. Or approved equal

2.2 MATERIAL SPECIFICATIONS

- A. Geopolymer Pipe Lining Mortar:
  - 1. The geopolymer lining shall conform to the following properties under laboratory conditions.

**Table 1 Minimum Geopolymer Liner Material Requirements**

Compressive Strength	ASTMC39 or C109	1 Day	2,500 psi
		28 Day	8,000 psi
Flexural Strength	ASTM C78	7 Day	750 psi
		28 Day	800 psi
Tensile Strength	ASTM C496	28 Day	800 psi
Shrinkage	ASTM C1090	28 Day	0% at 65% RH
Modulus of Elasticity	ASTM C469	1 Day	3,000,000 psi
		28 Day	5,000,000 psi
Bond Strength	ASTM C882 Type II	1 Day	900 psi
		28 Day	2,500 psi
Freeze Thaw Durability	ASTM C666	300 Cycles	Zero Loss
Set Time	ASTM C807	Initial	Less Than 75 min
		Final	Less Than 240 Min

- B. The SCGP lining geopolymer mortar shall be composed of at minimum 70% Pozzolanitic material selected from the list of: SiO<sub>2</sub>, MgO, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub> and be verified by third party certified X-ray Fluorescence (XRF) testing.
- C. Particle size of maximum aggregate of 2.38 mm based on 100% of material (except fibers) passing the No.8 Sieve.
- D. The lining shall be compatible with the thermal and chemical conditions of the existing sewer structures. Surface temperatures will range from 20°F to 100°F and pH may range as low as 1.0.

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- E. Acid Mitigation System (AMS):
  - 1. The finished geopolymer liner shall be capable of sustaining in low pH environments. Geopolymer manufacturer must demonstrate the geopolymer liner has zero mass loss in 12 week sulfuric acid at 1.0 pH immersion per ASTM C267. If the lining mortar does not achieve the specified chemical resistance on its own then a liquid sealant must be applied to the geopolymer lining mortar after the final thickness has been applied. The sealant is designed to provide additional chemical protection for the geopolymer lining from microbial induced corrosion (MIC) and should be designed to function with the geopolymer lining.
- F. Additional Materials:
  - 1. Additional materials including chemical grouts and hydraulic cements necessary to stop infiltration and create a surface for the geopolymer lining shall be applied as necessary.
  - 2. Specific materials must be compatible with the geopolymer lining and the Owner reserves the right to require preapproval of such materials.

### 2.3 DESIGN - GEOPOLYMER LINER THICKNESS

- A. The Contractor shall submit liner thickness calculations to the Engineer for review.
- B. These calculations will be performed by a third party registered professional engineer registered in the State of Michigan using the following minimum criteria:
  - 1. Design Life: 50 years
  - 2. Safety Factor: 2
  - 3. Ovality: 3% or the actual ovality of the sewer section, whichever is greater. For noncircular and irregular shape sewer, the calculation shall take into consideration any additional consideration due to noncircular shape.
  - 4. External Hydrostatic Pressure: 3 feet below ground surface.
  - 5. External Earth Load: 33 feet over top of pipe. Calculations for the thickness of the geopolymer liner shall be furnished by the Contractor shall include allowances for deflection, shrink-back, stiffness, ring bending and buckling, and shall have sufficient water tightness, and structural strength to support all dead loads, live loads, and groundwater load.
  - 6. Live Load: AASHTO HS-20
- C. The structural geopolymer lining rehabilitation systems shall be designed in accordance with a fully deteriorated pipe condition for structural linings conditions.
- D. The minimum structural liner thickness, independent of design, shall be 1.5 inches and the maximum thickness shall be 1.75 inches.
- E. The minimum liner thickness, independent of design, shall be 1.0 inches for all manholes.
- F. The Contractor shall submit their price proposal based on the appropriate length, size and existing pipe parameters designated in the Proposal Section.
- G. Structural Design should be based on physical properties of materials and should use the more conservative ASTM C78 values for Flexural Strength not values obtained from ASTM C293.

- H. The deterioration of pipelines and manholes is an on-going process. Should pre-construction inspections reveal the pipeline and manhole system to be in a substantially different conditions than those in the design considerations, the Contractor shall notify Owner of such conditions making the current design unacceptable.
- I. The liner shall be designed to withstand differential settlements of up to 1/350 angular distortion.

### PART 3 EXECUTION

#### 3.1 GENERAL

- A. All structural rehabilitation of existing pipe and manhole sections will follow the procedures listed below.
- B. The Contractor shall carry out their operations in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements involving work on an elevated platform and entry into a confined space.
- C. The Owner will be responsible for locating and identifying manholes at lining location.
- D. The Contractor shall make all necessary arrangements for access to water hydrants for cleaning and other work items requiring water. The Contractor shall coordinate with the City of Wyandotte for hydrant use, necessary backflow preventer, meter, and pay all associated fees.
- E. All surfaces, which have been damaged by the Contractor's operations, shall be restored to a condition at least equal to that in which they were found immediately prior to the beginning of the Contractor's operations. Suitable materials and methods shall be used for such restoration, and the Owner reserves the right to approve both the methods and materials. The restoration of existing property or structures shall be done as promptly as practical and shall not be left until the end of the construction period. Compensation for this work will be included in the rehabilitation item to which it pertains.
- F. Personnel shall treat all waste matter and materials removed from the sewer pipe as a contaminated material, unless otherwise specified.
- G. All contaminated substances from sanitary sewers such as fallen brick, sand debris, sludge and organic matter must be disposed of in the proper manner according to local ordinances.

#### 3.2 PIPE CLEANING

- A. Complete initial sewer cleaning as specified in Section 02751 Sewer Cleaning to remove debris currently in sewer.
- B. Pipe cleaning for SCGP shall be as specified herein.
- C. Properly cleaning the surface of the pipe is critical to the success of this rehabilitation method.

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- D. All internal debris should be removed from the original pipeline. Gravity pipes should be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment.
- E. If pipe diameters allow for manned entry, the use of high-pressure washers delivering a minimum of 3500psi may be utilized.
- F. The use of higher-pressure washers may be required to achieve the desired surface condition. In some instances, mechanical cleaning methods may be required.
- G. The surface of the pipe to be lined shall be capable of directly receiving the lining material.
- H. When grease and oil are present within the pipe, water may be heated to 200 degrees, or an approved detergent may be added to the water or a dilute solution of muriatic acid may be used integrally with the high-pressure cleaning water.
- I. All materials resulting from the cleaning of the pipe shall be removed prior to application of the geopolymer lining material.
- J. All loose or defective concrete, brick, or grout shall be removed to provide an even surface prior to application of the geopolymer lining material.
- K. Clean and re-clean pipe surface as necessary and coordinate with flow bypass system operations. Flow bypass system operates only during dry weather daylight hours and sanitary flow is returned each night to the sewer being rehabilitated.
- L. Prepare test section to demonstrate effort and methods to obtain cleaning and surface preparation requirements.

### 3.3 PRE-INSPECTION

- A. The Contractor will perform a pre-installation television inspection that meets NASSCO PACP requirements.
- B. Utilizing a color video inspection system (CCTV) with data recording capabilities, the entire pipe section to be lined shall be recorded on CD or DVD and two (2) copies produced. The interior of the pipe shall be carefully inspected to determine the location of any conditions, which may prevent the proper installation of the geopolymer liner, and it shall be noted so that these conditions can be corrected. A CD, DVD or other digital recording and suitable log shall be submitted to the Owner.
- C. A 360-degree Pan-and-Tilt view camera shall be used to inspect the pipe traveling upstream. At each connection the operator will stop and turn the camera lens toward the lateral thereby inspecting the first 8 to 12 inches of the lateral connection. If there remains a doubt as to whether or not the connection is live, additional "dye and flush" tests shall be performed as necessary.
- D. For each existing service connection determined by the Owner to be active, the Contractor shall determine the condition of the service connection to the main, make his recommendation for lateral connection repair, and record both items in his log. All lateral locations will be

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measured from the back wall (opposing wall) of the basis manhole, typically the downstream manhole.

- E. Verify that pipe and or manhole is clean, and conditions are suitable for installation of the geopolymer liner.
- F. Notify Engineer if conditions exist which will impact the installation.
- G. If pre-installation video inspection using PACP certified operators reveals an obstruction in the line segment (such as heavy solids, dropped joints, protruding service connections or collapsed pipe) that cannot be removed by conventional sewer cleaning equipment and the obstruction will prevent completion of the insertion process, perform point repairs or obstruction removal prior to the geopolymer liner installation. Obtain approval of the Engineer before performing work.

### 3.4 PREPARATION AND PRE-LINING REPAIRS

- A. If the cleaning process reveals that the pipe invert, crown or sidewalls are deteriorated, measures will be taken to provide a continuous slope to the pipe, including the use of a flow-able fill or the introduction of the wall lining material onto the pipes surface.
- B. Any open joints will be sealed with the geopolymer lining material prior to the lining of the pipe.
- C. The floor and interior walls of the pipe shall be thoroughly cleaned and made free of all foreign materials including dirt, grit, roots, grease, sludge and all debris or material that may be attached to the wall or bottom of the pipe.
- D. Active leaks must be seal prior to application of the lining material.
- E. The use of quick-setting mortars or chemical grouts are approved methods for stoppage of active leaks. All products employed in the stoppage of active leaks should be preapproved by the Owner and used in accordance with Manufacture's recommendations.
- F. If additional repair procedures must be undertaken by the Contractor to prepare the existing structure for lining a plan will be submitted for approval of the Owner prior to proceeding.
- G. The Contractor shall accurately field measure and size each individual manhole. The Contractor is reminded that each existing sewer manhole designated to receive the lining may have a different configuration and varying field dimensions.
- H. The Contractor shall accurately field measure and size each individual pipe sections. The Contractor is reminded that each existing sewer designated to receive the lining may have a different configuration and varying field dimensions.
- I. The Contractor is advised that the presence or absence of leakage through manhole walls is dependent upon the ground water levels and conditions at the time of the inspections. All leakage shall be stopped prior to lining any structures.

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- J. Remove existing steps from manholes being lined. Cut existing steps flush with manhole surface and stop all leaks prior to lining structure.

### 3.5 PREPARATION OF GEOPOLYMER LINING MATERIAL

- A. Contractor shall mix geopolymer material to Manufacture's recommended water cement ratio. Precision metering of water in a continuous mixing chamber is required to maintain the strict water to material ratio. It is important to maintain the specified water to geopolymer ratio throughout the application process. Uniform water to polymer ratio equates to consistent strength. The ability to closely adjust and monitor the addition of water through the use of a sight tube system is required.
- B. Mixing water temperatures must be determined before blending operations begin. The mixing water temperature must be recorded in the daily operation log at multiple times throughout the day during the installation process. If water temperatures exceed 80°F, then the water should be chilled to 80°F or lower. The ability to provide mixing water at a consistent temperature is a critical aspect of the mixing and installation process. Industrial electronic chillers are available and should be of a suitable capacity to provide the proper amount of water and at the required temperature. High temperature applications, those greater than 80°F, require the use of water chillers to maintain the water at the proper temperature.
- C. The geopolymer lining material shall be mixed in a high shear mixer. This ensures thorough and uniform mix of water with the material prior to pumping. Begin pumping through an adjustable rotor stator pump for continuous delivery to the appropriate application device.
- D. The mixing operations must be performed so that the minimum of dust is released into the surrounding environment.
- E. This process requires the use of continuous automated mixing and pumping, which eliminates human error and mechanical issues associated with maintaining consistent water/material ratio, mix time, mix speed and dwell time prior to pumping. The automation of dry material feed rate, precise metering of water and pump rate eliminates wet/dry and thick/thin variations resulting in a uniform structure regardless of the pumping distance.
- F. Pumps must be equipped with multiple sensors that stop the pump if material either runs out or is overflowing.
- G. Multiple spin casting units should be onsite to address any application issues that arise during the lining process.
- H. Multiple spin cast nozzles should be onsite at all times to address any application issues or failure of the nozzle. Multiple nozzles may be required to produce the required depth or finish of the liner surface.

### 3.6 SPIN-CASTING APPLICATION OF GEOPOLYMER LINING

- A. The work consists of spray applying and/or centrifugally spin-casting the specified geopolymer liner material to the inside of an existing structure. The necessary equipment and application methods to apply the liner materials shall be only as approved by the material Manufacturer. Material shall be mixed in accordance with Manufacturer's specifications to

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- proper consistency, then the materials shall be pumped through a material plaster hose for delivery to the appropriate and / or selected application device.
- B. The mortar delivery hose shall be coupled to a high-speed rotating applicator device.
  - C. The rotating casting applicator shall then be positioned within the center, or positioned higher inside the pipe, as required by the diameter the pipe
  - D. The spin cast nozzle must be cable of bidirectional operation.
  - E. The spin cast nozzle should be attached to a reciprocating head. The reciprocating head allows the spin cast mechanism and the associated selected nozzle to make multiple passes on the pipe wall in a single pass of the sled assembly.
  - F. The high-speed rotating applicator shall then be initialized, and pumping of the material shall commence. As the material begins to be centrifugally cast evenly around the interior of the cavity, the rotating applicator head shall uniformly travel back and forth at or near the center point of the pipe at a controlled frequency conducive to providing a uniform material thickness to the pipe walls.
  - G. Controlled multiple passes shall then be made until the specified minimum finished thickness is attained. If the procedure is interrupted for any reason, the operator shall arrest the retrieval of the applicator head until flows are recommenced.
  - H. Spraying shall be performed by starting at the pipe end-project location and progressing towards the entrance of the pipe.
  - I. Begin at one side of the pipe and retract the spin cast assembly at a monitored uniform rate. Just as important as knowing that a consistent amount of water is being added to the mix, the retrieval rate of the spin head must be measurable and constant. At the beginning of each pipe segment the retraction device should be calibrated. The calibration process includes setting the digital readout to the desired retrieval rate. Then the retrieval system is laid out and marked to show the distance traveled in two minutes. The rate obtained must be within 5% of the expected speed and can be verified by this process.
  - J. The geopolymer liner shall be applied to a specified uniform minimum thickness and can be applied in multiple passes.
  - K. Material thickness may be verified at any point with a depth gauge and shall be no less than a uniform 1/4-inch. If additional material is required at any level, the rotating applicator head shall be placed at the location and application shall recommence until that area meets the required thickness.
  - L. The geopolymer lining material shall be applied to a damp surface, with no flowing water.
  - M. When the pipe is sufficiently out of round hand spray application of the geopolymer lining maybe necessary, the mortar delivery hose shall be coupled to a medium-velocity spray application nozzle. Pumping of the material shall commence and the material shall be atomized by the introduction of air at the nozzle, creating a medium-velocity spray pattern for material application.

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- N. Hand spraying shall be performed by starting at the bottom of the structure and progressing up the wall.
- O. The medium-velocity spray nozzle and the centrifugal spin casting head may be used in conjunction to facilitate uniform application of the material to irregularities in the contour of the pipe walls.
- P. If desired, the geopolymer liner may be troweled following the spray application. Initial troweling shall be in an upward motion, to compress the material and solidify the pipe wall. Precautions shall be taken not to over-trowel. Only a wood float or Magnesium (Mg) float should be utilized.

### 3.7 CURING OF GEOPOLYMER LINING

- A. Follow manufacturer's recommended cure schedule in curing of the geopolymer liner. The material must be allowed to cure a minimum of 2 hours or until the material has reached an initial set condition whichever is longer prior to the release of bypass or flow through the pipe.
- B. The Contractor shall coordinate application of SCGP with flow bypass operations to allow for sufficient cure time before reestablishing flow.
- C. The Contractor is responsible for removing and reinstalling all SCGP damaged from reinstated wet weather and/or dry weather flow.
- D. Proper steps shall be taken to ensure the material is cured in a moist and moderate climate. General underground conditions are usually adequate to meet this curing requirement. However, when situations of dry and/or hot conditions are present, the use of a wind barrier and fogging spray may be required.
- E. The geopolymer liner should not be placed when the ambient temperature is 37°F and falling or when the temperature is anticipated to fall below 32°F during the next 24 hours, unless specific precautions are employed.
- F. Refer to ACI 305R-99 Hot Weather Concreting. Do not apply geopolymer liner material when ambient and surface temperatures are 100°F or 35°C and above. Shade the material and prepare the surface to keep it cool. To extend working time, mix the material with chilled water. Be certain the substrate is saturated surface dry (SSD) before application begins. Proper curing is always required and is particularly important in hot weather.
- G. Refer to ACI 306R-88 Cold Weather Concreting. Low-substrate and ambient temperatures slow down the rate of set and strength development. At temperatures below 45°F or 7°C, warm the material and monitor substrate temperatures. Properly ventilate the area when heating. Protect the new liner from freezing in the first 6 hours after application.

### 3.8 TERMINATION AND SEALING AT MANHOLE OUTLETS AND MID-PIPE

- A. Termination of the geopolymer liner at the end of a pipe or manhole shall be completed by hand applying the geopolymer liner to the outer surface of the pipe or into the interior of the manhole.

- B. Termination of the geopolymer liner at mid-pipe must be sealed and locked in utilizing a cut keyway (1-1/2" deep and 4" wide). Hand apply geopolymer liner at keyway forming a smooth transition to the surrounding pipe surface.

3.9 INTERNAL RECONNECTION OF LATERAL SERVICES

- A. The Contractor shall reopen the existing active connections after the final geopolymer lining pass. Restored openings shall be neatly and smoothly open and without rough edges. Care must be exercised not to damage the geopolymer lining while reinstating the lateral.

3.10 APPLICATION OF LIQUID SEALANT

- A. Apply a manufacturer approved post geopolymer sealant to sewer and manholes.
- B. The sealant shall be used full strength as received from the manufacturer and shall not be diluted.
- C. The sealant may be applied during the application of the geopolymer liner or anytime thereafter using a pressurized spray device to the Manufacturer's recommendation
- D. The sealant shall be applied adequately to achieve surface saturation.
- E. The sealant must be allowed to cure for a minimum of 6 hours to ensure that the surface has dried to releasing bypass.

3.11 POST APPLICATION INSPECTION

- A. The Contractor will perform a post-installation television inspection that meets NASSCO PACP requirements. The video will show the completed work, including condition of restored connections.
- B. Utilizing a color video inspection system (CCTV) with data recording capabilities, the entire pipe section to be lined shall be recorded on CD or DVD or other digital method and a copy will be provided to the Owner for Approval.
- C. All manhole/junction box work and annular seal shall be completed at time of Post-TV, with Post-TV being verification of completion.

3.12 FINAL CLEANUP

- A. Upon completion of rehabilitation work and testing, clean and restore project area affected by the Work.

3.13 QUALITY CONTROL, QUALITY ASSURANCE AND INSPECTIONS

- A. GENERAL
  - 1. It is hereby the stated policy that all services will be performed by the protocol specified including ACI, ASTM, NASSCO, OSHA or other appropriate guidelines. The final results will be of the highest quality possible, delivered on the date promised.

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2. All equipment and supplies shall be obtained and maintained in order to produce results of the highest quality while meeting ACI, ASTM, NASSCO, OSHA or other appropriate guidelines.
3. Personnel shall be fully qualified to perform the tasks assigned to them.
4. Continuing education and monitoring of the performance of personnel and equipment will be reviewed by management. Corrective action will be taken immediately if a problem is identified.
5. Quality assurance and quality control objectives are to produce rehabilitated structures of the highest quality.

B. DAILY LOGS

1. A daily activity log will be filled out completely anytime a work crew is on site. This log includes listing the personnel present at the site, when they arrived and when they left the site.
2. Important spray data includes the times material was applied and under which atmospheric conditions. The ambient air temperature, the dry powder temperature, the mixing water temperature, and the temperature inside the pipe are all recorded on the daily activity report.
3. The operating conditions are also recorded. These measurements include the water addition rate taken at the meter tube, the retrieval speed of the retraction system and the pump motor speed recorded at the pump. Any special conditions are to be noted in the daily log.
4. Amount of material used and work completed will be summarized on the log.
5. A copy of the daily log for all days of work on the project will be provided in the final quality assurance documentation provided to the owner.

C. EQUIPMENT CALIBRATION REPORTS

1. All applicable equipment calibrations must be maintained on site by the superintendent and available for inspection upon request of the Owner.

D. INSPECTIONS

1. Inspections of the lining products and materials may also be made by the owner after delivery. The lining products and materials shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though samples may have been accepted as satisfactory at the place of manufacture. Lining materials rejected after delivery shall be marked for identification and shall be removed from the job at once.

E. TESTING AND ACCEPTANCE

1. The completed liner shall be smooth and free from honeycomb and areas of segregation.
2. Contractor shall employ an independent third party ACI certified testing agency to conduct and report compressive strength testing of the concrete utilized in the rehabilitation.
3. At a minimum this shall include compressive strength (ASTM C39 or C-109) Min 8,000 psi at 28days tests. Additional samples may be held for retesting at 56 days in necessary.
4. Testing frequency shall include the first and last day of construction and: (a) the more frequent of once every 10 manholes or once for every 40,000 pounds of dry geopolymer material applied for manhole applications and (b) the more frequent of

- once every other day of application or once for every 40,000 pounds of dry geopolymer material applied for manhole applications
5. Thickness verification can be done with mass balance calculations where you calculate the amount of material that went in over the surface area to get an average depth.
  6. Small plastic indicator tabs can be attached on the structure to verify the proper thickness is achieved. These are positioned to be just below the specified thickness and are left in place when sprayed over.
  7. In addition, the engineer may request the contractor to remove a test core from the installed liner, at established intervals. This is at the Contractors' expense. The Contractor shall mark the core samples with the date that the liner was installed, the date that the core was removed, and the location taken. When requested by the engineer, the liner shall be cored at three different clock positions, and the average thickness measured shall be taken as the actual thickness of the liner. If a sample is not within 90% of the specified minimum thickness and or 90% of the 28-day compressive strength, the liner is considered unacceptable. Submit a proposed method of repair or replacement for review and approval by the engineer. Work required to remedy nonconforming work shall be at no additional cost.
  8. If the thickness or compressive strength of the installed spin cast pipe lining is less than 90 percent of the specified values, the product is considered unacceptable. Submit a proposed method of repair or replacement for review and approval by the Engineer. Work required to remedy non-conforming work shall be at no additional cost to the Owner.
  9. If it is determined that the geopolymer liner material did not match the submitted manufacturers claims, the product is considered unacceptable and non-conforming. Submit proof that the geopolymer liner meets the requirements of the specification through the use of samples analyzed or retained at the manufacturing facility, or submit a method for replacement of the sewer segment liner for review and approval by the Owner. Work required to remedy non-conforming work shall be at no additional cost to the Owner.
  10. For all instances, where the geopolymer liner is deemed unacceptable, other than thickness, for compressive strength, as described in this specification section, submit a proposed method of repair or replacement for review and approval by the Engineer. Work required to remedy non-conforming work shall be at no additional cost to the Owner.

### 3.14 MEASUREMENT AND PAYMENT

#### A. MEASUREMENT

1. Unit of measure for **Spin-Cast Geopolymer Lining, Mh, 48" inch** will be the actual number of vertical feet of manhole from the base surface elevation to the manhole chimney per barrel diameter. The same measurement will apply for the invert, any landings and also the chimney where it decreases in diameter. No adjustment in measurement will be made for these flat surfaces and the narrowing manhole diameter often found at the top.
2. Unit of measure for **Spin-Cast Geopolymer Lining, Sewer, 60 inch** will be actual number of linear feet.

#### B. PAYMENT

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1. Payment for **Spin-Cast Geopolymer Lining, Mh, 48" inch** shall be made at the Contract unit price per vertical foot for geopolymer liner, which price and payment shall include but not limited to minor complications and/or delays, cleaning (and re-cleaning) and preparing (and re-preparing) surfaces, patching and/or grouting, reapplying SCGP damaged as a result of reinstating flow too soon on uncured material, traffic maintenance & protection, removing existing steps, drilling for access or infiltration relief purposes, testing and all labor, materials, tools, fees, equipment and incidentals needed to complete work specified.
2. Payment for **Spin-Cast Geopolymer Lining, Sewer, 60 inch** shall be made at the Contract unit price per linear foot for geopolymer liner, which price and payment shall include but not limited to minor complications and/or delays, traffic maintenance & protection, cleaning (and re-cleaning) and preparing (and re-preparing) surfaces, patching and/or grouting, reapplying SCGP damaged as a result of reinstating flow too soon on uncured material, drilling for access or infiltration relief purposes, testing and all labor, materials, tools, fees, equipment and incidentals needed to complete work specified.

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