CITY OF DETROIT

Mike Duggan, Mayor

STANDARD SPECIFICATIONS

BOARD OF WATER COMMISSIONERS

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Chief Financial Officer

March 2021

City of Detroit
Water and Sewerage Department - Engineering Division
Standard Specifications

03 37 13	Shotcrete
03 39 00	Concrete Curing
03 60 00	Grouting
07 12 00	Built-Up Bituminous Waterproofing
07 13 00	Sheet Waterproofing
07 14 00	Fluid Applied Waterproofing
10 14 23	Post and Panel Signage
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31 05 17	Aggregates for Stormwater Management
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31 23 16.26	Rock Removal
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32 11 23	Aggregate Base Courses
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32 12 17	Permeable Asphalt Pavement
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32 91 14	Structural Cells for Urban Trees
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32 93 90	Green Infrastructure Maintenance
33 01 10.58	Disinfection of Water Utility Piping Systems
33 01 12.11	Water Main Leak Detection
33 01 15.71	Cured-in-Place Water Main Lining
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33 01 30 16	Sanitary Sewer Pipeline Inspection
33 01 30.17	Manhole Panoramic Inspection
33 01 30.18	Security Clearances and Communications
33 01 30.19	Sanitary Sewer Pipeline Cleaning
33 01 30.23	Sewer Pipe Bursting
33 01 30.24	Water Main Pipe Bursting
33 01 30.25	Sliplining of Existing Sewers
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33 01 30.79	Fold-and-Form Sewer Lining
33 01 30.81	Manhole Rehabilitation
33 05 05.25	Valve Operation
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33 05 07	Trenchless Installation of Utility Piping
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33 31 11	Public Sanitary Sewerage Gravity Piping
33 42 00	Stormwater Conveyance

33 42 13	Stormwater Culverts
33 44 20	Vertical Drains

SECTION 01 11 00 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contract description.
2. Contractor's use of Site.
3. Work sequence.
4. Permits.
5. Specification conventions.

1.2 CONTRACT DESCRIPTION

A. Perform Work of Contract under unit price Contract with Owner according to Conditions of Contract.

B. Description of Work included in the Project will be as presented in the Advertisement, Bid Schedule, and/or Drawings.

1.3 CONTRACTOR'S USE OF SITE

A. Limit use of Site to allow:

1. Owner occupancy.
2. Work by Others, if any, as listed in the Contract Documents.
3. Use of Site by the public within public right of way.

B. Construction Operations: Limited to areas indicated on Drawings.

C. Time Restrictions for Performing Work: Comply with Section 01 14 00 – Work Restrictions.

D. Sound Level Restrictions: Sound pressure level measured at boundary of Site shall not exceed 90 dBA.

1.4 CLEANING OF SITE

A. On a daily basis, following completion of the Work (pipe installation, concreting and asphalting, spreading top soil, or sodding and seeding) and prior to leaving the Site, the Contractor shall thoroughly clean the roadway and remove the excess material from the roadway so that it is not deposited in the roadway drainage system.

B. When directed by the Engineer, but not less than weekly, the Contractor shall sweep the streets with a street sweeper. The sweeper shall have a main broom, conveyor, sprinkler system, and a storage hopper. This requirement shall apply to any streets or roads in the vicinity of the Work which are affected by the Contractor's construction or hauling operations, and as well as to streets or roads in which the Work is located. Should the Contractor neglect his duties in maintaining the proper street or road cleanliness, the Owner has the authority to take necessary steps to perform such cleaning and will charge the Contractor for those costs.

C. The Contractor shall at all times keep the street pavement and right-of-way and any public or private premises temporarily occupied for purposes of Work under this Contract free from accumulations of waste material or rubbish caused by the Contractors employees or the Work. This requirement shall apply to any streets in vicinity of the Work which are affected by the Contractor's construction or hauling operations, as well as to streets in which the Work is located. If the Contractor shall fail to keep any street cleaned of debris resulting from their operations, and therefore creating a public nuisance, they shall be notified in writing by the Engineer to clean the street and remove the nuisance immediately. If, within 24 hours after the receipt of such notice, the Contractor shall have failed to clean such street satisfactorily, the Engineer shall order the street cleaned by the Department of Public Works or such other agency and all costs of such cleaning shall be paid by the Contractor.

D. Dirt, mud, construction materials or other debris deposited on public sidewalks or streets as the result of spilling, tracking by the wheels of trucks or construction equipment or by other actions of the Contractor, his employees or subcontractors shall be immediately removed by the Contractor.

1.5 MATERIAL STORAGE

A. Comply with Section 01 52 00 Temporary Facilities for all temporary staging area requirements for material, equipment, and supplies.

B. Materials delivered on the street shall be neatly and compactly stored in such a manner as to cause the least inconvenience to adjacent property owners and the general public.

C. Working and storage areas shall be promptly restored to their original conditions as soon as the required construction work has been completed at the particular location and shall not be used as a storage area for unneeded material or construction equipment.

D. All materials delivered and stored in close proximity to the working area shall be properly barricaded and protected maintaining a safe Site for workers and the general public.

E. Only materials and construction equipment currently being used may be stored at the construction site and within the jurisdictional right of way.

1.6 WORK SEQUENCE

A. Construct Work in phases during construction period. Coordinate construction schedule and operations with Owner.

1.7 PERMITS

A. Acquire necessary permits for construction of Work as listed in Book 1 of the Contract Documents.

1.8 SPECIFICATION CONVENTIONS

A. These Specifications are written in imperative mood and streamlined form. This imperative language is directed to Contractor unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

1.9 STANDARD SPECIFICATIONS AND DETAILS

A. These Specifications include Sections that may or may not be directly relevant to the Work of this Contract as described in the Contract Documents. Some Specifications are included for reference and will only be relevant if the Specification topic is encountered or required over the course of the Work as a result of the Contractor's performance and Site conditions.

B. All DWSD Standard Specifications as listed on the DWSD website shall be referenced and used as relevant to the performance of the Contract Work.

C. DWSD Standard Details may be included for reference in the Drawings or Contract Documents. All DWSD Standard Details as listed on the DWSD website shall be used and referenced as relevant to the performance of the Contract Work.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 01 11 00

SECTION 01 14 00 - WORK RESTRICTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements.
2. Private Land.
3. Planned Construction Locations.
4. Open Excavations.
5. Test Pits.
6. Cooperation within this Contract.
7. Protection of Construction and Equipment.
8. Precautions during Adverse Weather.
9. Confined Space Entry.

1.2 REQUIREMENTS

A. Coordination:

1. Furnish personnel, equipment and construction aids that will be efficient, appropriate, and sufficient to secure a satisfactory quality of work as defined by the Specification and a rate of progress that will ensure the completion of the Work within the time stipulated in the Contract Documents.
2. Coordinate with MISS DIG (811) and other Agencies having jurisdiction over property or structures in and around the construction area and locate all utilities potentially affected by the Work.
3. If at any time, Contractor's resources appear to the Engineer to be inefficient, inappropriate, or insufficient to achieve the required quality or rate of progress of the Work, the Engineer may ask the Contractor to increase the efficiency, change the character, or increase the number of personnel and equipment to meet the schedule of the Contract. Failure of the Engineer to give such direction shall in no way relieve the Contractor of its obligations to secure the required quality or rate of progress of Work.

B. Hours of Work:

1. Contractor may normally prosecute the Work during the daylight hours of any weekday excluding holidays, providing that the operations are conducted as to not create a public nuisance or disturb the peace. The Contractor may only perform the Work during the daylight hours and no earlier than 7 AM or later than 7 PM. However, should the Contractor be stopped, by order of a public authority, from working at times that are

contrary to or in violation of any law, ordinance, permit, or license, the Contractor shall not be entitled to an extension of time due to such stoppages.

2. At the beginning of Work, notify the Engineer in writing, of the days and hours that will constitute a normal work week. Whenever the Contractor intends to depart from the specified work week, the Contractor must request approval in writing so that the Engineer may review the request for approval and make the necessary arrangements to have required inspectors assigned to the Work. The request shall be made at least two (2) calendar days prior to the requested deviation from the specified work week. If an emergency arises that would require work to be performed outside of the normal working hours of the specified work week to save or protect life or property, the requirements of the request for approval would be waived. Notify the Engineer as soon as the Contractor determines that an emergency exists that necessitates a change in or extension of the normal hours of work. However, the Contractor's determination of the existence of an emergency is subject to review and revision by the Engineer.

C. Shutdowns:

1. A shutdown shall be defined as a portion of the normal operation of a unit or conduit that has to be suspended or taken out of service in order to perform the specified Work. For each shutdown, compile an inventory of labor and materials required to perform tasks, an estimate of the time required, including time for the Owner to take down and start up the unit or conduit, and a written description of steps required to complete all tasks. The inventory, the estimate, and written procedures shall be submitted to the Engineer for review 30 calendar days prior to the proposed start date of the shutdown. Request, in writing from the Engineer, approval for each shutdown a minimum of 14 calendar days prior to the proposed shutdown date. No shutdown shall be initiated until the inventory of materials and labor is verified by the Engineer on site prior to the proposed start date.
2. The Work required herein and any other Work required by the Engineer which may interrupt the normal operations shall be accomplished at such times that will be convenient to the Owner whether during the nighttime hours or during weekend hours. The Contractor shall include in its bid price all overtime and/or premium time required for performing any work associated with these shutdowns.
3. Have on hand and located in close proximity to the Work area, all tools, equipment, spare parts and materials, both temporary and permanent, necessary to complete each Work category without interruptions. Adequate numbers of personnel shall be scheduled for each shutdown, so that the Work shall be accomplished within the specified time frame. The Engineer shall be satisfied that Contractor has complied with these requirements, to the fullest extent possible, before shutdowns will be authorized.
4. If Contractor's procedures cause an unscheduled shutdown of the facilities, perform all Work necessary to immediately re-establish satisfactory operation. Notify the Engineer, in writing, immediately of any unscheduled shutdown. Permit Owner's personnel to work with Contractor's personnel, as deemed necessary by the Owner, to maintain the facilities in continuous satisfactory operation. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of the facilities that result in fines levied by regulatory agencies shall be the responsibility of Contractor if it is demonstrated that

Contractor was negligent in the Work or did not exercise proper precautions in the conduct of the Work.

5. Shutdowns of Electrical and Control Systems: Contractor and the Owner shall each lock out and tag circuit breakers and switches operated by the Owner and shall check cables and wires to be sure that they are de-energized to ground potential before Work begins. Upon completion of the Work, remove the locks and tags and notify the Engineer that the facilities are available for use. The Owner will then remove its locks and place facilities back into use. The Contractor shall supply own locks. Locks shall be checked at the beginning of each shift. Comply with the Owner's Lockout/Tagout procedure. Shutdowns for any electrical wiring or I&C cables shall be coordinated with the Owner.

D. General Requirements:

1. Develop a program in cooperation with the Engineer to provide for the construction and putting into service the new work in the most orderly manner possible and in coordination with continued operations of the facilities and all ongoing construction projects at the time of construction of this Project.
2. Adhere to such program except as deviations therefrom are expressly permitted in writing by the Engineer.
3. Plan all work of connecting with, cutting into, and reconstructing existing pipes or structures so as not to interfere with the operation and maintenance of the existing facilities. Schedule work that will affect operation of existing facilities for the shortest possible time and when the demands on the facilities best permit such interference, even though it may be necessary to work outside of normal working hours to meet these requirements.
4. For water main work, dewater process and utility pipelines back to the nearest closed valve at the beginning of each piping shutdown.
5. Provide all appropriate means and methods to ensure that water services in the areas and facilities associated with this Project are maintained uninterrupted during construction.
6. Make minor modifications in such work relating to existing structures as may be necessary, without additional compensation.
7. Before starting any work which may interfere with the operation of the existing facilities, do all possible preparatory work and see that all tools, materials, and equipment to be installed are made ready and at hand.
8. Conduct construction operations in most orderly manners such that these operations:

    a. Interfere as little as possible with the operations of the existing facilities and other ongoing Construction Contracts.
    b. Does not damage existing equipment, structures, etc., or cause disruption to the operations of the existing facilities.

9. Make no claim for additional compensation by reason of delay or inconvenience in adapting construction operations to the need for continuous operations of the existing facilities.
10. Do not begin any portion of Work that will interfere with continued operations of the facilities until such schedule is accepted and approved in writing by the Engineer.

11. Contact the Systems Control Center fourteen (14) days prior to any required 'Sewer Shutdown' or 'Manned Entry' required within the sewer. Complete an Equipment Shutdown Request form and call 313-267-6000 to inform Systems Control of the planned shutdown and entry. Equipment Shutdown Request form is found attached to this Specification.

1.3 PRIVATE LAND

A. Do not enter or occupy private land outside of the designated construction area or property limits, except as specified in the Contract Documents.

B. Provide Owner with copies of any agreements made by the Contractor with private land owners or other government agencies (i.e., Detroit Land Bank) to occupy or use their property.

C. Photographs and/or video shall be taken to document existing private land conditions and post construction conditions. The photographic documentation shall comply with Section 02 22 30 Pre-Construction Video and Photographic Record.

1.4 PLANNED CONSTRUCTION LOCATIONS

A. The work shall be installed substantially as indicated on the Drawings.

B. Where pipe fittings or other items are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve the Contractor from installing different or additional items where required to complete the work.

1.5 OPEN EXCAVATIONS

A. Comply with all requirements of MISS DIG Public Act 174 including contacting MISS DIG, hand excavation near utilities, and contacting 911 in case of emergency.

B. All open excavations shall be scheduled in advance with the Engineer and shall be coordinated in such a way to minimize disruption and provide full restoration as soon as possible.

C. Excavations shall have sloping, sheeting, shoring, and bracing conforming with 29CFR1926 Subpart P-Excavations, and OSHA requirements. Safeguard all open excavations by providing barricades, caution signs, lights, and other means to prevent accidents to persons or damage to property. Provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access during construction shall be removed when no longer required. The length of an open trench shall always be confined to the limits prescribed by the Engineer. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, prohibiting stacking excavated material in the street, and requiring that the trench not remain open overnight.

D. Take precautions to prevent injury to personnel due to open trenches. All trenches, excavated materials, equipment, or other obstacles that could be dangerous to the public, shall be well lit at night.

1.6 TEST PITS

A. Test pits for the purpose of locating underground pipelines or structures in advance of the construction shall be excavated and backfilled by the Contractor in accordance with Project Specifications and Drawings.

B. Test pits shall be backfilled immediately after their purpose has been satisfied and the surface shall be restored and maintained in accordance with Project Specifications and Drawings.

1.7 COOPERATION WITHIN THIS CONTRACT

A. Contractor and its subcontractors shall assist in incorporating the work of other trades where necessary or required.

B. Cutting, patching, drilling, and fitting shall be carried out by the trade or subcontractors having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

C. Phase the Work so that all chases or openings for the installation of its own or any other Contractor's or subcontractor's work are available to prevent delays. All sleeves or forms delivered to the work area shall be properly set in ample time to prevent delays. All chases, openings, and sleeves shall be located accurately and are of proper size and shape. Consult with the Engineer and any Contractors and subcontractors related to this Work.

D. In case of failure to leave or cut all such openings or have all such sleeves provided and set in the proper time, cut them or set them afterwards at no additional expense to the Owner. In so doing, confine the cutting to the smallest extent possible consistent with the Work to be done. In no case shall piers or structural members be cut without the written consent of the Engineer.

E. Carefully fit around, close up, repair, patch, and point around the Work specified herein to the satisfaction of the Engineer.

F. All of the Work shall be done carefully by workers competent to do such work and with the proper small hand tools. Power tools shall not be used except where, in the opinion of the Engineer, the type of tool proposed can be used without damage to any Work or structures and without inconvenience or interference to the operation of any facilities. The Engineer's concurrence with the type of tools shall not in any way relieve or diminish the responsibility of the Contractor for such damage, inconvenience, or interference resulting from the use of such tools.

G. Do not alter or permit any worker or subcontractor to alter the Work of any other Contractor or subcontractors working on said job, except with written consent of the Contractor or subcontractors whose Work is to be altered or with the written consent of the Engineer. All cutting, patching, or repairing made necessary by the negligence, carelessness, or incompetence of the Contractor or any of its subcontractors, shall be the responsibility of the Contractor and shall be done by or at the expense of the Contractor.

1.8 PROTECTION OF CONSTRUCTION AND EQUIPMENT

A. All newly constructed Work shall be carefully protected from damage in accordance with Contract Documents. Wheeling, walking or placing of heavy loads will be minimized and the Contractor, at its own expense, shall reconstruct any portions of the Site damaged.

B. All structures shall be protected in a manner approved by the Engineer. If, in the final inspection of the Work, any defects, faults, or omissions are found, repair or remove and replace utilizing specified materials and workmanship without extra compensation for the materials and labor required. Maintain and repair the construction and other Work undertaken herein, for the warranty period described in the Contract Document, or until the end of the maintenance period, whichever is longer.

C. Take all necessary precautions to prevent damage to any part of the Work due to water pressure during and after construction until such Work is accepted by the Engineer.

1.9 WINTER SHUTDOWN PROVISIONS

A. The winter shutdown requirements as listed below will pertain to water main and sewer Capital Improvement Plan (CIP) Contracts. All other Contracts shall be excluded from winter shutdown provisions unless otherwise notified by the Owner.

B. Due to the extreme inconvenience to Detroit Water and Sewerage customers and the public in general, and also due to the impossibility of performing prompt, permanent restoration during the winter season, work on water main and sewer CIP Contracts shall be temporarily halted after the second week of November or as authorized by the Engineer. The Contract work shall promptly resume during the third week of April of the following year or as authorized by the Engineer.

C. All requests to continue Work during the winter season shall be submitted via request for information (RFI) for approval from the Owner at least thirty (30) days prior to winter shutdown. The RFI shall include as a minimum:

1. Anticipated winter work schedule.
2. Scope of work.
3. Number of crews.

D. The following items shall be completed by the Contractor prior to winter shutdown:

1. All Contractor's equipment shall be removed from the site.
2. All pipe and materials not incorporated in the Work shall be removed from the site.
3. Hard surfaces, where permanent restoration has not been made, shall have stone and cold patch installed subject to approval by the Engineer.
    a. All hard surfaces must be restored within 30 days per the Contract unless otherwise stated in the Book 1 milestone dates.

4. All berm areas where mulched seeding has not been placed shall be rough graded and left free of depressions and piles of soil.
5. Repair of all known water main leaks.
6. Pumping out of all hydrants that were used.
7. Cleaning out of catch basins where required.

E. The above list is not inclusive. The site(s) shall be made safe to the general public and to abandoned in a manner to protect the Work. All winter shutdown provisions shall be performed to the satisfaction of the Engineer.

1.10 PRECAUTIONS DURING ADVERSE WEATHER

A. Take all necessary precautions during and against the possibility of adverse weather so that the Work may be done properly and satisfactory in all respects. Protection shall be provided by use of tarpaulins, wood and building-paper shelters, or other suitable means. All protection during adverse weather must be securely fastened.

B. During cold weather, materials shall be preheated, if required, and the materials and adjacent structure into which they are to be incorporated shall be made and kept sufficiently warm so that a proper bond will occur, and proper curing, aging, or drying will result. Protected spaces shall be artificially heated by suitable means resulting in a moist or a dry atmosphere according to the particular requirements of the Work being protected. Ingredients for concrete and mortar shall be sufficiently heated so that the mixture will be warm throughout when used. Provide suitable means of protection to prevent freezing below slabs and any other Concrete Work to frost heave. This shall include all existing and new facilities. The Contractor shall be responsible for following all cold weather provisions as listed in the DWSD Standard Specifications should the Contractor decide to continue work in cold weather.

1.11 CONFINED SPACE ENTRY

A. Applicable confined space entry procedures shall be followed.

B. At the preconstruction meeting, submit to the Engineer a copy of the Contractor's Safety Plan for confined space entry in accordance with current OSHA and MIOSHA requirements. Prior to entry into any confined space, submit to the Engineer a copy of the daily entry permit in accordance with current OSHA and MIOSHA requirements.

C. Perform all Work in accordance with the latest edition of Construction Safety Standards as adopted by the Michigan Department of Labor Construction Safety Standards for Occupational Health.

D. Perform all Work in accordance with the latest edition of Michigan Department of Environment, Great Lakes, and Energy Occupational Health Standard for Construction.

E. Comply with the latest edition of the requirements, specifications and standards as provided for under the Michigan Occupational Safety and Health Act., as amended, and in force at the date thereof and all other applicable Owner, Federal, State and Local requirements, ordinances, statutes and laws.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide materials for construction aids.

B. Materials for construction aids may be new or used provided they are suitable for the intended purpose and do not violate requirements of applicable codes and standards.

C. Maintain facilities and equipment in first-class condition.

2.2 CONSTRUCTION AIDS

A. Provide construction aids and equipment necessary to facilitate the execution of the Work, such as scaffolds, staging, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes, and other such facilities and equipment. Refer to respective sections for particular requirements for each trade.

B. When permanent stair framing is in place, provide temporary treads, platforms, and railings for use by construction personnel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Consult with the Engineer, review site conditions and factors that will affect construction procedures and identify necessary construction aids.

B. Determine if adjacent properties and public facilities will be affected by execution of the Work and develop strategies to address impacts.

3.2 INSTALLATION

A. Installation: According to OSHA/MIOSHA standards and manufacturer's instructions.

3.3 REMOVAL

A. Completely remove temporary materials, equipment, and services when construction needs can be met by use of permanent construction and at the completion of the Work. Remove foundations and underground construction aids. Grade areas of the site affected by temporary installations to required elevations and slopes and clear fire area.

B. Clean and repair any damage caused by installation or use of temporary facilities. Restore permanent facilities used for temporary purposes to original condition unless otherwise specified.

END OF SECTION 01 14 00

Detroit Water & Sewerage Department

735 Randolph Street, Detroit, MI 48226-2830

☐ Utility SHUTDOWN REQUEST (ESR) / ☐

Utility Address (Intersection):			
Utility Out of Service:			
Impact of Shutdown:			
Start Date & Time:			
Reason for Access / Shutdown:			
Additional Remarks: ⇨			
Traveling Operator Required: ☐Yes/ ☐No			

Y

REQUESTOR

Signature:

Name:

Title:

Company:

E. Mail:

For all Contracts Managed by Field Eng.

☐ Approved
☐ Not Approved

Name: Mazin Malallah SIGNATURE & DATE

Title: Field Engineering/Team Leader

E. Mail: malallahM@detroitmi.gov

For all Shutdowns Affecting Water Treatment Plants

☐ Approved
☐ Not Approved

Name: Mohamad Jaber SIGNATURE & DATE

Title: Field Engineering/ Supervisor

E. Mail: jaberM@Detroitmi.gov

☐ Approved
☐ Not Approved

Name: Sam Smalley SIGNATURE & DATE

Title: Asset Manager

E. Mail

Fax:

☐ Approved I **If Required**
☐ Not Approved

Name: Biren Saparia SIGNATURE & DATE

Title: SCC Manager

E. Mail

Notes:

1. Requests must be submitted 3 days in advance

SECTION 01 20 00 - PRICE AND PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Permit Allowances
2. Provisional Allowances
3. Contaminated Material allowances
4. Schedule of Values
5. Application for Payment
6. Change Procedures
7. Defect Assessment
8. Unit Prices
9. Measurement and Payment General Notes
10. Unit Price Schedule

1.2 PERMIT ALLOWANCES

A. If required, included in the Contract will be a stipulated sum/price for reimbursement of acquired permits as a permit allowance.

B. Costs Included in Permit Allowances: Cost of permit acquired by Contractor and applicable taxes. Any cost the Contractor deems necessary for overhead, profit, and other expenses on account of a permit allowance should be included elsewhere in the bid in the total Contract price.

C. Contractor Responsibilities:

1. Arrange for and acquire all necessary permits as stated in the Contract documents.
2. Promptly inspect products upon delivery for completeness, damage, and defects. Submit claims for transportation damage.

D. Payment under permit allowances will be on an actual cost basis. The receipts for permits that have been secured by the Contractor shall be presented to the Owner for reimbursement.

E. At closeout of Contract, funds remaining in the permit allowance will be credited to Owner by Change Order.

1.3 PROVISIONAL ALLOWANCES

A. If required, included in the Contract will be a stipulated sum/price for use upon Owner's instruction as a provisional allowance.

B. Contractor's costs for products, delivery, installation, labor, payroll, taxes, equipment rental, overhead, and profit will be included in Construction Change Authorizations authorizing expenditure of funds from this provisional allowance. Insurance and Bond premiums shall be included elsewhere in the bid and are not redeemable in the provisional allowance.

C. Funds will be drawn from provisional allowance only by a Construction Change Authorization.

D. At closeout of Contract, funds remaining in the provisional allowance will be credited to Owner by Change Order.

1.4 CONTAMINATED MATERIAL ALLOWANCES

A. If required, included in the Contract will be a stipulated sum/price for reimbursement of payment associated with the removal of contaminated material via a contaminated material allowance.

B. Requirements for the handling, hauling, disposal, and all associated costs and fees of hazardous waste materials; non-hazardous waste materials; and petroleum contaminated soils will be included in the reimbursement cost of the contaminated material allowance. If chemicals of concern found in groundwater are of a nature and/or concentration that necessitate handling the groundwater as hazardous material, reimbursement of costs will be provided under the contaminated material allowance.

C. All costs for products, delivery, installation, labor, payroll, taxes, equipment, equipment rental, overhead, profit, field monitoring, on-site testing and laboratory testing for contaminated materials will be included elsewhere in the bid in the total Contract price and will not be included in the reimbursement via contaminated material allowance.

D. Payment under contaminated material allowances will be on an actual cost basis. The receipts for all reimbursement costs for the handling, hauling, disposal, and all associated costs and fees that have been incurred by the Contractor shall be presented to the Owner for reimbursement.

E. At closeout of Contract, funds remaining in contaminated material allowance will be credited to Owner by Change Order.

1.5 SCHEDULE OF VALUES

A. Submit printed schedule on Contractor's standard form or an approved electronic media printout will be considered for this use.

B. The Contractor shall submit a Schedule of Values for review and acceptance in agreement with the deadlines established in the Book 1 Contract Documents.

C. Format: Use Unit Price Schedule of this specification. Identify each line item with number and title of major bid item followed by a schedule of values for payment including division of all Lump Sum items into a schedule of values for payment.

D. Revise schedule to list approved Change Orders and Construction Change Authorizations with each Application for Payment.

1.6 APPLICATION FOR PAYMENT

A. Content and Format: Transmit application for payment using approved electronic procedures and forms. Use Schedule of Values for listing items in Application for Payment.

B. Payment Period: In accordance with the agreement between Owner and Contractor.

C. Substantiating Data: When Engineer requires substantiating information, submit data justifying dollar amounts in question.

D. Include the following as mandatory with each Application for Payment:

1. Contractor and Subcontractor waivers of claim: Partial release of liens from all Subcontractors and vendors.
2. Construction Progress Schedule revised and current as specified in Section 01 32 16 – Construction Progress Schedule.
3. Monthly Safety Reports

E. Include the following with each Application for Payment if requested by the Engineer:

1. Current construction photographs specified in Section 01 33 00 - Submittal Procedures.
2. Record Documents as specified in Section 01 78 39 – Electronic Project Record Documentation and Book 1 C-700 7.12, for review by Owner, which will be returned to Contractor.
3. Affidavits attesting to off-Site stored products.
4. Test reports and documentation
5. Updated Schedule of Submittals
6. Application for Payment Bid Items Supporting documentation; submittals, acceptance of work documents, etc.

1.7 CHANGE PROCEDURES

A. Submittals: Submit name of individual who is authorized to receive change documents and is responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.

B. Carefully study and compare Contract Documents before proceeding with fabrication and installation of Work. Promptly advise Engineer of any error, inconsistency, omission, or apparent discrepancy.

C. Requests for Interpretation (RFI) and Clarifications: Allot time in construction scheduling for liaison with Engineer; establish procedures for handling queries and clarifications.

1. Use e-Builder for requesting interpretations.
2. Engineer will respond with a direct answer on e-Builder or via a Field Order.

D. Engineer will advise of minor changes in the Work not involving adjustment to Contract Sum/Price or Contract Time by issuing supplemental instructions on a Field Order form.

E. Contractor shall submit a Change Proposal to propose changes on the Work. The request for change shall be submitted to the Engineer, describing proposed change and its full effect on the Work. Include a statement describing reason for the change and the effect on Contract Sum/Price and Contract Time with full documentation and a statement describing effect on the Work by separate or other Contractors.

F. Work Change Directive: Engineer may issue directive, signed by Owner, instructing Contractor to proceed with change in the Work, for subsequent inclusion in a Change Order. Document will describe changes in the Work and designate method of determining any change in Contract Sum/Price or Contract Time.

G. Stipulated Sum/Price Change Order: Based on Work Change Directive and Contractor's price quotation or Contractor's request for Change Order as approved by Engineer.

H. Unit Price Change Order: For Contract unit prices and quantities, the Change Order will be executed on a fixed unit price basis. For unit costs or quantities of units of that which are not predetermined, execute Work under Work Change Directive. Changes in Contract Sum/Price or Contract Time will be computed as specified for Time and Material Change Order.

I. Time and Material Change Order: Submit itemized account and supporting data after completion of change, within time limits indicated in Conditions of the Contract. Engineer will determine change allowable in Contract Sum/Price and Contract Time as provided in Contract Documents.

J. Maintain detailed records of Work done on time and material basis. Provide full information required for evaluation of proposed changes and to substantiate costs for changes in the Work.

K. Document each quotation for change in Project Cost or Time with sufficient data to allow evaluation of quotation.

L. Execution of Change Orders: Engineer will issue Change Orders for signatures of parties as provided in Conditions of the Contract.

M. Correlation of Contractor Submittals:

1. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as separate line item and adjust Contract Sum/Price.
2. Promptly revise Progress Schedules to reflect change in Contract Time, revise sub-schedules to adjust times for other items of Work affected by the change and resubmit.
3. Promptly enter changes in Record Documents.

1.8 DEFECT ASSESSMENT

A. Replace the Work, or portions of the Work, not conforming to specified requirements.

B. If, in the opinion of the Engineer, it is not practical to remove and replace the Work, the Engineer will direct appropriate remedy or adjust payment.

C. Individual Specification Sections may modify these options or may identify specific formula or percentage sum/price reduction.

D. Authority of the Engineer to assess defects and identify payment adjustments is final.

E. Nonpayment for Rejected Products: Payment will not be made for rejected products for any of the following reasons:

1. Products wasted or disposed of in a manner that is not acceptable.
2. Products determined as unacceptable before or after placement.
3. Products not completely unloaded from transporting vehicle.
4. Products placed beyond lines and levels of the required Work.
5. Products remaining on hand after completion of the Work.
6. Loading, hauling, and disposing of rejected products.

1.9 UNIT PRICES

A. Authority: Measurement methods are delineated as indicated below in the unit price schedule.

B. Take measurements and compute quantities. Engineer may verify measurements and quantities.

C. Unit Quantities: Quantities and measurements indicated on Bid Schedule are for Contract purposes only. Actual quantities provided shall determine payment.

1. When actual Work requires more or fewer quantities than those quantities indicated, provide required quantities at contracted unit sum/prices.
2. When the extended price of a particular item of Unit Price Work amounts to 5 percent or more of the Contract Price (based on estimated quantities and Unit Prices in the Bid Schedule) and the variation in the quantity of that particular item of Unit Price Work actually furnished or performed by Contractor differs by more than 25 percent from the estimated quantity of such item indicated in the Bid Schedule, Owner or Contractor may claim a Contract Price adjustment.

D. Payment Includes: Full compensation for required labor, products, tools, equipment, plant and facilities, transportation, services and incidentals; erection, application, or installation of item of the Work; overhead and profit.

E. Final payment for Work governed by unit prices will be made on basis of actual measurements and quantities accepted by Engineer multiplied by unit sum/price for Work incorporated in or made necessary by the Work.

F. Measurement of Quantities:

1. Weigh Scales: Inspected, tested, and certified by applicable State weights and measures department within past year.
2. Platform Scales: Of sufficient size and capacity to accommodate conveying vehicle.
3. Metering Devices: Inspected, tested, and certified by applicable State department within past year.
4. Measurement by Weight: Concrete reinforcing steel, rolled or formed steel, or other metal shapes will be measured by handbook weights. Welded assemblies will be measured by handbook or scale weight.
5. Measurement by Volume: Measured by cubic dimension using mean length, width, and height or thickness.
6. Measurement by Area: Measured by square dimension using mean length and width or radius.
7. Linear Measurement: Measured by linear dimension, at item centerline or mean chord.
8. Stipulated Sum/Price Measurement: Items measured by weight, volume, area, or linear means or combination, as appropriate, as completed item or unit of the Work.

1.10 MEASUREMENT AND PAYMENT GENERAL NOTES

The following items will not be paid for separately. All associated costs for these items shall be included in the total price of the Contract and among the bid items included in the bid schedule.

A. Tree Trimming

B. Shop Drawings

C. Temporary Steel Plating

D. Flow Control and Bypass Pumping

1.11 UNIT PRICE SCHEDULE:

The measurement and payment descriptions of this section provide a summary of the pay items. Please refer to the individual technical specifications for additional details on general requirements, materials, and execution.

Mobilization/Demobilization

a. The Contractor shall furnish all necessary personnel, equipment, labor, and materials for movement of equipment and personnel to the project site.

b. Etc.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 01 20 00

SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Coordination and Project Conditions.
B. Pre-Construction Meeting.
C. Site Mobilization Meeting.
D. Progress Meetings.
E. Pre-Installation Meetings.
F. Close-Out Meeting.

1.2 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and Work of various Sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Verify that utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate Work of various Sections having interdependent responsibilities for installing, connecting to, and placing operating equipment in service.

C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit as closely as practical; place runs parallel with lines of building. Use spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. Coordination Drawings: Coordinate all portions of Work. Show relationship and integration of different construction elements that require coordination during fabrication or installation to fit in space provided or to function as intended. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important.

E. Coordination Meetings: In addition to other meetings specified in this Section, hold regular weekly coordination meetings with personnel and Subcontractors to ensure coordination of Work.

F. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.

G. Coordinate completion and clean-up of Work of separate Sections in preparation for Substantial Completion and for portions of Work designated for Owner's occupancy.

H. After Owner's occupancy of premises, coordinate access to Site for correction of defective Work and Work not complying with Contract Documents, to minimize disruption of Owner's activities.

1.3 PRE-CONSTRUCTION MEETING

A. Engineer will schedule and preside over meeting after Notice of Award.

B. Attendance Required: Owner, Engineer, Design Consultant(s), Contractor, Contractor Quality Control Manager, Contractor Safety Manager, Superintendent, Project Manager, major Subcontractors, appropriate governmental agency representatives, utility representatives, and others as deemed appropriate by the Owner, Engineer, or Contractor.

C. Minimum Agenda:

1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of Subcontractors and Suppliers, list of products, schedule of values, and Progress Schedule.
5. Submission of list of future submittals as required per the Contract Documents and the Specifications.
6. Designation of personnel representing parties in Contract, Field Engineer/Representative, and Engineer.
7. Communication procedures.
8. Procedures and processing of requests for interpretations, field decisions, submittals, substitutions, Applications for Payments, proposal request, Change Orders, and Contract closeout procedures.
9. Projected Scheduling including mobilization.
10. Regulatory requirements affecting project.
11. Public Outreach.
12. Critical Work Sequencing.
13. Use of premises for work and storage areas.
14. Security, safety, and housekeeping procedures.
15. Procedures for laboratory testing of material requirements.
16. Project close-out requirements.
17. Application for Payment requirements - frequency and reporting period and required supporting documentation.

D. Contractor: Record minutes and distribute to participants within two (2) days after meeting.

1.4 SITE MOBILIZATION MEETING

A. Engineer will schedule and preside over meeting at Project Site prior to Contractor occupancy.

B. Attendance Required: Engineer, Owner, Contractor, special consultants, major Subcontractors, and others as deemed appropriate by the Owner, Engineer, or Contractor.

C. Minimum Agenda:

1. Use of premises by Owner and Contractor.
2. Owner's requirements.
3. Construction facilities and controls.
4. Field office requirements and location.
5. Material Storage.
6. Staging Area.
7. Temporary Utilities.
8. Survey/Staking.
9. Security and housekeeping procedures.
10. Community Outreach.
11. Schedules.
12. Procedures for testing.
13. Procedures for maintaining record documents.
14. Schedule project specific software training.
15. Requirements for startup of equipment.
16. Inspection and acceptance of equipment put into service during construction period.

D. Contractor: Record minutes and distribute to participants within two (2) days after meeting.

1.5 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals.

B. The Engineer will schedule meetings, prepare agenda with copies for participants, and preside over meetings. The Contractor shall supply an appropriate climate-controlled meeting space with sufficient seating for all invitees as identified in the field office requirements of the Specifications.

C. Attendance Required: Project superintendent, Contractor, major Subcontractors, Suppliers, professional consultants, Engineer, Owner, and others as deemed appropriate by the Owner, Engineering, or Contractor to address agenda topics for each meeting.

D. Minimum Agenda:

1. Review minutes of previous meetings.
2. Review of Work progress.
3. Field observations, problems, and decisions.
4. Identification of problems impeding planned progress.
5. Review of submittal schedule and status of submittals.
6. Review of off-Site fabrication and delivery schedules.
7. Maintenance of Progress Schedule.

8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Submittal of look ahead Progress Schedule.
11. Coordination of projected progress.
12. Maintenance of quality and work standards.
13. Effect of proposed changes on Progress Schedule and coordination.
14. Other business relating to Work.

E. Contractor: Record minutes and distribute to participants within two (2) days after meeting. Meeting minutes to dated, organized numerically, and include an action column with action item due date.

1.6 PRE-INSTALLATION MEETINGS

A. When required in individual Specification Sections, convene preinstallation meetings at Project Site before starting Work of specific Section.

B. Require attendance of parties directly affecting, or affected by, Work of specific Section.

C. Contractor to notify Engineer four (4) days in advance of meeting date.

D. Prepare agenda and preside over meeting:

1. Review conditions of installation, preparation, and installation procedures.
2. Review coordination with related Work.

E. Contractor: Record minutes and distribute to participants within two (2) days after meeting.

1.7 CLOSE-OUT MEETING

A. Schedule Project Close-Out Meeting with sufficient time to prepare for requesting Substantial Completion. Preside over meeting and be responsible for minutes.

B. Attendance Required: Contractor, major Subcontractors, Engineer, Owner, and others appropriate to agenda.

C. Contractor to notify Engineer four (4) days in advance of meeting date.

D. Minimum Agenda:

1. Start-up of facilities and systems.
2. Operations and maintenance manuals.
3. Testing, adjusting, and balancing.
4. System demonstration and observation.
5. Operation and maintenance instructions for Owner's personnel.
6. Contractor's inspection of Work.

7. Contractor's preparation of an initial "punch list."
8. Procedure to request Engineer inspection to determine date of Substantial Completion.
9. Completion time for correcting deficiencies.
10. Inspections by authorities having jurisdiction.
11. Certificate of Occupancy and transfer of insurance responsibilities.
12. Partial release of retainage.
13. Final cleaning.
14. Preparation for final inspection.
15. Closeout Submittals:
    a. Project record documents.
    b. Operating and maintenance documents.
    c. Operating and maintenance materials.
    d. Affidavits.
16. Final Application for Payment.
17. Contractor's demobilization of Site.
18. Maintenance.

E. Contractor: Record minutes and distribute to participants within two (2) days after meeting.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 01 30 00

SECTION 01 31 27 – PROJECT MANAGEMENT COMMUNICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Summary.
B. Users.
C. Communications.
D. Record Keeping.
E. Equipment and Internet Connection.

1.2 SUMMARY

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Project Management Communications Software:

1. The Contractor is required to utilize e-Builder® Construction Program Management Software for all project management documentation and correspondence, including but not limited to: RFI's, NCR's, submittals, meeting minutes, pay applications, change proposals/change orders, close-out documentation, etc.
2. The website, www.e-Builder.net, is an internet-based software system with controlled access through licensed accounts. The software is designed for contract management between the Owner and the Contractor to act in accordance with their respective roles. The Contractor shall be responsible for possessing the materials and broadband internet connection for accessing the website to fully comply with the specifications. Contact e-Builder® for further information at www.e-builder.net or 1-800-580-9322.
3. The use of project management communications as herein described does not replace or change any contractual responsibilities of the participants.
4. The project communications database is on-line and fully functional. User registration, electronic and computer equipment, and Internet connections are the responsibility of each project participant. The sharing of user accounts is prohibited.
5. The Owner will provide the Contractor with two (2) license and initial software training for the selected Project representative at no cost. Except for the one (1) license and initial training, the Owner assumes no responsibility for any real or potential costs associated with the use of e-Builder® by the Contractor and the project participants. The Contractor may at their expense purchase additional licenses from e-Builder® which the Owner will allow access to the contract. The named parties will be provided to the Owner within three (3) working days of the signed Agreement. In the event of personnel changes experienced by the Contractor, the licenses can be reassigned by the Contractor with approval of the Owner. Upon completion of the contract all licenses will be removed from the system.

6. Contractor and Subcontractors shall have the responsibility for visiting the Project website on a daily basis, and as necessary to be kept fully appraised of Project developments, for correspondence, assigned tasks and other matters that transpire on the site.
7. The e-Builder® website is used to facilitate electronic communication between the Contractor and the Owner. The e-Builder® system allows enhanced reporting capabilities whereby providing transparency, visibility, and collaboration to the Owner and the Contractor for more timely and responsive partnering. The e-Builder® website will manage RFIs, contract documents, submittals, shop drawings, working drawings, meeting minutes, pay applications, and other forms of documentation and communication required by the contract documents and at the discretion of the Owner. This functionality of e-Builder® will allow Contractor participants to create and upload all submittals, shop drawings, working drawings, RFI's, issue log entries and any other contract documents for review. Review and approval of all submittal documents will occur in e-Builder® with all participants notified of the results of reviews via e-Builder® email notifications. Additional functions and exceptions of the website may be made on a case by case basis at the Owner's discretion.
8. In the case of an emergency where the timeframe of a review does not allow it to be processed through e-Builder® the Contractor will be required to retroactively document the submission and approval process through e-Builder®.

C. Copyrights and Ownership:

1. Nothing in this specification or the subsequent communications supersedes the parties' obligations and rights for copyright or document ownership as established by the Contract Documents. The use of CAD files, processes or design information distributed in this system is intended only for the project specified herein.

1.3 USERS

A. Authorized Users:

1. Access to the web site will be by individuals who are licensed users.
2. Individuals shall be responsible for the proper use of their passwords and access to data as agents of the company in which they are employed.

B. Administrative Users:

1. Administrative users have access and control of user licenses and all posted items.
2. Do not post private or your company confidential items in the database.

1.4 COMMUNICATIONS

A. The use of fax, email and courier communication for this project is discouraged in favor of using e-Builder® to send messages.

1.5 RECORD KEEPING

A. Except for paper documents which require original signatures and large format documents (greater than 8½ x 11 inches), all other 8½ x 11 inches documents shall be submitted by transmission in electronic form to the e-Builder® web site by licensed users.

B. The Owner and his representatives and the Contractor and his subcontractors and suppliers at every tier shall respond to documents received in electronic form on the web site and consider them as if received in paper document form.

C. The Owner and his representatives and the Contractor and his subcontractors and suppliers at every tier reserves the right to and shall reply or respond by transmissions in electronic form on the web site to documents actually received in paper document form.

D. The Owner and his representatives and the Contractor and his subcontractors and suppliers at every tier reserves the right to and shall copy any paper document into electronic form and make same available on the web site.

1.6 EQUIPMENT AND INTERNET CONNECTION

A. In addition to other requirements specified in this Section, the Owner and his representatives, and the Contractor and his subcontractors and suppliers at every tier required to have a user license(s) shall be responsible for the following:

1. Providing suitable computer systems for each licensed user at the user's normal work location with high-speed Internet access, i.e. DSL, local cable company's Internet connection, or T1 connection.
2. Operating system and software shall be properly licensed.
3. Internet Explorer or other browser (current version is a free distribution for download). This specification is not intended to restrict the host server or client computers provided that industry standard HTTP clients may access the published content.
4. Adobe Acrobat Reader (current version is a free distribution for download).
5. Or, users intending to scan and upload to the documents area of e-Builder® should have Adobe Acrobat (current version must be purchased).
6. Users should have the standard Microsoft Office Suite (current version must be purchased) or the equivalent.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 01 31 27

SECTION 01 32 16 - CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittals.
B. Quality Assurance.
C. Network Analysis Schedules.
D. Review and Evaluation.
E. Updating Schedules.
F. Distribution.

1.2 SUBMITTALS

A. Submit Contractor’s qualifications.

B. Within ten (10) calendar days after Effective Date of the Contract, submit to the Owner the proposed schedule electronically.

C. Schedules shall be provided in Primavera P6 Version 16.2 (or later).

D. Submit updated network schedules with each Application for Payment.

E. Schedule Updates:

1. Overall percent complete, projected and actual.
2. Completion progress by listed activity and sub-activity, to within seven (7) calendar days prior to submittal.
3. Changes in Work scope and activities modified since submittal.
4. Delays in submittals or resubmittals, deliveries, or Work.
5. Adjusted or modified sequences of Work.
6. Other identifiable changes.
7. Revised projections of progress and completion.

1.3 QUALITY ASSURANCE

A. Scheduler: Contractor's personnel specializing in CPM scheduling with two (2) years minimum experience in scheduling construction work of complexity comparable to the Project.

1.4 NETWORK ANALYSIS SCHEDULES

A. All activities and Work performed by subconsultants or subcontractors shall be included.

B. Reasonable duration shall be assigned to activities shown for permits and licenses from authorities, departments, and any other agency.

C. Activities shall be logically linked and sequenced with a minimum of lags.

D. The use of imposed start and finish constraints must be kept to an absolute minimum and only used when a logical constraint is not applicable.

E. All contractual milestones including interim milestones shall be shown.

F. Contractor shall strive not to show submittal approval activities by the Owner or Engineer on the critical path unless it is obviously the case.

G. Provide sufficient and generally accepted durations (or as specified in the Submittal section) for review of submittals by the Owner or Engineer.

H. Interface or coordination activities with other contractors or third parties like permitting or utility agencies shall be shown.

I. Schedule shall be cost loaded and the cost should match the Schedule of Values (SOV) and contract amount and locations should match the drawings.

J. Activities shall be scheduled and coded in alignment with the accepted Work Breakdown Structure (WBS).

K. Retained logic and not Progress Override shall be used as the default setting while calculating the schedule.

L. The use of positive or negative lags is generally not allowed unless specifically approved in writing by the Engineer.

M. DWSD will retain ownership of project schedule contingency.

N. Contractor shall incorporate and factor all weather impacts into the schedule and use only calendar days for the project and activity calendar unless DWSD specifically allows the use of other calendars like a 5-day work week calendar.

O. If the Contract specifies a contract duration and the contractor submits an early completion schedule, no claims shall be entertained under any circumstances until the contract duration is exceeded.

P. Delay claims shall be accompanied by a Time Impact analysis schedule clearly showing the contractor and owner caused delays in the schedule.

Q. Project Total Float shall be a project shared resource and shall be used by whoever reaches and uses it as long as there is no gross abuse in its usage.

R. Illustrate order and interdependence of activities and sequence of the Work; how start of any given activity depends on completion of preceding activities, and how completion of activity may restrain start of subsequent activities.

S. Illustrate complete sequence of construction by activity, identifying Work of separate stages. Indicate dates for submittals and return of submittals; dates for procurement and delivery of critical products; and dates for installation and provision for testing. Include legend for symbols and abbreviations used.

T. Schedule Layout to include the following:

1. Activity ID.
2. Activity description.
3. Estimated duration of activity, in maximum fifteen (15)-day intervals. Status of critical activities.
4. Earliest start date.
5. Earliest finish date.
6. Actual start date.
7. Actual finish date.
8. Latest start date.
9. Latest finish date.
10. Total and free float; accrue float time to Owner and to Owner's benefit.
11. Monetary value of activity, keyed to Schedule of Values.
12. Percentage of activity completed.
13. Responsibility.

1.5 REVIEW AND EVALUATION

A. Participate in joint review and evaluation of schedules with the Engineer at each submittal.

B. Evaluate Project status to determine Work behind schedule and Work ahead of schedule.

C. After review, revise schedules incorporating results of review and resubmit within fourteen (14) calendar days.

1.6 UPDATING SCHEDULES

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each activity. Update schedules to depict current status of Work.

C. Upon approval of a Change Order, include the change in the next schedule submittal.

D. Indicate changes required to maintain Date of Substantial Completion.

1.7 DISTRIBUTION

A. Schedules to be submitted via e-Builder in native file format, (Primavera P6 .xer/.xml) with all accompanying role and resource data.

1.8 LOOK-AHEAD PROGRESS SCHEDULE

A. Contractor shall supply a three (3) week look-ahead schedule at least once a week to represent a snapshot of the Construction Progress Schedule and focus on the most immediate activities. Look-ahead schedule may be submitted in PDF format for ease of review and discussion.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 01 32 16

SECTION 01 32 25 – GPS STRUCTURE DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for Contractor to collect, document, validate and submit accurate and complete Global Positioning System (GPS) spatial data, in formats compatible with Geographic Information System (GIS) as defined in this specification.
2. Requirements for submittal of interim GPS and GIS deliverables as Project progresses, with complete and final GIS datasets to be delivered upon substantial completion of work.
3. Guidelines for performing GPS data collection prior to initiating CCTV, manhole inspection or other inspection or investigative activities.

1.2 SUBMITTALS

A. The Contractor shall provide the equipment, software and technical resources to successfully complete all GPS data collection, validation and delivery as outlined in this Standard. At DWSD's discretion and direction, the Contractor may be provided access to DWSD's ArcGIS Online environment and associated Collector application to be used for GPS data collection.

B. The Contractor shall provide interim GPS and GIS deliverables as the project progresses and complete final GPS and GIS datasets upon completion of the substantial completion of work activities. Schedule of deliveries is described in more detail below.

C. Upon receipt of a data deliverable, the Owner shall perform a data review which may include, but is not limited to:

1. Verification of spatial accuracy (and associated feature-level metadata).
2. Verification of attribute data accuracy and consistency, including domain values and valid values (such as Asset IDs) a check for omissions, duplications, inconsistencies, validation of geometry, and review of the topological relationships between features in the data deliverable. Any errors in spatial location (within the specified spatial accuracy) or attribute value shall result in that feature being identified as being in error. If the features of any single feature class within a data deliverable do not meet the 99% confidence level, the complete data deliverable shall be rejected.

D. Content of resubmitted data deliverables shall not change except to address the deficiencies identified. New features shall not be added to resubmitted data deliverables except as required to resolve deficiencies or address other comments.

1.3 QUALITY ASSURANCE

A. The Contractor is required to implement and execute a quality control or reliability assessment procedure in order to show compliance to specified guidelines or standards (i.e. positional accuracy, content accuracy, completeness, data format adherence, and data integrity assurance). The GPS and GIS data provided by the Contractor shall be error free. The Contractor shall be prepared to entirely re-survey those areas that do not meet the compliance standard at their own cost.

PART 2 - PRODUCTS

2.1 DELIVERABLE FORMAT

A. DWSD shall provide to the Contractor the DWSD GPS Survey geodatabase schema (Esri .gdb format) as outlined in Section 2.3 of this Standard, which shall be used as a template for the collection of all GPS data. The Contractor shall not make any modifications to the database structure of schema as provided by DWSD.

B. All GPS data deliverables shall be provided either through Esri ArcGIS Online (if utilizing DWSD's ArcGIS Online environment), on a flash drive, portable hard drive, or through an approved file transfer or FTP site. Each file folder submittal shall have the main folder clearly labeled with the Project name and number and the date of the delivery.

C. If approved for use, the flash drive or portable hard drive shall be readable by a personal computer running the latest version of the Microsoft Windows operating system.

D. The use of CDs or DVDs for data transfer shall not be approved.

2.2 DELIVERABLE CONTENT

A. Features shall be delivered with GPS coordinates that match the existing or as-built conditions.

B. GPS data shall be provided as follows:

1. All horizontal data shall be captured, collected and managed within the Michigan State Plane South Coordinate System, North American Datum (NAD) 1983, HARN (EPSG 2898), with the parameters as outlined below:
    a. Projection: Lambert Conformal Conic.
    b. Standard Parallel 1: 43.66666666666666.
    c. Standard Parallel 2: 42.1.
    d. Latitude of Origin: 41.5.
    e. Central Meridian: -84.36666666666666.
    f. False Easting: 13123359.58.
    g. False Northing: 0.

2. All vertical measurements for the above GPS datasets shall be recorded based on the North American Vertical Datum of 1988 (NAVD 88) and measured in feet above datum.

C. Spatial coordinates shall be accurate to within 0.2 feet horizontally and 0.2 feet vertically, unless otherwise noted.

D. Project Report – Submit a project report including the following information:

1. A brief description of the work (i.e. purpose, target accuracy, location, etc.).
2. A key map showing the project area and a description of any GPS Reference Stations used.
3. A summary of the project including planning, field data collection equipment, methods and parameters (i.e. GPS receiver settings/defaults), data processing methods and parameters (i.e. post-processing settings/defaults), and any project problems, anomalies, or deviations from the requirements as outlined in this Specification.
4. An explanation of the deliverables (digital and hard copy) including formats, naming conventions, etc.
5. A copy of all field notes (digital only).
6. A list of features that have been mapped or surveyed.

2.3 GEODATABASE STRUCTURE

A. Contractor shall match utilize data types, valid values and/or domains for all applicable fields in the GPS Asset Survey feature class of the DWSD GPS Survey geodatabase schema. This includes the use of correct Asset IDs for all DWSD assets located using GPS.

B. The following required fields must be populated for all features captured within the GPS Asset Survey feature class of the DWSD GPS Survey geodatabase:

A. Asset ID.
B. Asset Type.
C. Asset Size.
D. Asset Status.
E. Location Description.
F. GPS Status.
G. Northing.
H. Easting.
I. Elevation.
J. Horizontal Accuracy.
K. Vertical Accuracy.
L. Position of Dilution of Precision (PDOP).
M. Horizontal Dilution of Precision (HDOP).
N. Vertical Dilution of Precision (VDOP).
O. Fix Type.
P. Correction Age.
Q. Station ID.
R. Number of Satellites.

C. Contractor shall request to be on an e-mail chain or receive copies of schema changes made by the Owner to the DWSD GPS Survey geodatabase schema.

2.4 DIGITAL PHOTOGRAPHS

A. Contractor shall provide at least one (1) digital photo showing the physical extent of each feature, where possible within reasonable effort. The digital photo shall be provided at the same time as the initial data delivery of a feature.

B. The digital photos shall be of sufficient resolution, clarity, brightness and picture quality such that it is easy to discern the feature.

C. The digital photos shall be provided in JPEG or TIFF format. The photos shall be named such that the filename of each photograph is associated with the Asset ID of the feature and its associated GIS feature via the Attachments related table in the DWSD GPS Survey geodatabase.

D. The use of Esri Collector or other compatible and approved software shall be used to collect and link all required photographs to the obtained feature GPS location.

2.5 DATA OWNERSHIP

A. All data submitted during this project becomes the property of the Owner upon initial submission.

B. The Contractor shall not distribute any of the GPS data or any draft data that contributed to the final GPS datasets without written approval from the Owner.

PART 3 – EXECUTION

3.1 DATA COLLECTION

A. All GPS collected locations must be tracked using the existing Asset IDs maintained in the current DWSD GIS geodatabase for each relevant feature class. The contractor shall compare the features in the existing GIS feature class against the GPS locations and assign the GPS location the correct Asset ID. For new features not currently recorded in the GIS database or for features which cannot be located in the field the following procedures should be followed:

1. For assets existing in the current GIS but determined to not exist in the field, the Contractor shall assign these features an Asset Status of “Does Not Exist.”
2. For features which are located in the field but do not exist in the GIS database the contractor shall collect the GPS location and all required attributes of these features and assign a status of “Unmapped Asset.” To assign an Asset ID the Contractor shall copy the Asset ID of the nearest existing feature and add an alpha-suffix starting with “A” to the end of the Asset ID to maintain uniqueness in the Asset ID field.

B. The Contractor shall request and receive for their use the DWSD GPS Survey geodatabase schema. This schema shall be used to collect, validate and deliver all data, and no modifications to the schema should be made. Required fields and a description of the data to be collected is outlined in Section 2.3 of this Standard.

C. The Esri Collector Application or approved equal shall be used to collect the horizontal (X and Y coordinates), elevation (Z values) GPS data with attached photographs of the asset, asset cover or access point, as well as photo documentation of any other conditions.

D. All data collected must be delivered in the provided DWSD GPS Survey geodatabase schema (.gdb) as feature classes and attachment tables. Any changes made to the DWSD GPS Survey geodatabase schema shall result in a rejection of the submittal.

E. Type and size of manhole, catch basin, valve covers, and hydrants shall be documented and submitted with GPS location elevation data.

F. Brief description of manhole, lamp hole, junction chamber, catch basin, valve cover, and hydrant location (street, sidewalk, berm, etc.) shall be documented and included in the Description field of the GPS Asset Survey feature class.

G. If an existing feature with a known Asset ID is inaccessible and/or the GPS information cannot be retrieved (parked cars, gated yards, etc.) or there is a lack of signal caused by multipath errors (heavy vegetation, electrical wires, buildings, weather, or other conditions) the Contractor shall track those features in the Asset Status field and assign them a value of "Unable to Access." The Contractor shall determine if the collection of the structure can be achieved at a later date and shall return to the site to collect the data.

END OF SECTION 01 32 25

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Definitions.
2. Submittal Procedures.
3. Construction Progress Schedules.
4. Proposed Product List.
5. Product Data.
6. Use of electronic CAD files of Project Drawings.
7. Shop Drawings.
8. Samples.
9. Other Submittals.
10. Test Reports.
11. Certificates.
12. Manufacturer's Instructions.
13. Manufacturer's Field Reports.
14. Erection Drawings.
15. Construction Photographs.
16. Contractor Review.
17. Engineer’s Review.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action.

B. Informational Submittals: Written and graphic information and physical Samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL PROCEDURES

A. Comply with Section 01 31 27 – Project Management Communications.

B. Transmit each submittal using approved electronic procedures and forms.

C. The Contractor is required to utilize e-Builder® Construction Program Management Software for all submittals.

D. Identify: Project, Contractor, Subcontractor and supplier, pertinent Drawing and detail number, and Specification Section number appropriate to submittal.

E. Certify that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is according to requirements of the Work and Contract Documents.

F. A Schedule of Submittals shall be prepared and maintained by the Contractor and shall include the required submittals and the time requirements for Engineer's review of the submittals.

1. The Schedule of Submittals shall be updated by the Contractor and submitted to the Engineer every thirty (30) calendar days.

2. If the Contract scope is to be performed on an as-needed or emergency basis, all submittals for the potential scope of work as listed in the Contract Documents shall be submitted for approval at the commencement of the Contract for approval.

G. A preconstruction conference will be held to establish a working understanding of the submitted schedules. The Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

H. Schedule submittals to expedite Project and deliver to Engineer. Coordinate submission of related items.

I. Identify variations in Contract Documents and product or system limitations that may be detrimental to successful performance of completed Work.

J. Allow space on non-electronic submittals for Contractor and Engineer review stamps.

K. When revised for resubmission, identify changes made since previous submission.

L. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

M. Submittals not requested will not be recognized or processed.

N. Incomplete Submittals: Engineer will not review. Complete submittals for each item are required. Delays resulting from incomplete or incorrect submittals are not the responsibility of Engineer, and no claim shall be made therefor.

O. The Engineer will review a submittal or resubmittal a maximum of two (2) times, after which the cost of review shall be borne by the Contractor. The cost of engineering shall be equal to the Engineer's full cost.

1.4 CONSTRUCTION PROGRESS SCHEDULES

A. Comply with Section 01 32 16 - Construction Progress Schedule.

1.5 PROPOSED PRODUCT LIST

A. Within ten (10) days after the Effective Date of the Contract, submit list of major products proposed for use with the name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, indicate manufacturer, trade name, model or catalog designation, and reference standards.

1.6 PRODUCT DATA

A. Product Data Action Submittal: Submit to Engineer for review for assessing conformance with information given and design concept expressed in Contract Documents.

B. Identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

C. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

D. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.7 ELECTRONIC CAD FILES OF PROJECT DRAWINGS

A. Electronic CAD Files of Project Drawings may only be used to expedite production of Shop Drawings for the Project. Use for other Projects or purposes is not allowed.

B. Electronic CAD Files of Project Drawings will be distributed only under the following conditions:

1. Use of files is solely at receiver's risk. The Engineer does not warrant accuracy of files. Receiving files in electronic form does not relieve receiver of responsibilities for measurements, dimensions, and quantities set forth in the Contract Documents. In the event of ambiguity, discrepancy, or conflict between information on electronic media and that in Contract Documents, notify Engineer of discrepancy and use information in hard-copy Drawings and Specifications.
2. CAD files do not necessarily represent the latest Contract Documents, existing conditions, and as-built conditions. Receiver is responsible for determining and complying with these conditions and for incorporating addenda and modifications.
3. User is responsible for removing information not normally provided on Shop Drawings and removing references to Contract Documents. Shop Drawings submitted with information associated with other trades or with references to Contract Documents will not be reviewed and will be immediately returned.

4. Receiver shall not hold the Engineer responsible for data or file clean-up required to make files usable, nor for error or malfunction in translation, interpretation, or use of this electronic information.
5. Receiver shall understand that even though the Engineer has computer virus scanning software to detect the presence of computer viruses, there is no guarantee that computer viruses are not present in files or in electronic media.
6. Receiver shall not hold the Engineer responsible for such viruses or their consequences, and shall hold the Engineer harmless against costs, losses, or damage caused by presence of computer virus in files or media.

1.8 SHOP DRAWINGS

A. Shop Drawings Action Submittal: Submit to the Engineer for assessing conformance with information given and design concept expressed in Contract Documents.

B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a Professional Engineer responsible for designing components shown on the Shop Drawings:

1. Include signed and sealed calculations to support design.
2. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
3. Make revisions and provide additional information when required by authorities having jurisdiction.

D. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.9 SAMPLES

A. Samples Action Submittal: Submit to the Engineer for assessing conformance with information given and design concept expressed in Contract Documents.

B. Samples for Selection as Specified in Product Sections:

1. Submit to the Engineer for aesthetic, color, and finish selection.
2. Submit Samples of finishes, textures, and patterns for the Engineer selection.

C. Submit Samples to illustrate functional and aesthetic characteristics of products, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.

D. Include identification on each Sample with full Project information.

E. Submit number of Samples specified in individual Specification Sections; the Engineer will retain two (2) Samples.

F. Reviewed Samples that may be used in the Work are indicated in individual Specification Sections.

G. Samples will not be used for testing purposes unless specifically stated in the individual Specification Sections.

H. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.10 OTHER SUBMITTALS

A. Closeout Submittals: Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Within ten (10) days after the Effective Date of the Contract, submit a list of permits to be obtained, identifying the granting agency and the required date of permit submittal.

C. Informational Submittal: Submit data for Engineer's knowledge as Contract Administrator or for Owner.

D. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.

E. Submit all requirements as described in the General Conditions and Supplementary Conditions including but not limited to:

1. Preliminary Schedules.
2. Construction Quality Plan.
3. Environmental Health and Safety Plan.
4. Work Plan.

1.11 TEST REPORTS

A. Informational Submittal: Submit reports for the Engineer's knowledge as Contract Administrator or for the Owner.

B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.12 CERTIFICATES

A. Informational Submittal: Submit certification by manufacturer, installation or application Subcontractor, or Contractor to Engineer, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or product but must be acceptable to Engineer. The certificates may be submitted to the Engineer for approval prior to Notice of Award.

1.13 MANUFACTURER'S INSTRUCTIONS

A. Informational Submittal: Submit manufacturer's installation instructions for the Engineer's knowledge as Contract Administrator or for the Owner.

B. Submit printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, to the Engineer in quantities specified for Product Data.

C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.14 MANUFACTURER'S FIELD REPORTS

A. Informational Submittal: Submit reports for the Engineer's knowledge as Contract Administrator or for the Owner.

B. Submit report within five (5) days of observation to Engineer for information.

C. Submit reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.15 ERECTION DRAWINGS

A. Informational Submittal: Submit Drawings for the Engineer's knowledge as Contract Administrator or for the Owner.

B. Submit Drawings for information assessing conformance with information given and design concept expressed in the Contract Documents.

C. Data indicating inappropriate or unacceptable Work may be subject to action by the Engineer or the Owner.

1.16 CONSTRUCTION PHOTOGRAPHS

A. Comply with Section 01 78 39 – Electronic Project Record Documentation.

B. Comply with Section 02 22 30 – Pre-Construction Video and Photographic Record.

C. Provide photographs of Site and construction throughout progress of Work produced by a commercial photographer acceptable to the Engineer.

D. Submit photographs monthly.

E. Provide before and after photographs of each portion of the site.

1.17 CONTRACTOR REVIEW

A. Review for compliance with Contract Documents and approve submittals before transmitting to the Engineer.

B. Submittals shall be complete and address:

1. Determination and verification of materials including manufacturer's catalog numbers.
2. Determination and verification of field measurements and field construction criteria.
3. Checking and coordinating information in submittal with requirements of Work and of Contract Documents.
4. Determination of accuracy and completeness of dimensions and quantities.
5. Confirmation and coordination of dimensions and field conditions at Site.
6. Construction means, techniques, sequences, and procedures.
7. Safety precautions.
8. Coordination and performance of Work of all trades.

C. Stamp, sign or initial, and date each submittal to certify compliance with requirements of Contract Documents.

D. Do not fabricate products or begin Work for which submittals are required until the Engineer has documented that resubmittal is not required.

1.18 ENGINEER'S REVIEW

A. Do not make "mass submittals" to Engineer. "Mass submittals" are defined as six (6) or more submittals or items in one day or twenty (20) or more submittals or items in one week. If "mass submittals" are received, Engineer's review time stated above will be extended as necessary to perform proper review. Architect/Engineer will review "mass submittals" based on priority determined by Architect/Engineer after consultation with Owner and Contractor.

B. Informational submittals and other similar data are for Engineer's information, do not require Engineer's responsive action, and will not be reviewed or returned with comment.

C. Submittals made by Contractor that are not required by Contract Documents may be returned without action.

D. Return of Submittal does not authorize changes to Contract requirements unless accompanied by Change Order or Work Change Directive.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 01 33 00

SECTION 01 35 29 – SAFETY PROGRAM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparation and implementation of the Contractor's safety provisions for the Work.

B. Related Requirements:

1. Section 01 33 00 – Submittal Procedures.
2. Section 01 57 33 – Temporary Security Measures.
3. Section 31 50 00 – Excavation Support Systems.

1.2 SUBMITTALS

A. Submit thirty (30) days prior to the start of any field work:

1. Project Specific Safety Plan.
2. Emergency Response Plan.
3. Description of any prior arrangements made with local authorities or emergency service providers (fire, police, ambulance) to be implemented in the event of an emergency.
4. A resumé of the Safety Manager's qualifications and experience. Include a description of the Safety Manager's education, safety and first aid training, safety conferences attended, and experience.

B. Submit, for information only, monthly reports by the Safety Manager; and copies of accident reports, OSHA citations, and accident claims; as specified herein.

1.3 SAFETY AND PROTECTION

A. Comply with safety and protection requirements in Book 1 Contract Documents Section C-700 7.13.

B. Comply with all requirements of MISS DIG Public Act 174 including contacting MISS DIG, hand excavation near utilities, and contacting 911 in case of emergency.

1. If a utility is damaged resulting in the escape of any flammable, toxic, or corrosive gas or liquid, or endangering life, health, or property, the Contractor shall call 9-1-1 and provide immediate notice to the utility owner or utility operator. The Contractor shall also take

reasonable measures to protect the excavator, those in immediate danger, the general public, and the environment until the utility owner or utility operator, or emergency first responders, have arrived and taken control of the site.

C. Comply with all Occupational Safety and Health Act (OSHA) requirements and other similar applicable safety laws or codes in the performance under this Contract.

1.4 PROJECT SPECIFIC SAFETY PLAN

A. Clearly define and document all risks associated with the Work. Assess the risks posed to the Contractor's work force, the Engineer, and the Owner in the construction of potentially hazardous aspects of the Work. Use this assessment in devising safe systems of work and document these safe systems in a Project Specific Safety Plan (PSSP) to be implemented throughout the construction. Include the list of risks as defined in the PSSP.

B. The PSSP shall be provided for regular, weekly safety meetings and safety training programs for all personnel engaged in the Work.

C. The PSSP shall address the availability and maintenance of safety and rescue equipment. Equipment shall include such items as fire extinguishers, first aid kits, safety ropes and harnesses, stretchers, breathing apparatus, resuscitators, gas detectors, equipment required by law, and any other equipment deemed necessary by the Contractor.

D. The PSSP shall include a Confined Space Entry (CSE) Program, including identification of the primary rescue team.

E. The PSSP shall include requirements to obtain a permit for Hot Work (non-electrical).

F. The PSSP shall include requirements for Lockout-Tagout practices for work on motor driven equipment or electrical systems.

G. The PSSP shall be designed and operated to correct safety hazards and violations as they are discovered and reported.

H. The PSSP shall include requirements that the project site be drug and alcohol-free. The PSSP shall specify that all Contractor workers and those of its subcontractors participate in a drug testing program. The PSSP shall document drug testing protocols for how Contractor tests and screens employees and its subcontractor including the requirements and frequency of testing.

I. Provide certified statement that all workers on the project have adhered to the requirements of the testing protocols and have met the criteria for passing the drug screen. Update the required documentation upon changes to the Contractor's program, or its workforce.

J. The PSSP shall include requirements for safety precautions associated with working during a pandemic.

1.5 SAFETY TRAINING

A. All Contractor personnel shall complete MISS DIG training certification and provide proof of certification to the Engineer prior to starting the Work.

B. Train all persons working on the site so they are able to carry out their tasks and duties safely and in a manner that will not endanger either their own health or the health of others. Instruct persons when first employed on the site in the hazards inherent in the site, precautions to be taken, the form of construction, and emergency procedures.

C. Reinforce safety and emergency training by periodic practice drills.

D. Document employee safety training to establish that the Contractor has a structured program of training; that the training is held on a planned basis; and that all members of the work force receive the training.

1.6 EMERGENCY RESPONSE PLAN

A. Prepare an Emergency Response Plan to be implemented in the event of a serious injury or general emergency (such as fire, explosion, collapse) to ensure a rapid, coordinated, and effective response. The Contractor shall implement the Plan.

B. The Emergency Response Plan shall:

1. Identify key personnel and define their roles and responsibilities.
2. List telephone numbers for key personnel.
3. Identify the emergency command center.
4. Establish lines of communication between the incident location and the command center.
5. Identify internal and external support services to be called upon in the event of an emergency (rescue team, fire, police, ambulance).
6. Provide a plan of action to speed the transfer of injured persons from working areas and to ensure that ambulances can reach access points quickly.
7. Define procedures for emergency evacuation for ensuring that injured persons are not left behind or unaccounted for.
8. Provide immediate notification of the Owner in the event of an emergency.

1.7 PUBLIC SAFETY

A. Install surveillance equipment and employ a watchman if required by the Contract, or if deemed necessary by the Contractor to safeguard the work, equipment, or the public.

B. Install and maintain trench safety systems in accordance with Specification Section 31 50 00 – Excavation Support Systems and as set out in the provision of Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29 CFR, Part 1926, Subpart P (current edition).

C. Maintain railings, barricades, steel plates, or other barriers at openings, obstructions, or other hazards in roadways, walkways, and other travel ways accessible to the public. Place flashing lights and proper signs as necessary to provide adequate warning to the public day and night.

D. Maintain secure fencing around worksites, equipment, or materials stockpiles to prevent unauthorized entry.

1.8 SAFETY MANAGER

A. Employ a Safety Manager qualified in areas of safety related to the Work under this Contract with the minimum requirements as set forth in the bidding documents. Such person(s) shall report directly to a corporate officer and shall be assigned full time to the Contract and be present at the worksite or field offices. Safety Manager must be authorized to enforce compliance with the Contractor's Safety Program.

B. The Safety Manager or a qualified and approved deputy officer shall be on site at all times.

C. The Safety Manager shall be conversant with corporate safety policy, management operational instructions, regulations, legislation, and current best practice and how these relate to site safety.

D. The Safety Manager shall be capable of identifying the existing and predictable hazards in the areas surrounding the project or those working conditions at the project that are dangerous to employees or are unsanitary. The Safety Manager shall have the authority to make prompt corrective measures to eliminate those hazards.

E. The Safety Manager's duties shall include:

1. Hazard recognition, accident prevention, new employee orientation (including subcontractors), and supervising a safety program.
2. Posting appropriate notices regarding safety and health regulations at locations that afford maximum exposure to affected personnel and posting appropriate instructions and warning signs with regard to hazardous areas or conditions.
3. Maintaining safety records and current copies of all pertinent safety rules and regulations.

F. The Safety Manager shall prepare monthly audit reports for the Contractor's Project Manager and responsible corporate officer. At a minimum, these reports shall include activities of safety personnel, records of training, log of equipment safety checks, summary of safety meetings, records of accidents and citations, and critical review of the Project Specific Safety Plan, including revisions, if required.

G. The Safety Manager shall submit a monthly report, for information only, to the Owner with each Application for Payment, providing the following information:

1. Summary of routine site safety inspections, deficiencies noted, and disposition of such deficiencies.

2. Site visits by OSHA and other regulatory enforcement agencies.
3. Certification of new employee orientation.
4. Safety meeting topics and reports.
5. Status of lost-time injuries.
6. Status of citations.
7. Major equipment problems.

1.9 NOTIFICATIONS TO OWNER

A. Notify the Owner immediately, by telephone, e-mail, or messenger, of any injury or damage, or of any emergency threatening life, limb, or property, resulting from the Work.

B. Provide a preliminary accident report to the Owner, in writing, describing any accident involving injury to persons or damage to the Work or property, within 24 hours of the event.

C. Follow any preliminary accident report with a summary accident report to the Owner, in writing, describing known details of the accident, and corrective actions to be taken to reduce the possibility of recurrence, to be submitted within two weeks of the event.

D. Submit to the Owner, within two (2) days of receipt, a copy of any citations concerning safety aspects of the project received from OSHA or any other regulatory enforcement agency.

E. Submit to the Owner, within two days of receipt, a report of any claim against the Contractor or Subcontractor resulting from an accident, giving full details of the claim, including investigation and restitution.

1.10 QUALITY ASSURANCE

A. Safety requirements of the Contract Documents represent the minimum measures for performance of the Work. Implement additional safety measures as necessary to protect persons and property from injury that may result from construction operations or from the passage of the general public through the work zones.

B. The Contractor's obligations to ensure safety under this Contract shall be executed in such a manner that they are understood and carried out by all, including non-English speaking employees.

C. Compliance with health and safety requirements shall be the responsibility of the Contractor's managers and work force at every level.

D. The Owner may bring to the Contractor's attention any apparent deficiencies in his compliance with the Contractor's safety program. These deficiencies shall be corrected within 24 hours of notice. A report describing the deficiency and corrective action taken by the Contractor shall be submitted within 48 hours.

E. The Owner's review of submittals required under this Section are for the purpose of determining general conformance with Contract requirements and shall not be construed to alter the Contractor's responsibility for safety as defined in the General Terms and Conditions, Article 14.

PART 2 – PRODUCTS – Not Used

PART 3 – EXECUTION – Not Used

END OF SECTION 01 35 29

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittals.
B. Quality Control.
C. Defective Work.
D. Construction Quality Plan.
E. Tolerances.
F. References.
G. Labeling.
H. Mock-Up Requirements.
I. Testing and Inspection Services.
J. Manufacturers' Field Services.

1.2 SUBMITTALS

A. Construction Quality Plan.

1.3 QUALITY CONTROL

A. Monitor quality control over suppliers, manufacturers, products, services, Site conditions, and workmanship, to produce Work of specified quality.

B. Comply with specified standards as the minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

C. Perform Work using persons qualified to produce required and specified quality.

D. Products, materials, and equipment may be subject to inspection by Engineer or Owner at place of manufacture or fabrication. Such inspections shall not relieve Contractor of complying with requirements of Contract Documents.

E. Supervise performance of Work in such manner and by such means to ensure that Work, whether completed or in progress, will not be subjected to harmful, dangerous, damaging, or otherwise deleterious exposure during construction period.

F. The Engineer will conduct at least one Quality Audit each construction season to review Contractor quality activities and documentation, and compliance with the Construction Quality Plan. The specific Audit date will be selected at the Engineer’s discretion. The Contractor will be provided at least 7 (seven) days advance notice and shall assist by providing requested

quality control documentation to verify compliance, and by making staff available during the Audit. All Contractor costs for the cooperation with the Quality Audit and providing requested documentation shall be included and no extra payment will be made.

1.4 DEFECTIVE WORK

A. Comply with quality requirements in Book 1 Contract Documents Section C-800 SC-14.03.

1. Contractor shall be responsible for responding to all Notice of Defective Work (NODW) and Non-Conformance Reports (NCR) and performing all associated corrective action as listed.

1.5 CONSTRUCTION QUALITY PLAN

A. Comply with quality requirements in Book 1 Contract Documents Section C-800 SC-2.03.

1.6 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' recommended tolerances and tolerance requirements in reference standards. When such tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.7 STANDARDS

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard except when more rigid requirements are specified or are required by applicable codes.

B. Comply with standards by date of issue current as of the date of the Contract Documents except where a specific date is established by code or specified.

C. Obtain copies of standards and maintain on Site when required by product Specification Sections.

D. When requirements of indicated reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

E. Neither contractual relationships, duties, or responsibilities of parties in Contract nor those of Engineer shall be altered from Contract Documents by mention or inference in reference documents.

1.8 LABELING

A. Attach label from agency approved by authorities having jurisdiction for products, assemblies, and systems required to be labeled by applicable code.

B. Label Information: Include manufacturer's or fabricator's identification, approved agency identification, and the following information, as applicable, on each label:

1. Model number.
2. Serial number.
3. Performance characteristics.

C. Manufacturer's Nameplates, Trademarks, Logos, and Other Identifying Marks on Products: Not allowed on surfaces exposed to view in public areas, interior or exterior.

1.9 MOCK-UP REQUIREMENTS

A. Tests shall be performed under provisions identified in this Section and identified in individual product Specification Sections.

B. Assemble and erect specified or indicated items with specified or indicated attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mockups shall be comparison standard for remaining Work.

D. Where mockup has been accepted by Engineer and is specified in product Specification Sections to be removed, remove mockup and clear area when directed to do so by Engineer.

1.10 TESTING AND INSPECTION SERVICES

A. Employ and pay for services of an independent testing firm or laboratory acceptable to Owner to perform specified testing.

1. Before starting Work, submit testing laboratory name, address, and telephone number, and names of full-time specialist and responsible officer for approval by the Owner.
2. Submit copy of report of laboratory facilities' inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of deficiencies reported by inspection.
    a. Laboratory certifications may also be accepted from a national recognized laboratory certification program such as AASHTO LAP/LIP/AAP or MDOT pre-qualifications.

B. Independent firm shall perform tests, inspections, and other services specified in individual Specification Sections and as required by Engineer, Owner, or authorities having jurisdiction.

1. Laboratory: Authorized to operate in the State of Michigan.
2. Laboratory Staff: Maintain full-time specialist on staff to review services.
3. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to National Bureau of Standards or accepted values of natural physical constants.

C. Testing, inspections, and source quality control may occur on or off Project Site. Perform off-Site testing as required by the Specifications, Engineer, or Owner.

D. Reports shall be submitted by independent firm to Engineer, Contractor, and authorities having jurisdiction, indicating observations and results of tests and compliance or noncompliance with Contract Documents.

1. Submit final report indicating correction of Work previously reported as non-compliant.

E. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.

1. Notify Engineer and independent firm 24 hours before expected time for operations requiring services.
2. Make arrangements with independent firm and pay for additional Samples and tests required for Contractor's use.

F. Employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work according to requirements of Contract Documents.

G. Retesting or re-inspection required because of nonconformance with specified or indicated requirements shall be performed by the same independent firm.

H. Testing Agency Responsibilities:

1. Test Samples of mixes submitted by Contractor.
2. Provide qualified personnel at Site. Cooperate with Engineer and Contractor in performance of services.
3. Perform indicated sampling and testing of products according to specified standards.
4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
5. Promptly notify Engineer and Contractor of observed irregularities or nonconformance of Work or products.
6. Perform additional tests required by Engineer.
7. Attend preconstruction meetings and progress meetings.

I. Testing Agency Reports: After each test, promptly submit copies of report to the Engineer, Contractor, and authorities having jurisdiction. When requested by Engineer, provide interpretation of test results. Include the following:

1. Date issued.
2. Project title and number.
3. Name of inspector.
4. Date and time of sampling or inspection.
5. Identification of product and Specification Section.
6. Location in Project.
7. Type of inspection or test.
8. Date of test.
9. Results of tests.
10. Conformance with Contract Documents.

J. Limits on Testing Firm:

1. Testing Firm or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Testing Firm or laboratory may not approve or accept any portion of the Work.
3. Testing Firm or laboratory may not assume duties of Contractor.
4. Testing Firm or laboratory has no authority to stop the Work.

1.11 MANUFACTURER'S FIELD SERVICES

A. When specified in individual Specification Sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe Site conditions, conditions of surfaces and installation, quality of workmanship, startup of equipment, testing, adjusting, and balancing of equipment as applicable, and to initiate instructions when necessary.

B. Submit qualifications of observer to Engineer thirty (30) days in advance of required observations. Observer is subject to approval of Engineer or Owner.

C. Report observations and Site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturer's written instructions.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 01 40 00

SECTION 01 51 36 - TEMPORARY WATER SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Performance of all operations pertaining to the construction, installation, maintenance and removal of surface manifolds, valves, and the connection of temporary water services to DWSD customers during water main improvements.
2. Pipe and fittings for temporary lines, including potable water service lines and fire service lines.
3. Tapping sleeves.
4. Bedding and cover materials.
5. If the use period for the temporary water services is during freezing conditions or weather, provide insulation for all exposed temporary service piping to prevent freezing.

B. Related Requirements:

1. Section 02 22 30 – Pre-Construction Video and Photographic Record.
2. Section 02 61 13 – Excavation and Handling of Contaminated Materials.
3. Section 31 23 33 – Trenching and Backfill.
4. Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.
5. Section 33 05 63 – Concrete Vaults and Chambers.
6. Section 33 14 13 – Public Water Utility Distribution Piping.
7. Section 33 14 17 – Water Services.
8. Section 33 14 17.81 – Lead Service Line Replacement.
9. Section 33 14 19 – Valves and Hydrants for Water Utility Service.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

B. ASTM International:

1. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A193 - Standard Specification for Alloy Steel and Stainless-Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications.

3. ASTM A194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
4. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
5. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
6. ASTM A536 - Standard Specifications for Ductile Iron Castings.
7. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft lb./ft3 (600 kN m/m3).
8. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
9. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
10. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
11. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

C. American Water Works Association (AWWA):

1. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
2. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.
3. AWWA C605 – Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
4. AWWA C651 - Disinfection of Water Mains.
5. AWWA C900 - AWWA C900-16 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In.
6. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In., for Waterworks.

D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry:

1. MSS SP-60 - Connecting Flange Joints between Tapping Sleeves and Tapping Valves.

E. National Fire Protection Association (NFPA):

1. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

F. NSF International:

1. NSF 14 – Plastic Piping System Components and Related Materials.
2. NSF 61 - Drinking Water System Components - Health Effects.
3. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Coordinate Work of this Section with termination of water main connection at Site boundary, connection to municipal water utility service, and trenching.

1.4 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 – Administrative Requirements.

B. Convene pre-installation meeting a minimum two weeks prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Requirements.

B. Product Data: Submit manufacturer information regarding pipe materials, pipe fittings, valves, and hydrants.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

E. Preconstruction Photographs: Submit digital files of color photographs of Work areas and material storage areas according to Section 02 22 30 – Pre-Construction Video and Photographic Record.

F. Submit a plan for any temporary water systems to DWSD for review and approval prior to beginning work on such system. The plan shall include:

1. The type of system intended for use, the method of construction, and the operations and maintenance procedures.
2. Identification of each existing customer, except for those who agree in writing to have their service temporarily disconnected. Obtain said agreements.
3. Any agreements with the property owner regarding access and use of private property.
4. The name and phone number of a contact person and at least one alternate who shall be available on a twenty-four (24) hour basis for repair and/or maintenance of the temporary water system.

G. Qualifications Statements: Submit qualifications for manufacturer and installer.

1.6 QUALITY ASSURANCE

A. Valves: Mark valve body with manufacturer's name and pressure rating.

B. Materials in Contact with Potable Water shall be certified according to NSF 61 and NSF 372.

C. Perform Work according to this Specification.

D. Maintain one copy of each standard affecting Work of this Section on-site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three (3) years' experience in installation of water distribution materials.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage. Damaged and defective materials shall not be used for the work and shall be returned.

B. Storage:

1. Store materials according to manufacturer instructions. Cap all pipe to prevent entry of animals or foreign material.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Do not place pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

PART 2 - PRODUCTS

2.1 WATER PIPING

A. All materials furnished for use as temporary bypass pipe, service hose, connections and related appurtenances that come into contact with drinking water are to be certified for conformance with American National Standards Institute/National Sanitation Foundation Standard 61 (ANSI/NSF Standard 61) by an American National Standards Institute (ANSI) approved third-party certification program or laboratory. All materials shall be able to withstand the required water pressure and all other conditions of use and shall be watertight before being put into service. All equipment used shall be specifically designed and properly disinfected for the handling, and delivery of potable water.

B. Plastic temporary water service materials should also be certified for conformance with NSF Standard 14 and be marked NSF-PW.

C. Used temporary bypass pipe shall be drawn from water main equipment stocks that are dedicated exclusively for use in pipe projects involving fresh potable water and shall never have been utilized for any other use.

D. Service shall be supplied to each structure presently served by DWSD in the work area. The following minimum criteria shall be used for service to each structure:

1. Forty (40) psi minimum, one hundred (100) psi maximum delivery pressure measured at the connection to the structure.
2. Five (5) gallons per minute flow at the above delivery pressure measured at the connection to the structure. Commercial and other business structures may require higher water flows.
3. Potable water system and water quality shall conform to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Drinking Water Standards.
4. All services to structures shall be valved to allow individual control of service to each structure.

E. Materials used for temporary water service shall conform to the requirements of these Specifications. The temporary water service system shall be constructed from one (1) or more of the following materials: polyvinyl chloride (PVC) (AWWA C900), high-density polyethylene (HDPE) (AWWA C906), copper, or ductile iron (AWWA C151).

F. The primary water feeder pipe shall be a minimum of four (4) inches in diameter.

2.2 TEMPORARY WATER SERVICE

A. Hose connection between the temporary water main and structure shall be designed for potable water use with NSF 61 Certification and be made of a material that will not have an adverse effect on the taste or odor of the water.

2.3 TEMPORARY FIRE HYDRANT

A. Temporary fire hydrant shall consist of a 4-inch by 4-inch tee or 4-inch 90° bend, with a butterfly valve connected to the end of the tee or bend, and an operating nut to control the valve. Temporary fire hydrant shall be equipped with a 4-1/2-inch diameter Detroit Fire Department threaded nozzle with hydrant cap installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

B. All temporary water service equipment shall be disinfected per ANSI/AWWA C651, Disinfection of Water Mains, as also described in Section 33 01 10.58 – Disinfection of Water Utility Piping Systems. All bacteriological samples required under these Specifications shall be done by a testing laboratory certified by the State of Michigan. Upon adequate notice, the Detroit Water and Sewerage Department will make all bacteriological tests, at no charge to the Contractor.

C. All temporary service equipment shall be disinfected prior to connecting to a residence or business and shall be disinfected each and every time the equipment is moved or connected to another residence per above-referenced Specifications.

D. The Engineer shall be notified twenty-four (24) hours prior to the installation of any temporary water system. The Engineer shall be present to inspect the disinfection process of any temporary water service system.

E. No residence presently serviced by the DWSD system shall be without water for a period greater than ten (10) hours in any twenty-four (24) hours period or without water overnight. Each residence or business owner shall be notified per the requirements of Section 33 01 30.18 – Security Clearances and Communications before they are transferred on or off the temporary water system and before any other service interruption.

F. Following the successful installation of the temporary water system, the existing water service shall be appropriately disconnected at a main shutoff valve inside the structure. Qualified personnel who are familiar with building plumbing systems shall accomplish the disconnection of the existing water service. This Work shall be performed to prevent backfeeding water through the service connection.

G. Fire hydrants may be used as a water source for a temporary water system. Obtain a hydrant permit from DWSD and meet all permit conditions (winter use of a hydrant shall require special permission from DWSD). In addition, provide a gate valve assembly at the fire hydrant as a shutoff valve for the temporary water system. Furnish and install a backflow prevention device at

the temporary meter connected to the hydrant. Repair any damage to the hydrant and temporary service piping at no cost to the Owner.

H. If fire hydrants are not available in the near vicinity to supply water using temporary piping, the Detroit Water & Sewerage Department will furnish water from existing mains in service. Contractor shall provide the tap, if required. Perform all necessary excavation and backfill.

I. In order to minimize interference with vehicle and pedestrian traffic, whenever temporary bypass pipe crosses a driveway or sidewalk, the temporary bypass pipe shall be covered with a mound of hot mix asphalt, aggregate materials, or suitable ramps.

J. Maintain an emergency telephone number and have personnel available by phone during nonworking hours to handle complaints and emergencies regarding interruption in temporary service or fire protection or other causes. In the event that the Contractor fails to repair or maintain the temporary system and DWSD is required to perform repairs and/or maintenance, all costs associated with said repairs or maintenance will be deducted from the Contract amount.

K. Not more than twenty-six (26) residential street connections shall be connected for temporary water service between two (2) successive gate valve locations.

L. Piping:

1. Handle and assemble pipe according to manufacturer instructions and as indicated on Drawings.
2. Maintain ten (10) feet of horizontal separation and eighteen (18) inches of vertical separation between water main and sanitary and storm sewer piping unless otherwise shown on drawings.
3. Prevent foreign material from entering pipe during placement.
4. Allow for expansion and contraction without stressing pipe or joints.
5. Close pipe openings with watertight plugs during Work stoppages.
6. Install access fittings to permit disinfection of water system performed under Section 33 01 10.58 – Disinfection of Water Utility Piping Systems and AWWA C651.

M. Valves and Hydrants: As specified in Section 33 14 19 - Valves and Hydrants for Water Utility Service.

N. Tapping Sleeves and Valves: As indicated on Drawings and according to manufacturer instructions.

O. Temporary Service Connections:

1. Make all connections to the customer's water service line on a day and at a time that is convenient to the customer.
2. Connection from the temporary bypass pipe to the water service line shall be made inside the building at the meter, outside at the hose bib, or any suitable area not directly in the street.

3. Hose shall be run into the building through a window, or a temporary opening shall be made in the building wall of a size just large enough to pass the hose through. Dryer vents are not to be used. The opening shall be secured to prevent any access by unauthorized individuals and shall be completely sealed to prevent access by rodents, water intrusion, and to minimize heat loss.
4. Hose connection made at the hose bib shall be done by connecting a two (2) hose Y-adaptor with dual shutoff capable of allowing independent use of two (2) hoses from one (1) faucet. The leg designated for outdoor use shall be equipped with an ASSE 1052 backflow preventer.
5. If access into the building is impossible or impractical, and the hose bib is not accessible, the connection shall be made to the water service line in any suitable area not directly in the street. Excavate, expose and cut the water service line, and connect the hose. Backfill excavated area or install orange construction fencing with flashers around the excavated area. If the area where the excavation is made is paved, cover the excavation with heavy gauge steel plates capable of supporting an AASHTO H20 Highway Loading.
6. Make satisfactory arrangements with the customer so that stop and waste valves shall be accessible at all times.

P. Disinfection of Potable Water Piping Systems: As specified in Section 33 01 10.58 - Disinfection of Water Utility Piping Systems and AWWA C651.

Q. Fire Protection:

1. Four (4) inch valved hydrant outlet shall be provided at the intersections for each fire hydrant taken out of service and every 500 feet thereafter.
2. All temporary by-pass lines containing four (4) inch hydrant outlets shall be a minimum of four (4) inches in diameter; and shall be connected in a looped system with no dead ends.
3. Fire Protection Requirements: Use of Siamese connections and access for fighting equipment shall be subject to approval by the Detroit Fire Department prior to DWSD approval of the Contractor's "Sequence of Operations". If fire hydrants are not available in the near vicinity to supply water for temporary piping, DWSD will allow the Contractor to obtain water from any existing main in service which has an adequate supply. All work and material required for the temporary tap and its removal, shall be furnished by the Contractor at no increase in the Contract Price.

R. Restoration of Service:

1. After completion of lining or water main replacement, clear the water service lines by back flushing with potable water. Once the water main has been bacteriologically tested, recharged and put back into service, flush each water service at full velocity for a period of at least ten (10) minutes, prior to re-installation of the water meter. Utilize the hose connection from the inlet side of the meter, out to the street for the flush. Flush water will travel from the charged water main through the existing water service to the meter inlet hose connection and out through the hose to the street. The water service curb valve shall be left in the full open position for the duration of the flush. Precautions shall be taken to ensure the hose outlet is directed to the street and directed away from any lawn areas.

2. In instances where the outside hose bib is used for the bypass pipe connection to the home instead of at the inside meter location, the final flush out of the service will be through the hose connection to the outside hose bib. Arrange to remove the meter and install a splice pipe. The water service may not be flushed through the water meter. Following the flush, the splice piece shall be removed and the meter reinstalled. The same procedure will apply in cases where the meter is in an exterior meter pit.
3. Multiple services may be flushed at the same time. Water meters shall be reinstalled on the same day that the service flush takes place. If a water meter cannot be installed on the same day, a re-flush of the service will be required.
4. Record the size and material of the water service as it enters the building upstream of the water meter on the Water Service Identification Cards provided by the City. These cards shall be submitted to the project Engineer at the completion of work on each street in the project.
5. Instructions for interior flushing of the property plumbing shall be issued to each dwelling following installation of the water meter. DWSD will provide the Contractor with the appropriate pamphlets and/or door hangers for distribution. The Contractor's representative shall advise the resident not to drink water until the resident has completed the flushing of the internal building plumbing.
6. Disconnect the hose, restore the water service line back to normal conditions, and restore water flow. Access points shall be properly restored to pre-construction status. Temporary openings into buildings/residences shall be permanently repaired using a material and method acceptable to the Engineer. Removal or draining of temporary water service during freezing weather and its subsequent return to service shall be at no additional cost to DWSD.
7. When temporary bypass is used during a water main cleaning and lining project, and the situation arises where a City-owned building is vacant and boarded-up, the City will make arrangements to allow the Contractor to gain access to the building to connect a temporary bypass hose for use in flushing back the water service to clean out debris that may accumulate at the location where the service is connected to the water main. For non-City-owned vacant buildings, if the Contractor is not able to gain access to the building after making every reasonable attempt to contact the building owner or his representative, the Engineer may direct the Contractor to clean and line the water main without making provision to flush back the service. In some cases, for non-City-owned vacant buildings, the Engineer may direct the Contractor to excavate the water service at the curb stop to connect a flush-back hose before the water main is cleaned and lined. In other cases, after the water main has been cleaned and lined, the Project Manager may direct the Contractor to excavate at the location where the service to the vacant building is connected to the water main, disconnect the service and clean out any debris that may have accumulated in the service at this location. Once cleaned out, the service shall be reconnected to the water main, the excavation backfilled, and the surface restored.
8. Discharge of chlorinated water into watercourses or surface waters is regulated by the National Pollutant Discharge Elimination System (NPDES). Disposal of the chlorinated disinfection water and the flushing water is the Contractor's responsibility. Dechlorinate the disinfection water such that the chlorine residual complies with EGLE regulations, and NPDES General Permit MIG670000, Wastewater Discharge from Potable Water Supply.

3.2 FIELD QUALITY CONTROL

A. Testing:

1. Pressure test temporary plastic piping system on the surface at standard line pressure and inspect for visual leaks.
    a. Conduct hydrostatic test for a minimum of two (2) hours.
    b. Raise pressure to specified test pressure.
    c. Observe joints, fittings, and valves under test.
    d. Remove and renew cracked pipes, joints, fittings, and valves showing visible leakage, and retest.
    e. Correct visible deficiencies and continue testing at same test pressure for additional two (2) hours to determine leakage rate.
    f. Maintain pressure within plus or minus five (5) psi of test pressure.
    g. Leakage:
        1. If test of pipe indicates leakage, locate source of leakage, make corrections, and retest until leakage is within limits defined in Section 33 14 13 Public Water Utility Distribution Piping.
        2. Correct visible leaks regardless of quantity of leakage.

B. Compaction Testing: As specified in Section 31 23 33 – Trenching and Backfill.

END OF SECTION 01 51 36

SECTION 01 52 00 - TEMPORARY FACILITIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities:

1. Temporary Electricity.
2. Communication Services.
3. Temporary Water Service.

B. Construction Facilities:

1. Field Offices and Sheds.
2. Staging Area.
3. Vehicular Access.
4. Parking.
5. Progress Cleaning and Waste Removal.

C. Temporary Controls:

1. Water Control.
2. Dust Control.

1.2 TEMPORARY ELECTRICITY

A. Provide and pay for power service required from utility source as needed for construction operation.

1.3 COMMUNICATION SERVICES

A. Telephone Service: Provide, maintain, and pay for telephone service to field office and Architect'/Engineer's field office at time of Project mobilization and until completion of Work.

B. Internet Service: Provide, maintain, and pay for broadband Internet service rated at 150 Mbps to field office and Engineer's field office at time of Project mobilization. Provide desktop computer with Microsoft operating system and appropriate office function software, modem, and printer.

1.4 TEMPORARY WATER SERVICE

A. Provide and pay for potable quality water service as needed to maintain specified conditions for construction operations.

B. Provide containerized, tap-dispenser, bottled-water drinking–water units, including paper supply. Provide electric water coolers to maintain dispensed water temperature between 45 and 55° F.

1.5 FIELD OFFICES AND SHEDS

A. The Contractor shall be responsible for acquiring and maintaining any permits for the site which a field office or shed is located. The Contractor furnish written evidence to the Engineer of all permits and the landowner's permission for use of the land. Such evidence will include all terms, conditions, considerations and payments for the use of the land.

B. Field Office: Weathertight, with lighting, a minimum of 10 duplex electrical outlets, heating, cooling, and ventilating equipment, and equipped with sturdy furniture including chairs, conference table, drawing rack, filing cabinets, drawing display table and permanent sanitary facilities.

C. Field office should be equipped with built-in toilet, wash tub sink, and be connected to existing underground facilities.

D. Provide space for Project meetings, with table and chairs to accommodate ten persons. Meeting space shall be equipped with a projector or TV with necessary cables capable of projecting a laptop display for meeting purposes. The TV or effective projector screen size shall be a minimum of 48 inches measured corner to corner diagonally.

E. Provide separate private office, similarly, equipped and furnished, for use of the Engineer.

F. Locate field offices and sheds a minimum distance of 30 feet from existing and new structures.

G. Do not use permanent facilities being constructed for field offices or for storage.

H. Construction: Portable or mobile buildings, or buildings constructed with floors raised aboveground, securely fixed to foundations with steps and landings at entrance doors.

1. Construction: Structurally sound, secure, weathertight enclosures for office and storage spaces. Maintain during progress of Work; remove enclosures when no longer needed.
2. Thermal Resistance of Floors, Walls, and Ceilings: Compatible with occupancy and storage requirements.
3. Exterior Materials: Weather-resistant, finished in one color acceptable to Engineer.
4. Interior Materials in Field Offices: Sheet-type materials for walls and ceilings, prefinished or painted; resilient floors and bases.
5. Lighting for Field Offices: 50 ft-C at desktop height; exterior lighting at entrance doors.

6. Interior Materials in Storage Sheds: As required to provide specified conditions for storage of products.

I. Heating, Cooling, and Ventilating for Offices: Automatic equipment to maintain 68° F heating and 76° F cooling.

J. Preparation: Fill and grade Sites for temporary structures sloped for drainage away from buildings.

K. Installation:

1. Install field office spaces ready for occupancy at least 30 days prior to any field activity.
2. Employee Residential Occupancy: Not allowed on Owner's property.

L. Maintenance and Cleaning:

1. Weekly janitorial services for field offices; periodic cleaning and maintenance for sheds and storage areas.
2. Maintain walks free of mud, water, snow, debris, and the like.

M. Removal: At completion of Work remove buildings, foundations, utility services, and debris. Restore areas to same or better condition as original condition.

1.6 STAGING AREA

A. The Contractor shall be responsible for securing a staging area within the vicinity of the Work to store materials, equipment, and supplies. Only materials and construction equipment currently being used may be stored at the construction site and within the jurisdictional right of way.

B. The Contractor may wish to contact the Detroit Land Bank Authority (DLBA) to locate opportunities for staging areas near the Site.

C. The Contractor shall furnish written evidence to the Engineer of the landowner’s permission for use of the land. Such evidence will include all terms, conditions, considerations and payments for the use of the land.

D. After the Contractor’s Work is complete, the Contractor shall furnish written evidence to the Engineer that the land used by the Contractor for his operations have been restored to the satisfaction of the land owner.

1.7 VEHICULAR ACCESS

A. Construct temporary all-weather access roads from public thoroughfares to serve construction area, of width and load-bearing capacity to accommodate unimpeded traffic for construction purposes.

B. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage.

C. Extend and relocate vehicular access as Work progress requires and provide detours as necessary for unimpeded traffic flow.

D. Locate as indicated on Drawings or approved by Engineer.

E. Provide unimpeded access for emergency vehicles. Maintain 20 foot-wide driveways with turning space between and around combustible materials.

F. Provide and maintain access to fire hydrants and control valves free of obstructions.

G. Provide and maintain access to all residential and commercial access points and driveways.

1. Temporary materials such as steel plating, cold patch, and granular material shall be installed and maintained until such time that permanent restoration allows for full access to the residential or commercial property.

H. Provide means of removing mud from vehicle wheels before entering streets.

1.8 PARKING

A. Provide temporary surface parking areas to accommodate construction personnel.

B. Locate where shown on the drawings.

C. If Site space is not adequate, provide additional off-site parking.

D. Use of designated areas of existing on-Site streets and driveways used for construction traffic is permitted. Tracked vehicles are not allowed on paved areas, unless they are slated for replacement as part of the project.

E. Use of designated areas of existing parking facilities by construction personnel is permitted.

F. Do not allow heavy vehicles or construction equipment in parking areas.

G. Designate and reserve three parking spaces for Engineer.

H. Permanent Pavements and Parking Facilities:

1. Bases for permanent roads and parking areas may be used for construction traffic.
2. Avoid traffic loading beyond paving design capacity. Tracked vehicles are not allowed.

I. Maintenance:

1. Maintain traffic and parking areas in sound condition free of excavated material, construction equipment, products, mud, snow, ice, and the like.

2. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original condition.

J. Removal/Repair:

1. Remove temporary materials and construction before Substantial Completion.
2. Repair existing facilities damaged by use, to original condition.

K. Mud from Site vehicles: Provide means of removing mud from vehicle wheels before entering streets.

1.9 PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris, and rubbish. Maintain Site in clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, before enclosing spaces.

C. Broom and vacuum clean interior areas before starting surface finishing and continue cleaning to eliminate dust.

1.10 FIRE-PREVENTION FACILITIES

A. Prohibit smoking within buildings under construction and demolition. Designate area on-site where smoking is permitted. Provide approved ashtrays in designated smoking areas.

B. Establish fire watch for cutting, welding, and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.

1.11 WATER CONTROL

A. Grade Site to drain. Maintain excavations free of water. Provide, operate, and maintain necessary pumping equipment.

B. Protect Site from puddles or running water. Provide water barriers as required to protect Site from soil erosion.

1.12 DUST CONTROL

A. Execute Work by methods that minimize raising dust from construction operations.

B. Provide positive means to prevent airborne dust from dispersing into atmosphere.

C. Comply with the City of Detroit Fugitive Dust Ordinance (Ordinance No. 32-17) requirements during Construction.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 01 52 00

SECTION 01 55 26 – TRAFFIC CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. All Work under this section shall be in accordance with the general and specific requirements of the City of Detroit Department of Public Works - Traffic Engineering Division, Wayne County, Michigan Department of Transportation (MDOT) Standard Specifications for Construction, and MDOT "Michigan Manual of Uniform Traffic Control Devices" (MMUTCD).

B. Maintain and protect vehicular and pedestrian traffic and the Work in accordance with the provisions of this Section.

C. Coordinate Work under this Contract with authorities having jurisdiction.

D. Prior to starting any Work, a traffic maintenance plan shall be submitted for approval to the City of Detroit or authority having jurisdiction.

E. This Work includes installing and maintaining the planned detour(s) as per the improvement plans.

F. Load Restrictions: Comply with all legal load restrictions when hauling materials on public roads.

1. Operate equipment of a weight or so loaded as to not cause damage to structures, roadway, and other infrastructure.
2. Do not exceed legal load limits unless permitted by the Engineer or jurisdiction having authority.

G. Haul Roads: Prior to hauling equipment or materials, provide written notification to the Engineer of the specific roads for the haul route.

1. Do not use off-road vehicles on bases or pavements unless permitted by the Engineer.
2. Do not haul on concrete pavement, base, or structures before the expiration of the curing period.
3. If the Engineer determines that haul route roads were properly used during construction to haul equipment and materials and that the haul route roads were damaged, then the Engineer may order the Contractor to perform immediate and practical repairs to ensure reasonably normal traveling conditions.
4. The Contractor shall not file a claim for delays or other impacts to the Work caused by disputes with the local authorities regarding the use of local roads as haul routes. The Contractor shall save the Owner harmless for any closures or hauling restrictions outside the Project limits beyond the control of the Owner.

1.2 SUBMITTALS

A. Submit a traffic maintenance plan for each Work area, no later than five (5) working days prior to mobilization, to the Engineer for review and approval.

B. Submit an "ADA Work Plan" for sidewalk and ADA ramp construction at least two (2) weeks prior to any sidewalk ramp closures or removals. The Work Plan must address pedestrian access and detours and clearly outline the access and routes around site. Plan will allow a ramp closure up to 96 hours. The Engineer will have seven (7) calendar days to review the plan for approval or provide comments for revisions required to obtain approval. Do not proceed with the Work until the Engineer has approved the Plan.

PART 2 - PRODUCTS

2.1 BARRICADES, ARROW BOARDS, TEMPORARY PAVEMENT MARKINGS, AND TEMPORARY SIGNS

A. Barricades, Arrow Boards, Temporary Pavement Markings, Temporary Signs, and other traffic control devices shall be in accordance with the current editions of the MDOT Standard Specifications for Construction and the MMUTCD.

PART 3 - EXECUTION

3.1 TRAFFIC FACILITIES AND TRAFFIC CONTROL – GENERAL

A. Construct and maintain facilities for vehicular and pedestrian traffic as required for the Project, including all detours, temporary walks, roads, bridges, culverts, and traffic control devices.

B. During the progress of Work, the Contractor shall make provisions for both vehicular and foot traffic on any public road and shall indemnify and save harmless the Owner from any expense whatsoever due to his operations over said roadways.

C. The provisions of this Section shall not in any way relieve the Contractor of any legal responsibilities or liabilities for the safety of the public. The Contractor shall provide and maintain safeguards, safety devices, and protective equipment and take any other needed actions that may be necessary to protect the public and property in connection with the Work. The Contractor shall restore all original pavement markings, signs, and traffic control devices.

3.2 LOCAL TRAFFIC

A. For local traffic, the Contractor shall provide and maintain in a safe condition, including snow and ice removal, such drives, temporary roadways, bypasses, sidewalks, or temporary structures as may be necessary to provide vehicular and pedestrian ingress and egress for the residents and

facilities adjacent to the improvements. Temporary approaches and crossings of intersecting highways shall also be provided and maintained in a safe condition.

B. The Contractor shall provide free access to all municipal, commercial, residential entrances, fire hydrants, and water and gas valves located in the Work vicinity. The Contractor shall lay and maintain temporary driveways, bridges, and trench crossings, which the Engineer deems necessary to maintain access to driveways and to reasonably accommodate the public at no additional.

3.3 THROUGH TRAFFIC

A. During construction, the Contractor shall maintain the planned detour for through traffic. Emergency vehicles (police, ambulance, fire, etc.) shall be the only through traffic allowed. The Contractor must make allowances for the safe and timely passage of these emergency vehicles.

B. When the street affected by Project construction is being used by traffic, including periods of suspension of the Work, the Contractor shall maintain by the use of labor, equipment, and materials, that portion of the street being used, such that it is smooth, free from holes, ruts, ridges, bumps, and dust. The street being used shall be provided with the necessary outlets to drain freely.

C. The jurisdictional authorities shall have the right to enter the area of Work where the Contractor is responsible for maintaining traffic to remove snow and ice and place abrasives at their own expense, as necessary. The Contractor shall be responsible for the removal of abrasives, for which no claim for additional compensation shall be allowed nor shall the Contractor be relieved in any way of his obligation for maintenance of traffic.

D. The Contractor shall lay and maintain temporary ramps, bridges, and trench crossings, such as in the opinion of the Engineer are necessary to accommodate through traffic and the general public.

3.4 TRAFFIC CONTROL

A. The specifications, installation, maintenance, and operation of all traffic controls and traffic control devices (e.g., signs, barricades, lights, and traffic regulators) shall conform to the requirements of the MMUTCD. Traffic control devices shall be provided with suitable supports of sufficient strength and stability.

B. Faces of construction signs, barricades, vertical panels, and drum banks shall be suitably reflectorized complying with MDOT standards.

C. Barricades and channelizing devices such as cones, vertical panels, hazard markers, and drums shall be highly visible. They shall also be protected by adequate advance warning devices and by suitable lighting or reflectorization at night (between the hours of sunset to sunrise). All such devices shall be provided by the Contractor.

D. Detour signs, traffic control signs, barricades, construction lighting, etc., shall be replaced whenever damaged, stolen, or vandalized.

E. Detour signs when not in use shall either be removed or covered to avoid motorist confusion.

F. Equipment and material stored on the street shall be marked at all times. At night, any such material or equipment stored between the side ditches or within five (5) feet behind any raised curbs, shall be clearly outlined with dependable lighted devices that are approved by the Engineer. In addition, the Contractor shall provide any other lights, barricades, etc., that may be needed for the protection of pedestrian traffic.

G. Furnish traffic regulators, warning lights, signs, and barricades as necessary to protect vehicular and pedestrian traffic within the Work limits.

H. Existing signs and traffic control devices within the Work limits shall remain in use during the construction period. If the Contractor needs to relocate or modify existing signs or traffic control devices as a consequence of his Work, he shall provide suitable supports and may modify the devices with prior approval of the Engineer and the maintaining agency. Routine maintenance of existing traffic control devices will remain the responsibility of the maintaining agency. The function of existing Stop or Yield signs shall be retained at all times although their position may be adjusted. Existing signs that must be relocated laterally shall be placed in accordance with the MMUTCD. The Contractor shall restore all relocated or modified signs to the position and condition which existed prior to construction.

I. When an existing signal operation must be interrupted for a period, the Contractor shall provide a temporary traffic control method approved by the Owner and the jurisdictional authority maintaining the signal.

J. Whenever it is necessary for the Contractor to divert the flow of traffic from its normal channel into another channel, the channel for such diverted traffic shall be clearly marked by the Contractor with cones, drums, barricades, vertical panels, pavement markings, or flashing arrow panels. This method of marking shall also be used where Work is being done adjacent to the part of the street or highway in use by the public or where Work is being done on the shoulder where the roadway is being used by the public. During darkness hours, barricades and drums shall be supplemented with yellow flashing or steady burning electric warning lights in accordance with the MMUTCD.

K. The Contractor shall obtain the approval of the Engineer and the jurisdictional authorities before closing a traffic lane or establishing a one-way traffic operation.

L. Maintenance during Construction:

1. Maintain the Work and detour routes throughout the course of construction. The Contractor is responsible for any damage done by its equipment.
2. Maintain the previous courses or subgrade during all construction operations when placing a course upon other courses of embankment, base, subgrade, concrete or asphalt pavement, or other similar items previously constructed. This maintenance includes, but is not limited to, draining, re-compacting, re-grading, or if destroyed, the removal of Work previously accepted by the Department.

M. If the Contractor fails to maintain roadways or structures at any time, the Engineer will immediately notify the Contractor of such noncompliance. If the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may immediately proceed to maintain the Project and deduct the entire cost of this maintenance from monies due to the Contractor on the Contract.

3.5 PEDESTRIAN OR NON-MOTORIZED FACILITIES

A. Maintain all facilities in accordance with The Americans with Disability Act (ADA) requirements. Provide facilities equivalent to or better than the route a person would have encountered prior to construction activities.

B. Close and detour any sidewalk ramps and crosswalk areas to pedestrian traffic that are impacted by the Work. Cover pedestrian signal heads when the crosswalk or ramp is affected.

C. Keep sidewalk areas clear of any equipment or materials at all times the sidewalks are open to pedestrian traffic.

3.6 PAVEMENT MARKING OPERATIONS

A. Moving marking operations shall be performed by a truck equipped with necessary flashers and warning signs and shall be protected by a similarly equipped trailing vehicle(s) separated a sufficient distance to provide advance warning to overtaking traffic. The marking operation should use the extreme left or right lane when possible. Where three (3) or more lanes exist, the operation shall allow traffic to pass on one side only.

B. Stationary marking operations in intersections, school zones, gores and other areas shall be protected with traffic control devices such as advance warning signs and cones.

3.7 TRAFFIC REGULATION

A. Whenever one (1) lane, two (2) way traffic is established, at least two (2) traffic regulators shall be used unless otherwise permitted by the Engineer, and signs, cones, barricades and other traffic control devices shall be erected by the Contractor in accordance with the MMUTCD. Traffic control devices shall be reflectorized. The Contractor shall maintain positive and quick means of communication between the traffic regulators at opposite ends of the restricted area.

B. Traffic regulators shall be equipped according to the standards for traffic regulation contained in the MMUTCD. A reflectorized Stop/Slow paddle shall be used, red flags are allowed for emergency situations only. At night, traffic regulator stations shall be adequately illuminated and traffic regulators may use a red glow cone in addition to the Stop/Slow paddle as approved by the Engineer.

C. The control and regulation of traffic by the traffic regulators and performance of their duties shall conform to the standards in the MMUTCD. In lieu of using flaggers or to supplement the flaggers, the Contractor may furnish, install, and operate a temporary traffic signal or signals to regulate traffic, in accordance with a written agreement approved by the Engineer and the jurisdictional authorities.

3.8 GENERAL MAINTENANCE OF TRAFFIC

A. Unless otherwise permitted, directed, or ordered by the Engineer, traffic shall be specifically maintained as follows:

1. A minimum of one (1) lane for emergency vehicles is to be provided at all times on all streets affected by this Project. Provide temporary access for emergency vehicles through the site during the full road closure periods as specified below.
2. During paving operation, one (1) lane of traffic must be maintained at all times. Traffic regulators are required to direct traffic where a one (1) lane, two (2) way configuration is maintained.
3. All trenches and openings shall be backfilled as soon as possible or as specified, and the pavement restored.
4. The Contractor shall confer with the Engineer, jurisdictional authorities, local property owners, and others who may be affected by the Project before starting any Work at locations affecting said parties; carrying out of this Work with respect to traffic maintenance shall be covered by agreements reached at such conferences.
5. The location, design, and construction of driveways, roads, and access and egress points for construction equipment vehicles to access public streets, which may be required by the Contractor for construction on easements and other locations, shall be approved by the Engineer. All such points shall be provided with adequate warning signs.
6. No parking or standing of vehicles on streets will be permitted.
7. The Contractor shall provide dust control on all streets in this Project, per the City of Detroit Fugitive Dust Ordinance (Ordinance No. 32-17), to the satisfaction of the Engineer.

B. During Work progress, the Contractor shall accommodate both vehicular and pedestrian traffic as provided in these Specifications and as indicated on the drawings. Access to fire hydrants and water valves shall always be maintained. The Contractor's truck and equipment operations on public streets shall be governed by all local traffic ordinances, regulations of the Fire and Police Departments, and all corresponding jurisdictional authorities. The Contractor shall provide access for emergency equipment and operations to the work site during non-working hours and shall provide any assistance required by police, fire, or other officials during working hours.

C. Small street openings necessary for manholes, alignment holes, sewer connection, or other purposes will be permitted. Such holes shall not be open longer than necessary and shall be done to the satisfaction of the Engineer. Small openings shall be covered with steel plates at pavement level and be secured in place when Work is not performed.

D. The Contractor is responsible for informing the local Fire Department in advance of street obstruction and detours so the Fire Department can plan for servicing the area in case of an emergency. The Contractor shall also notify the governing Police Department and the Engineer at least one (1) week prior to obstructing any street. All notifications should be made in writing or via email with the Engineer included in the distribution list.

E. Road Detours: The Contractor shall provide and maintain all temporary roadways as required due to his operations or as required under "Road Permits" or otherwise specified or shown on the plans.

END OF SECTION 01 55 26

SECTION 01 57 13 - EROSION CONTROL, SEDIMENTATION AND CONTAINMENT OF CONSTRUCTION MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all work and take all measures necessary to control soil erosion resulting from construction operations, prevent flow of sediment from construction site, and contain construction materials (including excavation and backfill) within protected working area as to prevent damage to any stream or wetlands.

1.2 STANDARDS

Comply with the latest edition of the following standards, except as modified herein:

A. Michigan Department of Environment, Great Lakes and Energy (EGLE):

1. Soil Erosion and Sedimentation Control; Part 91 of the Natural Resources and Environmental Protection Act 451 (NREPA).

B. Wayne County Department of Public Services Engineering Division:

1. Wayne County Soil Sedimentation Control Ordinance No. 2001-759.

1.3 SUBMITTALS

A. If work will disturb more than one (1) acre of land or is within 500 feet of a lake or stream, a Soil Erosion and Sedimentation Control Permit shall be obtained from the local soil erosion agency per MCL Part 91 of Act 451.

B. For all projects, submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.

C. At least ten (10) days prior to any field activity, submit an Erosion and Sedimentation Control Plan to the Engineer for review and approval, and include the following:

1. Description and location of the limits of proposed earth changes.
2. Timing and sequence of proposed earth changes.
3. Description, location, and details of proposed temporary erosion and sedimentation control measures including any dewatering operations.
4. Description, location, and details of proposed permanent erosion and sedimentation control measures.

5. A program proposal for the maintenance of erosion and sedimentation control facilities both during and after construction. The facilities, which are to remain after project completion, shall include a designation of the party responsible to carry out maintenance.
6. Statement of the site plan indicating who is responsible for maintenance of the soil erosion controls and that "the soil erosion controls will be inspected and maintained weekly and within 24 hours after every storm event."

1.4 QUALITY ASSURANCE

A. Comply with the requirements specified in Section 01 40 00 – Quality Requirements.

B. Use Best Management Practices, including use of water diversion structures, diversion ditches, settling basins, and sediment traps.

C. Operations shall be restricted to areas of work indicated on drawings and the area which must be entered for construction of temporary or permanent facilities.

D. If construction materials are washed away during construction, remove materials from fouled areas.

E. Limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill operations. The Engineer has the authority to direct the Contractor to take immediate permanent or temporary pollution control measures to prevent contamination of any stream or wetlands, including construction of temporary berms, dikes, dams, sediment basins, sediment traps, slope drains, sod inlet filters, vegetative buffer strips, and use of temporary mulches, mats, or other control devices or methods to control erosion.

PART 2 - PRODUCTS

2.1 EROSION CONTROL BLANKETS

A. Hay, straw, or other suitable material selected from the Michigan Department of Transportation (MDOT) Qualified Products List.

B. Top and bottom photodegradable, biodegradable, or natural fiber netting.

C. Use hardwood stakes or staples on slopes greater than 1:3. Spaced per manufacturer recommendations.

D. Use mulch blankets with netting on top side on slopes flatter than 1:2. Use mulch blankets as permanent stabilization treatment for ditches with slopes between 0.5 percent and 1.5 percent.

E. Use high velocity blankets with netting on top and fibers in contact with soil on slopes 1:2 or greater. Use high velocity mulch blanket as permanent stabilization treatment for ditches with slopes between 1.5 percent and 3.0 percent.

2.2 INLET FILTER FABRIC

A. Geotextile filter fabric wrapped around the grate of a low point inlet structure or protected by an inlet filter insert in the structure.

B. Products: Siltsack Type B, Inlet Pro Sediment Bag, Dandy Curb Sack, Basin Bag, or an approved equivalent.

2.3 SILT FENCE

A. Geotextile filter fabric from MDOT Qualified Products List with hardwood support system.

B. Reduce the velocity of sheet flow to a non-erosive level and retain suspended soil particles from leaving the construction site.

C. Install along a contour line of equal elevation on a slope.

D. Maximum sheet flow path of 100 feet.

E. Overlap sections of silt fence according to the DWSD Standard Detail Drawings.

F. Excavate 6-inch by 6-inch trench and backfill and compress tail of geotextile filter fabric into it; 6 inches of pea stone may be placed on the flap if the ground is frozen, and the fabric shall be trenched in as soon as the ground has sufficiently thawed.

G. Install drain guard around catch basins and storm inlets as shown on Erosion and Sedimentation Control Plan.

2.4 CHECK DAM

A. Permission from the governmental agency responsible for maintenance of the ditch shall be obtained prior to installation.

B. Ditch shall only be partially blocked to minimize the loss in ditch flow capacity. Maximum blockage shall not exceed 50 percent.

C. Rip rap shall be 2 to 4 inches in size for ditch grades less than 2 percent and 3 to 12 inches for ditch grades greater than 2 percent.

D. Base shall be at least twice the height of the dam.

E. Remove when upstream areas contributing flow are stabilized; thus, allowing the ditch to function as designed.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not discharge chemicals, fuels, lubricants, bitumen, raw sewage or other harmful waste into or alongside any body of water or into natural or man-made channels.

B. Design erosion and sediment controls to handle peak runoff resulting from 10-year, 24-hour storm events.

C. Inspect and maintain these control measures and ensure their proper function and adequate sediment storage at all times. Remove sediment once it reaches 50 percent of the capacity of the structure or when it reaches 1/3 the height of the fence. Sediment collected shall be disposed of off-site at no additional cost to the Owner.

3.2 INSTALLATION

A. Take steps to minimize erosive loss and resultant offsite sedimentation from the site and from stored piles of excavated spoils, topsoil, sand, gravel, and aggregate.

B. Use soil erosion techniques such as ground cover vegetation and seeding, compaction, rip rap, silt fence, and erosion control blankets where there is erosion potential.

C. Provide sedimentation control measures, such as inlet filter fabric, at affected existing or new storm drains prior to clearing, grubbing, or grading.

D. Construct earth berms or diversions to intercept and divert runoff water from critical areas.

E. Discharge silt-laden water from excavations onto filter fabric mat or baled hay or straw sediment traps. Ensure that only sediment-free water is allowed to flow to watercourses.

F. Do not place excavated soil material adjacent to watercourse in a manner that will cause it to wash away.

G. Prevent damage to vegetation by excessive watering or silt accumulation in the discharge area.

H. Do not dump spoiled material into any streams, wetlands, surface waters, or unspecified locations.

I. Prevent indiscriminate, arbitrary, or capricious operation of equipment in streams, wetlands or surface waters.

J. Do not pump silt-laden water from trenches or excavations into surface waters, streams, wetlands, or natural or man-made channels leading thereto.

K. Prevent damage to vegetation adjacent to or outside of construction area limits.

L. Do not dispose of trees, brush, debris, paints, chemicals, asphalt products, concrete curing compounds, fuels, lubricants, insecticides, washwater from concrete trucks or hydroseeders, or any other pollutant in streams, wetlands, surface waters, or natural or man-made channels leading thereto, or unspecified locations.

M. Do not alter flow line of any stream unless indicated or specified.

N. Positive dust control measures shall be taken at all times. Comply with the City of Detroit Fugitive Dust Ordinance (Ordinance No. 32-17) requirements during Construction.

O. All mud, dirt, and debris tracked onto existing roads from the Site shall be promptly removed.

P. All temporary erosion control facilities shall be removed at the completion of construction.

END OF SECTION 01 57 13

SECTION 01 57 15 - TEMPORARY SEWER BYPASS PUMPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for implementing a temporary pumping system for diverting existing flow around the Work area for duration of the work performed in the sewer.

B. Related Requirements:

1. Section 02 01 20 - Protecting Existing Underground Utilities.
2. Section 03 60 00 - Grouting.
3. Section 31 23 33 - Trenching and Backfill.

1.2 QUALITY ASSURANCE

A. Use only materials that are suitable for sewer piping systems.

B. Perform leakage and pressure tests on discharge piping before operation. Notify the Engineer 24 hours prior to testing. Should any liquid or solid matter from the bypass pump system be spilled, discharged, leaked or otherwise deposited into the open environment immediately clean up and disinfect the affected area. Notify the Owner and perform required cleanup at no additional cost to the Owner.

C. At a minimum, maintain and inspect temporary pumping system at the beginning and end of each shift that pumps are operating. Responsible operator shall be on site at all times when pumps are operating.

D. Keep and maintain spare parts for pumps and piping on site, as required.

E. Maintain adequate hoisting equipment and accessories on site for each pump.

F. Maintain daily maintenance and inspection logs.

1.3 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:

1. Detailed bypass pumping plan and description of proposed pumping system. Indicate number, size, material, location and method of installation of suction and discharge piping, size of pipeline or conveyance system to be bypassed, staging area for pumps, site access point, and expected flow.

a. Size and location of manhole or access points for suction and discharge hose or piping.
b. Sections showing suction and discharge pipe depth, embedment, select fill and special backfill, if buried.
c. Temporary pipe supports and anchoring required.
d. Thrust and restraint block sizes and locations.
e. Sewer plugging method and type of plugs.
f. Weir locations, heights and materials.
g. Bypass pump sizes, capacity, number of each size to be on site and power requirements.
h. Backup pump, power and piping equipment.
i. Calculations of static lift, friction losses, and flow velocity. Pump curves showing pump operating range.
j. Design plans and computation for access to bypass pumping locations indicated on drawings.
k. Calculations for selection of bypass pumping pipe size.
l. Method of noise control for each pump and/or generator.
m. Method of protecting discharge manholes or structures from erosion and damage.
n. Method of preventing odors from being generated above normal levels.
o. Schedule for installation and maintenance of bypass pumping lines.
p. Procedures to monitor upstream mains for backup impacts.
q. Procedures for setup and breakdown of pumping operations.
r. Cold weather operational plan as appropriate to protect equipment and pipes from freezing.
s. Alarm system that will allow prompt determination of either excessive sewer surcharging or loss of bypassing piping integrity during operation.
t. Plan to address wet weather flows if they are encountered.
u. Emergency plan detailing procedures to be followed in event of pump failures, sewer overflows, service backups, and sewage spillage.

B. Submit the following in accordance with Section 01 40 00 – Quality Requirements.

1. Certification by a Professional Engineer (PE) that the bypass system will meet requirements of codes and regulatory agencies having jurisdiction.

1.4 CONTRACTORS RESPONSIBILITY FOR OVERFLOWS AND SPILLS

A. Schedule and perform Work in manner that does not cause or contribute to incidence of overflows, releases or spills of sewage from sanitary sewer system or bypass operation. Should any liquid or solid matter from the bypass pump system be spilled, discharged, leaked or otherwise deposited into the open environment the immediately clean up and disinfect the affected area. Notify the Owner and perform required cleanup at no additional cost to the Owner.

1.5 DELIVERY AND STORAGE

A. Transport, deliver, handle, and store pipe, fittings, pumps, ancillary equipment and materials to prevent damage and following manufacturer's recommendations.

B. Inspect all material and equipment for proper operation before initiating Work.

C. Material found to be defective or damaged due to manufacturer or shipment:

1. When Engineer deems repairable: Repair as recommended by manufacturer.
2. When Engineer deems not repairable: Replace as directed by Engineer before initiating Work.

PART 2 - PRODUCTS MATERIALS

A. Discharge, Suction, and Bypass Pipes: As approved by Engineer.

1. Discharge piping: Determine according to flow calculations and system operating calculations submittal.
2. Suction piping: Determine according to pump size, flow calculations, and manhole depth following manufacturer's specifications and recommendations.
3. Homogenous throughout, free of visible cracks, discoloration, pitting, varying wall thickness, holes, foreign material, blisters, or other deleterious faults.

B. Flexible Hoses and Associated Couplings and Connectors:

1. Suitable for intended service per the specifications herein and as approved by Engineer.
2. Rated for external and internal loads anticipated by the pump selected for use, including test pressure expected during leakage and pressure tests.
3. When subject to traffic loading, compose system, such as traffic ramps or covers, install system and maintain H-20 loading requirements while in use or as directed by the Engineer.

C. Valves and Fittings: Determine according to flow calculations, pump sizes previously determined, and system operating pressures.

D. Plugs: Select and install according to size of line to be plugged, pipe and manhole configurations, and based on specific site.

E. Additional plugs: Make available in the event a plug fails. Plugs shall be inspected before use for defects which may lead to failure.

F. Neither aluminum "irrigation type" piping nor glued PVC piping will be permitted.

2.2 EQUIPMENT

A. Pumps:

1. Fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in priming system.
2. Electric or diesel powered.
3. Constructed to allow dry running for long periods of time to accommodate cyclical nature of effluent flows.
4. Provide:
    a. Necessary stop/start controls for each pump.
    b. One standby pump of equal size of primary pump which shall be online and isolated by individual valves and ready for immediate use in the event of failure of primary pump or an emergency.
    c. Noise control shall be utilized as a means to reduce noise to a level as required to comply with City of Detroit noise ordinances.

2.3 DESIGN REQUIREMENTS

A. Provide pipeline plugs, weirs, discharge piping and pumps of adequate size to divert the encountered dry weather flow.

B. Temporary bypass system shall be capable of operation 24 hours per day if necessary.

2.4 PERSONNEL

A. Contractor shall at all times of pump operation when a weir or plug is installed in the sewer, have personnel to operate and monitor the pump(s) including during non-working hours.

PART 3 - EXECUTION PREPARATION

A. Maintain copy of emergency plan on site for duration of project.

B. Determine location of bypass pumping system in order to minimize disturbance to existing utilities. Field locate existing utilities in proposed bypass area. Obtain approvals for placement within public or private property. Obtain Engineer's approval of locations prior to construction.

3.2 INSTALLATION AND REMOVAL

A. Provisions and requirements shall be submitted to the Engineer before starting construction.

B. Remove manhole sections or make connections to existing sewer and construct temporary bypass pumping structures at access locations to provide adequate suction conduit.

C. Plugging or blocking of sewage flows shall incorporate a primary and secondary plugging device. When plugging or blocking is no longer needed for performance and acceptance of Work, remove in a manner that permits the sewage flow to slowly return to normal without surge, or causing other major disturbances downstream.

D. Weirs shall be installed and removed so as not to cause structural damage to the sewers or manholes. Drill holes shall be filled as per Section 03 60 00 - Grouting.

E. When working inside manhole or force main, exercise caution. Follow OSHA, Local, State and Federal requirements. Take required measures to protect workforce against sewer gases and/or combustible or oxygen-deficient atmosphere.

F. Installation of Bypass Pipelines:

1. Lay bypass out of traveled way in manner to protect the bypass from damage.
2. When bypass pipeline crosses local streets and private driveways, place in roadway ramps.
3. When roadway ramps cannot be used, place bypass in trenches and cover with temporary pavement as approved by Engineer.

G. During bypass pumping operation, protect sewer lines from damage inflicted by equipment.

H. Upon completion of bypass pumping operations, remove piping, restore property to preconstruction condition and restore pavement.

END OF SECTION 01 57 15

SECTION 01 57 33 – TEMPORARY SECURITY MEASURES

PART 1 - GENERAL

1.1 SCOPE

A. Implement a security program during construction to prevent unauthorized entry into the Work areas; theft of small tools, equipment and materials; and willful destruction of property.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 SECURITY

A. Security at the sites shall be the sole responsibility of the Contractor. All materials necessary to provide any and all measures of security above and beyond those shown on the plans shall be at no additional cost to the Owner. Any materials stolen from the site shall be replaced by the Contractor at no additional cost to the Owner.

B. Until Substantial Completion of the Project, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements, from vandalism or from any other cause, whether arising from the execution or from the non-execution of the Work. Rebuild, repair, restore, and make good all injuries or damages to any portion of the Work before Substantial Completion.

C. Safely guard all Work, materials, Equipment, and property from loss, theft, damage, and vandalism. Safely guard the City's property and other private property or adjacent property from damage or loss in connection with the performance of the Work.

D. Make no Claim of any kind against the City for damage resulting from trespass.

E. Make good all damage to property of City and others arising from its failure to provide adequate security.

F. If temporary fencing or barricades are breached or removed for purposes of construction, provide and maintain temporary construction fencing accepted equal to the existing in a manner satisfactory to the Engineer.

G. Maintain Building and Site security at all times within the Work limits of this Contract and locations directly affected by the Project or the Work.

H. Provide temporary weather tight enclosures for all exterior openings. If required to maintain security and to protect the Contractor's and Owner's interest, employ watchmen at no extra cost to the City.

END OF SECTION 01 57 33

SECTION 01 58 13 – TEMPORARY PROJECT SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project identification sign.
2. Project informational signs.

1.2 STANDARDS

A. FHWA (SHS) – Standard Highway Signs; Federal Highway Administration, U.S. Department of Transportation, 2004.

1.3 QUALITY ASSURANCE

A. Design sign and structure to adequately withstand high winds.

B. Sign Manufacturer shall have experience in manufacturing signage with references on similar projects.

C. Finishes, Vinyl: Adequate to withstand weathering, fading, and chipping for the duration of construction.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Shop Drawing: Show content, layout, letting, color, foundation structure, sizes and grades of members.

C. Sign manufacturer’s qualifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Signs: Manufacturer shall be approved by Engineer or Owner based on experience in manufacturing signage with references from similar projects.

2.2 SIGN MATERIALS

A. Structure and Framing: New, wood, structurally adequate to support the sign including wind loadings.

B. Sign Surfaces: Exterior grade plywood, single sheet, with medium density overlay, and minimum ¾-inch thick.

C. Rough Hardware: Galvanized.

D. Vinyl: Exterior quality; sign background of color as specified.

E. Lettering: Vinyl or digitally printed, colors as specified.

2.3 PROJECT IDENTIFICATION SIGN

A. One vinyl graphic sign, 24 sq. ft. area, bottom 4 feet above ground.

B. Graphic Design, Colors, Style of Lettering: Arial.

2.4 PROJECT INFORMATIONAL SIGNS

A. Vinyl informational signs shall be of the same colors and lettering as the Project Identification sign; size lettering to provide legibility at 100-foot distance.

B. Provide at field office, and directional signs to direct traffic into and within site. Relocate as Work progresses.

C. Provide municipal traffic agency directional traffic signs to and within site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install project identification sign at least 14 days prior to any field activity.

B. Erect at designated location as directed by the Engineer.

C. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.

D. Install sign surface plumb and level. Anchor securely.

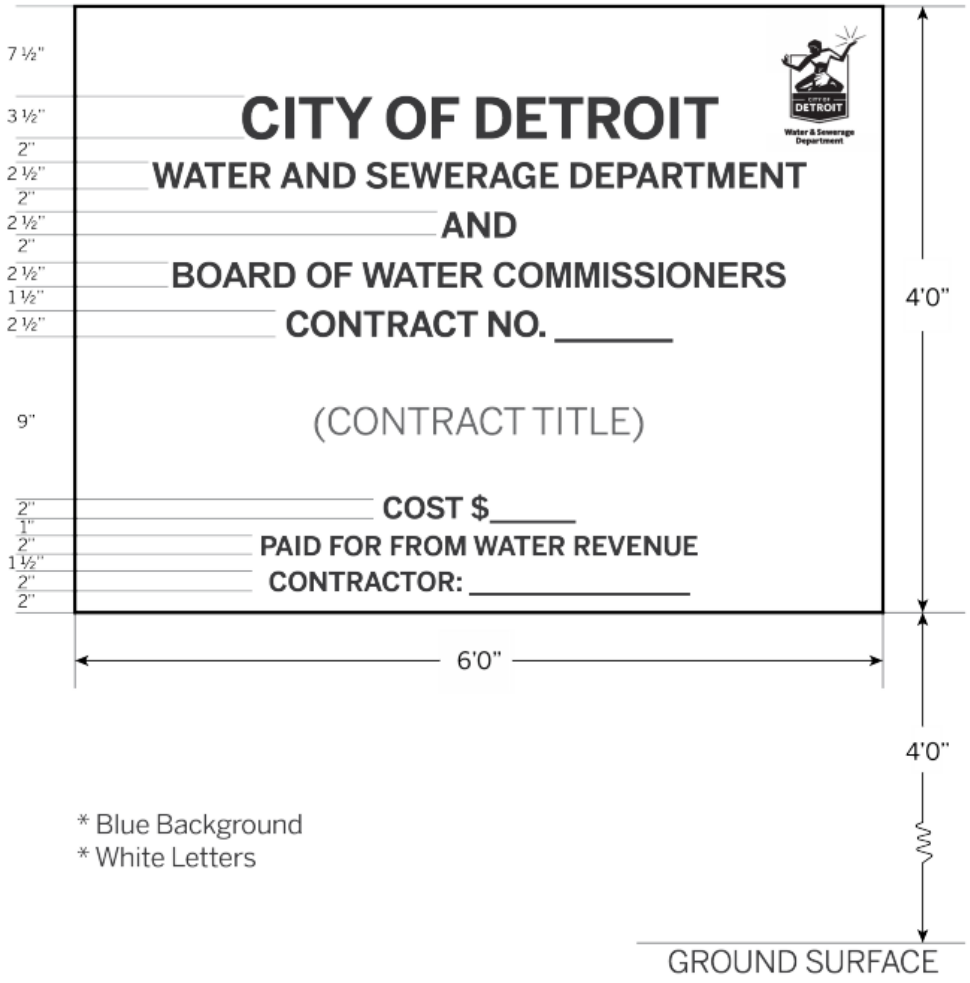
E. Exposed surfaces of signs, supports, and framing to be treated lumber.

3.2 MAINTENANCE

A. Maintain signs and supports; clean, repair deterioration and damage.

3.3 REMOVAL

A. Remove signs, framing, supports, and foundations at completion of Project and restore the area.



END OF SECTION 01 58 13

SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Field Engineering.
2. Closeout Procedures.
3. Starting of Systems.
4. Demonstration and Instructions.
5. Project Record Documents.
6. Operation and Maintenance Data.
7. Manual for Materials and Finishes.
8. Manual for Equipment and Systems.
9. Spare Parts and Maintenance Products.
10. Product Warranties and Product Bonds.
11. Maintenance Service.
12. Examination.
13. Preparation.
14. Installation.
15. Cutting and Patching.
16. Protecting Installed Construction.
17. Final Cleaning.

1.2 FIELD ENGINEERING

A. Employ a Land Surveyor registered in the State of Michigan and acceptable to the Engineer or Owner.

B. Locate and protect survey control and reference points. Promptly notify the Engineer of any discrepancies discovered.

C. Control datum for survey is indicated on Drawings.

D. Verify setbacks and easements; confirm Drawing dimensions and elevations.

E. Provide field engineering services. Establish elevations, lines, and levels using recognized engineering survey practices.

F. Maintain a complete and accurate log of control and survey work as Work progresses.

G. Protect survey control points prior to starting Site Work; preserve permanent reference points during construction.

H. Promptly report to the Engineer any loss or destruction of reference point, or any relocation required because of changes in grades or other reasons.

I. Replace dislocated or displaced survey control points based on the original survey control. Make no changes without prior written notice to the Engineer.

1.3 CLOSEOUT PROCEDURES

A. Prerequisites to Substantial Completion: Complete the following items before requesting Certification of Substantial Completion, either for the entire Work or for portions of the Work:

1. Submit maintenance manuals, Project record documents, digital images of construction photographs, negatives of construction photographs, and other similar final record data in compliance with this Section.
2. Complete facility startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance with this Section.
3. Conduct inspection to establish basis for request that Work is substantially complete. Create comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reasons for being incomplete, and date of anticipated completion for each item. Include a copy of the list with the request for Certificate of Substantial Completion.
4. Obtain and submit releases enabling Owner's full, unrestricted use of Project and access to services and utilities. Include certificate of occupancy, operating certificates, and similar releases from authorities having jurisdiction and utility companies.
5. Deliver tools, spare parts, extra stocks of material, and similar physical items to Owner.
6. Make final change-over of locks and transmit keys directly to Owner. Coordinate with DWSD Security and Advise Owner's personnel of change-over in security provisions.
7. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.
8. Perform final cleaning according to this Section.

B. Substantial Completion Inspection:

1. When Contractor considers Work to be substantially complete, submit to the Engineer:
   a. Written certificate that Work, or designated portion, is substantially complete.
   b. List of items to be completed or corrected (initial punch list).

2. After receipt of request for substantial inspection, the Engineer will promptly make an inspection to determine whether the Work or designated portion of the Work is substantially complete.

3. Should the Engineer determine that the Work is not substantially complete:
   a. The Engineer will notify Contractor in writing, stating reasons for its opinion.
   b. Contractor shall remedy deficiencies in the Work and send a second written request for Substantial Completion to the Engineer.
   c. The Engineer will re-inspect Work.

d. Redo and Inspection of Deficient Work: Repeated until the Work passes the Engineer's inspection.

4. When the Engineer finds that the Work is substantially complete, the Engineer will:
   a. Prepare a Certificate of Substantial Completion accompanied by the Contractor's list of items to be completed or corrected as verified and amended by the Engineer and Owner (final punch list).
   b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate.

5. After Work is substantially complete, Contractor shall:
   a. Allow Owner occupancy of the Project under the provisions stated in the Certificate of Substantial Completion.
   b. Complete Work listed for completion or correction within time period stipulated.

C. Prerequisites for Final Completion: Complete the following items before requesting final acceptance and final payment.

1. When Contractor considers the Work to be complete, submit written certification that:
   a. Contract Documents have been reviewed.
   b. Work has been examined for compliance with Contract Documents.
   c. Work has been completed according to Contract Documents.
   d. Work is completed and ready for final inspection.

2. Contractor shall submit the following:
   a. Final punch list indicating all items have been completed or corrected.
   b. Final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
   c. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
   d. Accounting statement for final changes to Contract Sum.
   e. Contractor's affidavit of payment of debts and claims.
   f. Contractor affidavit of release of liens.
   g. Consent of surety to final payment.

3. Perform final cleaning for Contractor-soiled areas according to this Section.

D. Final Completion Inspection:

1. After receipt of request for final inspection, the Engineer will promptly make an inspection to determine whether the Work or designated portion is complete.
2. Should the Engineer consider the Work to be incomplete or defective:
   a. The Engineer will notify the Contractor in writing, listing incomplete or defective Work.
   b. Contractor shall remedy stated deficiencies and send second written request to the Engineer that Work is complete.
   c. The Engineer will re-inspect Work.

d. Redo and Inspection of Deficient Work: Repeated until Work passes the Engineer’s inspection.

1.4 STARTING OF SYSTEMS

A. Coordinate schedule for startup of various equipment and systems.

B. Notify the Engineer seven (7) days prior to startup of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

D. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer.

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute startup under supervision of manufacturer's representative or Contractor’s personnel as specified.

G. When specified in individual Specification Sections, require manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve equipment or system installation prior to startup and will supervise placing equipment or system in operation.

H. Submit a written report according to Section 01 33 00 – Submittal Procedures that equipment or system has been properly installed and is functioning correctly.

1.5 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products to Owner's personnel two (2) weeks prior to date of Substantial Completion.

B. Video Recordings: Provide high-quality color digital video recordings of demonstration and instructional sessions. Video recordings shall comply with Section 02 22 30 – Pre-Construction Video and Photographic Record. Engage commercial videographer to record sessions. Include classroom instructions, demonstrations, board diagrams, and other visual aids. Include menu navigation.

C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six (6) months.

D. Use operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

E. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at designated location.

F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

G. Required instruction time for each item of equipment and system is specified in individual Specification Sections.

1.6 PROJECT RECORD DOCUMENTS

A. Comply requirements for electronic project documentation found in Section 01 78 39 – Electronic Project Record Documentation.

B. Maintain one set of the following record documents on-site during installation and until completion of construction; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, product data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjusting.

C. Ensure that entries are complete and accurate, enabling future reference by Owner.

D. Store record documents separate from documents used for construction.

E. Record information concurrent with construction progress, not less than weekly.

F. Specifications: Legibly mark and record, at each product Section, description of actual products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates used.
3. Changes made by Addenda and modifications.

G. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction as follows:

1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders.
2. Include locations of concealed elements of the Work.
3. Identify depth of buried utility lines and provide dimensions showing distances from permanent facility components that are parallel to utilities.
4. Dimension ends, corners, and junctions of buried utilities to permanent facility components using triangulation.
5. Identify and locate existing buried or concealed items encountered during the Project.
6. Measured depths of foundations in relation to finish floor datum.

7. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
8. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
9. Field changes of dimension and detail.
10. Details not on original Drawings.

H. Submit electronic files of legible marked-up documents using PDF or CAD software to the Engineer on completion of the Work and prior to final payment by DWSD.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit in PDF composite electronic indexed file.

B. Submit data bound in 8-1/2 x 11-inch text pages, three (3) D side ring binders with durable covers.

C. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS," title of Project**,** and subject matter of binder when multiple binders are required.

D. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab title clearly printed under reinforced laminated plastic tabs.

E. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

F. Contents: Prepare table of contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:

1. Part 1: Directory, listing names, addresses, and telephone numbers of the Engineer, Contractor, Subcontractors, and major equipment suppliers.
2. Part 2: Operation and Maintenance Instructions, arranged by system and subdivided by Specification Section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Include the following:
    a. Significant design criteria.
    b. List of equipment.
    c. Parts list for each component.
    d. Operating instructions.
    e. Maintenance instructions for equipment and systems.
    f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
    g. Safety precautions to be taken when operating and maintaining or working near equipment.

3. Part 3: Project documents and certificates, including the following:
    a. Shop Drawings and product data.

b. Air and water balance reports.
c. Certificates.
d. Originals of warranties and bonds.
e. Pressure testing reports.
f. Disinfection reports and bacteriological results.

1.8 MANUAL FOR MATERIALS AND FINISHES

A. Submit two (2) copies of preliminary draft or proposed formats and outlines of contents before start of the Work. The Engineer will review the draft and return one (1) copy with comments.

B. For equipment or component parts of equipment put into service during construction and operated by Owner, submit documents within ten (10) days after acceptance.

C. Submit one (1) copy of completed volumes before Substantial Completion. The Draft copy will be reviewed and returned after Substantial Completion, with Engineer's comments. Revise content of document sets as required prior to final submission.

D. Submit two (2) sets of revised final volumes within ten (10) days after final inspection.

E. Submit in PDF the composite electronic indexed file of the final manual within ten (10) days after final inspection.

F. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Include information for re-ordering custom-manufactured products.

G. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

H. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.

I. Additional Requirements: As specified in individual product Specification Sections.

J. Include listing in table of contents for design data, with tabbed fly sheet and space for insertion of data.

1.9 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit two (2) copies of preliminary draft or proposed formats and outlines of contents before start of the Work. Engineer will review draft and return one (1) copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

C. Submit one copy of completed volumes before Substantial Completion. Draft copy will be reviewed and returned after Substantial Completion, with Engineer comments. Revise content of document sets as required prior to final submission.

D. Submit two (2) sets of revised final volumes within ten (10) days after final inspection.

E. Submit in PDF composite electronic indexed file of final manual within ten (10) days after final inspection.

F. Each Item of Equipment and Each System: Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

G. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

H. Include color-coded wiring diagrams as installed.

I. Finished electrical coordination studies.

J. Operating Procedures: Include startup, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and special operating instructions.

K. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

L. Include servicing and lubrication schedule and list of lubricants required.

M. Include manufacturer's printed operation and maintenance instructions.

N. Include sequence of operation by controls manufacturer.

O. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

P. Include control diagrams by controls manufacturer as installed.

Q. Include Contractor's coordination drawings with color-coded piping diagrams as installed.

R. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

S. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

T. Include test and balancing reports as specified in Section 01 40 00 - Quality Requirements.

U. Additional Requirements: As specified in individual product Specification Sections.

V. Include listing in table of contents for design data with tabbed dividers and space for insertion of data.

1.10 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual Specification Sections.

B. Deliver to location as specified by Owner; obtain receipt prior to final payment.

1.11 PRODUCT WARRANTIES AND PRODUCT BONDS

A. Obtain warranties and bonds executed in duplicate by responsible Subcontractors, suppliers, and manufacturers within ten (10) days after completion of applicable item of Work.

B. Execute and assemble transferable warranty documents and bonds from Subcontractors, suppliers, and manufacturers.

C. Verify documents are in proper form, contain full information, and are notarized.

D. Co-execute submittals when required.

E. Include table of contents and assemble in three D side ring binder with durable cover.

F. Submit prior to final Application for Payment.

G. Time of Submittals:

1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within ten (10) days after acceptance.
2. Make other submittals within ten (10) days after date of Substantial Completion, prior to final Application for Payment.
3. For items of Work for which acceptance is delayed beyond Substantial Completion, submit within ten (10) days after acceptance, listing date of acceptance as beginning of warranty or bond period.

1.12 MAINTENANCE SERVICE

A. Furnish service and maintenance of components as indicated in Specification Sections.

B. Examine system components at frequency consistent with reliable operation. Clean, adjust, and lubricate as required.

C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by manufacturer of original component.

D. Do not assign or transfer maintenance service to agent or Subcontractor without prior written consent of Owner.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual Specification Sections.

D. Verify that utility services are available with correct characteristics and in correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance according to manufacturer's instructions.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer-required or -recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

3.3 INSTALLATION

A. Comply with manufacturer's installation instructions, performing each step in sequence. Maintain one (1) set of manufacturer's installation instructions at Project Site during installation and until completion of construction.

B. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.

D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances.
2. Physically separate products in place, provide electrical insulation, or provide protective coatings to prevent galvanic action or corrosion between dissimilar metals.
3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual-effect choices to Engineer for final decision.

E. Allow for expansion of materials and building movement.

F. Climatic Conditions and Project Status: Store and protect delivered equipment and materials according to manufacturer instructions; Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.

1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.

G. Mounting Heights: Where not indicated, mount individual units of Work at industry recognized standard mounting heights for particular application indicated.

1. Refer questionable mounting heights choices to Engineer for final decision.
2. Elements Identified as Accessible to Handicapped: Comply with applicable codes and regulations.

H. Adjust operating products and equipment to ensure smooth and unhindered operation.

I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by manufacturer.

3.4 CUTTING AND PATCHING

A. Employ skilled and experienced installers to perform cutting and patching.

B. Submit written request in advance of cutting or altering elements affecting:

1. Structural integrity of element.
2. Integrity of weather-exposed or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Visual qualities of sight-exposed elements.
5. Work of Owner or separate contractor.

C. Execute cutting, fitting, and patching including excavation and fill to complete Work and to:

1. Fit the several parts together, to integrate with other Work.
2. Uncover Work to install or correct ill-timed Work.
3. Remove and replace defective and nonconforming Work.
4. Remove samples of installed Work for testing.
5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.

D. Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing.

E. Cut masonry and concrete materials using masonry saw or core drill.

F. Restore Work with new products according to requirements of Contract Documents.

G. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.

H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.

I. At penetrations of fire-rated walls, partitions, ceiling, or floor construction, completely seal voids with fire-rated material, to full thickness of penetrated element.

J. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.

K. Identify hazardous substances or conditions exposed during the Work to Engineer for decision or remedy.

3.5 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual Specification Sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Use durable sheet materials to protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.

E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

3.6 FINAL CLEANING

A. Execute final cleaning prior to final Project assessment. Employ experienced personnel or professional cleaning firm.

B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces; and vacuum carpeted and soft surfaces.

C. Clean equipment and fixtures to sanitary condition with appropriate cleaning materials.

D. Clean filters of operating equipment.

E. Clean debris from roofs, gutters, downspouts, and drainage systems.

F. Clean Site; sweep paved areas, rake clean landscaped surfaces.

G. Remove waste and surplus materials, rubbish, and construction facilities from Site.

END OF SECTION 01 70 00

SECTION 01 78 39 - ELECTRONIC PROJECT RECORD DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for Contractor to collect, document, and provide accurate and complete spatial data, in formats compatible with GIS as defined in this specification, for all features being designed and constructed as part of the Project.
2. Provide interim GIS deliverables as Project progresses and complete and final GIS datasets upon completion of construction.

B. Related Requirements:

1. Section 02 22 30 – Pre-Construction Video and Photographic Record
2. Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection
3. Section 33 05 07.13 – Utility Directional Drilling
4. Section 33 14 13 – Public Water Utility Distribution Piping
5. Section 33 14 17 – Water Services
6. Section 33 14 17.81 – Lead Service Line Replacement
7. Section 33 31 11 – Public Sanitary Sewerage Gravity Piping

1.2 STANDARDS

Except as modified herein, comply with the latest version of the following standard:

A. International Organization for Standardization:

COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements

1.3 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Provide interim GIS deliverables as the project progresses and complete and final GIS datasets upon completion of the construction. Schedule of deliveries is described in more detail below.

C. Upon receipt of a data deliverable, the Owner will perform a data review which may include but not be limited to verification of spatial accuracy, attribute data accuracy, a check for omissions,

duplications, inconsistencies, validation of geometry, and review of the topological relationships between features in the data deliverable. Any errors in spatial location (within the specified spatial accuracy) or attribute value will result in that feature being identified as being in error. If the features of any single feature class within a data deliverable do not meet the 99% confidence level, the complete data deliverable will be rejected.

D. Content of resubmitted data deliverables shall not change except to address the deficiencies identified. New features shall not be added to resubmitted data deliverables except as required to resolve deficiencies.

1.4 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

1.5 QUALITY ASSURANCE

A. Define quality control and quality assurance procedures to be employed in the development and review of GIS data. The GIS data provided by the Contractor shall be error free. Contractor data review processes shall follow quality assurance procedures and standards as specified in ISO/DIS 19157 Geographic Information - Quality Evaluation Procedures (ISO9000).

B. Maintain one copy of each standard affecting the Work of this Section on Site.

1.6 QUALIFICATIONS

A. Licensed Professional: Professional Engineer or Professional Surveyor experienced in performing specified Work and licensed in the State of Michigan.

PART 2 - PRODUCTS

2.1 DELIVERABLE FORMAT

A. All GIS data deliverables shall be provided on a flash drive, portable hard drive, or through a Box folder. Each submittal shall have the main folder clearly labeled with the project name and the date of the delivery.

B. The flash drive or portable hard drive shall be readable by a personal computer running the latest version of the Microsoft Windows operating system.

C. Each project folder deliverable shall contain two sub folders. The first folder shall be named “Geodatabase _SP” and it shall contain a single geodatabase as described in this Section. The geodatabase shall be compatible with older versions of ArcGIS Desktop (going back no further

than 10.3.1) as well as the most recent production release (not beta-release) of ArcGIS. The second folder shall be named "Photos" and it shall contain all digital photos for the deliverable as described in this Section.

D. To facilitate logging and tracking of deliverable review, a text file shall be provided in the root folder of the main deliverable folder. The contents of this text file shall include the following:

1. Original Delivery Date: <date when version 1 of this deliverable was submitted>.
2. Deliverable Title: <contractor specified title that remains constant for all revisions>.
3. Deliverable Number: <Sequential delivery number>. <Revision number>.
4. Contact Person: <Name, phone, e-mail>.

2.2 DELIVERABLE CONTENT

A. GIS features shall be delivered with coordinates that match the actual, as-built conditions. The distance between two points on the ground shall equal the distance shown in the drawing or feature class. All subsurface (underground) features shall be depicted as if they were on the surface.

B. GIS data shall be provided as follows:

1. The dataset shall be provided in the Michigan State Plane South coordinate system. This dataset shall be provided in geodatabase format and placed in the "Geodatabase_SP" folder described above. It shall meet the following requirements:
   a. Coordinates shall be recorded in decimal international survey feet.
   b. Horizontal coordinates shall be based on the North American Datum of 1983 (NAD83) HARN and the Geographic Reference System 1980 (GRS 80) ellipsoid.

2. All vertical measurements for the above GIS datasets shall be recorded based on "North American Vertical Datum of 1988 (NAVD 88)" and measured in feet above datum.

C. Spatial coordinates shall be accurate to within 0.1-foot horizontally and 0.5-foot vertically, unless otherwise noted in the data dictionary.

D. Subsurface features shall have surveyed locations acquired before backfill. Photographs of the exposed feature shall be submitted per this specification section.

2.3 GEOMETRY

A. The geometry of all features provided in the data deliverable shall match the geometry type specified in the Data Dictionary (e.g., point, line, polygon). Complex geometry types (e.g., true curves, donuts, etc.) shall be converted to simple geometry so that the delivered data meet the spatial accuracy described above. Contractor shall notify Owner if it is not possible to accurately represent the feature using simple geometry types.

B. The features shall be represented by valid geometry.

C. Additional geometry rules for lines are listed below.

1. Two or more line features of the same feature type (e.g., road centerline) shall be split so that line segments begin and end at intersections, bridges, and tunnels.
2. End-vertices of connecting or intersecting line segments shall be collocated (i.e., be snapped to the same location with identical X, Y coordinates).
3. Line features shall contain an appropriate number of intermediate vertices placed at intervals such that the line feature does not stray from the actual feature by more than ½ the positional accuracy limit.
4. Lines shall be "broken" where the characteristics of a feature changes.
    a. Storm water drainage pipes shall be broken at manholes or where the pipe diameter or material changes.
    b. Water main lines may only be split at fittings (tee, cross, reducer/increaser, tap), TSV valves, at valves where 'Operated By' changes, and at special cases represented with a feature or attribute change (contract number, material, install date, 20' or large replacement, status, work order). All line segments should be merged that do not adhere to the above split rules.
    c. Gravity mains may be split at manholes or reducer fittings. Other split rules for gravity mains pending DWSD approval.

5. When building a network of linear features where direction is significant (e.g., surface drainage hydrography, storm drainage network, sanitary sewer network, and road centerlines), draw linear objects in the direction of flow, or traffic.

D. Additional geometry rules for polygons are listed below.

1. Polygons (or individual lines that enclose to define an area) shall be closed by snapping the line endpoint vertices to an identical X, Y coordinate.
2. Adjacent polygons sharing an edge shall have the same collocated vertices along that edge. This rule applies to adjacent features of the same type (e.g., pavement sections) and adjacent features of different feature types (e.g., roadway vs. parking).

E. The features shall pass the topological rules described below. These rules ensure the spatial relationship of features in the same and different feature classes.

1. Polygonal feature classes should satisfy the following topology rules: Shall be larger than cluster tolerance; shall not overlap; shall not intersect; shall not have gaps; shall not have dangles.
2. Line features should satisfy the following topological rules: shall be larger than cluster tolerance (1-foot); shall not overlap; shall not intersect.
3. Point features should satisfy the following topological rules: None.

2.4 GEODATABASE STRUCTURE

A. Contractor shall provide a feature class for any known features of the types, listed in the DWSD GIS Data Dictionary, located within the Project boundaries. All feature classes shall be stored within the feature dataset. The names of the feature classes shall exactly match the names listed in the Data Dictionary, including spelling, capitalization, and spacing.

B. Each feature class shall contain the attribute fields described in the Data Dictionary, that will be provided to the Contractor. The definition of the attribute fields (e.g., name, data type, length, domain, etc.) shall match the definition contained within the Data Dictionary.

C. All attribute values shall be populated with a non-null value, except as noted in the Data Dictionary.

D. Contractor shall submit a schema change request to the Owner. The Owner will make any schema changes to feature classes that already exist in the Owner's database. This includes:

1. Any fields added.
2. Any fields removed.
3. Any new or updated domains.
4. Any new or updated subtypes.

E. Contractor shall request to be on an e-mail chain or receive copies of schema changes made by the Owner.

2.5 DIGITAL PHOTGRAPHS

A. Requirements of this Section are in addition to Section 02 22 30 – Pre-Construction Video and Photographic Record.

B. Contractor shall provide at least one digital photo showing the physical extent of each feature, where possible within reasonable effort. The digital photo shall be provided at the same time as the initial data delivery of a feature.

C. The digital photos shall be of sufficient resolution, clarity, brightness and picture quality such that it is easy to discern the feature.

D. The digital photos shall be provided in JPEG, TIFF, or another format acceptable to the Owner. The photos shall be named such that the filename of each photograph is associated with the Feature ID of the feature and its associated PhotoPoint, as described in the Data Dictionary.

2.6 METADATA

A. Each feature class in a submittal shall include complete metadata that follows the "Content Standard for Digital Geospatial Metadata (CSDGM), Vers.2 (FGDC-STD-001-1998)." Metadata shall be validated as part of Contractor's Quality Control procedure.

PART 3 - EXECUTION

3.1 SUBMITTAL SCHEDULE

A. Contractor shall provide deliverables as described below.

1. As-Designed GIS Data: Submit as required by Specification 01 33 00 – Submittal Procedures
2. As-Built GIS Data: Prior to close-out of associated permits, Contractor shall provide a GIS data deliverable that contains as-built data for features covered by that permit. This As-Built GIS Data deliverable shall be accepted by the Owner as a prerequisite for permit close-out. For features not requiring permits, the As-Built GIS Data deliverable shall be delivered within 90 days of construction completion of said feature.

B. If a feature is modified or somehow altered in a way that affects the spatial or attribute data after GIS data have been submitted, a revised GIS feature description shall be submitted within 90 days of the revision. The Data Dictionary provides guidance on how to identify these data edits.

C. If a feature that has already been described in a GIS submittal is removed, an additional submittal shall be made within 90 days of its removal. The Data Dictionary provides guidance on how to identify these data deletions.

3.2 DATA OWNERSHIP

A. All data submitted during this project becomes the property of the Owner upon initial submission.

B. The Contractor shall not distribute any of the GIS data or any draft data that contributed to the final GIS datasets without written approval from DWSD.

END OF SECTION 01 78 39

SECTION 02 01 20 - PROTECTING EXISTING UNDERGROUND UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removing and plugging abandoned lines.
2. Compaction.
3. Alternative support methods.
4. Protecting thrust blocks.

B. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete.
2. Section 31 23 33 – Trenching and Backfill.
3. Section 31 23 23.33 – Flowable Fill.
4. Section 33 14 13 – Public Water Utility Distribution Piping.
5. Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.
6. Section 33 42 00 – Stormwater Conveyance.

1.2 COORDINATION

A. Comply with Section 01 30 00 – Administration Requirements.

1.3 PROJECT/SITE CONDITIONS

A. DWSD will provide a list of the abandoned properties contractor is required to disconnect from the public utilities. Drawings will be provided if available.

1.4 PRE-INSTALLATION MEETINGS

A. Contractor shall coordinate Construction Schedule and Operations with the Owner a minimum of one (1) week prior to commencing the abandonment of the public water leads, public storm and sanitary leads.

B. Representatives of DWSD, Contractor Representative, and Engineer will convene with each either in the field or in the office to discuss the Work Plan. Cost for meeting shall be considered incidental to the project.

1.5 SUBMITTALS

A. Submit the following shop drawings in accordance with Section 01 33 00 – Submittal Requirements.

1. Sanitary Piping per Specification 33 31 11 – Public Sanitary Sewerage Gravity Piping.

2. Storm Water Piping per Specification 33 42 00 – Storm Water Conveyance.

3. Water Main piping per Specification 33 14 13 – Public Water Utility Distribution.

4. Section 31 23 23.33 – Flowable Fill.

5. Reinforced Concrete Beam, Reinforced Concrete Support Wall and Structural Steel Beam per Section 3.5 Protective Measures.

6. Compression Coupling per 2.1.B.

1.6 QUALITY ASSURANCE

A. Comply with Section 01 40 00 – Quality Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Except as indicated, or as specifically authorized by the Engineer, where existing utilities to remain must be removed, Contractor shall reconstruct utilities with new material of the same size, type and quality as that removed.

B. Compression Coupling: ASTM C425, compression couplings. Use at least two lengths of pipe in crossing the trench section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Notify MISS DIG (811) at least three (3) days in advance of proposed start of project, but not more than 14 calendar days before digging operations are scheduled to begin. Do not dig unless all utilities have been marked by MISS DIG (811).

B. Notify the Michigan Department of Transportation (MDOT):

1. Underground ITS Infrastructure Staking Request. Download and complete MDOT Form 5300, MDOT Underground ITS Infrastructure Staking Request Form (http://mdotcf.state.mi.us/public/webforms/public/5300.pdf).

2. Underground Electrical Infrastructure Staking Request. Download and complete MDOT Form 5300A, MDOT Metro Region Underground Electrical Infrastructure Staking Request Form (http://mdotcf.state.mi.us/public/webforms/public/5300.pdf).

C. Notify Kirit Patel, Detroit Department of Public Works, at (313) 628-5641, for locating traffic signal conduit, at least 3 days prior to construction. Alternate contact is Meena Antani, Detroit Department of Public Works, at (313) 628-5640.

D. Review existing site conditions including all surface features and landscaping. All surface features removed or damaged due to the required abandonment of water leads, sanitary & storm leads shall be restored in equal or better condition in accordance with DWSD, MDOT, or Wayne County Standards.

E. Excavate test pits to field verify the locations, depth of bury, diameter, and pipe material of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Engineer if conflicts are encountered.

1. Contractor shall submit a written descriptive summary to be used for removal of existing sanitary sewer/storm sewer leads as required by his work. Submittal shall provide a secondary method for removal of existing sanitary/storm leads should the primary method fail.

3.2 PREPARATION

A. Where utilities are parallel to or cross the proposed work, but do not conflict with work the Contractor shall notify the utility owner at least 3 days in advance of construction at the crossing. Coordinate the construction schedule with the Utility Owner(s).

3.3 PROCEDURES

A. Perform Work according to DWSD, MDOT, or Wayne County Standards and or in accordance of adjacent Utility Owner(s).

B. Protect utilities in place unless abandoned, and maintain the utility in service, unless otherwise indicated or specified.

C. All disturbed or damaged pavements and/or sidewalks and driveways shall be restored by the contractor in accordance with DWSD Standards or as directed by the Engineer.

D. Provide Traffic Control as required.

E. Contractor shall immediately notify Utility Owner if existing utilities that are to remain are damaged by Contractor's construction operations. Any damage caused by the Contractor shall be repaired at no cost to the owner.

F. Where indicated on drawings or as directed by the Engineer, Contractor shall remove existing abandoned sanitary/storm leads and abandoned water leads.

1. Locate abandoned sanitary & storm sewer leads at both mainline sewer and right-of-way.
   a. Sawcut and remove a 3-foot section of abandoned sanitary/storm lead at each end.
   b. Plug lower end of lead with approved watertight plug and 8-inch wall of brick and mortar.
   c. Fill abandoned lead for its entire length with Flowable Fill in accordance with Specification Section 31 23 23.33.
   d. Plug upper end of lead with approved watertight plug and 8-inch wall of brick and mortar.
   e. Provide required backfill and restoration.

2. At locations directed by Engineer, contractor shall remove a portion of the existing sanitary/storm main line sewer at the abandoned service lead connection.
   a. Sawcut and remove a 3-foot section of sanitary/storm sewer.
   b. Provide and insert new section of mainline pipe of the same length, diameter and material type as the removed section.
   c. Connect inserted pipe on both ends to existing pipe with approved compression coupling.
   d. Provide flowable fill in accordance with Specification 31 23 23.33 to a minimum of 6 inches around compression coupling.
   e. Provide required backfill and restoration.

3. Where indicated on drawings or as directed by the Engineer, Contractor shall locate existing abandoned water service.
   a. Abandoned water service lead shall be shut off at the existing shut off valve box located approximately at the right-of-way line.
   b. Contractor shall excavate, cut and remove approximately one foot of existing service lead from the private side and provide an approved watertight compression plug on each cut end.
   c. Provide required backfill and restoration.

4. Properly dispose of removed materials off-site.

3.4 COMPACTION

A. Protecting Existing Utilities:

1. Backfill and compact under and around utilities. Compaction shall conform to Section 31 23 33 – Trenching and Backfill.

2. Where compaction cannot adequately be performed around utility due to the presence of encroaching existing utilities, utilize flowable fill or Class C Concrete.

3.5 PROTECTIVE OF EXISTING UTILITIES

A. Reinforced Concrete Beam:

1. Support utilities as required by a reinforced concrete beam to prevent settlement of the utility line and protect existing utilities. Provide required backfill.

B. Reinforced Concrete Support Wall:

1. Support utilities as required by a reinforced concrete support wall to prevent settlement of the utility line and protect existing utilities. Provide required backfill.

C. Structural Steel Beam:

1. Support utilities as required by a structural steel beam to prevent settlement of the utility line and protect existing utilities. Provide required backfill.

3.6 PROTECTION OF THRUST BLOCKS

A. Contractor shall review the DWSD Thrust Block Standards which will provide approximate locations and sizes of thrust blocks located on active waterlines and sewer force mains throughout the project area. Thrust in the direction of the new excavation may be affected by the construction. Contractor shall protect thrust blocks on existing waterlines or sewer force mains in place or shore to resist the thrust by a means accepted by the Engineer**.** If existing thrust blocks are exposed or rendered to be ineffective in the opinion of the Engineer**,** Contractor shall reconstruct them to bear against firm unexcavated or approved backfill material.

1. Provide firm support by backfilling affected portion of the trench two feet on each side of the thrust block to be reconstructed from the pipe bedding to the pavement subgrade with either:
   a. Flowable fill. See Section 31 23 23.33 – Flowable Fill.
   b. Native material compacted to a relative compaction of 96 percent. Comply with Section 31 23 33 – Trenching and Backfill for compaction requirements.

2. Excavate existing backfill material for construction of the thrust block. Provide temporary support as required or as directed by the Engineer.

3. Test compaction of the backfill material before pouring any concrete thrust block. Concrete shall conform to Section 03 30 00 – Cast-in-Place Concrete.

4. Backfill trench with specified compacted material.

3.7 CLOSEOUT ACTIVITIES

A. Provide in accordance with Section 01 70 00 – Execution and Closeout Procedures.

B. Replace in kind street improvements, such as curbs and gutters, barricades, traffic islands, signalization, fences, signs, etc., that are cut, removed, damaged, or otherwise disturbed by the construction.

C. Provide 3-point locations for all plugs on abandon leads and locations of pipe replacement on main line sewers.

END OF SECTION 02 01 20

SECTION 02 22 30 – PRE-CONSTRUCTION VIDEO AND PHOTOGRAPHIC RECORD

PART 1 - GENERAL

1.1 GENERAL

A. Document the pre-construction and post-construction phases of the Project with color audio-video recordings as set forth herein.

B. Document the stages of construction with digital photographs to illustrate the condition of construction and state of progress.

1.2 SUBMITTALS

A. Informational: Statement of Qualification (SOQ) for professional videographer.

B. Pre-Construction Video Recordings capturing Pre-Existing Conditions: Submit three (3) copies, including Project video log, at least thirty (30) calendar days prior to any field activity.

C. Construction Photographs:

1. Submit one (1) copy of digital construction photographs monthly depicting the various stages of the Project from views and at such times as directed by the Engineer.
2. The number of photographs shall be adequate to indicate the Work being performed and the progress of the Work.
3. The minimum acceptable number of photographs per month shall be fifty (50) plus any others the Contractor, Engineer, or Owner deem necessary to clearly show the Work being performed.

PART 2 - PRODUCTS

2.1 VIDEO MATERIALS

A. Digital Video Disc (DVD), Universal Serial Bus (USB), or other electronic media acceptable to the Owner.

B. File format shall be AVU, FLV, WMV, MOV, MP4, or another format acceptable to the Owner.

2.2 PHOTOGRAPHIC MATERIALS

A. Digital Video Disc (DVD), Universal Serial Bus (USB), or other electronic media acceptable to the Owner.

B. File format shall be JPEG, TIFF, or another format acceptable to the Owner.

PART 3 - EXECUTION

3.1 AUDIO-VIDEO RECORDINGS

A. Pre-Construction and Post-Construction Audio-Video Recordings:

1. At least thirty (30) days prior to beginning Work at the Site, perform video survey of the Construction Site, entire roadway, and property adjacent to the Site.
2. Video emphasis shall be directed to the physical condition of existing vegetation, above ground structures (electrical cabinets, telephone cabinets, electric poles, fences, buildings, garages, etc.), surface features (curbs, driveways, ditches, culverts, manholes, gate wells, stop boxes, hydrants, catch basins, etc.), and pavements along construction area. Videos for authorized haul routes and access roads, and areas adjacent to and within the Right-of-Way or easement, and storage and staging areas. Of particular concern shall be the existence and location of any faults, fractures, and defects.

B. No equipment or materials shall be placed or delivered to the construction area, nor shall Work begin in the area, prior to the pre-construction recording and the Engineer's review and approval of content and quality of video for that area.

C. Consult with the Engineer on subject matter and vantage points from which video recordings are taken.

D. If training sessions are required by detailed specification, record video of the session.

E. Video recording will be by a professional commercial videographer, hired by the Contractor, and experienced in performing pre-construction video surveys for construction documentation.

F. Video recording shall be done during a time of good visibility. No recording shall be done during periods of visible precipitation or when more than ten (10) percent of the ground area is covered with snow or standing water, unless authorized by the Owner.

G. The distance from the camera lens to the ground shall be between eight (8) and ten (10) feet to ensure proper perspective. If conventional wheeled vehicles are used, the distance from the camera lens to the ground shall be at least eight (8) feet.

H. The rate of speed in the general direction of the video recording shall not exceed forty (40) feet per minute. Panning and zoom rates shall be electronically or manually controlled to provide clear viewing during playback.

I. Houses and buildings shall be identified visually by house number, when visible, in such a manner that structures of the proposed system can be located by reference. In all instances, location shall be identified by audio or visual means at intervals not-to-exceed 100 linear feet in the general direction of travel.

J. Video Format and Quality:

1. Video:
   a. 1080 line High-Definition (HD) Video.
   b. Electronically display the month, day, year, and time of recording, as well as the project contract number.

2. Audio:
   a. Audio documentation shall be clear, precise, and at a moderate pace.
   b. Indicate date, Project name, and a brief description of the location of taping, including:
      1) Facility name.
      2) Street names or easements.
      3) Addresses of private property.
      4) Direction of coverage, including engineering stationing, if applicable.

3. Documentation of video recordings shall indicate:
   a. DWSD.
   b. Unique video number (numbered sequentially).
   c. Project name and DWSD Contract Number.
   d. Name of street(s) or easement(s) included.
   e. Start and end locations by approximate engineering stationing and GPS coordinates.
   f. Date and time of coverage.

K. Project Video Log: Maintain an ongoing log that incorporates above-noted documentation information for electronic media on the Project.

3.2 PHOTOGRAPHIC RECORDS

A. Photography shall be done by a responsible commercial photographic studio skilled and regularly engaged in the business of taking commercial photographs.

B. Good quality digital color photographs shall be of correct exposure and focus, displaying high resolution and sharpness.

C. Digital photos shall include captions, descriptions, and key words as necessary for identification.

D. Photos shall clearly indicate existing site conditions, construction means and methods, structures, crossing utilities, stream and drain crossings, soil erosion and sedimentation control measures, verification of completion, or other project conditions deemed necessary by the Contractor, Engineer, or Owner.

E. Digital Camera: Minimum sensor resolution of twelve (12) megapixels.

F. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.

G. Photographs shall have the following title block in the lower right corner of digital photos:

1. Detroit Water and Sewerage Department.
2. Contract Number.
3. Project Title.
4. Address/Location.
5. Photo By: (Firm name of photographer).
6. Date: (When photo was taken).

H. Identification: Provide the following information with each image description in file metadata tag:

1. Name of Project.
2. Name and contact information for photographer.
3. Name of Engineer.
4. Name of Contractor.
5. Date photograph was taken.
6. Description of vantage point, indicating location, direction (by compass point).
7. Unique sequential identifier keyed to accompanying key plan.

END OF SECTION 02 22 30

SECTION 02 31 13.23 - UTILITY LINE REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removing or abandoning, in whole or in part, sanitary and storm drainage structures, culverts, sanitary and storm sewers, fire hydrants, gate wells and water mains and other public or private utilities as specified herein or indicated on the Drawings.
2. Coordination with the appropriate public utility companies as shown on the drawings when removal of their appurtenances is required.
3. Salvaging, storing, and disposing of removed materials, and the backfilling and compacting of the excavated sites.

B. Related Requirements:

1. Section 01 51 36 – Temporary Water Service
2. Section 01 57 15 – Temporary Sewer Bypass Pumping
3. Section 03 60 00 – Grouting
4. Section 31 10 00 – Site Clearing
5. Section 31 23 23.33 – Flowable Fill
6. Section 31 23 33 – Trenching and Backfill
7. Section 33 14 13 – Public Water Utility Distribution Piping
8. Section 33 31 11 – Public Sanitary Sewerage Gravity Piping

1.2 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Sequence of Construction Procedure: Submit description of construction procedure which allows all live water and sewer services to be maintained during construction. Comply with Section 01 51 36 – Temporary Water Service and Section 01 57 15 – Temporary Sewer Bypass Pumping.

C. Product Data: Submit manufacturer information for proposed materials including mechanical joint caps and restraints.

D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Location of final disposal of all excavated material and written permission from property Owner, if applicable.

1.3 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents: Record invert elevations and actual locations of utilities being removed or abandoned. Indicate limits of removal versus abandonment.

C. Identify and describe discovery of undocumented utilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete: Grade P2 or S2 in accordance with MDOT Standard Specifications for Construction.

B. Grout: A mixture of two-(2) parts sand to one-(1) part Portland cement or similarly approved material, and non-shrink non-metallic grout as specified in Section 03 60 00 – Grouting.

C. Aggregate: 21AA as per MDOT Standard Specifications for Construction.

D. Flowable Fill: As specified in Section 31 23 23.33 – Flowable Fill.

E. Caps: Mechanical Joint Caps conform to ANSI/AWWA/C110/A21.10 and 350 psi pressure rated.

F. Restraint: The restraint shall be series 1100 Megalug restraint as manufactured by EBAA Iron, Inc. or approved equal.

PART 3 - EXECUTION

3.1 SEWERS, CULVERTS AND RELATED STRUCTURES

A. Removal and Abandonment:

1. When removing or abandoning a sanitary or a storm drainage structure, any live sewers connected to them shall be rebuilt as directed by the Engineer in accordance with Section 33 31 11 – Public Sanitary Sewerage Gravity Piping and redirected through the removal or abandonment area. Services shall be maintained during construction operations through bypass pumping.
2. If the Drawings call for abandoning a sanitary or a storm drainage structure, the existing frames, covers and grates shall be carefully removed to prevent damage and the structure broken down to a minimum three (3) feet below the pavement subgrade or at least three (3) feet below the final ground elevation outside the pavement area.

3. The bottom of all structures abandoned in place shall be broken or cracked to such an extent that water may drain freely through the bottom.
4. Existing castings, hydrants, covers, or other materials noted by the Owner, not scheduled for re-use shall be salvaged. Salvaged materials are the property of DWSD and shall be promptly transported and turned over to the Owner at 6425 Huber Street, Detroit, MI.
5. All pipe culverts specified to be removed, including all end treatments, shall be completely removed and the excavation backfilled in accordance with Backfilling Excavated Areas.
6. Where existing culvert pipe is to be extended or the existing end treatment is to be replaced; only such portions of the existing culvert pipe shall be removed in order to provide a proper connection to the new work. Care shall be taken to not damage any portion of the remaining culvert pipe.
7. All pipe culverts to be abandoned shall be bulkheaded as specified herein unless otherwise approved by the Engineer. If the culvert is not in suitable condition for abandonment, in the judgment of the Engineer, remove the culvert in its entirety and backfill the excavation in accordance with Backfilling Excavated Areas.
8. Culvert pipe designated to be abandoned, with top elevation within six (6) feet of the top of the pavement, shall be removed in its entirety and the excavation backfilled in accordance with Backfilling Excavated Areas.
9. For abandoned piping and structures, all new work shall be constructed and in service before any abandonment takes place. Obtain the Engineer's approval prior to the abandonment process.
10. Any Work connecting to an active existing pipeline or structure shall be encased in concrete unless a gasketed connection is provided, or otherwise indicated on Drawings.

B. Disposing of Materials:

1. Remove all excavated materials, together with all debris, stones, logs, stumps, roots, removed Lead (Pb) water services, and other unsuitable materials, from the site and dispose off-site.
2. Conform to state and local laws and code requirements for the hauling and disposing of trees, shrubs, stumps, roots, rubbish, debris, removed Lead (Pb) water services, and other matter. Obtain and pay for all disposal permits and fees. Disposal of any materials will not be permitted in a wetland or flood plain. Disposed materials shall not be stockpiled in a wetland or floodplain.

C. Backfilling Excavated Areas:

1. Backfill the excavated areas per the standard details. Backfilling shall be placed and compacted according to MDOT Controlled Density Method at least to 95 percent maximum weight unless indicated otherwise on the Drawings.
2. All sewers (storm, sanitary, or combined) or parts thereof which are specified to be removed, or that interfere with the new construction, shall be removed. Active sewers to be replaced shall be as directed by the Engineer.

3. Where existing sewers are to be extended or otherwise incorporated into the new Work, only such part of the existing sewer shall be removed as to provide a watertight connection to the new Work. The connecting edges shall be cut, chipped, and trimmed to the required lines and grades without weakening or damaging the parts of the sewer to be retained.
4. All connecting Work shall be encased in concrete unless a gasketed connection is provided unless otherwise indicated on Drawings.

D. Abandoning Sewers With Flowable Fill:

1. Bulkheads: All sewers to be abandoned shall be bulkheaded with Grade P2 or S2 concrete or with brick block masonry. A bulkhead shall be constructed from the inner wall of the drainage structure a minimum of two (2) feet into the pipe.
2. Alternatively, backfill abandoned sewers by filling the sewer with flowable fill or with grout composed of two (2) parts sand to one (1) part cement.
3. Backfill concrete shall be deposited through drop pipes placed over the abandoned sewer and at locations approved by the Engineer. Drop-pipe holes shall be spaced at intervals that will ensure the proper and complete filling of the sewer. All drop holes shall be sleeved for their entire length with a metal casing. The casing shall extend completely through the wall of the sewer. The drop-pipe shall be fitted with suitable and sufficient baffles to ensure the re-mixing of the concrete rather than a separation of the materials. The size of the drop-pipe shall be adequate for the placing of the concrete mix.
4. When the drop holes are no longer needed and the Engineer orders their abandonment, the casings shall be removed so that adjacent structures, utilities, and pavement will not be damaged. The hole shall then be filled with a 1500 psi concrete mix to within five (5) feet of the surface. The upper portion of the hole shall be filled with compacted aggregate and the surface replaced in kind to that originally found to the satisfaction of the Engineer.
5. Grout shall be placed under a pressure adequate to fill completely the abandoned portion of the sewer. However, grout pressures shall not be so high as to cause leakage from the sewer and the filling of adjacent sewers, utilities and basements.
6. Start sewer abandonment process at the downstream end and work in the upstream direction.

3.2 WATER MAINS AND APPURTENANCES

A. Removal And Abandonment:

1. Water service line abandonment includes water service lines up to and including two (2) inches in diameter unless otherwise indicated on Drawings.
2. Abandonment of existing water mains shall include removing, disposing, capping or plugging of mains, backfilling of abandoned gate boxes and gate wells with flowable fill, removal of valves, and salvage of hydrants per this specification. Watermains abandoned in place shall be filled with grout per Section 31 23 23.33 – Flowable Fill.

3. If the Drawings call for abandoning a water main or water main structure, any existing frames, covers and grates shall be carefully removed to prevent damage and the structure broken down to a minimum three (3) feet below the pavement subgrade or at least three (3) feet below the final ground elevation outside the pavement area.
4. The bottom of all structures abandoned in place shall be broken or cracked to such an extent that water may drain freely through the bottom.
5. Abandonment of existing structures such as gates, wells and vaults shall be in accordance with this specification and Section 02 41 00 – Demolition.
6. Cut and cap water service lines five (5) feet from the building envelope.
7. Cut and cap water service lines immediately adjacent to the existing main line when the existing main line will remain active.
8. Remove the corporation stop and box and install a solid threaded brass plug in place of the removed corporation stop when principal water main will remain active.
9. Asbestos-Cement Pipe: If removing an existing concrete waterline pipe that was constructed before 1980, it may be an asbestos pipe. Test the pipe by using an Asbestos Hazard Evaluation Specialist certified by the Michigan Department of Licensing and Regulatory Affairs to determine if it is an asbestos pipe. If it is determined that the pipe is asbestos containing and is designated to be removed, a Michigan licensed Asbestos Hazard Abatement Contractor shall perform the work. Dispose of all asbestos containing pipe at a solid waste or Construction and Demolition Debris facility that is licensed by the Local Health Department and permitted by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) for the acceptance of asbestos containing material.
10. When removing or abandoning water mains or appurtenances, any live water connections to them shall be rebuilt and reconnected through the removal area in accordance with Section 33 14 13 – Public Water Utility Distribution Piping. Services shall be maintained during these construction operations. Refer to the drawings for extent of removal and abandonment of water mains and appurtenances.
11. Water main to be abandoned and filled with flowable fill shall be per Section 31 23 23.33 – Flowable Fill.

B. Disposing Of Materials:

1. All excavated materials, together with all debris, stones, logs, stumps, roots, removed Lead (Pb) service lines, and other unsuitable materials, shall be removed from the site and disposed of off-site.
2. Conform to state and local laws and code requirements for the hauling and disposing of trees, shrubs, stumps, roots, rubbish, debris, removed Lead (Pb) service lines, and other matter. Obtain and pay for all disposal permits and fees. Disposal will not be permitted in a wetland or flood plain.
3. Dispose of all asbestos containing pipe at a solid waste or Construction and Demolition Debris facility that is licensed by the Local Health Department and permitted by the EGLE for the acceptance of asbestos containing material.

C. BACKFILLING

1. Backfill the excavated areas according to standard details. Backfilling shall be placed and compacted according to MDOT controlled Density Method at least to 95 percent maximum weight unless otherwise indicated on Drawings.
2. Refer to the Drawings for details regarding removal and abandonment of other utilities and services.

END OF SECTION 02 31 13.23

SECTION 02 41 00 – DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide demolition and alterations of existing conditions as indicated and specified.

B. This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings, garages, sheds, decks, fences, guardrails, structures, old pavements, abandoned pipe lines, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the contract. It shall also include the salvaging and storage within the project limits of designated materials and backfilling the resulting trenches, holes, and pits.

C. Related Requirements:

1. Section 01 57 13 – Erosion Control Sedimentation and Containment of Construction Materials.
2. Section 02 31 13.23 – Utility Line Removal.
3. Section 02 61 13 – Excavation and Handling of Contaminated Materials.
4. Section 03 60 00 – Grouting.
5. Section 31 10 00 – Site Clearing.
6. Section 31 23 23.33 – Flowable Fill.
7. Section 31 23 33 – Trenching and Backfill.
8. Section 32 92 19 – Seeding.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. National Fire Protection Association (NFPA):

1. Comply with NFPA 241.

B. Occupational Safety and Health Administration (OSHA):

1. OSHA 29 CFR 1926 – U.S. Occupational Safety and Health Standards, Current Edition.

1.3 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Submit a Demolition Plan providing descriptions of sequence, methods, and equipment used for demolition and disposal.

C. Submit pre-demolition photos or videos showing the existing conditions of adjoining construction and site improvements, including finished surfaces that may be affected by building or structure demolition operations. Comply with Section 02 22 30 – Pre-Construction Video and Photographic Record.

D. Submit copies of all permits and authorizations required by Buildings, Safety, Engineering, and Environmental Department (BSEED) and others to perform demolition work.

E. Submit documentation from landfills or other disposal facilities confirming acceptance of demolition materials. Receipts shall bear the date, job address, location of landfill facility, cubic yardage dumped, signature of Contractor's driver, and signature of receiving facility representative.

1.4 QUALITY ASSURANCE

A. Comply with the requirements specified in Section 01 40 00 – Quality Requirements.

B. Issue written notices of planned demolition to companies or authorities owning utility conduit, wires, or pipes running to or through the project site. Copies of said notices shall be submitted to the Owner prior to commencement of work.

C. Notify utility companies or authorities furnishing gas, electrical, telephone, or cable service to remove any equipment in the structures to be demolished, and to remove, disconnect, cap, or plug their services to facilitate demolition.

1.5 JOB CONDITIONS

A. Protection:

1. Execute the demolition and removal work to prevent damage or injury to structures, occupants thereof, and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use and free and safe passage between adjacent structures.
2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the work by the placement or storage of materials will not be permitted and all operations shall be conducted with a minimum interference to traffic.
3. Erect and maintain barriers, lights, sidewalk sheds, and other required protective devices as indicated on the Traffic Control Plan or as directed by the Owner or Engineer.

B. Scheduling: Carry-out operations to avoid interference with operations and work in the existing facilities. Perform demolition work Monday through Friday between 7:00 AM and 7:00 PM. Do not begin a demolition that cannot be completed in one day on a Friday. Do not leave partially demolished structures unstable overnight or partially demolished sites unattended over the weekend.

C. Notification:

1. Notify Owner of the date and time of demolition work at least 24 hours prior to commencing work. Owner may inspect the existing equipment and to identify and mark those items which are to remain the property of the Owner.
2. Notify utility owners to turn off affected utility services 48 hours before starting demolition work at new structures or at existing buildings to be demolished.

D. Conditions of Structures:

1. Each bidder or their authorized representatives shall, before preparing his proposal, visit all areas in which work is to be performed and inspect the existing conditions.
2. The Owner and the Engineer assume no responsibility for the actual condition of the structures to be demolished or modified.
3. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner as is practicable. However, variations within a structure may occur prior to the start of demolition work.

E. Repair Damage: Promptly repair damage caused to adjacent facilities by demolition operation when directed by the Engineer and at no additional cost to the Owner. Repairs shall be made to a condition at least equal to or better that which existed prior to construction.

F. Traffic Access:

1. Comply with Section 01 55 26 – Traffic Control.
2. Conduct demolition, modification operations, and the removal of equipment and debris to minimize interference with roads, streets, on-site and off-site walks, and occupied or used facilities.
3. Special attention is directed towards maintaining safe and convenient access to the existing facilities. Provide warning signs, barricades, and fall protection. Protect workers and the public. Enclose hazard areas with yellow caution tape.
4. Do not close or obstruct streets, walks or other occupied or used facilities without permission from the Owner. Furnish alternate routes around closed or obstructed traffic in access ways.

PART 2 - PRODUCTS

2.1 CEMENT GROUT FILLER

A. As specified in Section 03 60 00 – Grouting.

2.2 LOW STRENGTH MORTAR BACKFILL

A. As specified in Section 31 23 23.33 – Flowable Fill.

PART 3 - EXECUTION

3.1 GENERAL

A. Demolish and remove existing construction, utilities, equipment, and appurtenances as indicated on the Drawings.

B. Provide maximum practicable protection from inclement weather for materials, equipment, and personnel located in partially dismantled structures.

C. Protect persons and property throughout progress of work. Provide safe working conditions for personnel.

D. Minimize spread of dust and airborne particles. Wet down work during demolition operations to prevent dust from arising. Comply with the City of Detroit Fugitive Dust Ordinance (Ordinance No. 32-17).

E. Removed materials, equipment, and appurtenances, not designated for relocation, become property of the Contractor and shall be legally disposed of off-site. Soil and contaminated material removals shall comply with Section 02 61 13 – Excavation and Handling of Contaminated Materials and Section 31 23 33 – Trenching and Backfill.

3.2 CONSTRUCTION REQUIREMENTS

A. All material being removed in conjunction with an improvement, renovation, remodel, and addition to City owned property is subject to the following provisions:

1. Immediately upon removal, the Contractor and his Subcontractor shall inform the Engineer when salvageable material is removed and available for inspection to determine if the respective item(s) shall be retained by the Owner.
2. If the material(s) are determined to be salvageable, the City has three days, unless additional time is requested, in which to claim any such items, during which time the Contractor shall store the materials at locations determined by the Engineer. If the material is not claimed within this time period, dispose of the material at no cost to the City.
3. Salvaged material shall be transported and turned over to the Owner at 6425 Huber Street, Detroit, MI.
4. The term salvage includes such items as: manhole covers, castings, piping, fire hydrants, brick, steel, iron, copper, brass, aluminum and other metals, wiring, conduit, lighting, lamps, panels, boxes, fixtures, motors, electrical incidentals, machines, plumbing, plumbing fixtures, water heaters, HVAC equipment and incidental appurtenances, miscellaneous building materials, doors, door frames, windows, frames, granites, marbles, stone panels, trees, shrubbery and plant material.

B. Raze, remove and dispose of all buildings and foundations, structures, fences, guardrails, old pavements, abandoned pipelines, storage tanks, septic tanks, vaults and other obstructions any portions of which are within the limits of the project, except utilities and those items for which other provisions have been made for removal. All designated salvageable material shall be removed, without unnecessary damage, whole, or if necessary, in sections or pieces which may be readily transported, and shall be stored and protected by the Contractor at specified places within the project limits. Unusable material shall be destroyed or disposed of outside the limits of the project with written permission of the property owner on whose property the material is placed. Copies of all agreements with property owners shall be furnished the Engineer 48 hours prior to moving off-site.

C. When existing conduits are encountered in removal operations and are determined by the Engineer to be inactive or to be abandoned, they shall be abandoned per this Section or as directed by the Engineer before backfilling operations proceed.

D. Burning of demolition debris is prohibited.

E. Protect existing structures, equipment, and appurtenances to remain.

F. Make necessary arrangements with and perform work required by utility companies for discontinuance or interruption of services due to demolition work.

G. Confine apparatus, storage of materials, demolition work, new construction, and operations of workmen within the construction limits. Provide and maintain lights, barriers, and temporary passageways for free and safe access.

3.3 PIPE REMOVAL AND ABANDONMENT

A. Existing pipe designated on the Drawings or as directed by the Engineer to be removed or abandoned shall comply with Section 02 31 13.23 – Utility Line Removal.

3.4 MANHOLE, CATCH BASIN, WELL AND INLET REMOVAL AND ABANDONMENT

A. Existing sanitary, storm, and water main structures designated to be abandoned shall be removed to a minimum of three feet below the finished subgrade or ground surface, whichever is lower, in a manner that will not damage pipes adjacent or connected thereto that are to remain.

B. Castings and structure covers shall become the property of the Owner unless otherwise directed by the Engineer.

C. Manhole, catch basin, well and inlet removal and abandonment shall comply with Section 02 31 13.23 – Utility Line Removal.

3.5 ELECTRICAL DEMOLITION

A. Survey the existing electrical systems and equipment identified for removal with representatives from the other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.

B. Equipment, building or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition. Disconnect all electrical power, communications, alarm and signal systems.

C. Disconnect abandoned outlets and remove devices.

3.6 ELECTRICAL REMOVALS

A. Electrical removals shall consist of the removal of existing transformers, distribution switchboards, control panels, motors, conduits and wires, poles and overhead wiring, panelboards, lighting fixtures and miscellaneous electrical equipment all as shown on the Drawings, specified herein, or required to perform the work.

B. Disconnect all electrical power, communications, alarm, and signal systems. All existing electrical equipment and fixtures specified or shown on the Drawings to be removed shall be removed after the station power supply has been disconnected.

C. Where shown or otherwise required, underground wiring shall be removed. All such wiring shall be salvaged and promptly transported and turned over to the Owner at 6425 Huber Street, Detroit, MI. Verify the function of all wiring before disconnection and removing it.

D. Lighting fixtures shall be removed as shown on the Drawings or as directed and removed from site.

E. All materials and equipment removed from existing work shall become the property of the Contractor, except for those which the Owner has identified and marked for his use. All materials and equipment marked by the Owner for salvage shall be carefully removed so as not to be damaged, cleaned and stored on or adjacent to the site in a protected place specified by the Engineer, or delivered to the Owner at 6425 Huber Street, Detroit, MI. All other miscellaneous electrical materials, devices, etc., associated with the equipment being turned over shall be demolished and removed from the site.

F. Unless otherwise specifically noted, remove unused exposed conduit and support systems back to point of concealment. Remove unused wiring back to source or nearest point of usage.

G. Disconnect and remove abandoned panelboards, disconnect switches, control stations, distribution equipment, etc.

H. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.

I. Trace out existing wiring that is to be removed and perform the removal work as required.

J. Remove exposed conduits, wireways, outlet boxes, pull boxes, and hangers.

3.7 REPAIR/RESTORATION

A. Repair or remove items that are damaged. Replace with new items of equal quality or repair and install damaged items to condition at least equal to that which existed prior to start of work.

B. Restore areas where structures are removed with topsoil and mulched seeding as specified in Section 32 92 19 – Seeding, unless otherwise indicated on the Drawings.

3.8 CLOSEOUT ACTIVITIES

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

END OF SECTION 02 41 00

SECTION 02 61 13 - EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes: The requirements for excavation, handling, temporary storage, and disposal of soil and/or groundwater that is suspected to be contaminated or potentially contaminated material that may be encountered during the course of the Work.

B. Site Characterization:

1. Known areas of soil or groundwater contamination may be shown in the plans or as a part of the geotechnical report. Areas of soil or groundwater contamination discovered as part of this project shall be handled, stored, and disposed as specified herein.
2. Separate specification requirements have been included for the testing, handling, and disposal of hazardous waste materials; non-hazardous waste materials; and petroleum contaminated soils. If chemicals of concern found in groundwater are of a nature and/or concentration that necessitate handling the groundwater as hazardous material, compensation will be provided under a contaminated material allowance.

C. Related Requirements:

1. Section 01 35 29 - Safety Program.
2. Section 31 23 33 - Trenching and Backfill.

1.2 DEFINITIONS

A. Beneficial Use: The use or reuse of a material that meets any of the “beneficial use” definitions of Michigan’s Part 115, Solid Waste Management, of the Natural Resources and Environmental Protection Act (NREPA) 451 of 1994, as amended.

B. Contaminated Material: A material that is contaminated with one (1) or more Chemicals of Concern (COCs) at concentrations that exceed applicable regulatory comparison standards.

C. Hazardous Waste: Hazardous waste as defined under federal Resource Conservation and Recovery Act (RCRA) 40 CFR 261 divided as listed and characteristic hazardous wastes. A waste that exhibits any of the characteristics as identified in NREPA 451 Part 111.

D. Non-Hazardous Waste: A waste that is not defined as a hazardous waste under federal and State regulations. Non-hazardous waste may include contaminated, but not hazardous waste; solid waste; infectious waste, and construction and demolition debris.

E. Petroleum-Contaminated Soil (PCS): Petroleum contaminated media and debris that fail the test for the Toxicity Characteristic of 40 CFR 261.24 (Hazardous Waste Codes D018 through D043 only) and are subject to the Underground Storage Tank (UST) site corrective action regulations under 40 CFR 280 are excluded from the definition of hazardous waste under 40 CFR 261.4(b)(10) and Michigan R299.9204(2)(l).

F. Unclassified Material: Material that has not been tested or classified.

G. Potentially Contaminated Material: Soil and/or groundwater that exhibits visual (e.g., discoloration, staining, free product, etc.) or olfactory (e.g. chemical, solvent or petroleum odors) indicators of contamination.

H. Chemicals of Concern: Chemical(s) that is/are suspected to be present in soil and/or groundwater at the site as a result of historical use.

I. Licensed Disposal Facility: A facility that has obtained the necessary permits or licenses that this or another state may require to accept materials for permanent burial, destruction, or treatment. Facilities are licensed based on the materials to be accepted such as solid waste, hazardous waste, non-hazardous waste, and petroleum contaminated soil.

J. Solid Waste: Discarded material defined as "solid waste" under federal regulations 40 CFR 261.2 and Michigan PA 451 Part 115.

K. Storage: To accumulate, collect, or stockpile excavated soil or groundwater on site or off site.

L. Treatment: Use of any method, process, or technique other than storage or disposal designed to change the physical, chemical, or biological character or composition of one or more COCs in contaminated material to render it non-hazardous or less hazardous; safer to transport, store, or dispose of; or amenable for recovery or reduced in volume.

1.3 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. Federal Requirements that govern hazardous material management or transportation, and disposal of hazardous waste material.

B. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA):

1. Respiratory Protection: 29 Code of Federal Regulations (CFR) 1910.134.
2. Construction Industry: 29 CFR 1926.
3. Hazard Communication: 29 CFR 1910.
4. Specifications for Accident Prevention Signs and Tags: 29 CFR 1910.14.
5. Lead in Construction: 29 CFR 1926.62.

C. U.S. Environmental Protection Agency (EPA):

1. Guidance on Field Methods for the Analysis of Petroleum Hydrocarbons: EPA 510-B-97-001.
2. Identification and Listing of Hazardous Waste: 40 CFR 261.
3. Standards applicable to Generators of Hazardous Waste: 40 CFR 262.
4. Standards applicable to Transporters of Hazardous Waste: 40 CFR 263.
5. Standards for Universal Waste Management: 40 CFR 273.
6. Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce and Use Prohibitions: 40 CFR 731.

D. State Requirements:

1. Petroleum Contaminated Soils: NREPA 451 R299.9204(2)(l).
2. Solid Waste: NREPA 451 Part 115.
3. Hazardous Waste Management Standards: NREPA 451 Part 111.
4. Liquid Industrial By-Products: NREPA 451 Part 121.

E. U.S. Department of Transportation (DOT):

1. Hazardous materials table, special provisions, hazardous materials communication, emergency response information, training requirements and security plans: 40 CFR 172.
2. Shippers- General requirements for shipments and packaging: 40 CFR 173.
3. Hazardous Materials Transportation Regulations: 40 CFR Parts 174 through 176.

F. American National Standards Institute (ANSI):

1. Z88.2-80, Practices for Respiratory Protection.

G. National Institute of Occupational Safety and Health (NIOSH):

1. Respiratory Protection – An Employer's Manual & Respiratory Protection – A Guide for the Employee.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 – Submittals Procedures.

B. Comply with Section 01 35 29 – Safety Program.

C. In addition to all other requirements of the Section 01 35 29 – Safety Program, identify the health and safety concerns pertaining to encountering potentially contaminated soils and groundwater, and include provisions for air monitoring and equipment to monitor VOC's (combustible gases), oxygen level, hydrogen sulfide level, and lower explosive limit (LEL) within the excavation. If any of the levels are exceeded, the Engineer shall be notified immediately. The plan shall identify the appropriate measures to be taken for both non-hazardous and hazardous soil and groundwater.

D. Submit an Emergency Response Cleanup Plan which details response procedures in the event of any spill or release of regulated material.

E. Submit the Site Safety and Health Officer qualifications, which shall include a minimum of five (5) years of experience with safety assessments and oversight associated with excavating contaminated soil and/or groundwater.

F. Submit the following items:

1. Soil and Groundwater Management Plans in accordance with this section, including descriptions of proposed methods and equipment to be used for handling, sampling, and transportation and disposal of contaminated soil and groundwater. Separate plans shall be submitted for the following:
   a. PCS.
   b. Hazardous material.
   c. Non-hazardous waste material.
   d. Groundwater with chemicals of concern.

2. Qualifications of the Contractor's analytical testing laboratory for all testing necessary for disposal, and the laboratory's anticipated turn-around time for results.
3. The name and address of the proposed licensed disposal and/or recycling facility(s) and waste hauler(s). Include copies of applicable permits and licenses.
4. Description of proposed disposal site(s) and/or recycling facility(s) including a pre-approval letter from each disposal/recycling site operator indicating the allowable range of contaminants that are acceptable at each site.
5. Analytical results and laboratory chain-of-custody records for all samples.
6. Records of transportation and disposal including weight tickets; manifests and/or non-hazardous certificates, as applicable; disposal receipts, etc.

1.5 QUALITY ASSURANCE

A. Maintain a safe worksite.

B. Furnish a Site Safety and Health Officer responsible for evaluating the safety conditions during excavation of contaminated soil and/or groundwater. The Health and Safety Officer shall have a minimum of 5 years of experience with safety assessments and oversight associated with excavating potentially contaminated soil and/or groundwater. Personnel shall be trained in accordance with 29 CFR 1926.65, Safety and Health Regulations for Construction for

Hazardous Waste Operations and Emergency Response. These requirements are in addition to all requirements included in Specification Section 01 35 29 – Safety Program.

C. Establish and maintain an Emergency Response Cleanup Plan which details the response plan in the event of any spill or release of regulated materials such as hazardous substances or petroleum products.

D. Pay for any violations and/or fines, etc. that arise from the mishandling, improper disposal or use of faulty equipment associated with the removal of contaminated soil and/or groundwater.

E. Maintain current licenses, permits and certifications as required by the applicable federal, state, or local jurisdictions for the removal, transporting disposal, or other regulated activity relative to work conducted under this contract.

F. The Owner, at his sole discretion, may provide a third-party inspector experienced in the identification and field screening of soil and/or groundwater to confirm the Contractor's observations. At any time, the Owner may perform duplicate sampling and testing to verify results for disposal or recycling activities. Properly handle, test, transport, and dispose of all excavated soil and groundwater regardless of any testing or inspection performed or not performed by the Owner directly or through a third party.

G. Perform all testing, transportation, disposal, and recycling activities in accordance with local, state and federal regulations.

H. Disposal and recycling facilities shall be licensed by the local, State, or federal agencies as applicable for the management of liquid, solid and/or hazardous waste.

I. Obtain all necessary permits and approvals for transporting material to a licensed disposal or recycling facility.

J. Groundwater discharge to any sanitary sewer shall be below the GLWA Local Limits. The GLWA Industrial Pretreatment Program is intended to prevent the introduction of pollutants to the GLWA wastewater treatment plant that could interfere with treatment operations, that may not receive adequate treatment in the process, and which may pass through the system into the receiving waters or the atmosphere or otherwise be incompatible with the system. In addition, the Pretreatment Program is intended to protect the general health and safety of the wastewater treatment plant, employees, and the environment.

PART 2 – PRODUCTS – Not Used

PART 3 - EXECUTION

3.1 GENERAL

A. Excavation and handling of contaminated soil and groundwater shall be conducted in such a manner that prevents any runoff or further contamination.

B. Locations of soil stockpiles and/or containers shall be submitted for pre-approval by the Owner. This information shall be included in the Soil and Groundwater Management Plan.

C. The Contractor shall be considered the transporter of all material removed from the Work site. The transporter shall be licensed in accordance with applicable federal, state, and local regulations.

D. The Owner shall be considered the generator of all material removed from the Work site.

E. Maintain daily logs, landfill tickets, and manifests that document the source, movement, and destination of each truckload of excavated soil.

1. Contaminated materials shall be transported in leak-proof vehicles or containers.
2. During the transport of excavated soil, open-top vehicles or containers shall be covered or tarped.
3. All waste material transported off-site shall be shipped under a bill of lading and, as applicable, waste manifests, waste profiles, land disposal restriction forms, and all other documentation required by federal, state, and local regulations.
4. The disposal/recycling facility shall determine the weight of the material and report the weight on the returned bill of lading and all other required documents.
5. Provide an initialed and dated copy of the weight ticket receipt to the Owner within 2 working days of the delivery. The weight ticket shall clearly identify the bill of lading.
6. Submit to the Owner final copies of all waste manifests and bills of lading for tracking material through transportation and treatment or disposal.

3.2 SOIL HANDLING, SAMPLING, TESTING, AND DISPOSAL

A. The Contractor’s Site Safety and Health Officer shall evaluate the air quality conditions within any trenching or open cut excavation operation within suspected contaminated areas, develop a baseline analysis of the air quality, and incorporate appropriate engineering controls and appropriate personal protective equipment (PPE) to allow for safe working conditions.

1. Before any workers enter the excavation, a multi-gas detector shall be used to determine, at a minimum, the oxygen level, hydrogen sulfide level, and lower explosive limit (LEL). If any of the levels exceed OSHA acceptable levels or indicate unsafe working conditions, workers will not be allowed to enter the excavation, and all workers shall evacuate the area to 150 feet upwind of the excavation.

2. A photoionization detector (PID) shall be used to monitor for volatile organic compounds (VOC's) within the excavation. If VOC levels exceed 20.0 parts per million (ppm), the site workers shall immediately exit the excavation and engineering control shall be re-evaluated.
3. Air quality shall be monitored continuously.

B. Adhere to the following procedures for PCS excavated from the areas identified in Part 1.1.B:

1. Notify the Owner prior to the start of excavation.
2. PCS material shall be handled, transported, and disposed in accordance with local, state and federal regulations.
3. The Owner will be considered the generator of all PCS.
4. The Site-Specific Health and Safety Officer shall require the use of appropriate PPE to allow for safe working conditions during excavation.
5. The PCS shall be segregated from other excavated materials on stockpiles on impermeable membranes or in approved leak-proof containers. During wet weather, stockpiles or containers shall be covered or tarped with impermeable membranes to prevent contact with precipitation and/or surface runoff. Caution shall be exercised to prevent spillage of PCS during transport to containers or stockpiles.
6. Excavation, transportation, and placement operations shall result in no visible dust.
7. Perform all field and analytical testing required by the licensed disposal and recycling facility or beneficial use criteria.
    a. Collect samples after the soil has been properly stockpiled or loaded into roll-off containers/trucks. Samples shall be representative of the stockpiled soil. No surface soil from the stockpiled or containerized soil shall be used.
    b. An appropriate number of samples shall be obtained to fully characterize the material, as required by the disposal or recycling facility.
    c. Field notes shall be completed and shall include sample location, sample number, date and time collected and other pertinent information.
    d. Chain of-Custody documents shall be prepared and sample containers shall be labeled with the project name, sample number, date and time collected, and analyses required.

8. If analytical results confirm that the material is PCS, handle, transport, and dispose of the material in accordance with state and federal requirements.
9. If visual or olfactory indicators, field screening, field testing, or analytical testing indicate that the material is potentially hazardous or is any type of contamination other than PCS, immediately notify the Owner and segregate the excavated material from other excavated materials in approved leak-proof containers or stockpile the material on impermeable membranes.
10. Decontaminate equipment used during the handling, sampling, storage and disposal of PCS Material prior to beginning the excavation of Unclassified Material. Any Potentially Contaminated Material generated by decontamination activities shall be characterized and disposed in accordance with state and federal regulations.

11. No additional compensation will be allowed for delays in accepting waste or waste rejected by the facility due to incomplete characterization, or due to invalid or expired transporter permits.
12. The waste profile must be signed by the Owner.
13. The waste manifest must be signed by the Owner.

C. Adhere to the following procedures for hazardous material excavated from the areas identified in Part 1.1.B:

1. Notify the Owner prior to the start of excavation.
2. Handle, transport and dispose of hazardous waste in accordance with state and federal regulations. Hazardous waste must be transported by an appropriately permitted hauler to a properly licensed disposal facility.
3. The Owner will obtain the necessary hazardous waste facility identification number from the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and provide it to the Contractor. The Owner will be considered the generator of all hazardous waste.
4. The Site-Specific Health and Safety Officer shall require the use of appropriate PPE to allow for safe working conditions during excavation.

D. Hazardous material shall be segregated from other excavated materials on stockpiles on impermeable membranes or in approved leak-proof containers. During wet weather, stockpiles or containers shall be covered or tarped with impermeable membranes to prevent contact with precipitation and/or surface runoff. Caution shall be exercised to prevent spillage of hazardous material during transport to containers or stockpiles.

1. Excavation, transportation, and placement operations shall result in no visible dust.
2. Perform all field and analytical testing required by the licensed disposal and/or recycling facility or beneficial use criteria.
    a. Collect the appropriate number of samples. Samples shall be representative of the stockpiled soil. No surface soil from the stockpiled or containerized soil shall be used.
    b. An appropriate number of samples shall be obtained to fully characterize the material, as required by the disposal facility.
    c. Field notes shall be completed and shall include sample location, sample number, date and time collected and other pertinent information.
    d. Chain-of-Custody documents shall be prepared and sample containers shall be labeled with the project name, sample number, date and time collected, and analyses required.

3. If analytical results confirm that the material is hazardous waste, handle, transport, and dispose of the material as specified in the Contractor's Soil Management Plan and in accordance with state and federal regulations.
4. Decontaminate equipment used during the handling, sampling, storage and disposal of Hazardous Material prior to beginning the excavation of Unclassified Material. Any Potentially Contaminated Material generated by decontamination activities shall be characterized and disposed in accordance with state and federal regulations.

5. No additional compensation will be allowed for delays in accepting waste or waste rejected by the facility due to incomplete characterization, or due to invalid or expired transporter permits.
6. The waste profile must be signed by the Owner.
7. The waste manifest must be signed by the Owner.

E. Adhere to the following procedures for non-hazardous waste excavated from the areas identified in Part 1.1.B:

1. Notify the Owner prior to the start of excavation.
2. Non-hazardous waste material shall be handled, transported, and disposed in accordance with state and federal regulations.
3. The Owner will be considered the generator of all non-hazardous waste.
4. The Site-Specific Health and Safety Officer shall require the use of appropriate PPE to allow for safe working conditions during excavation.
5. The non-hazardous waste shall be segregated from other excavated materials on stockpiles on impermeable membranes or in approved leak-proof containers. During wet weather, stockpiles or containers shall be covered or tarped with impermeable membranes to prevent contact with precipitation and/or surface runoff. Caution shall be exercised to prevent spillage of non-hazardous during transport to containers or stockpiles.
6. Excavation, transportation, and placement operations shall result in no visible dust.
7. Perform all field and analytical testing required by the licensed disposal and/or recycling facility or beneficial use criteria.
    a. Collect samples after the soil has been properly stockpiled or loaded into roll-off containers/trucks. Samples shall be representative of the stockpiled soil. No surface soil from the stockpiled or containerized soil shall be used.
    b. An appropriate number of samples shall be obtained to fully characterize the material, as required by the disposal or recycling facility.
    c. Field notes shall be completed and shall include sample location, sample number, date and time collected and other pertinent information.
    d. Chain-of-Custody documents shall be prepared and sample containers shall be labeled with the project name, sample number, date and time collected, and analyses required.

8. If analytical results confirm that the material is non-hazardous waste, handle, transport, and dispose of the material in accordance with state and federal regulations.
9. If visual or olfactory indicators, field screening, field testing, or analytical testing indicate that the material is potentially PCS, hazardous waste, or any type of contamination other than non-hazardous waste, immediately notify the Owner and segregate the excavated material from other excavated materials in approved leak-proof containers or stockpile the material on impermeable membranes.
10. Decontaminate equipment used during the handling, sampling, storage and disposal of Non-hazardous waste material prior to beginning the excavation of Unclassified Material. Any Potentially Contaminated Material generated by decontamination activities shall be characterized and disposed in accordance with state and federal regulations.

11. No additional compensation will be allowed for delays in accepting waste or waste rejected by the facility due to incomplete characterization, or due to invalid or expired transporter permits.
12. The waste profile must be signed by the Owner.
13. The waste manifest must be signed by the Owner.

F. Testing shall be performed by an independent, certified analytical laboratory.

G. If any type of contaminated material is detected at any location other than those listed in Part 1.1.B, immediately take all necessary precautions to protect worker health and safety, secure the area, notify the Owner, and segregate any materials already excavated.

H. The link to the EGLE website listing Hazardous Waste Facilities licensed in Michigan is as follows https://www.michigan.gov/deq/0,4561,7-135-3312_4118_4240-8987--,00.html. In general, a landfill classified as a Hazardous Waste Facility will accept different types of hazardous waste, except some may not accept wastes with high concentrations of PCB's. However, note that certain facilities may only accept certain types of hazardous waste (i.e., solids, liquids, battery recycling, mercury, electrical equipment, PCBs, etc.). Therefore, the Contractor will need to contact the facility to ensure that they accept soil classified as hazardous waste. The Contractor, for bidding purposes, shall assume that the soil will not contain high PCB concentrations that would preclude disposal at a hazardous waste landfill.

3.3 GROUNDWATER HANDLING, SAMPLING, TESTING, AND DISPOSAL

A. Test all groundwater prior to discharging it to the sewer system if approved by DWSD and GLWA. Testing shall be performed by an independent, certified analytical laboratory provided by the Contractor.

B. Provide proper equipment capable of removing and treating potentially contaminated groundwater without causing unsafe work conditions.

C. Remove groundwater from excavation by pumping, bailing, or other methods acceptable to the Owner and in accordance with other specification sections and applicable requirements of the U.S. EPA, EGLE, State Fire Marshal, and local regulatory agencies. Sample and provide necessary testing of groundwater encountered during excavation and dewatering activities for waste characterization and as required by disposal facilities.

D. Characterize the groundwater as petroleum contaminated media similar to PCS, hazardous waste, or non-hazardous liquid industrial by-products based on analytical testing and site information.

E. The liquid waste shall be handled, transported, and disposed of in accordance with state and federal regulations.

1. Notify the Owner immediately.
2. The Owner will be considered the generator of all waste.

3. The Owner will obtain the necessary waste facility identification number from EGLE.
4. The waste profile must be signed by the Owner.
5. The waste manifest must be signed by the Owner.
6. Liquid waste must be transported by an appropriately permitted hauler to a properly licensed disposal facility.
7. No additional compensation will be allowed for delays in accepting waste or waste rejected by the facility due to incomplete characterization, or due to invalid or expired transporter permits.

END OF SECTION 02 61 13

SECTION 03 10 00 - CONCRETE FORMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Design, furnish and install materials for fabricating, erecting and removing formwork, falsework and shoring for cast-in-place concrete as shown on the Contract Drawings and specified herein for a complete installation.
2. Use formwork to cast all cast-in-place concrete structures.

B. Related Requirements:

1. Section 03 20 00 – Concrete Reinforcing.
2. Section 03 30 00 – Cast-in-Place Concrete.
3. Section 03 31 00 – Construction and Expansion Joints.
4. Section 31 23 33 – Trenching and Backfill.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Concrete Institute (ACI):

1. ACI 117/117R - Standard Tolerances for Concrete Construction and Materials.
2. ACI 301 - Specifications for Structural Concrete.
3. ACI 309.2R - Identification and Control of Visible Effects of Consolidation on Formed Concrete Surfaces.
4. ACI 318/318R - Building Code Requirements for Structural Concrete and Commentary.
5. ACI 347R - Guide to Formwork for Concrete.
6. ACI 350.5 - Specifications for Environmental Concrete Structures.

B. APA – The Engineered Wood Association (formerly American Plywood Association).

C. National Institute of Product Standards and Technology:

1. Voluntary Product Standard PS 1 Structural Plywood.

D. Occupational Safety and Health Administration (OSHA):

1. OSHA 29 CFR 1926, current edition.

1.3 DESIGN REQUIREMENTS

A. Design formwork in conformance with methodology of ACI 347R for anticipated loads, lateral pressures, depth of concrete placement and rate of concrete placement. Design shall consider any special requirements due to the use of self-consolidating, plasticized and/or retarded set concrete. All forms and shoring shall be designed at the Contractor's expense.

B. Provide and design forms with openings to allow placement and consolidation of concrete without segregation. Provide drop chutes or drop pipes to prevent accumulation of hardened concrete on forms and reinforcement above fresh concrete and to prevent concrete segregation.

1.4 QUALIFICATIONS

A. Formwork Designer: Formwork, falsework, and shoring design shall be by the Contractor's Professional Engineer registered in the State of Michigan.

1.5 SUBMITTALS

A. Submit product data for form ties, spreaders, chamfer strips, form coatings, and bond breakers at least fourteen (14) days prior to any field activity.

B. Submit the following shop drawings:

1. Form Ties-Tapered Through-Bolts.
2. Proposed method of sealing form tie holes.

C. For cast-in-place concrete structures only, submit formwork design calculations signed and sealed by a Professional Engineer registered in the State of Michigan.

1.6 QUALITY ASSURANCE

A. Design of Formwork:

1. Design, engineer, and construct formwork. Forms shall be designed to produce concrete members identical in shape, to the lines and dimensions shown in the Contract Documents.
2. When high range water reducer (superplasticizer) is used in concrete mix or when self-consolidated concrete is specified, forms shall be designed for full hydrostatic pressure per ACI 347.
3. The formwork shall be designed for the loads and lateral pressures in accordance with ACI 347 and wind and other loads as specified by Michigan Building Code.
4. Construction and contraction joints, openings, offsets, keyways, recesses, moldings, chamfers, blocking, screeds, bulkheads, waterstops, anchorages, inserts, and other features shall be provided.

5. Formwork shall be designed to be readily removable without impact, shock, or damage to 'green' concrete surfaces and adjacent materials.
6. The maximum panel deflection shall be 1/360 of the span between structural members.

B. Unless otherwise specified herein, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits as given in ACI 117 and as indicated in Table 03 10 00-1.

C. Materials, fabrications, and workmanship found defective shall be promptly removed and replaced and new acceptable work shall be provided in accordance with Contract requirements at no additional cost to the Owner.

1.7 DELIVERY, STORAGE AND HANDLING

A. Materials shall be delivered to the site in an undamaged condition and at such intervals as will avoid delay in the work.

B. Material shall be stored and protected in a clean, properly drained location. Material shall be kept off the ground under a weather-tight covering permitting good air circulation. Formwork materials shall be stored on dry wood sleepers, pallets, platforms or other appropriate supports which have slope for positive drainage. Materials shall be protected from distortion, excessive stresses, corrosion and other damage. Materials shall not be stored on the structure in a manner that might cause distortion or damage to the supporting structure.

PART 2 - PRODUCTS

2.1 LUMBER

A. Boards shall be six (6) inches or more in width.

2.2 PLYWOOD

A. Only grade-marked plywood conforming to APA shall be provided.

B. Plywood used in form construction shall be Grade B-B, Class 1 plyform, mill-oiled, and sanded on both sides in conformance with U.S. Product Standard PS 1 Structural Plywood.

C. Thickness shall be sized to maintain alignment and surface smoothness, but not less than 5/8-inch thick.

2.3 STEEL FORMS

A. Commercial grade sheets not less than 16-gage shall be provided.

B. Stock material that is free from warps, bends, kinks, cracks, and rust or other matter that could stain the concrete shall be provided.

C. Steel forms shall be used for the inside face of circular arcs. Forms shall provide a continuous, smooth surface, truly cylindrical, and of the correct diameter throughout. Timber may be used to form transitions and short sections.

D. Provide forms with strength to restrain forms from deflecting beyond finish tolerances specified.

E. Provide forms having sheet steel lining with steel back-up framing. Do not use sheet steel lining with wood back-up framing.

2.4 FORM MATERIAL LOCATIONS

A. Wall Forms and Underside of Slabs and Beams:

1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particleboard, or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce specified finish.

B. Column Forms:

1. Rectangular Columns: As specified for walls.
2. Circular Columns: Fabricated steel or fiber reinforced plastic with bolted together sections or spirally wound laminated fiber form internally treated with release agent for height of column.

C. All Other Forms: Materials as specified for wall forms.

D. Rustication Grooves and Chamfer Strips: Non-absorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two (2) surfaces.

2.5 FORM TIES

A. Locate form ties on exposed surfaces in a uniform pattern. Place form ties so that they remain embedded in the concrete except for a removable portion at each end. Form ties shall have conical or spherical type inserts with a maximum diameter of one (1) inch. Construct form ties so that no metal is within 1-1/2 inches of the concrete surface when the forms, inserts, and tie ends are removed. Do not use wire ties. Ties shall withstand all pressures and maintain forms within acceptable deflection limits.

B. Tapered form ties shall be tapered through-bolts or through-bolts that utilize a removable tapered sleeve. Tapered form ties shall not be used on portions of structures required to be watertight.

C. Wire ties will not be permitted.

D. Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:

1. Integral steel water stop 0.103-inch thick and 0.625-inch in diameter tightly and continuously welded to tie.
2. Neoprene water stop 3/16-inch thick and 15/16-inch diameter whose center hole is one-half diameter of tie, or molded plastic water stop of comparable size.

E. Elastic Vinyl Plug:

1. Design and size of plug shall allow insertion with tool to enable plug to elongate and return to original length and diameter upon removal forming watertight seal.
2. Manufacturer:
   a. Dayton Superior, Miamisburg, OH; A58 Sure Plug.
   b. Or approved equal.

F. Mechanical EPDM Rubber Plug:

1. Mechanical plug for taper tie.
2. Manufacturers:
   a. Greenstreak Group Inc., St. Louis, MO; X-Plug.
   b. Or approved equal.

3. Friction fit plugs will not be allowed.

2.6 BOND BREAKER

A. Bond breaker shall be a V.O.C.-compliant nonstaining type that will provide a positive bond prevention.

B. Manufacturers:

1. Edoco Burke; Clean Lift 90 W.B.
2. Nox-Crete, Inc.; Silcoseal 97EC.
3. Dayton Superior, Miamisburg, OH; J6 WB.
4. Or approved equal.

2.7 FORM CAULKING

A. Form caulking shall be a one-component, gun-grade silicone sealant that is capable of producing flush, watertight and non-absorbent surfaces and joints. Sealant shall be compatible with the type of forming material and concrete ingredients used.

B. Products:

1. Series 1200 Construction Caulking; GE Silicones, Waterford, NY.
2. Dow Corning 999-A; Dow Corning Co., Midland, MI.
3. Sikasil-GP; Sika Corporation Industry Products, Madison Heights, MI.
4. Or approved equal.

2.8 CHAMFER STRIPS

A. Provide 3/4-inch x 3/4-inch chamfer strips milled from clear, straight-grain pine, surfaced each side, or having extruded vinyl type with or without nailing flange unless otherwise shown in the Contract Documents.

2.9 INSERTS

A. Provide galvanized cast steel or galvanized welded steel inserts, complete with anchors to concrete and fittings such as bolts, wedges and straps.

2.10 FORM RELEASE AGENT

A. Form release agent shall not bond with, stain, or adversely affect concrete surfaces and shall not impair subsequent treatments of concrete surfaces when applied to forms. A ready-to-use water-based material formulated to reduce or eliminate surface imperfections and containing no mineral oil or organic solvents.

B. Manufacturers and Products:

1. BASF, Shakopee, MN; MBT, Rheofinish 211.
2. Cresset Chemical Company; Crete-Lease 20-VOC.
3. Unitex Chemicals; Farm Fresh.
4. Magic Kote: Symons Corporation, Des Plaines, IL.
5. Or approved equal.

PART 3 - EXECUTION

3.1 FORM TOLERANCES

A. Comply with the requirements of ACI 117 for tolerances for formed surfaces except as specified in Table 03 10 00-1.

Table 03 10 00-1	
Item	**Tolerance**
Vertical alignment (plumbness)	1/4 inch in any 10 feet and 1 inch maximum for entire length.
Variation in the lines and surfaces of foundation mats, base slabs and walls	1/4 inch in any 10 feet and 1-inch max. for entire length.
Variation from the level or from the grades indicated on the drawings	1/4 inch in any 10 feet .
Variation of the linear building lines from established position in plan	1/2 inch in any 20 feet and 1 inch maximum for entire length.
Variation of distance between walls	1/4 inch in any 10 feet and 1 inch maximum for entire length and height.
Variation in the sizes and locations of sleeves, floor openings and wall openings	Minus 1/4 inch. Plus 1/2 inch.
Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus 1/4 inch. Plus 1/2 inch.
Offset between adjacent panels of formwork facing material	1/2 inch (ACI 117 Class C finish).
Offset between adjacent panels of formwork facing material for exposed surfaces where appearance is of importance	1/8 inch (ACI 117 Class A finish).

B. Tolerances are not cumulative.

C. Where equipment is to be installed, comply with manufacturer's tolerances if more restrictive than above.

D. Failure of the forms to produce the specified concrete surface and surface tolerance shall be grounds for rejection of the concrete work. Rejected work shall be repaired or replaced at no additional cost to the Owner.

3.2 PREPARATION

A. Clean form surfaces to be in contact with concrete or foreign material prior to installation. Tape, gasket, plug, and/or caulk joints, gaps, and apertures in forms so that the joint will remain watertight and withstand placing pressures without bulging outward or creating surface irregularities.

B. Coat form surfaces in contact with concrete with a form release agent prior to form installation.

C. Keep form coatings off steel reinforcement, items to be embedded, and previously placed concrete.

D. Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

E. Form liners to be installed for architectural concrete finish shall be in accordance with the manufacturer recommendations.

3.3 ERECTION AND INSTALLATION

A. Forms shall be constructed in accordance with ACI 347 to required dimensions, plumb, and straight. All joints and seams shall be made mortar-tight. Forms shall be substantial, properly braced, and tied together to maintain position and shape and to resist all pressures to which they may be subjected to. Unless otherwise indicated on the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits in ACI 117 and herein specified.

B. Provide means for holding adjacent edges and ends of form panels tight and in accurate alignment to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Forms shall be tight and shall prevent the loss of mortar and fines during placing and vibration of concrete.

C. Provide exterior exposed corners in concrete members with chamfers as specified, unless otherwise noted.

D. Provide means for removing forms without injury to the surface of finished concrete.

E. Do not embed any form-tying device or part thereof other than metal in the concrete.

F. Locate large end of taper tie on the "wet" side of the wall.

G. Use only form or form-tying methods that do not cause spalling of the concrete upon form stripping or tie removal.

H. Form surfaces of concrete members except where placement of the concrete against the ground is shown in the Contract Drawings.

I. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure water tightness. Provide openings with continuous keyways and water stops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with additional reinforcement as shown in the Contract Drawings. Reinforcing shall be at least two (2) inches clear from the opening surfaces and encased items.

J. Set anchor bolts and other embedded items accurately before placing concrete and hold securely in position until the concrete is placed and set. Check special castings, channels, or other metal parts that are to be embedded in the concrete prior to and again after placing concrete. Check

nailing blocks, plugs, and strips necessary for the attachment of trim, finish, and similar work prior to placing concrete.

K. Maintain steel form temperature between 50-degree F and 95-degree F before, during, and after concrete placement until the forms are removed.

L. If the ambient temperature is below 40-degree F, forms shall be removed only after review by the Engineer or if the strength of each of two (2) adjacent field cured test cylinders representing the concrete to be stripped exceeds the minimum strengths indicated. Field cylinders selected to determine minimum strength for stripping purposes shall be field cylinders taken from the concrete at the end (i.e., during the last hour) of the placement.

3.4 PROTECTION

A. During installation, the forms shall not be used as a storage platform nor as a working platform until the forms have been permanently fastened in position.

3.5 PIPES AND WALL CASTINGS CAST IN CONCRETE

A. Comply with requirements in Section 03 30 00 – Cast-in-Place Concrete.

3.6 REMOVAL OF FORMS

A. Forms shall be removed in accordance with ACI 347 recommendations without damage to concrete and in a manner to ensure complete safety to the structure. Forms, form ties and bracing shall not be removed without specific permission of the Contractor's Professional Engineer registered in the State of Michigan.

B. Table 03 10 00-2 indicates the minimum allowable time after the last cast concrete is placed before forms, shoring, or wall bracing may be removed; during which the air surrounding the concrete is above 50 degrees F.

Table 03 10 00-2

Sides of footings and encasements.	24 hours.
Walls, vertical sides of beams, girders, columns, and similar members not supporting loads.	48 hours.
Slabs, beams, and girders.	10 days (forms only).
Shoring for slabs, beams, and girders.	Until concrete strength reaches 70 percent specified 28-day strength.
Wall bracing.	Until top or roof slab concrete reaches 70 percent specified 28-day strength.

C. Removal times will be increased if the concrete temperature following placement is permitted to drop below 50 degrees F.

D. Do not remove supports and reshore unless otherwise accepted by Engineer.

3.7 PATCHING OF TAPERED TIE HOLES

A. Choose one of the following systems for patching of tapered tie holes:

1. Elastic Vinyl Plug:
   a. Clear tie hole of all loose debris with a taper tie void brush and flush debris from tie hole with air or water.
   b. Install elastic vinyl plug from larger tie hole end in accordance with manufacturer's instructions using an insertion tool as recommended by the manufacturer.
   c. Coat entire annular surface of the hole with epoxy bonding compound prior to filling with non-shrink, non-metallic patching mortar. Apply epoxy in accordance with manufacturer's instructions.
   d. Fill each side of hole with mortar. Apply mortar to the "wet" side of the wall first. Consolidate mortar solidly into the hole.

2. Mechanical Plug:
   a. Clear tie hole of all loose debris with a taper tie void brush and flush debris from tie hole with air or water.
   b. Install mechanical plug in accordance with manufacturer's instructions.
   c. Coat entire annular surface of the hole with epoxy bonding compound prior to filling with non-shrink, non-metallic patching mortar. Apply epoxy in accordance with manufacturer's instructions.
   d. Fill each side of hole with mortar. Apply mortar to the "wet" side of the wall first. Consolidate mortar solidly into the hole.

3.8 ALUMINUM SURFACES IN CONTACT WITH CONCRETE

A. Coat aluminum surfaces that will be in contact with concrete with bituminous coating to avoid chemical reaction. Under no circumstances shall aluminum contact dissimilar metal or concrete.

END OF SECTION 03 10 00

SECTION 03 20 00 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Reinforcing bars.
2. Welded wire fabric.
3. Reinforcement accessories.

B. Related Requirements:

1. Section 03 10 00 – Concrete Forming.
2. Section 03 25 00 – Concrete Accessories.
3. Section 03 30 00 – Cast-in-Place Concrete.
4. Section 03 31 00 – Construction and Expansion Joints.
5. Section 03 37 13 – Shotcrete: Reinforcement for shotcrete.
6. Section 03 39 00 – Concrete Curing.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 318 - Building Code Requirements for Structural Concrete.
3. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures
4. ACI SP-66 - ACI Detailing Manual.

B. American Welding Society:

1. AWS D1.4 - Structural Welding Code - Reinforcing Steel.

C. ASTM International:

1. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
2. ASTM A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
3. ASTM A775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
4. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.

5. ASTM A934 - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
6. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

D. Concrete Reinforcing Steel Institute:

1. CRSI 10-MSP - Manual of Standard Practice.
2. CRSI 10-PLACE - Placing Reinforcing Bars.

1.3 COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Coordinate Work of this Section with placement of formwork, formed openings, and other Work.

1.4 PRE-INSTALLATION MEETINGS

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Shop Drawings:

1. Indicate bar sizes, spacings, locations, splice locations, and quantities of reinforcing steel, bar supporters and welded wire fabric.
2. Indicate bending and cutting schedules.
3. Indicate supporting and spacing devices.
4. Indicate bend details of bars with mechanical couplers.
5. Include manufacturer’s certification and cut-sheets for mechanical couplers.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Submit certified copies of mill test report of reinforcement materials analysis.

E. Welder Certificates:

1. Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

2. Welders: Qualify procedures and personnel according to AWS D1.4.

F. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, submit Manufacturer's literature that contains instructions and recommendations for installation for each type of coupler used; certified test reports that verify the load capacity of each type and size of coupler used; and Shop Drawings that show the location of each coupler with details of how they are to be installed in the formwork.

1.6 QUALITY ASSURANCE

A. Perform Work according to ACI 315.

B. Prepare Shop Drawings according to ACI SP-66.

1.7 QUALIFICATIONS

A. Welders: AWS qualified within previous 12 months for employed weld types.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel:

1. Comply with ASTM A615.
2. Yield Strength: 60 ksi.
3. Billet Bars: Deformed.
4. Finish: Uncoated.

B. Reinforcement:

1. Material: Steel bars.
2. Comply with ASTM A706.
3. Yield Strength: 60 ksi.
4. Finish: Uncoated.
5. These bars shall be used only where welding is indicated or approved by the Engineer.

C. Deformed Wire:

1. Comply with ASTM A1064.
2. Finish: Uncoated.

D. Plain Wire:

1. Comply with ASTM A1064.
2. Finish: Uncoated.

E. Welded Deformed Wire Fabric:

1. Comply with ASTM A1064.
2. Configuration: Flat sheets.
3. Finish: Uncoated.

F. Welded Plain Wire Fabric:

1. Comply with ASTM A1064.
2. Configuration: Flat sheets
3. Finish: Uncoated.

2.2 SHOP FINISHING

A. Epoxy-Coated Finish for Steel Bars: Comply with ASTM A775. For coating applied after fabrication, comply with ASTM A934.

B. Epoxy-Coated Finish for Steel Wire: Comply with ASTM A884, Class A.

2.3 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage, annealed type, epoxy coated.

B. Chairs, Bolsters, Bar Supports, and Spacers Size and Shape: To strengthen and support reinforcement during concrete placement conditions.

C. Special Chairs, Bolsters, Bar Supports, and Spacers Adjacent to Weather-Exposed Concrete Surfaces:

1. Material: Stainless steel.
2. Size and Shape: To meet Project conditions.

D. Reinforcing Splicing Devices:

1. Type: Mechanical threaded; full tension and compression.
2. Size: To fit joined reinforcing.
3. Mechanical couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcing bars being spliced at each splice.
4. Coupler system shall possess a current and valid International Code Council Evaluation Service Report.
5. Where the type of coupler used is composed of more than one component, all components required for the complete splice shall be supplied.
6. Manufacturers:
   a. Erico (Pentair) – Lenton Form Saver.
   b. Dayton Superior – DBDI Splice System.
   c. Approved equal.

E. Epoxy Coating Patching Material: Type as recommended by coating manufacturer.

2.4 SOURCE QUALITY CONTROL

A. Certificate of Compliance:

1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 FABRICATION

A. Fabricate concrete reinforcement according to ACI SP-66.

B. Form standard hooks for 180-degree bends, 90-degree bends, stirrups and tie hooks as indicated on Drawings.

C. Form reinforcement bends with minimum diameters according to ACI 318 or ACI 350.

D. Weld reinforcement according to AWS D1.4.

E. Epoxy-Coated Reinforcement: Clean surfaces, weld, and re-protect welded joint according to CRSI 10-PLACE.

F. Splicing: If not indicated on Drawings, locate reinforcement splices at point of minimum stress. However, such locations shall be subject to approval by the Engineer.

3.2 INSTALLATION

A. Place, support, and secure reinforcement against displacement.

B. Do not deviate from required position beyond specified tolerance.

C. Do not weld crossing reinforcement bars for assembly except as permitted by Engineer.

D. Accommodate placement of formed openings.

E. Spacing and Concrete Cover:

1. Space reinforcement bars at spacing indicated on the Drawings within the specified tolerances.
2. Place reinforcement bars with minimum clear concrete cover according to ACI 350 unless shown otherwise on the Drawings.
3. If bars are indicated in multiple layers, place upper bars directly above lower bars.

F. Comply with tolerance requirements in Section 01 40 00 - Quality Requirements.

G. Install reinforcement to tolerances given in ACI 350 unless otherwise indicated or specified.

3.3 FIELD QUALITY CONTROL

A. Comply with Contractor procured inspecting and testing requirements in Section 01 40 00 - Quality Requirements.

B. Field quality control inspection and testing may also be performed by an independent firm retained by the Owner according to ACI 315. This shall be independent from the inspection and testing conducted by the Contractor.

C. Provide unrestricted access to Work and cooperate with Owner-appointed inspection and testing firm.

D. Reinforcement Inspection:

1. Placement Acceptance: Inspect specified material requirements and specified placement tolerances.
2. Welding: Inspect welds according to AWS D1.4.
3. Periodic Placement Inspection: Inspect for correct materials, fabrication, sizes, locations, spacing, concrete cover, and splicing.
4. Continuous Weld Inspection: Inspect reinforcement according to ACI 350.
5. Periodic Weld Inspection: Inspect other welded connections.
6. Post-installed reinforcement dowels shall be tension tested in accordance with grout manufacturer's requirements. Should any tension test fail, all dowels installed that day shall be tested.

END OF SECTION 03 20 00

SECTION 03 25 00 – CONCRETE ACCESSORIES

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joint Fillers.
2. Joint Sealants.
3. Waterstops.
4. Miscellaneous Embedded Items in Concrete.

B. Related Requirements:

1. Section 03 10 00 – Concrete Forming.
2. Section 03 20 00 – Concrete Reinforcement.
3. Section 03 30 00 – Cast-in-Place Concrete.
4. Section 03 31 00 – Construction and Expansion Joints.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. ASTM National:

1. ASTM A193 – Standard Specification for Alloy-Steel and Stainless-Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications.
2. ASTM A194 – Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
3. ASTM A563 – Standard Specification for Carbon and Alloy Steel Nuts.
4. ASTM B633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
5. ASTM F436 – Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
6. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit certified manufacturer's literature, catalog data, and statement of compliance with referenced standards and specifications for materials specified herein.

C. Provide technical data sheets for the Contractor's personnel and the Owner covering joint preparation, priming, and sealant materials application.

D. Submit a schedule of concrete pouring and indicate locations of proposed construction and expansion joints.

1.4 SEQUENCING

A. Sequence installation of miscellaneous embedded items with the Work of Section 03 10 00 - Concrete Formwork, Section 03 20 00 - Concrete Reinforcement, and Section 03 30 00 - Cast-in-Place Concrete.

1.5 MANUFACTURER'S SERVICES

A. Prior to joint preparation for joints receiving sealant materials, the Contractor shall require joint manufacturer's technical representative to demonstrate at the site joint preparation, priming, and sealant materials application for the Contractor's personnel performing joint work. Manufacturer's technical representative shall complete this demonstration no later than 5 days prior to start of this work by the Contractor's personnel. The manufacturer's representative or the inspector shall observe as many instances of the Contractor's personnel performing this work as possible.

PART 2 - PRODUCTS

2.1 JOINT FILLER

A. Comply with Section 03 31 00 – Construction and Expansion Joints.

2.2 WATERSTOPS

A. Comply with Section 03 31 00 – Construction and Expansion Joints.

2.3 CONCRETE ANCHORS

A. General:

1. Unless otherwise specified, select type and size to achieve required loading capacity using information provided by manufacturer. If the required type is not indicated, select types appropriate to conditions and items being fastened.
2. Maintain critical edge distance and spacing per manufacturer's recommendations for all anchors. Provide tamper proof hardware where specified on Drawings.

3. Provide cast-in-place headed anchor bolts where indicated on Drawings, for high temperature applications, for vibratory applications / situations, and where recommended by the equipment manufacturer.

B. Adhesive Anchors:

1. Injectable adhesive shall be used for installation of all reinforcing steel dowels or threaded anchor rods and inserts into new or existing concrete.
2. Combination injectable adhesive and insert system; chisel pointed threaded rod with hex nut/washer, reinforcing bar, or internally threaded insert, installed into a pre-drilled anchor hole using rotary hammer drill. Adhesive shall be a hybrid adhesive consisting of a methacrylate resin, hardener, cement, and water formulated for fast curing and high strength and stiffness.
3. Adhesive shall be furnished in containers which keep components A and B separate.
4. Adhesive anchors shall be as defined on the Drawings or approved equal.
5. Threaded rod: ASTM A193 Grade B7 Type 2, ASTM A194 Grade 2H or ASTM A563 Grade DH nuts, and ASTM F436 washers; plated in accordance with ASTM B633, SC1, with Type II yellow chromate treatment,.
6. Threaded Insert: Stainless steel tubular insert, internally threaded.

C. Wedge Type Anchors:

1. One-piece body with expansion mechanism installed in pre-drilled hole using matching tolerance bit.
2. Wedge type anchors, if indicated or permitted, shall be galvanized steel unless otherwise noted, shall be of the expansion type, and shall be Simpson String-Tie Strong-Bolt 2 anchor, Hilti Kwik-Bolt TZ anchor, or an approved equal.

2.4 CAST-IN-PLACE HEADED ANCHOR BOLTS

A. Where indicated on the Drawings, the anchors bolts shall be cast-in-place headed anchor bolts.

B. Carbon steel anchor bolts shall conform to ASTM F1554 Grade 36 or Grade 55 as indicated on the Drawings. Finish shall be plain or hot-dipped galvanized as indicated on the Drawings. Nuts shall conform to ASTM A563 (hex or heavy hex depending upon the diameter) and washers shall conform to ASTM F436.

C. Stainless steel anchor bolts shall conform to ASTM A193 Grade B8 Class 2 (AISI 304) as indicated on the Drawings. Nut shall conform to ASTM A194 Grade 8 and washer shall conform to SS304 for Grade B8 Class 2 bolt.

PART 3 - EXECUTION CONTRACTOR'S VERIFICATION

A. Inspect the locations and surfaces to receive joint filler, joint sealer, waterstops, or miscellaneous embedded items and correct defects or conflicts which will affect the proper performance of the item to be placed.

3.2 PREPARATION

A. All accessories to be embedded into concrete shall have contact surfaces free of dirt, curing compound, protrusions of hardened concrete or any other foreign material which would affect bond with concrete.

B. Prime surfaces in accordance with manufacturer's recommendations.

3.3 INSTALLATION OF JOINT SEALANTS

A. Joints shall not be sealed when the sealant, air, or concrete temperature is less than 40°F. Bond breaker and backup material shall be installed where required as indicated on the Plans or per manufacturer's recommendations.

3.4 CONCRETE ANCHORS

A. Do not begin installation until substrates have been properly prepared. Do not proceed with installation if substrate preparation is unsatisfactory.

B. Clean surfaces thoroughly prior to installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Install in accordance with manufacturer's instructions and recommendations and as required by applicable code. Anchor applied items neatly, with item mounted plumb and level unless otherwise indicated.

D. The anchor manufacturer's representative shall demonstrate proper installation procedures for post-installed anchors and shall observe Contractor's installation procedures. Conduct at least two pullout or shear tests to determine adequacy of anchors.

E. The minimum embedment length for anchors shall be as noted in Drawings. If embedment length is not specified, provide embedment to develop full strength of the anchor.

F. Cast-in-place headed anchor bolts shall be set with a template.

3.5 PVC WATER STOPS

A. Water stops shall be heat spliced at ends and intersections to ensure continuity. Bent water stops up from footing and slab joint and splice to wall water stop to result in a watertight structure. Construct forms for construction joints in such a manner as to prevent injury to water stops. Hold water stops securely in position in the construction joints by wire ties, continuous bars, and rings as indicated. Install water stops in construction and expansion joints in hydraulic structures or where shown in the drawings.

B. Make field splices with a thermostatically controlled heating iron in conformance with the manufacturer's current recommendations. Allow at least 10 minutes before pulling or straining the new splice in any way. The finished splices shall provide a cross section that is dense and free of porosity with tensile strength of not less than 80% of the un-spliced materials.

3.6 INSTALLATION OF JOINT SEALANTS

A. Immediately before installing the joint sealant, clean the joint cavity by sandblasting or power wire brushing. Install bond breaker tape per manufacturer's instructions.

B. Apply masking tape along the edges of the exposed surface of the exposed joints.

C. Application criteria for the sealant materials, such as temperature and moisture requirements and primer cure time, shall be in accordance with the recommendations of the sealant manufacturer.

D. After the joints have been prepared as described above, apply the joint sealant. Apply the primer, if required, and joint sealant only with the equipment and methods recommended by the joint sealant manufacturer.

E. Trowel the joints smooth with a tuck-pointing tool wiped with a solvent recommended by the sealant manufacturer.

F. After applying the sealant, remove the masking tape and any sealant spillage.

3.7 MISCELLANEOUS EMBEDDED ITEMS

A. All sleeves, inserts, anchor bolts, and other embedded items required for adjoining Work or for its support shall be placed prior to concreting.

B. Embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into voids.

END OF SECTION 03 25 00

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Class A Concrete: Normal-weight concrete shall be used in all cast-in-place structures except where Class B concrete is permitted.
2. Class B Concrete: Normal-weight concrete shall be used where specified in the Plans.
3. Class D Concrete: Normal-weight unreinforced concrete to be used as a concrete fill below foundation and where noted in Plans or permitted by the Engineer.

B. Related Requirements:

1. Section 03 10 00 - Concrete Forming and Accessories.
2. Section 03 20 00 - Concrete Reinforcing.
3. Section 03 31 00 - Construction and Expansion Joints.
4. Section 03 39 00 - Concrete Curing.

C. Provide labor, materials, equipment and incidentals necessary to furnish, install and test cast-in-place concrete as specified and as shown on Contract Drawings.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Concrete Institute (ACI):

1. ACI 214 - Recommended Practice for Evaluation of Strength Test Results of Concrete.
2. ACI 301 - Specifications for Structural Concrete.
3. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
4. ACI 305R - Guide to Hot Weather Concreting.
5. ACI 306.1 - Standard Specification for Cold Weather Concreting.
6. ACI 309 - Recommended Practice for Consolidation of Concrete.
7. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures.

B. ASTM International:

1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2. ASTM C33 - Standard Specification for Concrete Aggregates.
3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
6. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
9. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
10. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
11. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
12. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
13. ASTM C295 - Standard Guide for Petrographic Examination of Aggregates for Concrete.
14. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
15. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
16. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
17. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
18. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
19. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete.
20. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
21. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.
22. ASTM C1260 - Standard Test Method for Potential Alkali Activity of Aggregates (Mortar-Bar Method).
23. ASTM D75 - Standard Practice for Sampling Aggregates.
24. ASTM E329 - Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction.

C. Michigan Department of Transportation (MDOT) Latest Edition of Standard Specifications for Construction.

D. American Association of State Highway and Transportation Officials (AASHTO) T26 Quality of Water to be Used in Concrete.

1.3 DEFINITIONS

A. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations greater than 3/16-inch, cracks 0.005-inch or wider as well as any crack or joints that leaks in liquid containment structures and below-grade habitable or watertight spaces, cracks 0.010-inch wide and larger in non-liquid holding structures, spalls, chips, air bubbles greater than 3/4-inch in diameter, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from

form joints, fins and other projections, form popouts, texture irregularities, and stains and other color variations that cannot be removed by cleaning.

1.4 COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer's specifications and instructions including for attachment accessories, admixtures and Material Data Sheets (MDS) for admixtures. Manufacturer's certification of compatibility of all admixtures.

C. Design Data: Submit the following:

1. Name and address of Contractor's proposed testing laboratory firm and a brief description and references for prior work which is similar to that proposed for this project. ASTM E329 shall also be used for evaluating the testing laboratory firm.
2. Manufacturer's Certificate of Compliance for Portland Cement, Fly Ash, Aggregates, and Admixtures. Identify chloride content of admixtures and whether or not chlorides were added during manufacture.
3. State of Qualifications for the Mix Designer and Batch Plant.
4. Submit concrete mix design for each concrete strength. This shall include total gallons of water per cubic yard, brand / type / quantity of Portland Cement and Fly Ash, Specific gravity of all constituents, surface-dry weight and gradation of aggregates, ratio of fine to total aggregates, brand / type / ASTM Designation / quantity of each admixture, slump, air content, and unit weight. Concrete mix design shall be accompanied with matching trial batch and/or field-test data. Shrinkage Test data shall also be submitted for Class A Concrete designs. All strength data shall be for the proposed mix design or sufficiently close to it and shall not be any older than 12 months from the date of the submittal.
5. Concrete mix designs different in admixture type and quantity shall be deemed as different mix designs and shall be submitted individually with their own respective strength data.

D. Manufacturer Instructions: Submit installation procedures and interfacing required with adjacent Work.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of embedded utilities and components concealed from view in finished construction.

1.7 QUALITY ASSURANCE

A. Perform Work according to ACI 301 unless otherwise indicated or specified**.**

B. Comply with ACI 305R when placing concrete during hot weather.

C. Comply with ACI 306.1 when placing concrete during cold weather.

D. Acquire cement from one source for Work.

E. Acquire aggregate from one source for Work.

F. Qualifications: Batch Plant currently certified by the National Ready Mixed Concrete Association.

G. Project Concrete Conference:

1. Required attendees:
   a. Owner or Engineer.
   b. Contractor, including pumping, placing and finishing, and curing sub-contractor(s).
   c. Ready-Mixed concrete producer.
   d. Admixture representative, if requested by Owner.
   e. Testing and sampling personnel / technician.

2. Schedule and conduct prior to start of any concrete work and in a timely manner to facilitate the project schedule. Schedule the conference in coordination with all the attendees.

3. Agenda shall include:
   a. Mix designs, test of mixes, and submittals.
   b. Admixture types, dosage, and performance.
   c. Placement methods, techniques, equipment, consolidation, and form pressures.
   d. Slump and placement time to maintain slump.
   e. Finishing, curing, and water retention.
   f. Protection procedures for weather conditions.
   g. Other specified requirements requiring coordination.

H. Trial Mix:

1. When field experience records are inadequate or out-of-date to confirm the quality of a proposed concrete mix, or when required by the Engineer, an independent testing laboratory designated by the Contractor and acceptable to the Engineer shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial

batch shall be prepared using the aggregates, cement, and admixtures proposed for the Project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials shall already be performed before any trial mix is developed and tested. The cost of the laboratory trial batch tests for each specified concrete mix shall be at no additional cost to the Owner.

2. The independent testing laboratory shall observe the preparation of the trial batch, and they shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C31 in addition to conducting slump (ASTM C143), air content (ASTM C231), and unit weight (ASTM C138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully labelled. If the average 28-days compressive strength of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch testing required shall be performed at no additional cost to the Owner. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

I. Shrinkage Test:

1. The testing laboratory shall perform drying shrinkage tests for the trial batches as specified herein.

2. Fabricate, cure, dry, and measure specimens in accordance with ASTM C157 modified as follows:
   a. Remove specimens from molds at an age of 23 hours +/- 1 hour after trial batching, place immediately in water at 70°F +/- 3° degrees F for at least 30 minutes, measure within 30 minutes thereafter to determine original length, and then submerge in saturated lime water at 73°F +/- 3 degrees. At age seven days, make measurement to determine expansion, expressed as a percentage of original length. This length at age seven days shall be the base length for drying shrinkage calculations (zero days' drying age).
   b. Then, store specimens immediately in a humidity-controlled room maintained at 73°F +/- 3°F and 50 percent +/- 4 percent relative humidity for the remainder of the test. Make and report measurements to determine shrinkage expressed as percentage of base length separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.

3. Compute the drying shrinkage deformation of each specimen as the difference between the base length (at zero days' drying age) and the length after drying at each test age. Compute the average drying shrinkage deformation of the specimens to the nearest 0.0001 inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004 inch, disregard the results obtained from that specimen. Report results of the shrinkage test to the nearest 0.001 percent of shrinkage.

Take compression test specimens in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project.

4. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age, shall be 0.036 or 0.042 percent, respectively. Use a mix design for construction that has first met the trial batch shrinkage requirements.

5. If the trial batch specimens do not meet the shrinkage requirements, revise the mix design and/or materials and retest.

6. Shrinkage test requirement applies only to Class A concrete designs.

J. Do not place concrete until design mix, material tests, and trial concrete batch mix compression test results are approved by the Engineer.

K. Concrete delivered to the job site with a temperature outside the specified concrete temperature limitations shall be rejected.

L. Do not place concrete in water, or on frozen or disturbed ground.

M. Acceptance of Structure: Acceptance of completed concrete work requires conformance with dimensional tolerances, appearance, and strength as indicated or specified.

1.8 AMBIENT CONDITIONS

A. Comply with Section 01 52 00 - Temporary Facilities.

B. Do not place concrete until conditions and facilities for making and curing control test specimens are in compliance with ASTM C31 and as specified herein.

C. Maintain concrete temperature after installation at minimum 50°F for minimum seven days.

D. Maintain high-early strength concrete temperature after installation at minimum 50°F for minimum three days.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete:

1. Portland Cement:

a. Portland Cement shall be Type I/II or Type II in accordance with ASTM C150. Type I cement may be used with Class B and Class D concrete.
b. For concrete mixed with only Portland Cement, the total alkalis in the cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.40% unless aggregates to be used meet the requirements for non-reactivity with alkalis as stated in paragraph 2.1.A.5.h.1.
c. For concrete mixed with Portland Cement and an appropriate amount of fly ash, the total alkalis in the Portland Cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.85% unless aggregates to be used meet the requirements for non-reactivity as stated in article 2.1.A.5.h.1.
d. Reject the entire Portland Cement shipment when cement is lumpy, wetted, partially or wholly set, or otherwise damaged.
e. Portland cement shall be from one approved manufacturer unless otherwise approved by the Engineer. Use cement of uniform color.
f. Cement shall be stored in a suitable weather-tight building to prevent deterioration or contamination.

2. Fly Ash:
   a. Class F fly ash conforming to ASTM C618 for chemical and physical properties.
   b. Supplemental requirements:
      1) Maximum carbon content; 3%.
      2) Maximum sulfur trioxide (SO3) content; 4%.
      3) Maximum loss on ignition; 3%.
      4) Maximum water requirement (as a % of control); 100%.
      5) Fineness, maximum retained on No. 325 sieve; 25%.
   c. Maximum available alkalis; 1.5%.
   d. Fly ash shall also meet the optional physical requirements for uniformity as per ASTM C618.
   e. Where fly ash is included in the concrete mix to waive the 0.4% alkali requirement of the Portland Cement, the fly ash constituent shall be between 15% and 25% of the total weight of the combined Portland Cement and fly ash. The percentage of fly ash shall be set so that the mean mortar bar expansion of the cement-fly ash mix shall be 0.08% or less when tested at 16 days in accordance with ASTM C1260. The Portland Cement and aggregates used in the mix for this test shall be the same as proposed for use on the Project.

3. Ground Granulated Blast Furnace Slag (GGBF): GGBF, when used, shall meet the requirements of ASTM C989, Grade 100 or better.

4. Silica Fume: Comply with ASTM C1240. Use silica fume only where indicated on the Drawings. Silica fume shall not exceed 10 percent of the total weight of the silica fume plus the cement.

5. Normal Weight Aggregates:
   a. All aggregate used shall comply with ASTM C33.

b. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces.
c. Wash all aggregate to remove dust, clay, or silt coating.
d. Aggregates that have been washed shall not be used sooner than 24 hours after washing, unless approved by the Engineer.
e. Fine aggregate (sand) shall consist of natural siliceous sand, clean and free from deleterious substances and shall conform to the requirements of ASTM C33 with a finest modulus between 2.50 and 3.00.
f. Coarse aggregate shall be gravel or crushed rock conforming to ASTM C33.
g. Aggregates shall be tested for soundness in accordance with ASTM C88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using magnesium sulfate.
h. When aggregates, which are non-reactive with alkalis, are desired in order to waive the alkali content requirement of cement as stated herein, the following tests shall be performed:
    1) A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Aggregates containing more than the following quantities of constituents shall be considered potentially reactive:
        a) Optically strained, microfractures, or microcrystalline quartz exceeding 5.0%.
        b) Chert or Chalcedony exceeding 3.0%.
        c) Tridymite or cristobalite exceeding 1.0%.
        d) Opal exceeding 0.5%.
        e) Natural volcanic glass in volcanic rocks exceeding 3.0%.

    2) Aggregates shall be evaluated by ASTM C1260. Aggregates sources that exhibit mean mortar bar expansions at 16 days greater than 0.8% shall be considered potentially reactive. Tests shall be made with cement proposed for use on the Project.

i. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.
j. No aggregates that have become intermixed prior to proportioning shall be used. Sufficient aggregate shall be available to preclude the possibility of delays while placing the concrete.

6. Water:
    a. Potable water approved by the State Department of Public Health may be used without testing.

    b. For water requiring testing, the tests shall be conducted in accordance with AASHTO T26 and meet the following requirements:
        1) Total solid matter; 0.30% maximum.
        2) Organic matter; 0.05% maximum.
        3) Alkalinity-acidity; neutral to litmus.

4) Water-soluble chloride ions by weight of cement 0.06 % maximum.

B. Concrete Admixtures:

1. Provide admixtures produced by established, reputable manufacturers, and used in compliance with the manufacturer's printed instructions.
2. All admixtures shall be obtained from one manufacturer. The manufacturer shall be capable of providing a qualified field service representative.
3. The admixture manufacturer shall certify the compatibility of multiple admixtures used in the same concrete mix.
4. Maintain required compressive strength and maximum water-cement ratio indicated in this section when using admixtures. Include all admixtures in solution form in the water-cement ratio calculations.
5. Do not use calcium chloride, admixtures containing chloride ions or other admixtures causing accelerated setting of cement. Do not use combinations of admixtures and cements producing erratic or otherwise undesirable results with aggregates.
6. Reject admixtures that have been in storage for longer than manufacturer's recommendations or which have been subjected to freezing.
7. Do not use admixtures is greater dosages than recommended by the manufacturer.
8. The quantity of the admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.
9. The strength of concrete with proposed admixtures after 48 hours shall not be less than the strength of similar concrete without admixtures.
10. Air Entrainment:
    a. Air entrain all concrete, unless specified otherwise.
    b. Use air-entraining admixture complying with ASTM C260.
    c. Measure air content in accordance with ASTM C231.
    d. Adjust the dosage rate to accommodate fly ash or pozzolan requirements, and other admixtures when used, in order to obtain the specified air content.
    e. Products:
        1) SIKA AER by Sika Corporation.
        2) MB-VR by Master Builders.
        3) Daravair by W.R. Grace & Co.
        4) Or approved equal.
11. Mid- Range Water Reducer:
    a. Comply with ASTM C494.
    b. Use admixture Type A.
    c. Products:
        1) Use Daracem by W.R. Grace.
        2) Polyheed by BASF.
        3) Sikament by Sika Corporation.
        4) Or an approved equal.
12. High -Range Water Reducer (Super plasticizer):
    a. Use admixture Type F or G with extended slump life.
    b. High-range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified.

c. No more than 14 ounces of water reducer per sack of cement shall be used.
d. Concrete shall be mixed at mixing speed for a minimum of 70 mixer revolutions or 5 minutes after the addition of high-range water reducer, unless otherwise recommended by the manufacturer.
e. Products:
1) Use ADVA by W.R. Grace.
2) ViscoCrete by Sika Corporation.
3) Glenium by BASF.
4) Or an approved equal.

13. Retarder:
a. Use admixture Type B.
b. When the air temperature at the time of concrete placement is expected to be consistently greater than 80°F, a concrete retarder shall be used.
c. Products:
1) Plastocrete 161MR by Sika Corporation.
2) Pozzolith or Delvo by BASF.
3) Daratard by W.R. Grace.
4) Or an approved equal.

14. Water Reducer and Retarder: Use admixture Type D.
15. Water Reducer and Accelerator:
a. Use admixture conforming to Type E.
b. When the air temperature at the time of concrete placement is expected to be consistently less than 40°F, a non-corrosive accelerating admixture shall be used.
c. Use of accelerator shall not relax cold-weather placement requirements.
d. Products:
1) Plastocrete 161FL by Sika Corporation.
2) Pozzutec 20 by BASF.
3) Daraset by W.R. Grace.
4) Or an approved equal.

16. Plasticizer and Retarder: Use admixture compliant to ASTM C1017, Type II.
17. Color Pigment:
a. Compliant to ASTM C979, synthetic mineral-oxide pigment or colored water-reducing admixtures; color stable, free of carbon black, non-fading, and resistant to lime and other alkalies.
b. Color: concrete for electrical duct bank and other appurtenant work shall have an integral red oxide pigment. Surface paint, spraying, or coating of concrete shall not be acceptable.

2.2 CONCRETE MIX

A. Select proportions for concrete according to ACI 350 trial mixes or field test data. When trial mixes are used, they shall also confirm to paragraph 3.1.

B. Use ready-mixed concrete, secured from a batching or mixing plant conforming to ASTM C94, capable of developing specified characteristics and being placed without segregation.

C. Limit maximum size of coarse aggregate to 1-1/2 inch for walls greater than 8 inches in thickness, grade beams, footings, foundations, and base slabs. Limit maximum size of coarse aggregate to 3/4 inch for all other concrete.

D. Produce concrete mix of homogeneous consistency, capable of being worked into constricted areas of forms, corners, and around embedded items, without segregation or bleeding of water.

E. Performance and Design Criteria:

1. Class A Concrete:
    a. 28-Day Compressive Strength: 5,000 psi.
    b. Maximum water / cementitious material ratio: 0.42 by weight.
    c. Minimum Cement Content: 564 lb./cu. yd.
    d. Slump: 4-inch nominal unless high-range water reducing admixture is used. 3-inch maximum before addition of high-range water reducing admixture. 8-inch maximum after addition of high-range water reducing admixture.
    e. Total Air Content by volume:
        1. 4 to 6 percent for concrete with 1-1/2-inch maximum aggregate size.
        2. 5 to 7 percent for concrete with 3/4-inch maximum aggregate size.
        3. Air content in concrete to receive trowel finish shall be limited to 3 percent maximum.
    f. Uniformly disperse fiber reinforcement in concrete mixture used for topping at a rate of 1.5 lb./cu. yd.
2. Class B Concrete:
    a. 28-Day Compressive Strength: 4,000 psi.
    b. Maximum water / cementitious material ratio: 0.48 by weight.
    c. Minimum Cement Content: 517 lb./cu. yd.
    d. Slump: 4-inch nominal unless high-range water reducing admixture is used. 3-inch maximum before addition of high-range water reducing admixture. 8-inch maximum after addition of high-range water reducing admixture.
    e. Total Air Content by volume:
        1. No air entrainment is required unless exposed to freeze / thaw cycles.
        2. 4 to 6 percent for concrete with 1-1/2-inch maximum aggregate size.
        3. 5 to 7 percent for concrete with 3/4-inch maximum aggregate size.
        4. Air content in concrete to receive trowel finish shall be limited to 3 percent maximum.
    f. An integral red oxide color pigment, batched at a rate of 8 pounds per cubic yard, shall be provided for duct bank encasement and other concrete appurtenant to electrical work.
3. Class D Concrete:
    a. 28-Day Compressive Strength: 2,000 psi.
    b. Maximum water / cementitious material ratio: 0.60 by weight.
4. Admixtures:
    a. Include admixture types and quantities indicated in concrete mix designs only if approved by Engineer.

b. For concrete exposed to deicing chemicals, limit fly ash, pozzolans, and silica fumes content as required by applicable code.

2.3 ACCESSORIES

A. Bonding Agent:

1. The bonding agent shall be epoxy adhesives, unless approved otherwise by the Engineer.
2. Bonding agent for bonding freshly-mixed, plastic concrete to hardened concrete shall be:
   a. Sikadur 32 Hi-Mod epoxy adhesive by Sika Corporation.
   b. Concresive Liquid (LPL) by MBT/Degussa Building Systems.
   c. BurkEpoxy MV by Edoco.
   d. Or an approved equal.
3. Bonding agent for bonding hardened concrete to steel shall be:
   a. Sikadur 31 Hi-Mod Gel by Sika Corporation.
   b. BurkEpoxy NS by Edoco.
   c. Concresive Paste (LPL) by MBT/Degussa Building Systems.
   d. Or an approved equal.
4. Non-Epoxy bonding agent shall be used where specified on the Drawings or approved by the Engineer and shall be one of the following:
   a. Weld-Crete by Larsen Products Corporation.
   b. Eucoweld by Euclid Chemical Co.
   c. Or approved equal.

B. Non-shrink, non-metallic Grout:

1. Premixed compound consisting of non-metallic aggregate, cement, and water-reducer, plasticizing agents and only requiring addition of water.
2. Minimum 28-day compressive strength of 5,000 psi.
3. Comply with ASTM C1107, Grade A, B, or C.
4. Products:
   a. Five Star Grout by U.S. Grout Corp.
   b. SikaGrout 212 by Sika Corporation.
   c. MasterFlow 928 Grout by Master Builders.
   d. Or approved equal.

C. Concrete Reinforcing Fibers:

1. High-strength industrial-grade synthetic macro fibers specifically engineered for secondary reinforcement of concrete.
2. Fibers shall be 100 percent virgin homopolymer polypropylene-fibrillated fibers, containing no reprocessed olefin materials.
3. Comply with ASTM C1116.
4. Tensile Strength: 70 to 110 ksi in accordance with ASTM D2256.
5. Fiber Length: 1 ½ inches.
6. Dosage rate: Per manufacturer's recommendations or as specified on the drawings.

7. Concrete topping shall be provided with reinforcing fibers unless specified otherwise on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify requirements for concrete cover over reinforcement.

C. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Previously Placed Concrete:

1. Prepare previously placed concrete by bush hammer, sand blasting or cleaning with steel brush, as applicable, and applying bonding agent.
2. Remove laitance, coatings, and unsound materials.

C. In locations where new concrete is doweled to existing work, drill holes in existing concrete and install steel dowels with epoxy adhesive per manufacturer's written instructions.

D. Remove debris and ice from formwork, reinforcement, and concrete substrates.

E. Remove water from areas receiving concrete before concrete is placed.

3.3 PIPES AND WALL CASTINGS CAST IN CONCRETE

A. Install wall spools, wall flanges, hydrophilic waterstops and wall anchors before placing concrete. Do not weld, tie, or otherwise connect the wall castings or anchors to the reinforcing steel.

B. Support pipe and fabricated fittings to be encased in concrete on concrete piers or pedestals. Carry concrete supports to firm foundations so that no settlement occurs during construction.

C. Pipes or wall castings located below operating water level shall have water stop ring collars and shall be cast in place. Do not block out such piping and grout after the concrete section is cast

unless approved, authorized or directed by the Engineer. Pipes fitted with thrust rings shall be cast-in-place.

3.4 INSTALLATION

A. Production of Concrete: Batch, mix, and deliver concrete in conformance with ASTM C94. Batch all constituents at central batching or mixing plant. Produce concrete in conformance with ACI 301 and as specified herein.

B. Transporting and Mixing:

1. Conform to concreting procedures set forth in ACI 304R and as specified herein.
2. Transport concrete to discharge locations without altering the specified properties of water-cement ratio, slump, air entrainment, temperature, and homogeneity.
3. Discharge concrete into forms within 1-1/2 hours, with the addition of a retarding admixture conforming to ASTM C494 Type B, D or G, after cement has entered mixing drum or before the drum has revolved 300 revolutions after the addition of water, whichever occurs first. Do not add re-tempering water at jobsite, nor exceed the maximum water content in the approved concrete design mix.

C. Conveying: Convey concrete from agitator or mixer truck to place of final deposit in forms by one of the following methods:

1. Buckets or hoppers with discharge gates having a clear opening equal to not less than one-third the maximum interior horizontal area or five times the maximum aggregate size being used, whichever is greater, and side slopes of not less than 60 degrees to the horizontal.
2. Buggies or wheelbarrows equipped with pneumatic tires.
3. Round bottom, metal or metal-lined chutes with inclined slope of between two to three feet horizontally to one foot vertically and sufficient capacity to avoid overflow.
4. Circular drop pipes with a top diameter of at least eight times the maximum aggregate size, but not less than 4-inch, or tapered to not less than six times maximum aggregate size. Do not drop concrete more than 5 feet without drop pipes.

D. Pumping:

1. Use equipment procedures with backup to maintain steady flow of concrete at discharge end of pipe.
2. Maintain concrete properties of unit weight, slump, air content, and temperature. Adjust concrete proportions as necessary to provide concrete properties in accordance with the approved concrete design mix and as specified herein.
3. Do not pump concrete through aluminum piping.
4. Use pipe having a diameter of at least 4 times the maximum coarse aggregate size, but not less than 4-inch.
5. Take samples at the point of discharge. Adjust slump and air content to maintain the specified requirements at the discharge end of the pipe.

6. Furnish labor and assistance as required by the testing laboratory in obtaining and handling test specimens.

E. Placing Concrete:

1. Place concrete according to ACI 301.
2. Notify testing laboratory and Owner minimum 24 hours prior to commencement of operations.
3. Conform to ACI 305R and as specified herein for hot weather concreting. Do not add retarder to concrete unless approved by the Engineer.
4. Conform to ACI 306R and as specified herein for cold weather concreting. Do not add accelerator to concrete unless approved by the Engineer.
5. Do not place concrete containing pozzolan during cold weather concreting as defined in ACI 306R.
6. Ensure that reinforcement, inserts, embedded parts, waterstops, formed expansion and contraction joints, and are not disturbed during concrete placement.
7. Deposit concrete at final position, preventing segregation of mix.
8. Place concrete in continuous operation for each panel or section as determined by predetermined joints.
9. Place concrete in continuous units between predetermined expansion, control, and construction joints as specified and approved by the Engineer. Where required on the Drawings and wherever practical, the placement of concrete in such unit shall be done in an alternating or checkerboard pattern.
10. Do not interrupt successive placement and do not permit cold joints to occur.
11. Consolidate concrete.
12. Maintain records of concrete placement, including date, location, quantity, air temperature, and test samples taken.
13. Screeding:
    a. Screed floors and slabs on grade level.
    b. Surface Flatness: maximum 1/4 inch in 10 feet, unless specified otherwise on the Drawings.

F. Consolidation:

1. Consolidate concrete using mechanical vibrators operated within the mass of concrete conforming to procedures set forth in ACI 309R and as specified herein.
2. Conduct vibrations in a systematic manner with regularly maintained vibrators. Furnish sufficient backup units at job site. Use vibrators having minimum frequency of 8,000 vibrations per minute and of amplitude to consolidate concrete. Use not less than one vibrator with crew for each 35 to 40 cubic yards of concrete placed per hour.
3. Insert and withdraw vibrator vertically at a uniform spacing over the entire area of placement. Space distances between insertion points such that spheres of influence of each insertion overlap.
4. Place concrete in horizontal lifts. Insert vibrator rapidly to bottom of layer, and at least six inches into underlying layer. Hold stationary for several seconds, and then withdraw slowly at a rate of about 3 inches per second. Conduct vibration to produce concrete of

uniform texture and appearance, free of honeycombing, streaking, cold joints, or visible lift lines.

5. Use additional vibration with pencil vibrators on vertical surfaces and on all exposed concrete to bring full surface of mortar against the forms so as to eliminate air voids, bug holes, and other surface defects. Employ the following additional procedures for vibrating concrete:
    a. Reduce distance between internal vibration insertions and increase time for each insertion.
    b. Insert vibrator as close to face of form as possible without contacting the form or reinforcement.
    c. Thoroughly vibrate area immediately adjacent to waterstops without damaging the waterstop.
    d. Use spading as a supplement to vibration where particularly difficult conditions exist.

G. Concrete Acceptance:

1. Accept or reject each batch of concrete delivered to the point of agitator or mixer truck discharge. The signature of Contractor's authorized representative on the delivery ticket batch ticket shall indicate concrete acceptance.
2. Reject concrete delivered without a complete concrete delivery batch ticket as specified herein. The concrete supplier shall furnish copies of the signed batch ticket to the Contractor and the Engineer. The batch tickets shall have following information as a minimum:
    a. Date and truck number.
    b. Ticket number.
    c. Mix designation of concrete.
    d. Cubic yards of concrete.
    e. Cement brand, type, and weight in pounds.
    f. Weight in pounds of fly ash and silica fume.
    g. Weight in pounds of fine aggregate and course aggregates.
    h. Air entraining agent brand and weight in pounds / ounces.
    i. Other admixtures – brands and weights in pounds/ounces.
    j. Water in gallons added at the batch plant.
    k. Water in gallons – maximum that can be added onsite without exceeding design w/c_m ratio, when approved by the Engineer.
    l. Time of loading.
    m. Time of delivery to the job site.
    n. Detailed placement location of concrete.
    o. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information shall be rejected and such truck shall immediately depart from the job site.

3. The testing agency shall perform field tests at the point of discharge. Accept or reject concrete on the basis of conformity with slump, air content, and temperature specified.

4. The testing agency shall inspect concrete transit truck's barrel revolution counter and gauge for measuring water added to the concrete. Reject concrete which exceeds the maximum barrel revolution of 300 or which has water content exceeding the specified water-cement ratio.
5. Reject concrete exceeding time or temperature limitations specified.
6. Reject concrete not conforming to specification before discharging into the forms.
7. The Engineer reserves the right to reject concrete. Engineer's right to reject concrete shall supersede Contractor's right to reject concrete.

H. Joints and Embedded Items:

1. Provide construction joints and expansion joints as specified in Section 03 31 00 – Construction and Expansion Joints. Bush hammer or lightly sandblast all construction joints to expose coarse aggregate and to remove loose concrete and laitance before placing adjoining concrete. Do not damage exposed concrete edges, key groves, waterstops, or reinforcement.
2. Embedded Items:
   a. Clean embedded items of oil and all foreign matter.
   b. Install inserts, anchors, sleeves, and other items indicated or specified under other sections of these specifications.
   c. Check location and support of piping and other embedded items before depositing concrete.

I. Separate Floor Toppings:

1. Prior to placing floor topping, remove deleterious material, roughen substrate concrete surface, broom, and vacuum clean.
2. Place required edge strip, reinforcement and other embedded items to be cast in concrete.
3. Apply bonding agent to substrate unless specified otherwise.
4. Place concrete floor toppings to required lines, levels, and slopes.

3.5 CONCRETE FINISHING

A. General: Dusting with dry cement or other mixtures or water addition during finishing shall not be permitted.

B. Locations:

1. Steel-trowel finish all top, horizontal, and inclined surfaces not otherwise specified or indicated. This includes concrete fills and toppings, top of walls, floors, and roof surfaces to which roof insulation or roofing is to be applied.
2. Hand steel-trowel finish all surfaces shaped with or without forms and over which liquids will flow.
3. Float finish floors scheduled to receive concrete fills and toppings.
4. Broom finish exterior walkways, exterior stairs, entrance platforms, and loading docks.

5. Use smooth forms for all structures in conformance with Section 03 10 00 – Concrete Forming, and as specified.

C. Descriptions:

1. Steel-Trowel Finish: Remove excess laitance from surfaces by tamping, screeding, and magnesium bull floating. Compact surface with motor-driven floats, if feasible, when slab has hardened so that water and fine material will not work to top and trowel smooth. Leave surfaces with smooth hard finish free of blemishes.
2. Float Finish: Prepare surfaces by tamping with special tools to force coarse aggregate away from surface, screeding with straight edges to bring surfaces to required line and then magnesium bull float.
3. Broom Finish: Steel-trowel surface then broom normal to direction of travel with fine hair stable broom to produce non-slip surface of uniform appearance.
4. Smooth Form Finish: Remove fins, finish flush with parent concrete and make necessary repairs. Wet and rub finned and repaired surfaces with carborundum stone or other abrasive until uniform color and texture are produced. Complete rubbing not later than 24 hours after the curing period.

3.6 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Protect concrete footings from freezing for minimum of seven days.

C. Maintain concrete with minimal moisture loss at relatively constant temperature for period as necessary for hydration of cement and hardening of concrete.

D. Cure concrete floor surfaces as specified in Section 03 39 00 - Concrete Curing.

3.7 CONCRETE WORK IN COLD WEATHER

A. Cold weather concreting procedures shall conform to the requirements of ACI 306.

B. Do not place concrete at any time when air temperature is 40°F or lower unless cold weather concreting requirements are met. If concrete work is permitted, the concrete shall have a minimum temperature, as placed, of 55°F for placement of concrete section less than 12-inches thick, 50°F for concrete section 12-inches to 36-inches thick, and 45°F for concrete sections more than 36-inches thick. The temperature of the concrete as placed shall not exceed the aforementioned minimum values by more than 20°F.

C. All aggregate and water shall be pre-heated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water are heated to a temperature exceeding 100°F in order to

meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing shall not be permitted.

D. All reinforcement, forms, and ground with which the concrete is to come in contact shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

3.8 CONCRETE WORK IN HOT WEATHER

A. Hot weather concreting procedures shall conform to the requirements of ACI 305.

B. When air temperature exceeds 85°F or when extremely dry conditions (relative humidity below 20 percent) exist even at lower temperatures, particularly if accompanied by high winds exceeding 30 mph, exercise special and precautionary measures in preparing, delivering, placing, finishing, curing, and protecting the concrete. All necessary materials and equipment shall be on hand and in position prior to each placing operation.

C. Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel, and in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing concrete. No standing puddles of water shall be permitted in those areas which are to receive the concrete.

D. The temperature of the concrete mix when placed shall not exceed 90°F.

E. Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being taken into account. Stockpiled aggregates shall, if necessary, be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, it must be entirely melted prior to addition of the water to the mix.

F. Delivery schedules shall be carefully planned in advance so that concrete is placed as soon as practical after it is properly mixed. For hot weather concrete work, discharge of the concrete to its point of deposit shall be completed within 60 minutes from the time the concrete is batched when concrete temperature at time of placement is between 85 and 90°F. Concrete with a temperature of more than 90°F at time of placement shall be rejected.

G. Arrange for an ample work force to be on hand to accomplish transporting, consolidating, finishing, and covering of fresh concrete as rapidly as possible.

3.9 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Comply with Section 01 70 00 - Execution and Closeout Requirements.

C. Additional Inspection and Testing: May be performed by Owner's testing laboratory according to ACI 350.

D. Coordinate with the Engineer for the on-site scheduling of the testing firm's personnel for required concrete testing.

E. Provide unrestricted access to Work and cooperate with appointed testing and inspection firm.

F. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work.

G. Concrete Inspections:

1. Continuous Placement Inspection: inspect for proper installation procedures.
2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.

H. Tests shall be made for each concrete class of each batch of concrete delivered, each 50 cubic yards, or whenever consistency appears to vary.

I. Test for Consistency:

1. The consistency of the concrete shall be checked by standard slump cone tests. Make any necessary adjustments in the mix as the Engineer may direct and upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications.
2. Slump test shall be made in accordance with ASTM C143. Slump tests shall be performed as deemed necessary by the Engineer and each time the compressive strength test samples are taken.
3. Concrete with a specified nominal slump shall be placed having a slump of +/- 1 inch of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than or equal the specified slump.

J. Test for Air Content:

1. Samples of freshly mixed concrete shall be tested for entrained air content in accordance with ASTM C231.
2. Air content tests shall be performed as deemed necessary by the Engineer and each time compressive strength test samples are taken.
3. If test results are outside the limits specified, additional tests shall be made. Admixture quantity adjustments shall be made immediately upon discovery of an incorrect air entrainment.
4. If concrete placed by the Contractor is suspected of not having proper air content, an independent test laboratory will obtain and test samples for air content in accordance with ASTM C457.

K. Test for Compressive Strength:

1. Samples of freshly mixed concrete shall be taken by the independent test laboratory and tested for compressive strength in accordance with ASTM C172, C31, and C39, except as modified herein. Any proposed deviations from the requirements specified shall require Engineer's prior approval and, thereupon, recorded in the test report.
2. In general, one sampling shall be taken for each placement in excess of five (5) cubic yards, with a minimum of one (1) sampling for each day of concrete placement operations, for each fifty (50) cubic yards of concrete of each type (class), whichever is greater.
3. All compressive strength test cylinders shall be 6-inch diameter x 12 inch high. The Engineer may approve 4-inch diameter x 8-inch-high cylinders at Contractor's request; however, such approval shall be subject to limitation on maximum aggregate size and required increase in number of test cylinders for each sampling.
4. Each sampling shall consist of at least four (4) cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the cylinder.
5. Furnish labor to the independent test laboratory for preparing test cylinders. Provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the specimens made in any four consecutive working days and to protect the specimens. The box shall be erected, furnished, and maintained by the Contractor. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C31. Such box shall be located in an area free from the vibrations such as pile driving and traffic of all kinds. No concrete requiring testing shall be delivered to the site until such storage curing box has been provided. Specimens shall remain undisturbed in the curing box until ready for delivery to the testing laboratory but not less than sixteen hours.
6. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.
7. Compression tests shall be performed in accordance with ASTM C39. One test cylinder shall be tested at seven days and two at 28 days. The remaining cylinder shall be held to verify test results, if necessary.
8. The acceptance test results shall be the average of the strength of the two (2) specimens tested at 28 days. If one (1) specimen in a test manifests evidence of improper sampling, molding, or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result. Should both specimens in a test show any of the above defects, the entire test shall be discarded.
9. Acceptance of Concrete: The strength level of the concrete will be considered satisfactory so long as the following conditions are met:
    a. The averages of all sets of three (3) consecutive strength test results equal or exceed the specified 28-day strength.
    b. No more than 20 percent of the compressive tests have strength less than that specified.
    c. No individual strength test result falls below the 28-day strength by more than 500 psi.
    d. In the even that any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation and additional testing

(per paragraph 3.9.M below) shall be performed to qualify the concrete already placed.

e. When a ratio of 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day strength form any sampling be more than 10 percent below the established strength, the Contractor shall:
   1) Immediately provide additional periods of curing in the affected area form which the deficient test cylinders were taken.
   2) Maintain or add temporary structural support as required.
   3) Correct the mix for the next concrete placement operation, if required to remedy the situation.

10. All concrete which fails to meet the ACI requirements and these specifications shall be subject to removal and replacement at no additional cost to the Owner.

L. Test for Concrete Temperature: Determine the temperature of concrete sample for each strength test.

M. Additional Test for Compressive Strength:

1. Additional tests on in-place, when and if ordered by the Engineer, shall also be provided and paid for by the Contractor.
2. In the event that the 28-day test cylinders fail to meet the strength requirements (as outlined in paragraph 3.9.K.9 above), the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.
3. Three cores shall be taken for each sample in which the strength requirements were not met. Core holes shall be filled with non-shrink grout or repair mortar.
4. The drilled cores shall be obtained and tested in conformance with ASTM C42. The tests shall be conducted by an independent testing laboratory.
5. The location from which each core is taken shall be approved by the Engineer. Each core specimen shall be located, when possible, so that its axis is perpendicular to the concrete surface and not near formed joints or obvious edges of a unit of concrete placement.
6. The core specimens shall be taken, if possible, so that no reinforcing steel is within the confines of the core.
7. The diameter of the core specimens should be at least 3 times the maximum nominal size of course aggregate used in the concrete, but not less than 2-inches in diameter.
8. The length of the specimen, when capped, shall be at least twice the diameter of the specimen.
9. The core specimens shall be taken to the laboratory and when transported, shall not be thrown, dropped, allowed to roll, or damaged in any way.
10. These test results shall be transmitted to the Engineer and the Contractor at the earliest possible opportunity. The concrete in question will be considered acceptable if the average of the test results on core specimens taken from a given area equal or exceed 85 percent of the specified 28-day strength and if the lowest core strength is greater than 75 percent of the specified 28-day strength.

3.10 REPAIR

A. Repair all surface defects immediately after form removal. Surface defects include tie holes, air voids and bug holes with a nominal diameter or depth greater than 1/4-inch, honeycombed areas, visible construction joints, fins, burrs, color and texture variations and other defects as determined by the Engineer. Make concrete repairs in concrete surfaces to produce a uniform color and texture and free of all irregularities.

B. Surface defects in all concrete surfaces that adversely affect the durability of the concrete shall be repaired per the requirements of this section. Such surface defects that require repair include all visible cracks in tank floors and walls and the exterior envelope of structures below grade, regardless of width, cracks in all other areas in excess of 0.02-inch width, honeycombs, rock pockets, holes left by tie rods and bolts, and spalls.

C. Repair of Cracks:

1. Cracks that are structural in nature shall be pressure grouted using an injectable epoxy.
2. Cracks in water retaining or below grade members that show sign of leakage, or are positioned such that leakage cannot be observed, shall be pressure grouted using hydrophilic resin.
3. Cracks in other members that exceed 0.020 inch in width shall be pressure grouted using hydrophilic resin.
4. Apply crack repair materials in accordance with the manufacturer's directions and recommendations.

D. Repair of Defective Areas:

1. Remove rock pockets, honeycombed and other defective concrete down to sound concrete. Chisel edges a minimum of 1-inch deep perpendicular to the surface or slightly undercut. No featheredges permitted.
2. Dampen the area to be patched and area at least 6-inches wide surrounding it for at least 24 hours to prevent absorption of water from patching mortar.
3. Concrete repair material shall be prepackaged polymer-modified cementitious repair mortar with the following minimum properties:
    a. Compressive strength at 1-day: 2,000 psi (ASTM C109).
    b. Compressive strength at 28-day: 6,000 psi (ASTM C109).
    c. Bond strength at 28-day: 1,800 psi (ASTM C882 modified).
    d. NSF Standard 61: potable water approved when used in water treatment and related facilities.
4. Use no more mixing water than necessary for handling and placing. Mix patching mortar and allow it to stand with frequent manipulation with a trowel, without addition of water, until it has reached stiffest consistency that will permit placing.
5. Brush bond coat of neat cement well into surface after surface water has evaporated from area to be patched. Consolidate mortar into place and strike off so as to leave patch slightly higher than surrounding surface to permit initial shrinkage. Leave patch

undisturbed for at least 1 hour before final finish. Keep patched area damp for a minimum of 7 days.

E. Tie Holes: Fill tie holes solid with patching mortar after cleaning and dampening. Fill tie holes in liquid containing structures with specified non-shrink, non-metallic grout.

F. Core Holes: Roughen concrete surface, clean and dampen for at least 24 hours. Fill core holes with the specified repair mortar. Wet cure concrete for 7 days after placement. Fill anchor holes completely with specified non-shrink, non-metallic grout after cleaning and dampening.

G. Final determination as to acceptability of concrete repairs of surface defects and associated finishes will be made by the Engineer.

END OF SECTION 03 30 00

SECTION 03 31 00 - CONSTRUCTION AND EXPANSION JOINTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Concrete construction and expansion joints.

1.2 STANDARDS

Except as modified herein, comply with the latest version of the following Standards:

A. ASTM International:

1. ASTM C 920: Specification for Elastomeric Joint Sealants.
2. ASTM D 1752: Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
3. ASTM D 2628: Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
4. ASTM D 2835: Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements.

B. US Army Corps of Engineers Spec. CRD-C572: Specification for Polyvinylchloride Waterstop.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product data for materials, including location where product is to be used.
2. Certification that materials meet the specifications.
3. Testing laboratory data substantiating results of waterstop zero water leakage tests conforming to test arrangement in the 1959 Journal of the ACI.
4. Manufacturer's application and installation instructions.
5. Samples of waterstops and joint fillers.
6. Color samples or charts for joint compounds.
7. Record documents and shop drawings marked to record actual construction.

PART 2 - PRODUCTS

2.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site in the manufacturer's sealed bags, unopened containers and banded pallets.

B. Store materials off ground on platform or skid supports, and protect with covers from snow, rain and ground splatter.

C. Store plastic products under cover in a dry, cool location out of direct sunlight.

2.2 JOINT COMPOUNDS

A. In surface facilities, provide joint compound for joints in horizontal and inclined surfaces less than 30 degrees from the horizontal conforming to ASTM C920, Type S or M, Grade P, Class 25. Provide Type T compound in pedestrian and vehicular traffic areas, and Type NT in non-vehicular areas. Provide preformed joint seals where indicated.

B. In surface facilities, provide joint compound for joints in walls inclined surfaces greater than 30 degrees from the horizontal conforming to ASTM C920, Type S or M, Grade NS, Class 25.

C. Provide compatible joint compounds as recommended by manufacturer when they abut each other.

D. Provide compound made for continuous submergence in liquid containing structures.

E. Provide preformed polychloroprene elastomeric joint seal (compression seal) made of vulcanized elastomeric compound using polychloroprene as the only base polymer. Provide in expansion joints where indicated and conform to ASTM D2628.

F. Provide one-component polychloroprene compound conforming to ASTM D2835 as lubricant for installation of elastomeric joint seal.

2.3 BOND BREAKER FOR JOINT COMPOUNDS

A. Provide polyethylene tape, coated paper, metal foil, or similar type material.

B. Provide 100 percent closed-cell material, compressible, non-shrink, nonreactive with joint compound, and nonabsorbent.

2.4 BACK-UP MATERIAL FOR JOINT COMPOUNDS

A. Provide 100 percent closed-cell material, compressible, non-shrink, nonreactive with joint compound, and nonabsorbent.

B. Extruded butyl or polychloroprene foam rubber is acceptable.

C. Material impregnated with oil, bitumen, or similar substances is not acceptable.

D. Provide back-up material which is compatible with joint compound and as recommended by manufacturer and has same expansion and contraction capability as compound.

2.5 PREMOLDED-JOINT FILLER

A. Provide pre-molded joint filler complying with ASTM D1752, Type I or Type II.

B. Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types) ASTM D1751.

C. Provide joint filler having same thickness as expansion joint width indicated.

D. Provide maximum length filler manufactured to minimize field cutting.

2.6 POLYVINYL CHLORIDE (PVC) WATERSTOP

A. Provide in accordance with US Army Corps of Engineers Specification CRD-C572.

B. Provide waterstops of type and size indicated with looped galvanized steel wire along both edges. Manufacture from virgin polyvinyl chloride plastic compound that has a minimum tensile strength of 1750 psi.

C. Provide waterstops having zero water leakage when tested to 50 psi minimum water pressure conforming to test arrangement in the 1959 Journal of the ACI.

D. Provide factory-made and tested crosses, tees, and ells, manufactured using thermostatically controlled electric heat source.

E. PVC waterstops shall be manufactured by:

1. Catalog No. R638 (6-inch wide ribbed flat-strip) at construction joint and Catalog No. RB912 (9-inch wide ribbed center-bulb) at expansion joint - as manufactured by Vinylex Corporation, Knoxville, TN.
2. Wirestop Waterstop Part # FR-6380 (6-inch wide ribbed flat-strip) at construction joint and CR-9380 (9-inch wide ribbed center-bulb) at expansion joint - as manufactured by Paul Murphy Plastics, Roseville, MI.
3. Style No. 679 (6-inch wide ribbed flat-strip) at construction joint and Style No. 735 (9-inch wide ribbed center-bulb) at expansion joints - as manufactured by (Sika) Greenstreak Plastic Products Company, St. Louis, MO.
4. Or approved equal.

2.7 RETROFIT WATERSTOPS

A. Seal joints where new construction interfaces with an existing concrete and can be suitable for moving joints. Systems shall include stainless steel batten bars and fasteners for anchoring to the existing structure with the aid of an epoxy gel.

B. Provide retrofit waterstop systems as specified in Plans and manufactured by:

1. Style No. 667 as manufactured by (Sika) Greenstreak Plastic Products Company, St. Louis, MO.
2. Style No. 609 as manufactured by (Sika) Greenstreak Plastic Products Company, St. Louis, MO.
3. Or approved Equal.

2.8 HYDROPHILIC RUBBER WATERSTOPS

A. Provide flexible, hydrophilic synthetic rubber, strip waterstop (1"x3/4" min.) with manufacturer recommended adhesive, shall be used in joints in wall and slabs where indicated on the plans.

B. Provide hydrophilic rubber gasket waterstops as manufactured by:

1. Duroseal Gasket Waterstop manufactured by BBZ USA, Southington, CT.
2. Adeka Ultraseal MC-2010M manufactured by Adeka North America, Spearfish, SD.
3. Swellseal 8 manufactured by De Neef Construction Chemicals, Inc., Waller, TX.
4. Or approved equal.

2.9 HYDROPHILIC PASTE WATERSTOPS

A. Provide hydrophilic rubber paste waterstops of urethane paster, thixotropic vinyl monomer or similar materials.

B. Hydrophilic rubber paste shall be compatible with waterstop material.

C. Hydrophilic paste shall be 100% solids.

D. Provide hydrophilic paste waterstops which meet or exceed the criteria in the following table:

Table 03 31 00-1: Waterstop Criteria

Property	Test Methods	Limit
Ultimate Elongation	ASTM D 638	50% minimum
Tensile Strength	ASTM D 638	25 psi
Ozone Resistance	ASTM D 1149	No Failure
Volatile Loss	ASTM D 1203	0.50% maximum
Hardness, Shore A	ASTM D 2240	20 to 60

E. Provide hydrophilic rubber paste as manufactured by:

1. Duroseal Paste manufactured by BBZ USA, Southington, CT.

2. Adeka Ultraseal P-201 manufactured by Adeka North America, Spearfish, SD.
3. Swellseal Cartridge manufactured by De Neef Construction Chemicals, Inc., Waller, TX.
4. Or approved equal.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Do not omit, add, or relocate construction and expansion joints without Engineer's prior written approval.

B. Cast slabs and beams monolithically without horizontal joints.

C. Allow 48 hours minimum elapsed time between pours of adjacent slab or wall at construction joints.

D. Do not use horizontal joints within footings, foundation mats, pile caps, slabs, and other similar structural elements.

E. Provide concrete construction and expansion joints in fills and toppings at the same location as the construction and expansion joints in the supporting concrete.

F. Place waterstops in joints, in location indicated, before concrete placement.

G. Use factory-made and tested crosses, tees and ells at all corners and intersections where radius is less than 6 inches.

H. Reject before placing concrete, all waterstops bent around corners and remove from the construction or expansion joint and replace with factory-made pieces at no additional cost to the Owner.

I. Spark test all waterstop splices before installation in accordance with manufacturer's instructions.

J. Clean all expansion joint sidewalls before installing joint compound and compression seals.

3.2 JOINT PREPARATION

A. General:

1. The joints shall be accurately located and constructed to produce straight joints; and shall be vertical or horizontal, except where walls intersect sloping floors.
2. The concrete pour shall not commence until after the joint preparation has been inspected by the Engineer.

B. Preparation of Construction Joints:

1. Terminate each day's pour with a construction joint, as shown on the Drawings or as approved by the Engineer, and a suitable bulkhead.
2. Maintain on hand, at all times, sufficient keyway material, waterstops, and dowels for emergency use if a construction joint is required due to stoppage of concrete pour because of an emergency shutdown.
3. Temporary stoppage of pouring concrete may result in a cold joint; however, such instances shall be eliminated to the greatest extent by proper and contingent planning. Prior to resuming concrete placement on this plane, the surface shall be thoroughly cleaned of all laitance, loose or defective concrete, coatings, sand and other foreign material. The surface shall be prepared to a sufficient depth to expose sound concrete. Immediately prior to covering with fresh concrete, the joint shall be wet sandblasted, washed with air-water jet, and surface dried.

3.3 CONSTRUCTION JOINTS

A. Provide construction joints as indicated or approved or directed by the Engineer.

B. Prior to placing the abutting concrete, the contact surface shall be prepared as specified herein. The exposed portion of the reinforcing steel shall be cleaned of all concrete.

C. Roughen the surface of the hardened concrete by one of the following methods:

1. Sandblasting the previously placed concrete and reinforcing dowels after such concrete has fully cured to remove all laitance and spillage, and to expose sound aggregate.
2. Water blasting the previously placed concrete and reinforcing dowels after such concrete has partially cured to remove all laitance and spillage, and to expose sound aggregate.
3. In no case shall the roughening process cause microfractures on the treated surface.

D. At least 2 hours shall elapse after depositing concrete in the columns or walls before depositing in beams, girders, or slabs supported thereon. Beams, girders, brackets, column capitals, and haunches shall be considered as part of the floor or roof system and shall be placed monolithically therewith.

E. Furnish key groove with key width one-third the thickness of the member in which the key is placed and a key depth of 1-1/2 inch, unless otherwise indicated.

F. Use tapered key groove forms, with taper being no greater than 2 inches per foot, to permit form removal without damage to groove after concrete has cured.

G. Center waterstops in construction joints unless otherwise indicated.

H. The PVC strip shall be embedded one-half its width in the poured concrete at the construction joint. The exposed half width of strip shall be adequately protected against damage and shall be cleaned and repaired, if needed, prior to being embedded in the next adjacent pour.

I. Secure waterstops in position by tie wire from loops to adjacent reinforcement every 12 inches along each edge both sides.

J. Continue reinforcement across and perpendicular to the construction joint unless specifically indicated otherwise.

K. Consolidate concrete during placement adjacent to key groove and around waterstop.

L. Do not remove key groove forms until after concrete has been cured for 24 hours.

M. Key groove forms left in place shall not be acceptable.

N. Clean key groove of laitance, curing compound, foreign materials, protrusions of hardened concrete, roughen, and blow out debris and dust with oil-free compressed air.

O. Protect exposed key groove from damage.

3.4 EXPANSION JOINTS

A. Provide expansion joints as indicated.

B. Center waterstops in expansion joints unless otherwise indicated.

C. Secure waterstops in position by tie wire from loops to adjacent reinforcement every 12 inches along each edge both sides.

D. Terminate reinforcement across the expansion joint.

E. Consolidate concrete during placement adjacent to expansion joint and around waterstop.

3.5 POLYVINYL CHLORIDE WATERSTOPS

A. Provide waterstops in longest continuous lengths to minimize field splices.

B. Bending waterstops in forms is not permitted. Use factory-made and tested crosses, tees and ells at all corners and intersections where radius is less than 6 inches.

C. Split waterstops are not permitted.

D. Make all splices on a bench following manufacturer's splicing procedures and instructions. Use miter guide and portable power saw to cut spliced ends.

E. Maintain continuity through splice of characteristic features of waterstop cross-section, including ribs and center bulb.

F. Remove looped steel wire along both edges of waterstop adjacent to saw-cut ends prior to splicing.

G. Make splices by heat sealing adjacent surfaces using a thermostatically controlled electric heat source in accordance with manufacturer's printed instructions.

H. Reform waterstop at splices using a remolding iron having pattern matching waterstop.

I. After splice has cooled, spark test all splices in accordance with manufacturer's printed instructions. If splice shows any separation or lack of fusion, reject the splice, recut back at least one inch from rejected splice each side, re-weld, and retest.

J. Position and tie waterstop to form a continuous, watertight diaphragm in joint, to prevent leakage.

K. Support and protect waterstop.

L. Replace or repair, in accordance with manufacturer's printed instructions, damaged or punctured waterstop.

M. Clean waterstop of curing compound, foreign materials, and protrusions of hardened concrete.

N. Consolidate concrete during placement adjacent to waterstop.

O. Maintain 2 inches minimum clearance between waterstop and reinforcement, and all embedded items, unless otherwise shown on Drawings.

3.6 PREMOLDED-JOINT FILLER

A. Treat cut surface as recommended by manufacturer, when strips are cut. Clean groove of laitance, curing compound, foreign materials, protrusions of hardened concrete; blow out dust with oil-free compressed air.

B. Place against the bulkhead form and fasten to the inside of the form with non-corrodible fasteners.

C. Fill expansion joint completely.

D. Use tapered wood strips with the smaller width being the same width as the expansion joint and of depth to install the joint compound and back-up materials as recommended by manufacturer. Secure wood strips to surfaces which are to receive joint compound. Use materials to secure joint filler and wood strips which will not harm concrete or affect the joint compound's bond to concrete. Do not remove wood strips until after the concrete curing period.

E. Prevent disturbance of or damage to joint filler.

3.7 JOINT COMPOUND

A. Seal, clean, and dry concrete in accordance with manufacturer's printed instructions.

B. Install back-up and bond breaker materials to prevent 3-sided bending.

C. Prime concrete, fill flush with joint compound of required thickness, tool to concave joint and seal, all in accordance with the manufacturer's instructions, and ASTM C962.

D. Prevent spilling compound over adjoining surfaces. Use tape adjacent to joint if required. Remove all tape completely from concrete surface.

E. Do not seal when compound, air, or concrete temperature is less than 40 degrees F.

3.8 PREFORMED ELASTOMERIC JOINT SEAL

A. Remove all joint fillers as recommended by manufacturer for installation of compression seal.

B. Prior to installation, correct irregularities in the expansion joint face that would prevent contact between the joint seal and the joint face.

C. Sandblast without damaging, the exposed joint faces until the surfaces are free of dust, dirt, curing compound, joint filler, and any other material that might prevent readily inserting and bonding of the joint seal to the concrete or stainless steel.

D. Clean and dry expansion joints. The atmospheric and concrete temperatures shall be above 40 degrees F at the time of joint seal installation.

E. After final cleaning and immediately prior to joint seal installation, blow-out the expansion joints with oil-free compressed air and leave completely free of sand and water.

F. Lubricate and install the joint seal in accordance with the manufacturer's printed instructions.

G. Install the joint seal in the upright position and free form twisting, distortion and stretching that exceeds 5 percent. Install the joint seal to a depth of 3/16-inch, ± 1/16-inch, from the finished surface.

H. Make butt joints and intersecting splices with full contact. Use adhesive recommended by the seal manufacturer. Remove all dust, grease, or substances impeding the formation of the seal.

I. When rain interrupts sealing operations, re-clean and re-dry expansion joints prior to installing the joint seal.

J. If joint seals in place fail to meet specified requirements, remove them and install new seals at no additional cost to the Owner.

3.9 RETROFIT WATERSTOP

A. Use only where specifically shown in the Drawings or approved by the Engineer.

B. Install in full conformance with the manufacturer’s printed recommendations including that for surface preparation.

C. A waterstop system comprising of multiple components, shall be installed with all the components as supplied by the same approved manufacturer. No inter-mixing of components from different manufacturers shall be permitted.

D. Epoxy required for the installation shall be as manufactured and/or recommended by the waterstop manufacturer.

3.10 HYDROPHILIC WATERSTOP

A. Use only where specifically shown in the Drawings or approved by the Engineer. Install in accordance with the manufacturer's written instructions.

B. Locate the waterstop within the two curtains of vertical wall reinforcing bars as shown or provide a minimum of 2-1/2 inches of concrete cover over the waterstop.

C. Apply adhesive to concrete surface and allow drying for specified time before applying waterstop strip.

D. Butt ends of waterstop strip together at splices and corners and joins with sealant.

E. For vertical and overhead applications, apply adhesive and secure waterstop with concrete nails as 12-inch maximum spacing.

F. Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come in contact with waterstop.

END OF SECTION 03 31 00

SECTION 03 37 13 - SHOTCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Pneumatically applied concrete.

B. Related Requirements:

1. Section 03 10 00 – Concrete Forming and Accessories
2. Section 03 20 00 – Concrete Reinforcing
3. Section 07 90 00 – Joint Protection
4. Section 31 50 00 – Excavation Support Systems

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards.

A. American Concrete Institute:

1. ACI 506.2 - Specification for Shotcrete.

B. ASTM International:

1. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
2. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
3. ASTM C150/C150M - Standard Specification for Portland Cement.
4. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.
5. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete.
6. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
7. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

1.3 COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Ensure that concrete mix is provided with correct aggregate.

1.4 PREINSTALLATION MEETINGS

A. Comply with meeting requirements in Section 01 30 00 - Administrative Requirements.

B. Convene meeting at least one week prior to commencing the Work of this Section.

1.5 SUBMITTALS

A. Comply with requirements in Section 01 33 00 - Submittal Procedures.

A. Prepare shotcrete mix designs and laboratory 7-day and 28-day compressive tests or submit test reports of 7-day and 28-day compressive tests of the mix where the same mix has been used on two previous projects. Submit mix design in writing for review by the Owner at least 15 days before placement.

B. Provide certificates that aggregates comply with ASTM C33 and these specifications. State weathering region limits of aggregates: severe, moderate, or negligible. State basis of determining that potential reactivity is negligible. Identify certifications and tests to actual materials to be used in the work. Provide additional tests and certifications for each change in material source. Provide an alternate material source of aggregate if tests indicate that aggregates are reactive or possess severe weathering potential. Submit gradation analysis with concrete mix designs.

C. For ready mix shotcrete, provide delivery tickets or weighmasters certificate per ASTM C94, including weights of cement and each size aggregate and amount of water added at the plant. Record the amount of water added on the job on the delivery ticket. Water added at the plant shall account for moisture in aggregate.

D. For admixtures, provide manufacturer's certificate of compliance with these specifications.

B. Product Data: Provide certificate that cement used complies with ASTM C150 and these specifications.

C. Shop Drawings: Indicate tolerances, contours, accessories, shaped earthwork dimensions and thicknesses.

D. Source Quality-Control Submittals:
1. Indicate results of tests and inspections.
2. Submit minimum five years' documented experience of Company specializing in performing Work of this Section.
3. Submit qualifications for applicator.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CONCRETE IN DIRECT CONTACT WITH POTABLE WATER

Concrete in direct contact with potable water shall be tested by one of the following methods:

A. METHOD 1: Constituent Verification – Confirmation the components of the concrete are certified or tested using the following parameters. Concrete mixes using flyash may not be tested with Method 1.

1. Cement shall be NSF/ANSI 61 certified.
2. Admixtures shall be NSF/ANSI 61 certified.
3. Aggregates shall be tested and approved by one of the following methods:
    a. Soak Testing: Aggregates shall be supplied to an ANSI accredited lab, accompanied by the appropriate chains-of-custody and tested for regulated metals and gross alpha radionuclides. Testing shall be conducted by an ANSI accredited product certification body for Drinking Water Quality.
    b. Hardened Concrete Specimen Testing: Provide hardened concrete specimens using the proposed mix designs for the concrete that come in direct contact with potable water to an ANSI accredited lab, accompanied by the appropriate chains-of-custody. Concrete specimens shall be soak tested for regulated metals and radionuclides.

B. METHOD 2: Mix Design Verification through Concrete Specimen Testing.

1. If NSF/ANSI 61 certified cement and admixtures are not available or flyash is utilized within the concrete mix design, the following testing procedure can be utilized: Provide hardened concrete specimens for each mix design that will come in direct contact with potable water with the appropriate chains-of-custody to an ANSI accredited lab.
2. Concrete specimens shall be tested for the items listed in NSF/ANSI 61 Table 3.1 – Portland and Hydraulic Cements.

C. METHOD 3: Coat the interior concrete surface with a NSF/ ANSI 61 certified coating.

1.7 WATER

A. Use water that complies with ASTM C1116, Tables 2 and 3, and is clean and free from objectionable quantities of organic matter, alkali, salts, and other impurities that might reduce the strength, durability, or otherwise adversely affect the quality of the concrete.

1.8 QUALITY ASSURANCE

A. Perform Work according to ACI 506.2.

B. Perform Work of this section under direct supervision of a professional engineer experienced in design of this Work and registered in the State of Michigan.

1.9 QUALIFICATIONS

A. Applicator: Company specializing in performing Work of this Section with minimum five years documented experience.

1.10 MOCKUPS

A. Comply with Section 01 40 00 - Quality Requirements.

B. Size: Construct mockup of sufficient size to indicate required special treatment or finishes.

C. Locate where directed by Engineer or indicated on Drawings.

D. Remove mockup when directed by Engineer.

1.11 AMBIENT CONDITIONS

A. Comply with requirements for ambient condition control facilities for product storage and installation in Section 01 52 00 - Temporary Facilities.

B. Minimum Conditions: Maintain material and surrounding air temperature at minimum 50 degrees F prior to and during installation.

C. Subsequent Conditions:

1. Maintain material at above minimum temperature for seven days after completion of Work.
2. Provide equipment and cover to maintain minimum temperature.
3. Suspend operations during high winds, rainy weather, or near freezing temperatures if Work cannot be protected.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement:

1. Comply with ASTM C150/C150M, Type II or Type I/II.
2. Color: Gray, unless otherwise noted.

B. Aggregate:

1. Weight: Normal.
2. Comply with ASTM C33/C33M.

3. Maximum Size: 3/8 inch.

C. Aggregate:

1. Type: Lightweight.
2. Comply with ASTM C330/C330M.

D. Admixtures:

1. Admixtures shall comply with ASTM C1141.
2. If wet mix process is used, shotcrete shall contain an air-entraining admixture. Admixture shall conform to ASTM C260, except it shall be nontoxic after 30 days. Admixtures shall be Master Builders MB-AE 90, Sika AER-C, or equal.
3. Shotcrete shall contain a water-reducing admixture. The admixture shall conform to ASTM C494, Type A or Type D, except it shall contain no chlorides, shall be nontoxic after 30 days, and shall be compatible with the air-entraining admixtures. The amount of admixture added to the shotcrete shall be in accordance with the manufacturer's recommendations. Admixtures shall be Master Builders Pozzolith polymer-type normal setting, Plastocrete 161 normal set by Sika Chemical Corporation, or equal.
4. Do not use any admixture that contains chlorides or other corrosive elements.

E. Reinforcing Bars:

1. As specified in Section 03 20 00 - Concrete Reinforcing.
2. Type: ASTM A615.
3. Size: As noted on Plans.
4. Description: Welded-wire fabric.
5. Comply with ASTM A1064/A1064M.
6. Mesh: 2 by 2/W0.9 by W0.9 unless otherwise shown on the Drawings.
7. Finish: un-coated unless epoxy coated is shown on the Drawings.

F. Fiber Reinforcement:

1. Material: Steel.
2. Dimensions: As shown on the Drawings.

G. Proportion of Mix:

1. Shotcrete shall consist of either dry mixed fine aggregate and Portland cement pneumatically applied, to which mixture the water is added immediately previous to its expulsion from a nozzle, or mortar premixed by mechanical methods and pneumatically applied through a nozzle onto a prepared foundation.
2. Add admixtures for wet mix process in the batching process. Batch admixtures for dry mix process into the drum or tank of mixing water.
3. The dry mixture shall consist of one-part cement to not more than four and one-half parts of fine aggregate thoroughly mixed in a dry state.

4. The shotcrete shall contain not less than 610 pounds of Portland cement per cubic yard, fine aggregate, and water. A maximum of 30% pea gravel by weight may be substituted for the same weight of fine aggregate.
5. Shotcrete shall attain a minimum compressive strength of 3,000 psi at 28 days.

H. Water: Clean, potable, and not detrimental to shotcrete.

I. Curing Compound:

1. Membrane Curing Compound.
2. Not detrimental to application of subsequent surface finish materials.
3. Membrane curing compound shall only be used where acceptable to the Engineer.

J. Bonding Agent: Compatible with substrate and subsequent materials.

K. Alignment Wire: Small-gage, high-strength steel wire.

2.2 MIXES

A. Furnish wet or dry mix design that provides required compaction and low percentage of rebound, is stiff enough not to sag, and conforms to following requirements:

1. Minimum 28-day Compressive Strength per ASTM C109: 4,000 psi.
2. Minimum 28-day Direct Tensile Bond Strength per ACI 503R: 180 psi.
3. Minimum 28-day Flexural Strength per ASTM C348: 1,800 psi.
4. Minimum 28-day Splitting Tensile Strength per ASTM C496: 45.7 psi.
5. Minimum 28-day Slant Shear Bond Strength per ASTM C882: 400 psi.
6. Maximum Aggregate Size: 3/8 inch.
7. Air Entrainment: 5 percent.
8. Chemical Admixture: Conform to ASTM C494/C494M.
9. Pozzolanic Mineral Admixture: Conform to ASTM C618.
10. Slump: 1 inch, plus or minus 1/2 inch.

B. Maintain quality-control records during production of shotcrete and make records available to Engineer.

2.3 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Prior to start of work, independent testing agency will review mix proportions, gradation, and quality of aggregate.

C. Testing:

1. Test shotcrete for compliance with design mix.
2. Test samples according to ACI 506.2.
3. Modify mix design as required, based on results of testing.
4. Repair core holes after testing, according to ACI 506.2.
5. Independent testing agency will test mockup panels as follows:
    a. Drill 3-inch- diameter core samples from test panels.
    b. Test for strength, water absorption, drying and shrinkage.
    c. Modify mix design as required based on results of testing and inspection.
    d. Repair core holes after testing, according to ACI 506.2.

D. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with examination requirements in Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that conditions are acceptable and are ready to receive Work.

C. Verify that field measurements are as indicated on the Drawings.

D. Verify that fabricated forms are following:

1. Set to line and dimension as indicated on Drawings.
2. Adequately braced against vibration during placement.
3. Constructed to permit escape of air during gunning operations.
4. Constructed to minimize rebound during gunning operations.

E. Ensure that placement of reinforcement is correct and that sufficient clearance exists around reinforcement to permit complete encasement.

F. Ensure easy access to shotcrete surfaces for screeding and finishing, and to permit uninterrupted application.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Remove existing unsound concrete from substrate surfaces.

C. Minimize abrupt changes in thickness of repair.

D. Remove square external corners from substrate by radiusing (rounding) edges.

E. Sandblast surfaces to receive shotcrete.

F. Determine operating procedures for placement in close quarters, extended distances, or around unusual obstructions where placement velocities and mix consistency may be adjusted during application.

G. Prewetting:

1. Clean and wet cementitious or absorptive substrate surfaces prior to receiving shotcrete.
2. Keep porous surfaces damp for several hours prior to placement of shotcrete.
3. Apply bonding agent, where noted in the Plans or as directed by the Engineer.

H. Protect adjacent surfaces not receiving shotcrete.

3.3 APPLICATION

A. Alignment Control:

1. Provide alignment wire to establish thickness and plane of required surfaces.
2. Install alignment wire at corners and offsets not established by forms.
3. Tightening:
    a. Tighten alignment wire to establish lines as indicated on Drawings.
    b. Position adjustment devices to permit additional tightening.

B. Place reinforcement according to ACI 506.2.

C. Use mixing and delivery equipment capable of thoroughly mixing aggregate, cement, and water in sufficient quantity to maintain continuous and uniform placement.

D. Do not apply shotcrete more than 45 minutes after adding Portland cement to mix.

E. Do not place shotcrete on surfaces that are frozen, spongy, or where there is free water.

F. Achieve maximum compaction with minimum rebound.

G. Layering:

1. Build up to required thickness in multiple passes to achieve layering.
2. Encase reinforcement with first pass.
3. Allow each layer to take initial set before applying succeeding layers.

H. Do not permit applied shotcrete to sag, slough, or displace.

I. After initial set of final layer, remove excess material outside of forms and alignment lines.

J. Sandblasting:

1. Sandblast to remove laitance.
2. Clean with air/water pressure jet.

K. Finish surface of final layer with broomed finish unless shown otherwise on the Drawings.

L. Rebound Material:

1. Do not work rebound back into the construction. Remove rebound from the work. Do not incorporate rebound in later batches of shotcrete.
2. Remove rebound material that does not fall clear of Work.
3. Remove rebound material at construction and expansion joints.
4. Discard salvaged rebound material.

M. Maintain shotcrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of shotcrete.

N. Immediately after placement, protect shotcrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

O. Maintain surfaces wet for minimum seven days, unless approved otherwise by the Engineer.

P. Voids:

1. Sound-test applied material with hammer for voids.
2. Remove void areas and replace with new shotcrete ensuring full bond with adjacent Work.

3.4 FIELD QUALITY CONTROL

A. Comply with inspecting and testing requirements in Section 01 40 00 - Quality Requirements.

B. Comply with testing, adjusting, and balancing requirements in Section 01 70 00 - Execution and Closeout Requirements.

3.5 PROTECTION

A. Comply with protecting finished Work requirements in Section 01 70 00 - Execution and Closeout Requirements.

B. Do not permit applied work to damage adjacent surfaces.

END OF SECTION 03 37 13

SECTION 03 39 00 - CONCRETE CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Initial and final curing of horizontal and vertical concrete surfaces.

B. Related Requirements:

1. Section 03 10 00 – Concrete Forming.
2. Section 03 20 00 – Concrete Reinforcing.
3. Section 03 30 00 – Cast-in-Place Concrete.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Concrete Institute (ACI):

1. ACI 301 – Specifications for Structural Concrete.
2. ACI 302.1 – Guide to Concrete Floor and Slab Construction.
3. ACI 308.1 – Specification for Curing Concrete.
4. ACI 318 – Building Code Requirements for Structural Concrete and Commentary.
5. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary.

B. ASTM International:

1. ASTM C171 – Standard Specification for Sheet Materials for Curing Concrete.
2. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
3. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
4. ASTM D2103 – Standard Specification for Polyethylene Film and Sheeting.

C. American Association of State Highway and Transportation Officials (AASHTO):

1. M182 – Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.

1.3 SUBMITTALS

A. Comply with requirements in Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer's information on curing compounds, mats, paper, and film, including compatibilities and limitations.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

1.4 QUALITY ASSURANCE

A. Comply with ACI 301and ACI 302.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five **y**ears documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Membrane-Curing Compound – Dissipating Type. Type 1, Class A & B:

1. Comply with ASTM C309, Type 1, Class A & B.
2. Use non-yellowing formulation where subject to ultraviolet light.
3. Cured film must start to chemically break down in four to six weeks after application.
4. Manufacturers: Clear Resin Cure J11W by Dayton Superior, Kurez DR VOX by Euclid Chemicals, or approved equal.

B. Membrane-Curing Compound and Floor Sealer:

1. Comply with ASTM C1315, Type I, Class A.
2. Minimum 25 percent solids, acrylic, non-yellowing.
3. When using curing and sealing compound and where indicated, provide curing and sealing formulation with long-lasting finish that is resistant to chemicals, oil, grease, deicing salts, and abrasion.
4. Manufacturers: Dress & Seal 30 by L&M Chemical, Masterkure-N-Seal HS by Master Builders, MasterKure CC 250SB by BASF, Cure & Seal 30 by Dayton Superior, or approved equal.

C. Absorptive Mats:

1. Material: Burlap-polyethylene (PE).
2. Bonded to prevent separation during handling and placing.
3. Comply with ASTM C171 and AASHTO M182.

D. Waterproof Paper:

1. Description: Curing paper treated to prevent separation during handling and placing.
2. Comply with ASTM C171.

E. Polyethylene (PE) Film:

1. Comply with ASTM C171and D2103.
2. Thickness: 6 mils.

F. Water: Potable and not detrimental to concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with examination requirements in Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that substrate surfaces are ready to be cured.

3.2 APPLICATION

A. General:

1. Protect concrete from premature drying, hot or cold temperatures, and mechanical injury, beginning immediately after placement and maintain concrete with minimal moisture loss at relatively constant temperature.

2. All concrete shall be water cured, unless specified otherwise.
3. Comply with curing procedures set forth in ACI 301, applicable portion of ACI 308 and as specified herein.
4. Perform hot weather concreting in conformance with ACI 305R and as specified herein when the ambient atmospheric temperature is 80°F or higher.
5. Perform cold weather concreting in conformance with ACI 306R and as specified herein when the ambient atmospheric temperature is 40°F or lower.

B. Duration:

1. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared from unformed concrete surfaces. Initial curing starts as soon as formed concrete achieves final set. Forms left tightly in place are considered as part of the curing system, provided that the wooden forms are kept continuously moist for not less than 3 days.
2. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least 10 days.
3. For concrete sections over 30 inches thick, continue final curing for an additional 7 days, minimum where specified in Plans.
4. Avoid rapid drying at the end of the final curing period by slowly reducing the wetting of concrete surface over an additional 3 days where specified in Plans.

C. Curing Requirements:

1. Unformed Surfaces: Cover and cure entire surface of newly placed concrete immediately after completing finishing operations and water film has evaporated from surfaces or as soon as marring of concrete will not occur. Protect finished slabs from direct rays of the Sun to prevent checking, crazing, and plastic shrinkage.
2. Formed Surfaces: Minimize moisture loss from formed surfaces exposed to heating by the Sun by keeping forms wet until safely removed. Keep surfaces continuously wet by warm water spray or warm water saturated fabric immediately following form removal.
3. Water Retaining and Below-Grade Structures: Moist cure by the addition of water to maintain the surface in a continually wet condition. Use water that is free of impurities that could etch or discolor exposed concrete surfaces. Other concrete shall be cured by moist curing, by moisture-retaining cover curing, or using curing compound. Use curing compound at water retaining and below-grade structures only in cold weather after initial curing period and only when approved by the Engineer, in writing.

D. Curing Methods:

1. Water Curing: Use warm water curing for unformed surfaces. Continuously water cure all exposed concrete for the entire curing period. Provide moisture curing by any of the following methods:
   a. Keeping the surface of the concrete continuously wet by ponding or immersion.
   b. Continuous water-fog spray or sprinkling.
   c. Covering the concrete surface with curing mats, thoroughly saturating the mats

with water, and keeping the mats continuously wet with sprinklers or porous hoses. Place curing mats so as to provide coverage of the concrete surfaces and edges, with a 4-inch lap over adjacent mats. Weight down the curing cover to maintain contact with the concrete surface, as necessary.

2. Sealing Materials:
   a. Use common sealing materials such as plastic film or waterproofing (kraft) paper when approved by the Engineer.
   b. Lap adjacent sheets a minimum of 12 inches. Seal edges with waterproof tape or adhesive. Use sheets of sufficient length to cover sides of concrete member.
   c. Place sheet materials only on moist concrete surfaces. Wet concrete surface with fine warm water spray if the surface appears dry.
   d. The presence of moisture on concrete surfaces at all times during prescribed curing period is proof of acceptable curing using sheet material.

3. Membrane Curing Compound:
   a. Apply membrane-curing compound uniformly over concrete surface by means of roller or mechanical spray machine at a rate recommended by the curing compound manufacturer, but not less than 1 gallon per 150 sq. ft. of surface area. Agitate curing material in supply container immediately before transfer to distributor and thoroughly agitate it during application for uniform consistency and dispersion of pigment.
   b. Do not use curing compounds on construction joints or on surfaces to receive concrete fills and toppings or other applications requiring positive bond.
   c. Reapply membrane-curing compound to concrete surfaces that have been subjected to rainfall within 3 hours after curing compound has been applied by method for initial application.
   d. Maintain the continuity of the coating and repair damage to the coating during the entire curing period.
   e. Provide a copy of manufacturer's certification that the curing compound meets the requirements of ANSI/NSF 61 for concrete surfaces that will be in contact with potable water.
   f. When curing compound is authorized for application to water retaining or below-grade structures, it shall be applied at the manufacturer's recommended coverage rate and then applied again at the same rate to provide twice the recommended coverage.

4. Membrane Curing and Sealing Compound:
   a. Where indicated, provide curing and sealing formulation with long lasting finish that is resistant to chemicals, oil, grease, deicing salts, and abrasion.
   b. Apply at a rate stated by the manufacturer to conform to moisture-retention requirements specified, using second, immediate application at right angles to first, if necessary, and reapply if damaged by rain. Apply additional coat near substantial completion to act as sealer.

3.3 PROTECTION

A. Comply with protecting finished Work requirements in Section 01 70 00 - Execution and Closeout Requirements.

B. Protection from environmental conditions: Maintain the concrete temperature above 50°F continuously throughout the curing period. Make arrangements before concrete placing for heating, covering, insulation, or housing as required to maintain the specified temperature and moisture conditions continuously for the curing period.

1. When the atmospheric temperature is 80°F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering.
2. Protect the concrete continuously for the concrete curing period.
3. Maintain concrete temperature as uniformly as possible and protect from rapid atmospheric temperature changes.
4. Avoid temperature changes in concrete that exceed 5°F in any one hour and 50°F in any 24-hour period.

C. Protection from physical injury: Protect concrete from physical disturbances such as shock and vibration during curing period. Protect finished concrete surfaces from damage by construction equipment, materials, application of curing procedures and rain or running water. Do not load concrete in such a manner as to overstress concrete. Do not permit traffic over unprotected floor surfaces. Any traffic imposed shall be light enough as not to overstress, damage, or mar the concrete.

D. Protection from deicing agents: Do not apply de-icing chemicals to unsealed concrete surfaces.

END OF SECTION 03 39 00

SECTION 03 60 00 - GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material for grouting reinforcing bars and anchor bolts into existing or newly placed concrete.
2. Material for grouting under bearing plates for columns or beams.
3. Materials for grouting under equipment.
4. Materials for miscellaneous grouting including but not limited to railing posts, equipment guides, bollards, precast concrete joints and supports etc.

B. Related Requirements:

1. Section 03 20 00 – Concrete Reinforcing.
2. Section 03 30 00 – Cast-in-Place Concrete.
3. Section 03 39 00 – Concrete Curing.

C. Description: Furnish all labor, materials, equipment, testing and incidentals required, and install grout complete as shown on the Contract Drawings and as specified herein for equipment bases, column bases, topping and fill in structures and block outs.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. ASTM International:

1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM C150 - Standard Specification for Portland Cement.
3. ASTM C531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts, and Monolithic Surfacings.
4. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixes.
5. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
6. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic, Cement Grout (Non-shrink).

B. U.S. Army Corps of Engineers Standard:

1. CRD-C 621 - Corps of Engineers Specification for Non-shrink Grout.

1.3 SUBMITTALS

A. Submit shop drawings.

B. Product Data:

1. Commercially manufactured non-shrink, non-metallic cementitious grout: Include catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to referenced ASTM C1107 standards, and Material Safety Data Sheet.
2. Commercially manufactured non-shrink epoxy grout: Include catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to referenced ASTM C881 Standards, and Material Safety Data Sheet.
3. Cement grout: Include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures, and the proposed mix of the grout.
4. Concrete Fill or Topping: Include data for concrete as specified in Section 03 30 00 – Cast-in-Place Concrete. This includes the mix design, constituent quantities per cubic yard, and the water/cement ratio.
5. Bonding Agent: Include catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to referenced ASTM standards, and Material Safety Data Sheet.

C. Laboratory Test Reports: Submit laboratory test data as required under Section 03 30 00 – Cast-in-Place Concrete for concrete to be used as concrete fill or topping.

D. Mill test reports for each shipment of cement, regardless of quantity, prior to incorporation into the work.

E. Material Certificates signed by the manufacturer and the Contractor, certifying that each material item complies with or exceeds specified requirements.

F. Manufacturer's specifications and instructions for all admixtures, curing materials, and non-shrink non-metallic grout. Manufacturer’s certification of compatibility of all admixtures.

1.4 QUALITY ASSURANCE

A. Qualifications: Grout manufacturer to have a minimum of five years of experience in the production and use of the type of grout proposed for the Work.

1.5 RESPONSIBILITIES

A. Sampling and testing for concrete fill or topping shall comply with Section 03 30 00 – Cast-in-Place concrete.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers, and printed instructions.

B. Store materials in accordance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to six months or the manufacturer's recommended storage time, whichever is less.

C. Reject material that becomes damp, lumpy or otherwise unacceptable and immediately remove from the site and replace with acceptable material.

D. Deliver non-shrink cement-based grouts as pre-blended, prepackaged mixes requiring only the addition of water.

E. Deliver non-shrink epoxy grouts as premeasured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

1.7 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. Provide the services of a qualified manufacturer's technical representative who shall instruct the Contractor's personnel in the mixing, proper use, and application of the non-shrink grout and epoxy grout.

B. The manufacturer's representative shall provide written certification that materials have been mixed and applied properly and surfaces to receive these products have been prepared properly, all in conformance with manufacturer's requirements.

C. The on-site time required for the manufacturer's representative to achieve a successful installation shall be at the expense of the Contractor.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide materials produced by one manufacturer or supplier in order to provide standardization of appearance.

2.2 APPLICATION

A. Unless indicated otherwise, provide grouts as listed in Table 03 60 00-1:

Table 03 60 00-1: Grout

Type of Grout	Application
Cement Grout	Surface repairs when approved by the Engineer.
Non-Shrink – Class I	Non-motorized equipment.
	Filling block-out spaces for embedded items such as railing posts, gate guide frames, etc. (where placement time is less than 20 minutes).
	Repair of holes and defects in concrete members that are not water bearing and not in contact with soil or other fill material.
Non-Shrink – Class II	Column base plates.
	Filling block-out spaces for embedded items such as railing posts, gate guide frames, etc. (where placement time exceeds 20 minutes).
	Under precast concrete elements.
Non-Shrink Epoxy	Machinery subject to severe shock loads and high vibration.
Concrete Fill or Topping	Toppings and grout fill where other concrete is not indicated.

2.3 MATERIALS

A. Non-shrink Class I Grout:

1. Non-shrink Class I Grout shall have a minimum 28-day compressive strength of 5,000 pounds per square inch, when mixed at a fluid consistency.
2. Non-shrink Class I grout shall meet the requirements of ASTM C1107, Grade B or C, when mixed to fluid, flowable, and plastic consistencies.
3. Products:
   a. Sika Corp.: SikaGrout 212.
   b. Master Builders, Inc.: Set Grout.
   c. The Euclid Chemical Co.: NS Grout.
   d. Or approved equal.

B. Non-shrink Class II Grout:

1. Non-shrink grout shall be a high precision, fluid, extended working time grout. The minimum 28-day compressive strength shall be 7,500 pounds per square inch, when mixed at a fluid consistency.
2. Grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C827 at temperature extremes of 45 to 90°F in accordance with ASTM C1107.

3. Non-shrink grouts shall meet the requirements of ASTM C1107; Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C939.
4. The grout when tested shall not bleed or segregate at maximum allowed water.
5. Products:
    a. Master Builders, Inc.: Masterflow 928.
    b. The Euclid Chemical Co.: Hi-Flow Grout.
    c. Sika Corp.: SikaGrout 212.
    d. Or approved equal.

C. Cement Grout:

1. Cement grouts shall be a mixture of one-part Portland cement conforming to ASTM C150 types I, II, or III and one to two parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout, but not to the degree that it will allow the grout to flow.
2. Cement grout materials shall comply with Section 03 30 00 – Cast-in-Place Concrete.

D. Concrete Fill or Topping:

1. Concrete shall conform to the requirements of Section 03 30 00 – Cast-in-Place Concrete, except as specified herein.
2. Proportion with cement, coarse and fine aggregates, water, water reducer, and air entraining agent to produce a mix having a minimum 28-day compressive strength of 5,000 pounds per square inch unless otherwise indicated.
3. Coarse aggregate size shall be 3/8-inch maximum, unless specified otherwise.
4. Keep the W/C ratio as low as practical, but not more than 0.42, while still retaining sufficient workability.

E. Non-shrink epoxy-based grout:

1. Provide a pre-proportioned, three-component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a minimum compressive strength of 14,000 pounds per square inch in seven days when tested in conformity with ASTM D695 and have a maximum thermal expansion of 30 x 10^{-6} when tested in conformity with ASTM C531.
2. Products:
    a. Masterflow 648CP by Master Builders, Inc.
    b. Five Star Epoxy Grout by Five Star Products, Inc.
    c. Sikadur 42 Grout-Pak by Sika Corp.
    d. High Strength Epoxy Grout by the Euclid Chemical Co.
    e. Or approved equal.

F. Dry Pack Grout:

1. Make dry pack (to be packed or tamped in place) at no slump consistency.

2. When mixing the batch, add only enough water to the dry materials to produce a rather stiff mixture. Additions of water may be made in small increments until the desired consistency is obtained.

G. Non-epoxy Bonding Compound:

1. Provide non-epoxy bonding compound that is re-wetable for up to two weeks.
2. Products:
   a. Larsen Products Corp.: Weld-crete.
   b. Euclid Chemical Co.: Euco Weld.
   c. Or approved equal.

2.4 CURING MATERIALS

A. Curing materials for cement grout shall comply with Specification 03 39 00 – Concrete Curing, and as recommended by the manufacturer for prepackaged grouts.

PART 3 - EXECUTION

3.1 GENERAL

A. Grout shall not be placed until base concrete has attained its design strength, unless authorized or accepted by the Engineer.

B. Prepare surfaces for curing and protection of cement grout in accordance with Section 03 39 00 – Concrete Curing, and the prepackaged gout manufacturer.

C. Shade the work sites from sunlight for at least 24 hours before and 48 hours after grouting.

D. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable. Comply with manufacturer’s specified hot and cold weather practices along with its limits. Any violation of these practices shall be grounds for rejection of affected work.

3.2 PREPARATION

A. Clean concrete surfaces to receive grout free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints, and free of all loose or unsound material or foreign matter that may affect the bond or performance of the grout.

B. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse

aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

C. Remove all loose rust, oil or other deleterious substances from metal embedments prior to the installation of the grout.

D. Wash concrete surfaces clean and keep them moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturate by covering the concrete with a plastic sheet or using either a soaker hose, flooding the surface or other method acceptable to the Engineer. Remove visible water from the surface upon completion of the 24-hour period prior to grouting. Use an accepted adhesive bonding agent in lieu of surface saturation when accepted by the Engineer for each specific location of grout installation.

E. Surfaces in contact with epoxy grout shall be completely dry before grouting.

F. Construct grout forms or other leak proof containment. Forms shall be lined or coated with release agents recommended by the grout manufacturer.

G. Support equipment during alignment and installation of grout by shims, wedges, blocks, or other accepted means. Prevent the shims, wedges, and blocking devices from bonding to the grout by appropriate bond breaking coatings and remove them after grouting unless otherwise accepted by the Engineer.

3.3 INSTALLATION

A. Cement Grouts and Non-Shrink Cementitious Grouts:

1. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel, or admixtures without prior acceptance by the grout manufacturer and the Engineer.
2. Avoid mixing by hand. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the additional water required to obtain workability. However, do not exceed the manufacturer's maximum recommended water content.
3. Place grout into the designated areas in a manner that will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement shall proceed in a manner that will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (re-temper) after initial stiffening.
4. Just before the grout reaches its final set, cut back the grout to the substrate at a 45-degree angle from the lower edge of bearing plate unless otherwise accepted by the Engineer.
5. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its manufacturer-recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer.

B. Non-shrink Epoxy Grouts:

1. Mix in accordance with the written procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not over mix. Mix full batches only to maintain proper proportions of resin, hardener, and aggregate. Partial mixes will be rejected and will require the suspect grout to be removed and be replaced.
2. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60°F or above 90°F.
3. Place grout into the designated areas in a manner that will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
4. The extension of grout horizontally beyond base plate shall be less than or equal to the grout thickness.
5. Epoxy grouts are self-curing; do not apply water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

C. Concrete Fill or Topping:

1. Provide the underlying concrete surface with a rough or broomed finish. Protect and keep the surface clean until placement of concrete grout.
2. Remove the debris and clean the surface of all dirt and other foreign materials.
3. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface until the surface is coated with approximately 1/16-inch to 1/8-inch thick cement paste.

D. Dry Pack:

1. Dry pack consistency shall be such that the grout is plastic and moldable but will not flow.
2. The use of pneumatic pressure for dry-packed grouting requires acceptance of the Engineer.

3.4 FIELD QUALITY ASSURANCE TESTING

A. Furnish field testing and inspection services.

1. Sampling and testing for concrete fill or concrete topping shall comply with Section 03 30 00 – Cast-in-Place-Concrete.
2. Sampling and testing for the prepackaged grout shall be per manufacturer's recommendations.

END OF SECTION 03 60 00

SECTION 07 12 00 - BUILT-UP BITUMINOUS WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot-applied asphalt, Cold-applied asphalt, and Hot-applied coal-tar bituminous waterproofing with fabric reinforcement.

2. Drainage panels and protective cover.

1.2 STANDARDS

Except as modified herein, comply with the latest version of the following Standards:

A. ASTM International:

1. ASTM D41 - Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
2. ASTM D43 - Standard Specification for Coal Tar Primer Used in Roofing, Dampproofing, and Waterproofing.
3. ASTM D173 - Standard Specification for Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing.
4. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
5. ASTM D227 - Standard Specification for Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing.
6. ASTM D449 - Standard Specification for Asphalt Used in Dampproofing and Waterproofing.
7. ASTM D450 - Standard Specification for Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing.
8. ASTM D1327 - Standard Specification for Bitumen-Saturated Woven Burlap Fabrics Used in Roofing and Waterproofing.
9. ASTM D1668 - Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing.
10. ASTM D2178 - Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.
11. ASTM D2626 - Standard Specification for Asphalt-Saturated and Coated Organic Felt Base Sheet Used in Roofing.
12. Base Sheet Used in Roofing. ASTM D3747 - Standard Specification for Emulsified Asphalt Adhesive for Adhering Roof Insulation.
13. ASTM D4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free.
14. ASTM D5643 - Standard Specification for Coal Tar Roof Cement, Asbestos Free.

15. ASTM D5957 - Standard Guide for Flood Testing Horizontal Waterproofing Installations.

1.3 PRE-INSTALLATION MEETINGS

A. Administrative Requirements: Requirements for pre-installation meeting.

B. Convene minimum one (1) week prior to commencing Work of this Section.

C. Review Project conditions that will influence the integrity of the waterproofing assembly and work of other trades affected by the waterproofing installation.

1.4 SUBMITTALS

A. Submittal Procedures: Requirements for submittals.

B. Product Data: Submit properties of primer, bitumen, mastics, and characteristics of reinforcement fabric.

C. Shop Drawings: Indicate details and locations of metal membrane flexible flashings; control and expansion joints; sealing at openings projections penetrations and reglets; and waterproofing of holes slots sleeves.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer's Instructions: Submit special procedures and perimeter conditions requiring attention.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.5 QUALITY ASSURANCE

A. Maintain one (1) copy of each standard affecting the Work of this Section on-Site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three (3) years documented experience and approved by manufacturer.

1.7 MOCK-UPS

A. Quality Requirements: Requirements for mock-ups.

B. Size: Construct mockup 100 sq. ft. of horizontal and vertical waterproofed panel; to represent finished Work including internal and external corners, sealing, drainage panel, base flashings, counter flashings, protective cover, and control and expansion joints.

C. Locate where directed by Owner or where indicated on Drawings.

D. Incorporate accepted mock-up as part of Work.

1.8 AMBIENT CONDITIONS

A. Temporary Facilities and Controls: Requirements for ambient-condition control facilities for product storage and installation.

B. Maintain ambient temperatures above 40 degrees F 24 hours before and during application until membrane has cured.

1.9 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements of surfaces scheduled for waterproofing prior to installation. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Execution and Closeout Requirements: Requirements for warranties.

B. Furnish two (2) year installer's warranty for waterproofing failing to resist penetration of water.

C. Furnish fifteen (15)-year manufacturer's warranty for waterproofing failing to resist penetration of water.

D. For warranty repair work, remove and replace materials concealing waterproofing.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Waterproofing System: two (2) applications of bitumen with two (2) plies of integral fabric reinforcement to prevent moisture migration to interior, unless shown otherwise on the Drawings.

2.2 BITUMINOUS MEMBRANE WATERPROOFING – Not Used

2.3 MATERIALS

A. Hot Asphaltic Materials:

1. Asphalt: ASTM D449, Type I.
2. Asphalt Primer: ASTM D41, compatible with substrate.
3. Asphaltic Sealing Mastic: ASTM D4586, Type I.

B. Coal-Tar Materials:

1. Coal Tar: ASTM D450, Type II.
2. Coal-Tar Primer: ASTM D43, creosote type.
3. Coal-Tar Sealing Mastic: ASTM D5643, bitumen filled with mineral dust and mineral fibers, to mastic consistency.

C. Cold Asphaltic Materials:

1. Asphalt Emulsion: Conforming to ASTM D3747.
2. Asphalt Primer: ASTM D41, compatible with substrate.
3. Glass-Fiber Fabric: ASTM D1668, Type I, woven, asphalt treated.
4. Asphalt Cement: ASTM D4586, Type I.

D. Reinforcement Materials:

1. Cotton Fabric: ASTM D173, woven, 10 oz./sq. yd. average net mass of asphalt-saturated fabric.
2. Glass-Fiber Fabric: ASTM D1668, Type I, asphalt treated, Type II, woven, coal tar saturated, Type III - organic resin treated.
3. Glass-Fiber Felts: ASTM D2178 Type IV – coal tar saturated.
4. Jute Fabric: ASTM D1327 , woven, 9.8 oz./sq. yd. average net mass of [asphalt] [coal-tar]-saturated fabric.
5. Felt: ASTM D226; Type I, No. 15 unperforated asphalt felt.
6. Felts: ASTM D227 , 13 lb./100 sq. ft. average net mass of coal-tar-saturated fabric.
7. Coated Base Sheet: ASTM D2626 , 37 lb./100 sq. ft. net mass of asphalt-saturated sheet.

2.4 ACCESSORIES

A. Include protective cover over membrane when waterproofing work might be left exposed for extended period of time during construction, when work might be exposed to daylight or foot traffic, or where backfill or other placed material may damage membrane. Ensure material compatibility.

B. Protection Board: 1/8-inch -thick unless shown otherwise on the Drawings.

C. Drainage Panel: 1/4-inch -thick sheet with filter fabric unless shown otherwise on the Drawings.

D. Cant Strips: Pre-molded composition material.

E. Flexible Flashings: Butyl EPDM.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that substrate surfaces are durable and free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.

C. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full coverage of waterproofing materials.

D. Verify that items penetrating surfaces to receive waterproofing are securely installed.

E. Verify that substrate surface slopes to drain for horizontal waterproofing applications.

F. Do not apply waterproofing until Owner and manufacturer have inspected all surfaces required to be covered.

3.2 PREPARATION

A. Execution and Closeout Requirements: Requirements for installation preparation.

B. Ensure that cast-in-place concrete has achieved minimum cure time required by waterproofing manufacturer.

C. Clean and prepare surfaces to receive waterproofing. Vacuum substrate clean.

D. Do not apply waterproofing to surfaces unacceptable to manufacturer.

E. Apply mastic to seal penetrations, small cracks, or minor honeycomb in substrate.

F. Do not apply waterproofing until Owner and manufacturer have inspected all surfaces required to be covered.

3.3 INSTALLATION

A. Prime surfaces at rate of 2 gal./100 sq. ft. Permit primer to dry.

B. Install cant strips at inside corners.

C. Apply hot cold moppings of bitumen and embed felt reinforcement and embed fabric reinforcement and embed glass mat reinforcement.

D. Apply bitumen at temperature limited by equiviscous temperature plus or minus 25 degrees F; do not exceed finish blowing temperature for four hours.

E. Roll or press reinforcement firmly into bitumen, eliminating wrinkles, air pockets, or disruptions of continuity. Lap edges and ends 4 inches. Weather-lap reinforcement materials Secure reinforcement at intervals not exceeding 18 inches.

F. Apply two (2) additional felt fabric plies at corners, intersections, angles, and over joints.

G. Apply two (2) additional felt fabric plies diagonal to inside corner interruptions to membrane.

H. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum six (6) inches above horizontal surface for first ply and 6 inches at subsequent plies laid in shingle fashion.

I. Extend membrane and flexible flashing into drain clamp flange; apply adequate coating of mastic to assure clamp ring seal. Coordinate with drain installation.

J. Terminate top edge of membrane and flexible flashing under counterflashing; seal with mastic. Coordinate with metal flashing installation.

K. Continue reinforced membrane over control joints.

L. Embed manufacturer's expansion joint sheet into waterproofing membrane, minimum three (3) inches on each side of expansion joint. Lap and seal end joints a minimum of six (6) inches.

M. Apply top coat at rate of 2 gal./100 sq. ft. Apply coating to fully conceal reinforcement.

N. Seal protrusions to and penetrations through membrane with multiple plies of reinforcement and flood coating, flexible flashings, and mastic. Seal watertight.

O. Drainage Panel and Protection Board:

1. Place drainage panel directly against membrane; butt joints; place to direct drainage downward.
2. Place protection board directly against drainage panel; butt joints.
3. Attach protection board and drainage panel to substrate with mechanical fasteners with mastic (?). Scribe and cut boards around projections, penetrations, and interruptions.
4. Wrap or overlap filter fabric minimum of 4 inches at joints of adjacent drainage panels and at corners.
5. Coordinate lower termination of drainage panels with installation of foundation drainage system as detailed on Drawings.

3.4 FIELD QUALITY CONTROL

A. Quality Requirements: Requirements for inspecting and testing.

B. Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. On completion of horizontal membrane installation, dam installation area in preparation for flood testing.

D. Comply with flood test procedures for horizontal membranes according to ASTM D5957.

E. If leaking is found, remove water and repair leaking areas with new waterproofing materials as directed by the Engineer; repeat flood test. Repair damage to building.

F. When area is proven watertight, drain water and remove dam.

3.5 PROTECTION

A. Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Do not permit traffic over unprotected or uncovered membrane.

C. Protect membrane and board panel from damage.

D. Protect adjacent surfaces not designated to receive waterproofing.

END OF SECTION 07 12 00

SECTION 07 13 00 - SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet membrane waterproofing.

B. Related Requirements Specified Elsewhere:

1. Section 31 23 33 – Trenching and Backfill.

1.2 STANDARDS

Except as modified herein, comply with the latest version of the following Standards:

A. ASTM International:

1. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
2. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
3. ASTM D822 - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
4. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
5. ASTM D2240 - Standard Test Method for Rubber Property-Durometer Hardness.
6. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
7. ASTM D5957 - Standard Guide for Flood Testing Horizontal Waterproofing Installations.
8. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

1.3 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Convene the preinstallation meeting a minimum two weeks prior to commencing Work of this Section.

C. Review project conditions that will influence the integrity of the waterproofing assembly and Work of other trades affected by the waterproofing installation.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit data for surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants, with temperature range for application of waterproofing membrane.

C. Shop Drawings: Indicate details and locations of flashings; control and expansion joints; sealing at openings, projections, penetrations and reglets and waterproofing of holes, slots, and sleeves.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer's Instructions: Submit special procedures and perimeter conditions requiring attention.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:

1. Submit qualifications for membrane manufacturer and installer.
2. Submit membrane manufacturer's approval of installer.

1.5 QUALITY ASSURANCE

A. Maintain a copy of each standard affecting the Work of this Section On-Site.

1.6 QUALIFICATIONS

A. Membrane Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience and approved by membrane manufacturer.

1.7 MOCKUPS

A. Comply with Section 01 40 00 - Quality Requirements.

B. Construct mockup, 100 sq. ft. of horizontal and vertical waterproofed panel; to represent finished Work, including internal and external corners, seam jointing, attachment method, counterflashings, drainage panel, base flashings, protective cover, and control and expansion joints.

C. Locate where directed by Owner.

D. Incorporate accepted mockup as part of Work unless directed to remove mockup by Architect/Engineer.

1.8 AMBIENT CONDITIONS

A. Temporary Facilities and Controls: Requirements for ambient-condition control facilities for product storage and installation.

B. Maintain ambient temperatures above 40 degrees F 24 hours before and during application and until liquid or mastic accessories have cured.

1.9 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements of surfaces scheduled for waterproofing prior to installation. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Furnish five year installer's warranty for waterproofing failing to resist penetration of water.

C. Furnish 15 year manufacturer's warranty for waterproofing failing to resist penetration of water.

D. For warranty repair work, remove and replace materials concealing waterproofing.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Waterproofing System: Capable of resisting water head of <_____> feet and preventing moisture migration to interior.

2.2 MATERIALS

A. Rubber Membrane: EPDM conforming to ASTM D4637, Type I; with compatible seam tape and termination bar:
   1. Tensile Strength: Comply with ASTM D412.
   2. Elongation: Comply with ASTM D412.
   3. Shore A Hardness: Comply with ASTM D2240.
   4. Tear Strength: Comply with ASTM D1004.
   5. Water Vapor Permeance: Comply with ASTM E96, desiccant method.

6. Exposure: Comply with ASTM D822.
7. Brittleness: Comply with ASTM D746.

B. Seaming Materials: As recommended by membrane manufacturer.

C. Flexible Flashings: <_____>-inch thick neoprene.

2.3 ACCESSORIES

A. Surface Conditioner: compatible with membrane.

B. Adhesives: As recommended by membrane manufacturer.

C. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

D. Sealant: As supplied by membrane manufacturer.

E. Protection Board: 1/8-inch polystyrene foam.

F. Cant Strips: Pre-molded composition material.

G. Flexible Flashings: EPDM.

H. Counterflashings: Galvanized steel; 22-gauge.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that substrate surfaces are durable and free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.

C. Verify that items penetrating surfaces to receive waterproofing are securely installed.

D. Verify that substrate surface slopes to drain for horizontal waterproofing applications.

E. Do not apply waterproofing until Owner and manufacturer have inspected all surfaces required to be covered.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Ensure that cast-in-place concrete has achieved minimum cure time required by waterproofing manufacturer.

C. Clean and prepare surfaces to receive waterproofing. Vacuum substrate clean.

D. Do not apply waterproofing to surfaces unacceptable to manufacturer or applicator.

E. Seal cracks and joints with sealant materials using depth to width ratio as recommended by sealant manufacturer.

F. Apply surface conditioner at rate as recommended by manufacturer. Protect conditioner from rain or frost until dry.

3.3 INSTALLATION

A. Loose-Laid Membrane Waterproofing:

1. Roll out membrane. Minimize wrinkles and bubbles.
2. Overlap edges and ends, and seal by solvent welding, minimum 3 inches. Seal permanently waterproof.
3. Reinforce membrane with multiple thicknesses of membrane material over static or moving joints.
4. Weather-lap joints on sloped substrate in direction of drainage. Seal joints and seams.
5. Install flexible flashings. Seal watertight to membrane.
6. Seal flashings to adjoining surfaces.
7. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 6 inches above horizontal surface for first ply and 4 inches at subsequent plies laid in shingle fashion.

B. Installation Standards: Install Work according to manufacturer’s standards.

3.4 FIELD QUALITY CONTROL

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. On completion of horizontal membrane installation, dam installation area in preparation for flood testing.

C. Comply with flood test procedures for horizontal membranes according to ASTM D5957.

D. If leakage is found, remove water and repair leaking areas with new waterproofing materials as directed by Architect/Engineer; repeat flood test. Repair damage to building.

E. When area is proven watertight, drain water and remove dam.

3.5 PROTECTION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Do not permit traffic over unprotected or uncovered membrane.

C. Protect membrane and panel from damage.

D. Protect adjacent surfaces not designated to receive waterproofing.

END OF SECTION 07 13 00

SECTION 07 14 00 - FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fluid-applied rubberized-asphalt and elastomeric membrane waterproofing.
2. Surface dusting and protective covering.

B. Related Requirements:

1. Section 31 23 33 – Trenching and Backfill.

1.2 STANDARDS

Except as modified herein, comply with the latest edition of the following Standards:

A. ASTM International:

1. ASTM C836 - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
2. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
3. ASTM D429 - Standard Test Method for Rubber Property - Adhesion to Rigid Substrates.
4. ASTM D471 - Standard Test Method for Rubber Property - Effect of Liquids.
5. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
6. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
7. ASTM D822 - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
8. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

1.3 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Convene pre-installation meeting a minimum of two weeks prior to commencing Work of this Section.

C. Review Project conditions that will influence the integrity of waterproofing assembly and work of other trades affected by waterproofing installation.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit data for surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants, with temperature range for application of waterproofing membrane.

C. Shop Drawings: Indicate details and locations of flashings; control and expansion joints; sealing at openings, projections, penetrations and reglets; and waterproofing of holes, slots and sleeves.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer's Instructions: Submit special procedures and perimeter conditions requiring attention.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:

1. Submit qualifications for waterproofing material manufacturer and installer.
2. Submit waterproofing material manufacturer's approval of installer.

1.5 QUALITY ASSURANCE

A. Maintain a copy of each standard affecting the Work of this Section On-Site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years' experience and approved by manufacturer.

1.7 MOCKUPS

A. Comply with Section 01 40 00 - Quality Requirements.

B. Size: Construct mockup 100 sq. ft. of horizontal waterproofed panel; to represent finished Work, including internal and external corners, jointing, attachment method, flashings, drainage panel, base flashings, protective cover, and control and expansion joints.

C. Locate where directed by Owner.

D. Incorporate accepted mockup as part of Work unless required to remove mockup when directed by Architect/Engineer or shown on the Drawings.

1.8 AMBIENT CONDITIONS

A. Comply with Section 01 52 00 - Temporary Facilities.

B. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until liquid or mastic accessories have cured.

1.9 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements of surfaces scheduled for waterproofing prior to installation. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Furnish five-year installer's and manufacturer's warranty for waterproofing failing to resist penetration of water.

C. Furnish 15-year manufacturer’s warranty for waterproofing failing to resist penetration of water.

D. For warranty repair work, remove and replace materials concealing waterproofing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Waterproofing Membrane: ASTM C836 two-component elastomeric compound; cold applied.

B. Cured Membrane Characteristics:
1. Tensile Strength: Comply with ASTM D412.
2. Elongation: Comply with ASTM D412.
3. Shore A Hardness: Comply with ASTM D2240.
4. Tear Strength: Comply with ASTM D624 .
5. Water Absorption: Comply with ASTM D471.
6. Water Vapor Permeance: Comply with ASTM E96 desiccant method.
7. Exposure: Comply with ASTM D822.
8. Brittleness: Comply with ASTM D746.
9. Adhesion: Comply with ASTM D429.

2.2 ACCESSORIES

A. Surface Primer: compatible with membrane compound; as recommended by membrane manufacturer.

B. Elastic Flashings: as recommended by membrane manufacturer.

C. Joint Cover Sheet: designed for and compatible with membrane.

D. Cant Strips: Pre-molded composition material.

E. Drainage Panel: 1/4-inch-thick molded, flexible rubber sheet with filter fabric.

F. Joint and Crack Sealant: As recommended by membrane manufacturer.

G. Backup Material: Butyl rod.

H. Reglet Strip Devices: <_____>.

I. Counterflashings: Galvanized steel, 22-gauge minimum.

J. Tack-Free Surfacing: Type 1, Portland cement.

K. Separation Sheet: Sheet polyethylene 8 mils thick.

L. Protection Board: 1/8-inch-thick polystyrene foam sheet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.

C. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.

D. Verify that items penetrating surfaces to receive waterproofing are securely installed.

E. Verify that substrate surface slopes to drain for horizontal waterproofing applications.

F. Do not apply waterproofing until Owner and manufacturer have inspected all surfaces required to be covered.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Ensure cast-in-place concrete has achieved minimum cure time required by waterproofing manufacturer.

C. Clean and prepare surfaces to receive waterproofing. Vacuum substrate clean.

D. Do not apply waterproofing to surfaces unacceptable to manufacturer.

E. Seal cracks and joints with sealant materials using depth to width ratio as recommended by sealant manufacturer.

3.3 INSTALLATION

A. Apply surface conditioner at rate as recommended by manufacturer. Protect conditioner from rain or frost until dry.

B. Apply 12-inch-wide strip of joint cover sheet over cracks, expansion joints over cracks; expansion joints over 1/16 inch but not exceeding 1/2 inch in width, and non-working joints.

C. At expansion joints from 1/2 to 1 inch in width, loop cover sheet down into joint between 1-1/4 and 1-3/4 inch. Extend sheet 6 inches minimum on both sides of expansion joint.

D. Center cover sheet over crack or joints. Roll sheet into 1/8 inch coating of waterproofing material. Apply second coat over sheet extending minimum of 6 inches beyond sheet edges. Apply this procedure to expansion joints between horizontal and vertical surfaces.

E. Apply and spread waterproofing material to minimum <_____>-inch cured thickness, averaging <_____> inch in thickness.

F. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 6inches above horizontal surface for first ply and 4 inches at subsequent plies laid in shingle fashion. Install cant strips at inside corners.

G. Apply extra thickness of waterproofing material at corners, intersections, and angles and overlap joints.

H. Seal items protruding to or penetrating through membrane and install counterflashing membrane material.

I. Extend waterproofing material and flexible flashing into drain clamp flange; apply adequate coating of liquid membrane to assure clamp ring seal. Coordinate with drain installation.

J. Install membrane flashings and seal into waterproofing material.

3.4 FIELD QUALITY CONTROL

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. On completion of horizontal membrane installation, dam installation area in preparation for flood testing.

C. Comply with flood test procedures for horizontal membranes according to ASTM D5957.

D. If leakage is found, remove water and patch leaking areas with new waterproofing materials as approved by the Engineer; repeat flood inspection. Repair damage to building.

E. When area is proven watertight, drain water and remove dam.

3.5 PROTECTION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Do not permit traffic over unprotected or uncovered membrane.

C. Protect membrane and protection board from damage.

D. Protect adjacent surfaces not designated to receive waterproofing.

END OF SECTION 07 14 00

SECTION 10 14 23 – POST AND PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Post and Panel Signage for environmental and educational graphics.

B. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete.
2. Section 31 23 33 – Trenching and Backfill.
3. Section 31 50 00 – Excavation Support Systems.

1.2 STANDARDS

A. American Architectural Manufacturers Association (AAMA):

1. AAMA 2605 - Voluntary Specifications, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

B. ASTM International:

1. ASTM B209 - Standard Specifications for Aluminum and Aluminum Alloy Sheet and Plate.
2. ASTM B221 - Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
3. ASTM E84 - Standard Test Methods for Surface Burning Characteristics of Building Materials.

C. United States Department of Justice:

1. 2010 ADA Standards for Accessible Design.

1.3 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings and Data:

1. Submit complete product data and installation shop drawings for the materials to be provided. Include fabrication and installation details and attachments to other Work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.

C. Maintenance Instructions: Provide Manufacturer's written care instructions for sign maintenance and cleaning.

D. Warranty: Provide a 10-year Manufacturer's Warranty for the supplied products. This warranty shall cover the workmanship and materials used in the sign components. Failures include, but are not limited to, deterioration of finishes beyond normal weathering; delamination, peeling, blistering, or cracking of the sheet materials and components; and fading of the embedded graphic image.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Sign Panel:

1. Panel shall be exterior grade solid phenolic resin that is resistant to ultraviolet (UV) radiation deterioration, shatterproof, and resistant to graffiti, abrasions and burning. The embedded graphic panels shall have digitally printed subsurface images fused into a single panel and under the effect of high temperature and pressure. All exterior signage shall be weather tight.
2. The panel finish shall be opaque and matte. The panel shall be of uniform 1/8-inch thickness, rigid and flat; no warped areas or bowing will be accepted. If multiple sign panels are required, all panels must be obtained from a single manufacturer.

B. Sign Frame and Support Posts:

1. Sign frame shall run the entire perimeter of the sign panel and shall be manufactured as detailed on the Drawings with full metal backing. Sign frame shall include weep holes to drain water at the lowest part of the sign. Frame shall be mounted to two (2) 2-inch by 4-inch rectangular posts at a 45-degree angle as detailed on the Drawings. Provide preset anchor bolts of the size required by the manufacturer for connecting posts to concrete foundations as detailed on the Drawings.
2. All materials shall be aluminum with a black powder coat finish. All welds shall be free of porosity, inclusions, foreign matter, cracks, and pinholes. All welds shall be ground and sanded smooth. All sharp and ragged edges shall be eased smooth to eliminate any sharp edges.

C. Fasteners and Anchors: All accessories shall be manufacturer's standard as required for secure anchorage and assembly of signs, non-corrosive and suitable exterior exposure.

D. Concrete Foundations: The cast in place concrete for the foundations shall be Grade S2 concrete for substructure in accordance with the Structural Concrete section of the MDOT Standard Specifications for Construction. The batching, mixing and current methods and the inspection shall meet the approval of DWSD or its representative. The Contractor may submit for approval by the Engineer, a mix that is at least equivalent to the specified Grade S2 concrete.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Foundations:

1. Excavate foundations to dimension indicated on the Drawings.
2. Reconstruct subgrade that is not firm, undisturbed, or compacted soil, or that is damaged by freezing temperatures, frost, rain, accumulated water, or construction activities by excavating an additional 12 inches, backfilling with satisfactory soil or well graded aggregates, and compacted to original subgrade elevation.

B. Support Posts: Set post in position, support to prevent movement, and place concrete for foundation as indicated on the Drawings. Post shall be plumb within a tolerance of 1/16-inch in 3 feet. Leave anchorage joint exposed with 1/8-inch anchoring material sloped away from post.

C. Sign Frame and Sign Panels: Assemble sign frame and attach sign panels with hardware as per manufacturer's installation instructions.

D. Adjusting and Cleanup:

1. Remove and replace damaged or deformed signs and signs that do not comply with the specified requirements.
2. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
3. Remove temporary protective coverings and strippable films as signs are installed. Upon completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish.
4. Maintain signs in a clean condition during construction and protect from damage until acceptance by Engineer.

END OF SECTION 10 14 23

SECTION 26 05 26 – GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This Section includes materials, testing, and installation of electrical grounding system.

B. Related Requirements:

1. Section 01 33 00 – Submittal Procedures.

1.2 SUBMITTALS

A. Submit shop drawings in accordance with the General Provisions.

B. Submit material list for all grounding materials and equipment. Indicate size, material and manufacturer.

C. Submit test results. Indicate overall resistance to ground and resistance of each electrode.

1.3 SYSTEM REQUIREMENTS

A. Grounding System Resistance:

1. Separately Derived Sources (as Defined by NEC 250) Grounding Electrode: 10 ohms.

2. Grounds Not Covered Above: 25 ohms.

B. Contractor shall comply with Skilled Trade Regulation Act: Public Act 407 of 2016.

C. Contractor shall be responsible for the electrical inspection fees, the Building Permit Alterations cost, demolition fees.

D. Contractor shall be responsible for payment of Electrical Plan Review and for A1 Circuit Fee and A5 Service Fee.

E. Contractor shall be responsible for payment of Plumbing Plan ReviewContractor shall include the cost for an Electrical Service Reconnect permit from the City of Detroit Buildings, Safety Engineering, & Environmental Department's Electrical Inspection Division, in Room 408, Fourth Floor, in the Coleman A. Young Municipal Center (formerly the City-County Building).

F. Contractor shall include the cost of all materials, labor, equipment, hardware, and all other incidental materials necessary to complete the grounding system installation.

G. For indoor installation, Contractor shall drill the concrete slab with 1" coring bit and install the ground rod per the project requirement. After installing the ground rod, seal the openings with waterproof epoxy material to prevent future water leaks.

H. For outdoor installation, Contractor shall drill the wall with ½" coring bit and install the grounding wire as required per the contract documents. After installing the grounding wire, seal the openings with waterproof fireproof material that meets the existing fire rated wall and prevent future water leaks.

I. Contractor shall be responsible for coordinating the installation with the property Owner(s).

PART 2 - PRODUCTS

2.1 GROUND RODS

A. Ground rods shall be copper-clad steel, 3/4-inch in diameter, minimum 8 feet long, with hardened steel points. Ground rods shall be no closer than 12 inches from the building structure base, buried at least 6" below ground outdoors and 2" above slab indoors.

B. Waterproof penetration epoxy for floor and foundation penetration shall be Hydrotite by Multi-Urethanes or approved equal.

2.2 CONNECTIONS

A. Ground Clamps: Clamps for connection of ground wire to ground rod shall be bronze.

B. Exothermic Connections: Provide Cadweld, Burndy "Hyground", or approved equal.

2.3 CONDUCTORS

A. Equipment Ground: Conductors shall be Low-voltage building wire for use at 600 volts or less and shall be 600-volt insulated, Type XHHW or THWN, and rated for continuous operation at 75°C. Color: Green.

B. Direct burial cables for use at 600 volts and less shall have UL labeling "Type USE" and RHW insulation with black, neoprene sheath meeting the physical requirements and minimum thickness requirements of ICEA S 19-81.

C. Bare Copper Conductors: Annealed bare copper, conforming to ASTM B3 and B8.

PART 3 - EXECUTION

3.1 GROUND ELECTRODE

A. Buried or concealed joints or terminations are not permitted. Protect wires with a rigid PVC conduit where wires stub up through slab.

B. Connect the wire to the ground bus within the main service. Protect wire with a rigid PVC conduit where wire stubs up through slab or exposed.

C. Bond the interior metallic water system to the grounding system in accordance with NEC Article 250-52 and Table 250-66.

3.2 EXAMINATION

A. Verify existing grounding location and inspect main grounding system.

B. Clear the area where the ground rod will be installed and confirm that the new location will not impede other utilities services.

C. Contractor is responsible for any damages occur during installation and shall restore the area as it was before.

D. Contractor shall coordinate underground utilities location with Miss Dig to avoid damages during installation.

E. Contractor shall be responsible for installing a complete grounding system and shall comply with the contract documents. Any deviation from the contact documents shall be brought to the project manager attention immediately and no work should be executed without prior authorization from the project manager.

3.3 CONNECTIONS

A. Exothermic weld all underground connections.

B. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

3.4 TESTS

A. Before making connections to the ground electrode, measure the resistance of the electrode to ground using a ground resistance tester specifically designed for ground resistance testing. Perform testing in accordance with test instrument manufacturer's recommendations using fall-of-potential method. Perform the test not less than two days after the most recent rainfall and in the afternoon after any ground condensation (dew) has evaporated. If a resistance less than the performance requirements is not obtained, provide a ground rod driven 6 inches below grade

spaced 10 feet away from the ground well and connect to ground bus with No. 4 AWG bare copper wire and repeat the test. If the performance requirements are still not obtained, inform the Owner for resolution.

3.5 QUALITY ASSURANCE

A. Electrical Conductors, Connectors, Electrodes, and Accessories: Listed and labeled, per NFPA 70 Article 100, by a Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7 and which is acceptable to the authority having jurisdiction and marked for intended use.

END OF SECTION 26 05 26

SECTION 31 05 17 - AGGREGATES FOR STORMWATER MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Coarse-aggregate materials.
2. Fine-aggregate materials.
3. Base layers may include storage/reservoir layer, choker layer, filter layer, and other layers included in Contract Documents.

B. Related Requirements:

1. Section 01 57 13 – Erosion Control Sedimentation and Containment of Construction Materials
2. Section 31 23 33 – Trenching and Backfill
3. Section 31 24 00 – Bioretention
4. Section 32 11 23 – Aggregate Base Courses
5. Section 32 12 17 – Permeable Asphalt
6. Section 32 12 15 – Permeable Rubber Pavement
7. Section 32 13 14 – Permeable Concrete
8. Section 32 13 16 – Permeable Grass Paving
9. Section 32 14 14 – Permeable Concrete Unit Paving
10. Section 32 14 17 – Permeable Brick Unit Paving
11. Section 33 44 20 – Vertical Drains

1.2 STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Layers.
2. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM C33 – Standard Specification for Concrete Aggregates.
2. ASTM D3385 – Standard Method of Test for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer.
3. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

4. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3 (600 kN-m/m3)).
5. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft3 (2,700 kN-m/m3)).
6. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
7. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
8. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit name of imported materials source.

C. Supplier's Certificate: Certify that products meet or exceed specified requirements.

D. Source Quality-Control Submittals: Indicate results of tests and inspections.

E. Source Approval: Submit documentation of material prior to construction as follows:

1. Material Source – Certificate.
2. Cleanliness – Certification that stone is double-washed per this provision.
3. Properties – Certified Test Results for:
    a. Gradation.
    b. Smoothness.
    c. Percentage of Water.

4. Sample:
    a. Prior to production and delivery of aggregates, take at least one (1) initial sample in accordance with ASTM D75.
    b. Collect each sample by taking three (3) incremental samples at random locations from source material to make a composite sample.
    c. Repeat sampling procedure when source of material is changed or when deficiencies or variations from specified grading of materials are found in testing.

1.4 QUALITY ASSURANCE

A. Furnish each coarse and fine aggregate material from single source throughout Work.

B. Perform Work according to DWSD standards.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Coarse Aggregate:

1. Coarse aggregate shall be of the types designated in the Contract Documents and shall consist of clean, tough, durable fragments of crushed stone or crushed gravel, conforming to the following:
   a. Be double-washed, sufficient to remove dust and other coatings, and defined as meeting <0.5 % wash loss when tested with AASHTO T-11.
   b. Be free from clay balls, organic matter, and other deleterious substances.
   c. Course aggregate shall meet the gradation requirements shown on the DWSD Standard Detail Drawings.

2. The permeable pavement reservoir (storage) layer shall also meet the following:
   a. Have at least two (2) fractured faces, and 90% shall have one or more fractured faces as determined by ASTM D5821.
   b. Have not more than 5% of flat or elongated pieces (>5:1) as specified in ASTM D4791.
   c. Material shall have a California bearing ratio (CBR) of at least thirty (30) as determined by laboratory test on a four (4) day-soaked sample in accordance with ASTM D1883.
   d. Maximum Abrasion Loss of 10% for 100 revolutions and maximum of 50% loss for 500 revolutions as specified in ASTM C131.

3. The permeable pavement bedding/choker layer shall be placed below the permeable pavement and above the reservoir.

4. The bioretention bedding/choker layer shall be used between the bioretention soil and reservoir layer for bioretention systems. It shall be composed of a clean, double washed pea gravel following AASHTO No. 8 gradation.

5. The bioretention storage/drainage layer shall be placed below the choker layer, as indicated on drawings.

2.2 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Testing and Analysis:

1. Coarse-Aggregate Material: Comply with ASTM D4791, ASTM D5821, and ASTM D1883.
2. Fine Aggregate Material - Testing and Analysis: Perform according to ASTM D698 and ASTM D5856-95.

3. If tests indicate materials do not meet specified requirements, change material and retest.

C. Owner Inspection:

1. Make subsoil and topsoil available for inspection at source prior to packaging for shipment.
2. Notify Owner at least seven days before inspection is allowed.

D. Owner Witnessing:

1. Allow witnessing of source testing at supplier's test facility.
2. Notify Owner at least seven days before tests are scheduled.

E. Certificate of Compliance:

1. If supplier is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at source conforms to Contract Documents.
2. Specified source tests are not required for Work performed by approved supplier.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Preparation of Grade:

1. Excavation and sub-grade preparation to the lines and grades shown on the Contract Documents shall follow the following steps:
    a. Sub-grade shall not be compacted for installations where contract documents specify a minimum infiltration rate for the sub-grade.
    b. For permeable pavements and other storm water management systems installed in soft or yielding soils in locations specifying a minimum infiltration rate for the sub-grade, Contractor shall install geogrid in accordance with contract documents. Geotextile fabric shall not be used unless indicated on Contract Documents.
    c. For permeable pavements and other storm water management systems where no minimum infiltration rate is specified for the subgrade, Contractor shall be allowed to perform subgrade compaction, and can utilize geotextile fabric or impermeable liners as specified in the Contract Documents.
    d. Where erosion of sub-grade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and the underlying soils scarified to a minimum additional depth of 6 inches with a rake and a tracked vehicle used in combination, or equivalent.
    e. Construction equipment shall not be allowed on the subgrade, except as noted above.

B. Hauling: Trucks meeting the same cleanliness requirements of the double washed materials shall be used during hauling. Trucks shall be inspected and cleaned prior to each use.

C. Stockpiling:

1. Stockpile materials on Site at locations as indicated by Engineer.
2. Stockpile excavated material meeting requirements for coarse-aggregate and fine-aggregate materials.
3. Stockpile in sufficient quantities to meet Project schedule and requirements.
4. Separate different aggregate materials with dividers or stockpile apart to prevent intermixing of aggregate types or contamination.
5. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

D. Limitations on Placing: Do not install aggregate base layers when rainfall or other weather conditions will detrimentally affect the quality of the Work.

E. Placing, Shaping and Compacting:

1. Upon completion of sub-grade work, the Engineer shall be notified and shall inspect the sub-grade before the Contractor continues installation. Owner or Engineer shall have the option to perform infiltration testing on the subgrade to verify minimum infiltration rates, at the Contractor's expense where specified on the contract documents.
2. Any accumulation of debris or sediment which takes place after approval of sub-grade shall be removed prior to installation continuing at no extra cost.
3. Place geosynthetics, impermeable liner, pipe, and aggregate as required on the contract documents immediately after approval of sub-grade in accordance with the standards & specifications.
4. Do not dump aggregate base materials in piles, but evenly spread and place aggregate on the prepared sub-grade in 8 inch lifts of uniform thickness without segregation. Where the base layer is constructed in more than one lift, keep previously constructed layers free of loose and foreign matter prior to placing subsequent layers.
5. Moisten and roll each lift of aggregate with a 10-ton roller, keeping equipment movement over exposed sub-grades to a minimum. Roll each lift between 4 and 6 passes. If a required depth of aggregate in a lift exceeds 8 inches, the aggregate layer shall be rolled in ten 8 inch lifts.
6. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to insure a satisfactory aggregate base layer.

F. Finishing:

1. Geosynthetics along edges:
    a. Geotextile fabric or impermeable liners, or both, shall be used along the edges or side slopes of excavations to be filled with aggregate base materials for permeable pavement and bioretention as specified in the Contract Documents.
    b. Following placement of an aggregate base layer, and at the conclusion of each day's work, the geotextile or impermeable liner, or both, shall be folded back and secured to protect from sediment washout along all bed edges.
    c. At least a two-foot strip shall be used to protect stone from adjacent bare soil. This edge strip shall remain in place until all bare soils contiguous to infiltration beds are stabilized and fully vegetated, or until the wearing surface for the permeable pavement has been placed.

2. Unfinished Edges of Base Layer:
    a. In fill conditions, place earth or other approved materials along any unfinished edges of the base layer in such quantity that it will compact to the thickness of the aggregate base layer being constructed.
    b. In each operation, allow at least a two-foot width of shoulder along all unfinished edges to be rolled and compacted simultaneously with the rolling and compacting of each layer of aggregate.

G. Sampling:

1. Test aggregates at the source location per Section 2.2.B.
2. During Construction: Take at least one (1) random sample during construction within the first 500 tons of placed aggregate material, in accordance with ASTM D 75. Collect each sample by taking three (3) incremental samples at random locations from the placed material to make a composite sample by weight of not less than 75 pounds.
3. Sample Identification: Place each sample in a clean container, securely fastened to prevent loss of material. Tag each sample for identification and with the following information:
   Contract No._____
   Sample No._____ Quality _____
   Date of Sample_____
4. Repeat Sampling: Repeat the above sampling when a material source is changed or when unacceptable deficiencies or variations from a specified gradation of materials is found in testing.

H. Acceptance Testing:

1. Testing responsibilities will be performed by the Contractor's testing agency at the Contractor's expense. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered nor shall it obligate the owner for final acceptance at any time. Submit all Test Reports to the Engineer.
2. Gradation: Test each sample of aggregate base layer material for gradation in accordance with ASTM C 136 and with the sampling described in Section 3.1.G.
3. Thickness: Measure each 100 square yards of each layer of aggregate base layer placement. Make depth measurements by test holes, at least 3 inches in diameter, through the base layers. Where base layer deficiency is more than ½ inch, correct by scarifying, adding mixture of proper gradation, re-blading, and re-compacting. Where the measured thickness is more than ½ inch thicker than indicated, consider it as the indicated thickness plus ½ inch for determining the average. The average thickness is the average of the depth measurements for the entire area and shall not under-run the thickness indicated in the Contract Documents without written approval from the Engineer.

I. Protection:

1. Protection work will be performed by the Contractor at the Contractor's expense.
2. As construction is completed, maintain and protect the aggregate base layers, except where a portion of the succeeding layer is under construction thereon. Maintenance includes

drainage, rolling, shaping, and watering, as necessary, to maintain the layer in proper condition. Correct deficiencies in thickness, composition, and construction which develop during the maintenance, to conform to the requirements specified herein. Maintain sufficient moisture by light sprinkling with water at the surface to prevent dusty conditions. Comply with the City of Detroit Fugitive Dust Ordinance (Ordinance No. 32-17) requirements during Construction.

3. Finishing along the edges of the permeable pavement for protection during construction shall be as described in Section 3.1.F until the site is fully stabilized, at which time excess geotextile fabrics and impermeable liners can be cut back to the pavement edges.
4. In addition, runoff onto an aggregate base layer shall be minimized until the site is fully stabilized. Diversion ditches or other approved types of erosion and sediment control measures shall be placed at the toe of slopes which are adjacent to permeable pavement and bioretention areas, to prevent sediment from washing into areas aggregate base layer at all times during and after construction. Any sediment accumulation into the aggregate base layer shall be removed immediately by cleaning or replacement of the aggregate by the Contractor at no cost to the owner.

3.2 CLEANING

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Stockpile:

1. Remove stockpile and leave area in clean and neat condition.
2. Grade site surface to prevent freestanding surface water.

END OF SECTION 31 05 17

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removing surface debris.
2. Removing designated paving, curbs, and sidewalks.
3. Removing designated trees, stumps, shrubs, and other plant life.
4. Removing abandoned utilities.
5. Removing fence materials and gates.
6. Excavating topsoil.

B. Related Requirements:

1. Section 02 31 13.23 – Utility Line Removal.
2. Section 02 61 13 – Excavation and Handling of Contaminated Materials.

1.2 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit data for herbicide. Indicate compliance with applicable codes for environmental protection.

C. Location of final disposal of cleared materials and written permission from property owner.

1.3 QUALITY ASSURANCE

A. Conform to state, county, and local laws and code requirements for the trimming, removal, hauling and disposing of trees, shrubs, stumps, roots, rubbish, debris and other matter. Pay for all disposal permits and fees. Disposal will not be permitted in a wetland or floodplain unless permits are obtained from the appropriate regulatory agencies.

B. Perform Work in accordance with Environmental Protection Agency (EPA), Michigan Department of Transportation (MDOT), Wayne County, and Detroit Water and Sewerage Department (DWSD) standards. Perform Work in adherence to the City of Detroit Fugitive Dust Ordinance (Ordinance No. 32-17).

C. Maintain on-site two (2) copies of any disposal permit obtained.

D. Comply with all federal and state Emerald Ash Borer quarantines, if applicable. Comply with Michigan Department of Agriculture requirements.

E. Comply with all Federal and State regulations for the protection of the Indiana Bat. The clearing of plant life is prohibited during the dates of April 1 through September 30.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Herbicide: Submitted to and approved by the Engineer on a case by case basis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Verify that existing plant life designated to remain is tagged or properly identified.

C. Identify waste area for placing removed materials and soil stockpile location.

3.2 PREPARATION

A. Call Local Utility Line Information service MISS DIG (811) at 1-800-482-7171 no less than three full working days, excluding Saturdays, Sundays, and holidays, but no more than 14 calendar days before digging operations are scheduled to begin.

B. Request underground utilities to be located and marked within surrounding construction areas. Do not dig until all utilities have been marked by MISS DIG (811).

3.3 PROTECTION

A. Locate, identify, and protect utilities indicated to remain, from damage.

B. Protect trees, plant growth, and features designated to remain, as final landscaping.

C. Protect bench marks, survey control points, and existing structures from damage or displacement.

3.4 CLEARING

A. Clear and grub areas to a depth necessary for access to site and execution of the Work.

B. Remove trees and shrubs as required for access within water and sewer easements and marked areas. Remove stumps and root systems within marked areas to a minimum depth of 6 inches. Remove surface rock to 6 inches below subgrade. Trees and tree branches which encroach the access areas shall be trimmed and pruned to the satisfaction of the Engineer or jurisdictional authority.

C. Clear undergrowth and deadwood without disturbing subsoil.

D. Apply herbicide to remaining stumps within marked areas to inhibit growth.

3.5 REMOVAL

A. Remove debris, rock, and extracted plant life from site.

B. Partially remove paving, driveways, curbs, ADA ramps, and, sidewalks as indicated on Drawings. Neatly saw cut edges at right angle to surface.

C. Remove abandoned utilities in accordance with Section 02 31 13.23 – Utility Line Removal. Indicate removal termination points for underground utilities on Record Documents.

D. Remove fences, gates, traffic signs, mail boxes, etc., as indicated on the Drawings.

E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

F. Do not burn or bury materials on-site. Leave site in clean condition.

3.6 TOPSOIL EXCAVATION

A. Excavate topsoil from entire site without mixing with foreign materials for use in finish grading.

B. Do not excavate wet topsoil.

C. Stockpile in area designated on site to depth not exceeding 6 feet and protect from erosion. Stockpile material on impervious material and cover with same material until disposal.

D. Remove excess topsoil not intended for reuse from site to a location approved by the Engineer.

E. Contaminated materials management in accordance with Section 02 61 13 – Excavation and Handling of Contaminated Materials.

3.7 SCHEDULES

A. Protect the following materials:

1. Protect streets, roads, adjacent property, and all other facilities and structures from damage caused by the Contractor's operations.
2. Return to original condition, satisfactory to the Owner, facilities damaged by the Contractor's operation at the Contractor's expense.
3. Protect trees, shrubs, and grassed areas by using fences, barricades, wrapping, or other methods as shown, specified or approved by the Owner.

END OF SECTION 31 10 00

SECTION 31 23 16.26 - ROCK REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Excavating and removing identified and discovered rock during excavation.

B. Related Requirements:

1. Section 31 23 33 – Trenching and Backfilling

1.2 DEFINITIONS

A. Rock: Solid mineral material with volume in excess of 1/2 cu. yd. or solid material that cannot be removed with 3/4 cu. yd. capacity excavator without drilling or blasting, or continuous use of a ripper or other special equipment.

1.3 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. National Fire Protection Association (NFPA):

1. NFPA 495 – Explosive Materials Code.
2. MIOSHA Part 27 – Blasting and Use of Explosives.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Survey Report: Submit survey report on conditions of buildings near locations of rock removal.

1.5 PROJECT CONDITIONS

A. Conduct survey and document conditions of buildings near locations of rock removal, and photograph existing conditions identifying existing irregularities.

B. Advise owners of adjacent buildings or structures in writing, prior to executing seismographic survey.

C. Obtain seismic survey prior to rock excavation to determine maximum charges that can be used at different locations in area of excavation without damaging adjacent properties or other work.

1.6 SCHEDULING

A. Coordination and Project Conditions: Comply with Section 01 30 00 - Administrative Requirements.

B. Schedule Work to avoid disruption to occupied buildings nearby.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Verify site conditions and note subsurface irregularities affecting Work of this section.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

3.3 ROCK REMOVAL BY MECHANICAL METHOD

A. Excavate and remove rock by mechanical method. Alternatively, drill holes and use expansive tools and wedges to fracture rock.

B. Cut away rock at bottom of excavation to form level subgrade.

C. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.

D. Remove excavated materials from site.

E. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 31 23 33 – Trenching and Backfill, unless directed otherwise by the Engineer.

3.4 FIELD QUALITY CONTROL

A. Comply with field inspecting, testing, adjusting, and balancing requirements in Section 01 40 00 - Quality Requirements.

B. Request visual inspection of bearing surfaces by Engineer before installing subsequent work.

END OF SECTION 31 23 16.26

SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dewatering system.
2. Surface water control system.
3. Monitoring wells.
4. System operation and maintenance.
5. Water disposal.

B. Related Requirements:

1. Section 01 57 13 – Temporary Erosion and Sediment Control
2. Section 02 61 13 – Excavation and Handling of Contaminated Materials
3. Section 31 23 33 – Trenching and Backfill

1.2 DEFINITIONS

A. Dewatering:

1. Lowering of ground water table and intercepting horizontal water seepage to prevent ground water from entering excavations, trenches, tunnels, and shafts.
2. Reducing piezometric pressure within strata to prevent failure or heaving of excavations, trenches, tunnels, and shafts.
3. Legally disposing of removed water.

B. Piezometer: A tube inserted into a vessel or pipe to indicate the height (pressure) that a liquid can rise in the tube.

C. Pitometer: A measuring device that transforms a differential pressure into an electrical output current proportional to the flow rate.

D. Surface Water Control: The removal of surface water within open excavations.

E. Dewatering System: The system of wells, well points, sumps, ejectors, pumps, power supply, effluent treatment equipment, and other applicable equipment designed by the Contractor to effectively dewater the site as required herein and as specified.

1.3 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. ASTM International:

1. ASTM C33 – Standard Specification for Concrete Aggregates.
2. ASTM D1785 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
3. ASTM D2466 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
4. ASTM D2564 – Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe Systems.

B. Michigan Department of Environmental Quality (MDEQ) – Part 127, Act 368 PA 1978 "Michigan Well Code."

C. Soil Erosion and Sedimentation Control Act of the State of Michigan, Part 91 of Act 451; PA of Michigan.

D. National Pollutant Discharge Elimination System (NPDES) Permit.

1.4 COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Coordinate Work of this Section to permit the following construction operations to be completed on dry and stable substrate: Trenching for utilities as specified in Section 31 23 33 – Trenching and Backfill.

1.5 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Convene a pre-installation meeting a minimum two weeks prior to commencing Work of this Section.

1.6 SEQUENCING

A. Comply with Section 01 11 00 – Summary of Work.

B. Obtain required permits before start of dewatering operations.

C. Install and test monitoring systems a minimum seven (7) days before testing and operating dewatering systems.

D. Install and test dewatering and surface water control systems a minimum seven (7) days before starting excavation, trenching, tunneling, and shaft drilling.

1.7 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Dewatering System/Plan: Submit plan of dewatering system as indicated in Shop Drawings Section below.

C. Product Data:

1. Submit catalog cuts and product data sheets for major equipment items including pumps, motors, valves, pressure gauges, flow meters, piping, electrical power supply, and standby generators.
2. Submit pumping equipment for control of surface water within excavation.

D. Shop Drawings:

1. Indicate that the water to be extracted from subsurface does not contain hazardous materials. Comply with Section 02 61 13 – Excavation and Handling of Contaminated Materials.
2. Indicate dewatering system layout, well depths, well screen lengths, dewatering pump locations, pipe sizes and capacities, grades, filter sand gradations, surface water control devices, valves, and water disposal method and location.
3. Indicate primary and standby power system location and capacity.
4. Indicate layout and depth of monitoring wells, piezometers, and flow measuring devices for system performance measurement.
5. Include detailed description of dewatering and monitoring system installation procedures and maintenance of equipment.
6. Include description of emergency procedures to follow when problems arise. Provide a designated dewatering responsible person who will be the point of contact in the event of system failure or loss of power.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Design Submittals:

1. Submit a preliminary dewatering plan including:
   a. Proposed locations and number of wells, well points and monitoring wells.
   b. Anticipated groundwater drawdown range and depth.
   c. Schedule for installation, development, and testing of all dewatering system components, as well as the excavation activities at each dewatering site.

d. Proposed casing diameters, depths, and screen lengths.
e. Proposed location and size of the discharge header.
f. Performance curves for proposed pumps.
g. Proposed estimated total pumping horsepower and standby power generator(s) capacity.
h. Proposed locations and types of flow meters.
i. Suspended solids monitoring procedures.
j. Proposed monitoring frequency and reporting format for various construction stages and situations.
k. Designated dewatering responsible person who will be contacted in the event of system failure or loss of power.

2. Submit signed and sealed design and Shop Drawings of approved Dewatering Plan.
3. Indicate design values, analyses, assumptions, and calculations to support design.
4. Include description and profile of geology, soil, and ground water conditions.
5. Submit signed and sealed survey of existing adjacent buildings, structures, and improvements for position and elevation of principal elements before and after completion of dewatering operations.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections and testing and monitoring reports.

H. Reports:

1. Initial Installation Report: General
   a. Installation and development reports for well points and pumps including well performance data based on tests conducted at the time of installation including pumping rate, static level, pumping levels, drawdown, and pumping duration shall all be included on well log.
   b. Installation and baseline reports for monitoring of wells and piezometers.
   c. Test reports of well water analysis.
   d. Initial dewatering flow rates.

2. Weekly Monitoring Reports:
   a. Dewatering flow rates.
   b. Piezometer readings.
   c. Test reports of discharge water analysis.
   d. Maintenance records for dewatering and surface water control systems.

I. Qualifications Statements: Submit qualifications for manufacturer, installer, licensed professional, and representative that will oversee the dewatering system daily.

1.8 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations and depths of capped wells and piping abandoned in place.

1.9 QUALITY ASSURANCE

A. Comply with the applicable codes, ordinances, statutes, rules, and regulations of the City of Detroit, the State of Michigan, and Federal Government for the following:

1. Drilling and abandonment of wells used for dewatering systems (MDEQ "Well Construction Code").
2. Water discharge and disposal from pumping operations (NPDES, as administered by MDEQ, Natural Resources and Environmental Protection Act, 1994 PA 451).

B. If noted on the drawings or in the specifications, obtain a permit from the MDEQ under the National Pollutant Discharge Elimination System (NPDES) for discharge from the Site. The quality of the discharge from dewatering operations determines whether a NPDES permit is required. In general, the discharge of clean water will not require an NPDES permit.

C. Small portions of the City of Detroit have regulated municipal separate storm sewer systems (MS4). Discharge from dewatering operations to a MS4 shall comply with the illicit discharge definition (i.e., the discharge cannot be contaminated). Obtain approval from DWSD prior to discharging to their system from any dewatering operation.

D. Complete submittals required by MDEQ well abandonment procedures. Submittals shall be made directly to MDEQ, copying the Owner, within 15 days of completion.

E. Perform Work according to Detroit Water and Sewerage Department standards.

F. Maintain two copies of each standard affecting Work of this Section on-site.

1.10 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five (5) years documented experience and approved by the manufacturer and Owner.

C. Licensed Professionals:

1. Professional engineer experienced in design of specified Work and licensed in the State of Michigan.
2. Surveyor experienced in specified Work and licensed in the State of Michigan.
3. Water Well Driller experienced in specified work and licensed in the State of Michigan.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Lower the ground water level in excavations to provide a stable, dry subgrade for the execution of subsequent Work.

B. Furnish, install, and maintain dewatering and surface water control systems to permit the work to be completed on dry and stable subgrade.

C. Furnish, install and maintain well points/wells to dewater and relieve hydrostatic pressure within the strata as identified in the Contract Documents.

D. Furnish, install and maintain monitoring wells and monitoring equipment to obtain meaningful observations of conditions affecting the excavation. The ground water table shall be maintained a minimum of 3 feet below the excavation at all times.

E. Furnish, install and maintain monitoring wells to observe ground water conditions as designed in dewatering plan.

F. Standby Equipment:

1. Provide standby pumping and power equipment of sufficient capacity to maintain the dewatering system in an operable condition in the event of failure of any of the original equipment or power.
2. Store at Site and ready for immediate use upon failure of dewatering equipment.
3. Standby equipment shall include power generator(s) installed and available, and additional pumps of a quantity of at least 10% of the total number and sized pumps.

2.2 PERFORMANCE AND DESIGN CRITERIA

A. Design:

1. Lower water table within areas of excavation to minimum 3 feet below bottom of excavation to permit the work to be completed on dry and stable subgrade.
2. Relieve hydrostatic pressures in confined water bearing strata below excavation to eliminate risk of uplift or other instability of excavation.
3. Prevent damage to adjacent properties, buildings, structures, utilities, and other facilities from construction operations.
4. Prevent loss of fines, quick condition, or softening of foundation subgrade.
5. Maintain stability of all sides/faces/walls/bottoms of excavations, trenches, tunnels, and shafts.
6. Surface Water Control System: Collect and remove surface water and seepage entering excavation.

2.3 DEWATERING EQUIPMENT

A. Prepare a complete plan and design of the dewatering system. Submit to the Owner for review and approval. Design dewatering equipment to meet the specified performance requirements.

B. The dewatering system shall be of sufficient size and capacity to maintain a dry condition for construction of each part of the work without delaying construction operations. Control all water regardless of source. Comply with applicable environmental protection laws and requirements in operation of the dewatering system.

2.4 MONITORING EQUIPMENT

A. Piezometers:

1. Description: Sand filter or Push-in installation to monitor water elevation.
2. Type: Standpipe, strain gage, or vibrating wire.
3. Accessories: Signal cable and data recorder or logger.

B. Flow Measurement Devices:

1. Pitometer installed on discharge of pipe from each well.
2. Pitometer installed to measure flow from entire dewatering system.

2.5 ACCESSORIES

A. Valves and Fittings: Furnish valves and fittings as required to isolate each well from header pipe and to prevent loss of pump prime.

B. Filter Sand:

1. Description: Natural river or bank sand, washed, and free of silt, clay, loam, friable, or soluble materials.
2. Comply with ASTM C33/C33M.
3. Grading: To suit well screen.

C. Grout: Mixture of Portland cement and bentonite clay for sealing abandoned wells and piping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Review and evaluate the available subsurface data for the project site with respect to required dewatering facilities, including any additional groundwater monitoring data required. The subsurface conditions from the test borings and excavations apply only to the locations of the borings and at the times of the explorations. The subsurface conditions elsewhere at the site and at the time of construction may be different.

C. Conduct additional borings and investigations to supplement subsurface investigations as necessary to complete dewatering system design. Contractor may use monitoring wells left by the Owner's geotechnical engineer.

D. Utility Service Locator:

1. Call local utility service-line information MISS DIG at 811 between 3 days and 14 calendar days, excluding Saturdays, Sundays, and holidays, before beginning Work.
2. Request that underground utilities be located and marked within and immediately surrounding construction areas.
3. Identify required lines, levels, contours, and data.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Protect existing adjacent buildings, structures, and improvements from damage that may be caused by dewatering operations.

3.3 MONITORING WELLS

A. Install monitoring wells at locations as indicated on Contract Documents and Shop Drawings.

B. Test each monitoring well point to verify that installation is performing properly.

C. Install, calibrate, and test piezometers for proper operation.

D. Maintain accessibility to monitoring wells continuously during construction operations.

E. Maintain monitoring wells until groundwater can return to normal level.

3.4 DEWATERING SYSTEM

A. Install dewatering system according to Contractor's approved signed and sealed Dewatering Plan and Shop Drawings. Provide means and devices to remove promptly and dispose of water entering excavations and keep the bottoms of the excavations firm and free of standing water and side slopes stable until the structures to be constructed are completed or the backfill to be placed therein has been placed.

B. Locate system components to allow continuous dewatering operations without interfering with installation of permanent Work and existing public rights-of-way, sidewalks, and adjacent buildings, structures, and improvements.

C. Drilling:

1. Drill wells in sizes and to depths as indicated in Dewatering Plan.
2. Provide temporary surface casing if required to stabilize soil while advancing well.

D. Installation Standards: Install Work according to Detroit Water and Sewerage Department standards.

E. Perform the pumping and dewatering operations such that no disturbance to the bearing soil or to soil supporting any other work will result from the dewatering operations. The dewatering discharge shall not cause siltation or other negative environmental impact on natural waterways or other property; such discharge shall be in accordance with applicable federal, state, and local regulations. At dewatering discharge locations, install erosion-bales, silt barriers, or other erosion control measures to control and prevent siltation.

F. Operate the dewatering system continuously to prevent flotation of partially completed structures or other work and flooding/excess wetting of work areas.

3.5 SURFACE WATER CONTROL SYSTEM

A. Furnish, install, and maintain a surface water control system according to Contractor's approved signed and sealed Dewatering Plan. The location of every element of the dewatering system shall be such that interference with excavation and construction activity is minimized.

B. Construct and maintain ditches, berms, and other devices to divert and drain surface water from excavation area, as designed in Dewatering Plan and specified in Contract Documents, Section 01 57 13 – Erosion Control Sedimentation and Containment of Construction Materials.

C. Divert surface water and seepage water within excavation areas into sumps and pump water according to Contractor's Dewatering Plan and per the requirements of authorities having jurisdiction.

D. Control and remove unanticipated water seepage into excavation.

3.6 SYSTEM OPERATION AND MAINTENANCE

A. Operate dewatering system according to Contractor's approved signed and sealed Dewatering Plan.

B. Operate dewatering system continuously until backfill is complete.

C. Provide 24-hour supervision of dewatering system by personnel skilled in operation, maintenance, and replacement of system components.

D. When the dewatering system does not meet the specified requirements and, as a consequence, loosening or disturbance of the foundations strata, instability of the slopes, or damage to the foundations or structures occurs, provide materials, labor, and work for restoration of foundations soil, fill soils, slopes, foundations, or structures at no cost to the Owner.

E. When the dewatering system does not meet the specified requirements and consequently fill surfaces become too wet or the fill exceeds the specified moisture content, remove and replace the upper materials with materials placed and compacted to the specifications. Do not dry out overly wet fills resulting from failed or inadequate dewatering systems or mix with dry material and rework in-place to meet applicable fill specifications.

F. Monitoring:

1. Conduct daily observation of dewatering system and monitoring system.
2. Make required repairs and perform scheduled maintenance.

G. Fill fuel tanks before tanks drop to 25 percent capacity.

H. Start emergency generators at least twice each week to check operating condition.

I. System Failure:

1. If dewatering system cannot control water within excavation, notify Engineer and stop excavation Work.
2. Supplement or modify dewatering plan and provide other remedial measures to control water within excavation.
3. Demonstrate that revised dewatering plan complies with performance requirements before resuming excavation operations.

J. Modify dewatering and surface water control plan if operation causes or threatens to cause damage to new construction, existing site improvements, adjacent property, or adjacent water wells.

K. Correct unanticipated pressure conditions affecting dewatering system performance.

L. Do not discontinue dewatering operations without approval of Engineer.

3.7 WATER DISPOSAL

A. Discharge water according to Contractor's approved signed and sealed Dewatering Plan.

3.8 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Testing:

1. After dewatering system is installed, perform pumping test to determine at what point selected pumping rate lowers water level in well below pump intake.
2. Adjust pump speed, discharge volume, or both to ensure proper operation of each pump.

C. Monitoring and Recording:

1. Daily:
   a. Note average discharge flow rate for each deep well, eductor header, well point, and ground water elevation.
   b. Continue monitoring daily until steady state conditions occur, then monitor twice each week.

2. Sand Content:
   a. Monitor ground water discharge for sand content.
   b. Sample and test water from each well weekly for sand content.
   c. Maximum Permitted Sand Content: 5 ppm.

3. Contaminants:
   a. Monitor ground water discharge for contamination while performing pumping in vicinity of potentially contaminated sites.
   b. Sample and test water weekly for contaminants.

4. Existing Adjacent Buildings, Structures, and Improvements:
   a. Survey weekly during dewatering to detect movement in comparison to original elevations.
   b. Notify Engineer immediately of measured movement.

3.9 PROTECTION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Repair without cost to the Owner any damage to work in place, other contractors' equipment, and the excavation, including damage to the bottom of the excavation due to heave and removal of material and pumping out of the excavated area that may result from the Contractor's negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system.

C. Protect monitoring well standpipes from damage by construction operations.

3.10 SYSTEM REMOVAL

A. Remove dewatering and surface water control systems after dewatering operations are discontinued.

B. Remove piezometers and monitoring wells unless directed otherwise by the Owner.

C. Abandoned Wells: Per MDEQ Part 127, Act 368 PA 1978

END OF SECTION 31 23 19

SECTION 31 23 23.33 - FLOWABLE FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flowable fill for:
   a. Structure backfill.
   b. Utility bedding.
   c. Utility backfill.
   d. Filling abandoned utilities.

B. Related Requirements:

1. Section 31 23 33 – Trenching and Backfilling.
2. Section 33 14 13 – Public Water Utility Distribution Piping.
3. Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.

1.2 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, manhole, tank, or cable.

B. Flowable Fill: Lean Portland cement concrete fill for utility trenches, culverts, and filling abandoned utilities.

1.3 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. ASTM International:

1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
3. ASTM C150 - Standard Specification for Portland Cement.
4. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
5. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.
6. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
7. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
8. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

9. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Field Quality-Control Submittals:

1. Mix Design:
   a. Furnish flowable fill mix design for each specified strength.
   b. Furnish separate mix designs when admixtures are required for the following:
      1) Flowable fill during hot and cold weather.
      2) Air entrained flowable fill.

   c. Identify design mix ingredients, proportions, properties, admixtures, and tests.

2. Furnish test results to certify flowable fill mix design properties meet or exceed specified requirements minimum of fifteen (15) days prior to placement.

C. Method of Placement.

D. Delivery Tickets: Furnish duplicate delivery tickets indicating actual materials delivered to Project Site.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Minimum Conditions: Do not install flowable fill during inclement weather or when ambient temperature is less than 40° F.

PART 2 - PRODUCTS

2.1 FLOWABLE FILL

A. Furnish materials according to State of Michigan Department of Transportation standards.

B. Flowable Fill:

1. Filling abandoned utilities.
2. Utility Trenches.
3. Roadway Subgrade.
4. Any areas specified.

2.2 MATERIALS

A. Portland Cement: ASTM C150; Type I - Normal or Type IA - Air Entraining; for Excavatable Flowable Fill.

B. Granular Materials:

1. MDOT Standard Specifications for Construction for Class II requirements except that 100% shall pass the ½ inch sieve (Table 902-3).
2. Fine Aggregates: MDOT Standard Specifications for Construction for 2NS requirements (Table 902-4).

C. Fly Ash: ASTM C618 Class F with no limit on the loss of ignition.

D. Water: Potable, clean and not detrimental to concrete.

2.3 OPTIONAL MATERIALS

A. Ground Granulated Blast Furnace Slag: Ground blast furnace slag shall conform to ASTM C989, Grad 100. It shall be used only as a blending material with Type I or Type IA Portland Cement.

2.4 ADMIXTURES

A. Air Entrainment: ASTM C260.

B. Chemical Admixtures: ASTM C494:

1. Type A - Water Reducing.
2. Type B - Retarding.
3. Type C – Accelerating.
4. Type D - Water Reducing and Retarding.
5. Type E - Water Reducing and Accelerating.

2.5 MIXES

A. Mix and deliver flowable fill according to ASTM C94, Option C.

B. Flowable Fill Design Mix:

1. Cement Content (Type I): 50 lb./cu. yd.
2. Fly Ash Content (Class F): 200 lb./cu. yd.
3. Water Content: Sufficient water to provide the desired flowability (approximately 40 gal/cu. yd.).
4. Air Entrainment: 5 to 35 percent.

5. 28-Day Compressive Strength:
    a. 50 psi at 3 days.
    b. Maximum 150 psi at 28 days.

6. Unit Mass (Wet): 80 to 110 pcf.
7. Temperature, Minimum, at Point of Delivery: 50° F.

C. Provide water content in the design mix to produce self-leveling, flowable fill material at time of placement.

2.6 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Test and analyze properties of flowable fill design mix and certify results for the following:

1. Design mix proportions by weight of each material.
2. Aggregate: ASTM C33 for material properties and gradation.
3. Properties of plastic flowable fill design mix including:
    a. Temperature.
    b. Slump.
    c. Air entrainment.
    d. Wet unit mass.
    e. Yield.
    f. Cement factor.

4. Properties of hardened flowable fill design mix including:
    a. Compressive strength at 3 days and 28 days. Report compressive strength of each specimen and average specimen compressive strength.
    b. Unit mass for each specimen.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Verify excavation is dry and dewatering system is operating.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Support and restrain utilities to prevent movement and flotation during installation of flowable fill.

C. Protect structures and utilities from damage caused by hydraulic pressure of flowable fill before fill hardens.

D. Protect utilities to prevent intrusion of flowable fill.

E. The temperature of the flowable fill mix, as it is manufactured and delivered, shall be at least 50° F.

F. The flowable fill mix shall be transported to the point of placement in a revolving drum mixer or agitator.

3.3 INSTALLATION

A. Place flowable fill in a manner similar to that for concrete but that adheres to the requirements for backfilling, according to Section 31 23 33 – Trenching and Backfilling.

B. No placement of flowable fill will be allowed if the anticipated air temperature will be 35° F or less in the 24-hour period following the proposed placement.

C. No water shall be added to the flowable fill after batching.

D. Any pipes within the backfill area shall be secured in order to avoid buoyant effect of flowable fill.

3.4 INSTALLATION - FILL, BEDDING, AND BACKFILL

A. Place flowable fill by chute, pumping or other methods approved by Engineer.

B. Place flowable fill in lifts to prevent lateral pressures from exceeding structural capacity of structures and utilities.

C. Place flowable fill evenly on both sides of utilities to maintain alignment.

D. Place flowable fill to elevations indicated on Drawings without vibration or other means of compaction.

E. When flowable fill is used in pavement cuts, the fill shall be placed to the top of pavement. After setting, the flowable fill shall be removed to the bottom of a concrete pavement patch or the bituminous base course.

3.5 INSTALLATION - FILLING ABANDONED UTILITIES

A. Use excavatable flowable fill only.

B. Verify pipes and conduits are not clogged and are sufficiently empty to permit gravity installation or pumping of flowable fill for entire length indicated to be filled.

C. Place flowable fill under pressure into property vented open system until flowable fill emerges indicating pipe is completely filled. Pumping flowable fill must be completed under sufficient pressure to overcome friction and to fill water main from downstream to upstream end.

D. Seal lower end of pipes and conduits by method to contain flowable fill and to vent trapped air caused by filling operations during gravity installation.

E. Seal both ends of pipes and conduits with approved bulkheads suitable to contain flowable fill during pumping of flowable fill under pressure.

F. Provide batch and delivery tickets to the Engineer for all flowable fill material.

G. Place flowable fill using method to ensure there are no voids.

1. Fill pipes and conduits from high end.
2. Fill manholes, tanks, and other structures from grade level access points.

3.6 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Perform in place penetration (density) tests using handheld penetrometer to measure penetration resistance of hardened flowable fill according to ASTM C403. Perform tests at locations as directed by Engineer**.**

C. Defective Flowable Fill: Fill failing to meet the following test requirements or fill delivered without the following documentation.

1. Test Requirements:
   a. Minimum temperature at point of delivery.
   b. Compressive strength requirements for each type of fill.

3.7 CLEANING

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Remove spilled and excess flowable fill from Project Site.

C. Restore facilities and site areas damaged or contaminated by flowable fill installation to existing condition before installation.

END OF SECTION 31 23 23.33

SECTION 31 23 33 - TRENCHING AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Trench excavation width and safety.
2. Backfill materials and placement.
3. Utility identification using marking tape and trace wire.
4. Soil and aggregate materials.
5. Compaction and testing.

B. Related Requirements:

1. Section 02 22 30 – Pre-Construction Video and Photographic Record.
2. Section 31 23 16.26 – Rock Removal.
3. Section 31 23 23.33 – Flowable Fill.
4. Section 31 50 00 – Excavation Support Systems.
5. Section 32 11 23 – Aggregate Base Courses.
6. Section 33 14 13 – Public Water Utility Distribution Piping.
7. Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.

1.2 DEFINITIONS

A. Percent Compaction or Compaction Density: The field dry density of compacted material, expressed as a percentage of the maximum dry density.

B. Field Dry Density or Field Density: In-place density as determined by ASTM D6938 (Nuclear Method).

C. Maximum Dry Density: Laboratory density as determined by ASTM D1557 (Modified Proctor) and occurring at the optimum moisture content of the soil being tested.

D. Pipe Embedment: Comprised of the following or combination thereof:
1. Foundation: Required when the native trench bottom does not provide a firm working platform or the necessary uniform and stable support for the install pipe.
2. Bedding: Placed directly underneath the pipe and brings the trench bottom to grade. Provides a firm, stable, and uniform support of the pipe.
3. Haunching: The same material as the bedding, placed from bottom of pipe to springline.
4. Initial Backfill: The same material as the bedding, placed from top of haunching to 6 to 12 inches above top of pipe, as shown on the Drawings.

5. Final Backfill: Placed above the initial backfill to a level below that required for the trench restoration area.
6. Backfill: Includes initial and final backfill.

1.3 STANDARDS

Except as modified herein, comply with the latest version of the following standards:

A. American Association of State and Highway Transportation Officials (AASHTO):

1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.

B. ASTM International:

1. ASTM C33 - Specification for Concrete Aggregates.
2. ASTM C150 - Standard Specification for Portland Cement.
3. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
4. ASTM D75 - Standard Practice for Sampling Aggregates.
5. ASTM D421 - Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants.
6. ASTM D422 - Test Method for Particle-Size Analysis of Soils.
7. ASTM D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft3 (600 kN-m/m3)).
8. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
9. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
10. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).
11. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
12. ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
13. ASTM D2940/D2940M - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.
14. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
15. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
16. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

C. Michigan Department of Transportation (MDOT):

1. MDOT Specifications: Michigan Department of Transportation, Standard Specifications for Construction, 2012 edition.
2. MDOT Density Testing and Inspection Manual (rev. 2017).

D. City of Detroit, Department of Public Works, City Engineering Division:

1. Standard Specifications for Paving and Related Construction.
2. Street and Alley Standard Plans.

E. Occupational Safety and Health Administration (OSHA):

1. OSHA 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations.

F. MISS DIG

1. Public Act 174: MISS DIG Underground Facility Damage Prevention and Safety Act.

1.4 CLASSIFICATION OF EXCAVATION

A. Excavation is part of the unit prices of the contract. Excavation is not classified, except where rock excavation is authorized outside specified or indicated limits of excavation.

1.5 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Requirements:

1. Temporary excavation and shoring drawings for worker protection in accordance with the General Conditions.
2. Gradation analysis for each material including a separate submittal for the same material if from a different supplier.
3. Dewatering plan including disposition of groundwater, if required.
4. Manufacturer's catalog data and a sample of prefabricated drainage panel and filter fabric with manufacturer's installation instructions and details.
5. Materials Sources: Name of source, location, date of sample, sieve analysis, and laboratory compaction characteristics (proctor).
6. Test and Evaluation Reports:
    a. Field density testing reports: Provide results from field density testing of prepared subgrade and compacted fill.
    b. Grain-size analysis.
    c. Laboratory compaction characteristics of soils.
    d. Water content.

7. Geotextile:
    a. At least two (2) weeks prior to shipment, submit manufacturer's certificate of compliance and physical property data sheet indicating that requirements for materials and manufacture are in conformance as specified.
    b. For informational purposes only, submit manufacturer's printed installation instructions.

8. Compaction method and removal sequence of shoring.
9. Mix design and test results for flowable fill as specified in Section 31 23 23.33 – Flowable Fill.
10. MISS DIG training certification for all Contractor personnel.
11. MISS DIG ticket documentation prior to commencing excavations.

1.6 QUALITY ASSURANCE

A. Comply with the requirements specified in Section 01 40 00 – Quality Requirements.

B. Sample backfill materials in accordance with ASTM D75.

C. Testing will be provided by the Contractor. Payment for the cost of testing and inspection shall be in accordance with Section 01 20 00 – Price and Payment Procedures.

D. Protect workers in and near excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in of loose soil. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P.

1.7 DELIVERY STORAGE AND HANDLING

A. Provide geotextile fabric in rolls wrapped with protective covering to protect geotextile fabric from mud, dirt, dust, and debris. Label each roll of geotextile fabric with number or symbol to identify production run.

B. Protect geotextile fabric from sunlight during transportation and storage. Do not leave geotextile fabric exposed to sunlight for more than two weeks during installation operations.

1.8 EXISTING CONDITIONS

A. Geotechnical Report: If a report is made available, the documentation is for information only and is not part of the contract documents. Logs of borings are included in the report and indicate conditions encountered only at test boring locations. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.

PART 2 - PRODUCTS

2.1 BACKFILL MATERIALS

A. Suitable Material: Material from on-site excavation and permitted off-site sources that meets all specified requirements for its intended use and is not unsuitable. Wet subgrade material which meets other requirements for suitable material is suitable.

B. Unsuitable Material: Material that fails to meet requirements for suitable materials; or contains any of the following:

1. Organic clay, organic silt, or peat; as defined in ASTM D2487.
2. Vegetation, wood, roots, leaves, and organic, degradable material.
3. Stones or rock fragments over 6 inches in any dimension.
4. Porous biodegradable matter, excavated pavement, construction debris, rubbish, or refuse.
5. Ice, snow, frost, or frozen soil particles.

C. Bedding, Haunching, and Initial Backfill: Granular Fill, Open Graded; depth of 1/8 of diameter, 4 inches minimum, 6 inches maximum, or as illustrated in the standard details. MDOT Class II or City Engineering Grade “A”.

D. Final Backfill Not Under Pavement: Suitable, unclassified material excavated from trench; free of rocks with dimensions greater than 1/2 the compacted lift; and rocks provide less than 50 percent of the final backfill volume.

E. Granular Fill:

1. Densely Graded: MDOT Specifications, Section 902, No. 21AA, 21A or 22A.
2. Open Graded: ASTM C33, coarse aggregate, No. 57. MDOT Specifications, Section 902, 6A.

F. Sand: MDOT Specifications, Section 902; granular materials meeting the gradation limits of Class II or Class IIA.

G. Base Aggregate for Pavement: MDOT Specifications, Section 902; 21AA, 21A or 22A.

2.2 FLOWABLE FILL

A. Flowable Fill shall consist of a mixture of Portland cement, aggregate, fly ash, water, and admixtures conforming to Section 31 23 23.33 – Flowable Fill.

2.3 EQUIPMENT

A. Compaction equipment shall be capable of consistently achieving the specified compaction requirements.

2.4 UTILITY IDENTIFICATION

A. Trace Wire: Continuous, single-strand copper wire, insulated, maximum 10 AWG. Clear plastic covering imprinted with inscription describing specific utility in large letters.

B. Marking Tape: Use type specifically manufactured for marking and locating underground utilities. Acid- and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch, minimum strength of 1,750 psi lengthwise and 1,500 psi crosswise. Furnish and install tape manufactured with foil core at least 0.35-mil thick to enable detection by metal detection when tape is buried up to 3 feet deep. Tape shall bear continuous printed inscription describing specific utility. Tape color shall be as follows:

1. Electric conduits, duct banks, and cable: Red.
2. Potable water systems: Blue.
3. Gas, oil, dangerous materials: Yellow.
4. Telephone, CCTW, fire communications: Orange.
5. Sanitary sewer systems: Green.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Notify MISS DIG (811) at least three (3) days in advance of proposed start of Work, but not more than 14 calendar days before digging operations are scheduled to begin. Do not dig unless all utilities have been marked by MISS DIG (811).

B. Verify that dewatering support systems are in place before commencing with excavation.

C. Verify that excavation safety and support systems meeting the requirements of OSHA 29 CFR 1926, Subpart P are in place before commencing with excavation.

1. Minimum slopes for laying back excavations or materials are contained in OSHA 29 CFR 1926, Subpart P; Appendices A and B.
2. Minimum requirements for shoring and bracing are contained in OSHA 29 CFR 1926, Subpart P; Appendix C.

D. Verify that fill materials submittals have been accepted by Engineer before commencing with work requiring the use of these materials.

E. Verify that erosion and sediment control measures are in place and functioning properly.

F. Immediately notify the Engineer if unexpected subsurface facilities or suspected hazardous materials are encountered during excavation.

G. Test Pits: Excavate test pits to field verify the locations of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Engineer if conflicts are encountered.

3.2 PREPARATION

A. Underpin or otherwise support adjacent structures that could be damaged by excavation work.

B. Cut pavement with saw or pneumatic tools to prevent damage to remaining pavement. Dispose of large pieces of demolished pavement before proceeding with excavation.

3.3 PROTECTION OF IN-PLACE CONDITIONS

A. Comply with requirements specified in Section 02 01 20 – Protecting Existing Underground Utilities.

B. Support and protect from damage: existing pipes, poles, wires, fences, curbs, property line markers, and other features or structures which must be preserved in place to avoid being temporarily or permanently relocated.

C. Excavation Near Existing Structures:

1. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.

2. Excavate test pits near, or at intersection with, existing utilities or underground structures to determine the exact location of existing features.

D. Excavation Near Private Property:

1. Record existing condition of features on adjacent property by means of dated photographs or cameras. Provide construction photographs according to Section 02 22 30 – Pre-Construction Video and Photographic Record.

2. Enclose uncut tree trunks adjacent to work in wooden boxes of such height necessary to protect tree from injury due to piled material, equipment, or operations. Operate excavating machinery and cranes to prevent injury to overhanging branches and limbs.

3. Protect cultivated hedges, shrubs, and plants which would otherwise be damaged by the work.

4. Where protection of vegetation is not possible, dig up, temporarily transplant, and maintain. After active construction operations in the area have ceased, transplant vegetation to the original positions and provide water and nursery care until growth is re--established.

5. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved surfaces. Provide protection on pavement or tracks if construction traffic is unavoidable.

E. Maintain Public Access:

1. Provide suitable and safe crossings at all times during the Work for pedestrians and homeowners, including bridges, ramps, temporary stone, and temporary cold patch.

2. The Contractor shall lay and maintain temporary ramps, bridges, and trench crossings, such as in the opinion of the Engineer are necessary to accommodate through traffic and the general public.

3. The Contractor shall provide free access to all municipal, commercial, residential entrances, fire hydrants, and water and gas valves located in the work vicinity. The Contractor shall lay and maintain temporary driveways, bridges, and trench crossings, which the Engineer deems necessary to maintain access to driveways and to reasonably accommodate the public at no additional cost.

3.4 RESTORATION

A. Restore private property and structures promptly. Begin restoration work within 24 hours of when damage occurred.

B. Existing surfaces, features, or utilities that are to remain but are damaged during construction shall be repaired or replaced to at least the condition in which they were found immediately before work began, unless noted otherwise.

C. Damaged Trees to Remain: Cut all damaged branches, limbs, and roots smoothly and neatly without splitting or crushing. Neatly trim, cut the injured portions and cover with an application of grafting wax or tree healing paint. Replace damaged trees which subsequently die or continue to show lack of growth due to damage, one year after substantial completion.

D. Cultivated Vegetation: Includes, but is not limited to: hedges, shrubs, and plants. Vegetation that is damaged shall be replaced with equal kind and of at least the quality before work began.

3.5 TRENCH EXCAVATION

A. Comply with all requirements of MISS DIG Public Act 174 including contacting MISS DIG, hand excavation near utilities, and contacting 911 in case of emergency.

1. If a utility is damaged resulting in the escape of any flammable, toxic, or corrosive gas or liquid, or endangering life, health, or property, the Contractor shall call 9-1-1 and provide immediate notice to the utility owner or utility operator. The Contractor shall also take reasonable measures to protect the excavator, those in immediate danger, the general public, and the environment until the utility owner or utility operator, or emergency first responders, have arrived and taken control of the site.

B. Furnish, install, and maintain dewatering system to allow for working conditions in dry, stable soil. Properly dispose of water to avoid damage to property and in accordance with laws and regulations. Lower groundwater table prior to excavation and keep a minimum of 24 inches below lowest excavation subgrade until structure has sufficient strength to withstand soil and water pressures.

C. Sheet and brace trenches, excavations, and adjacent structures to comply with laws and regulations and to provide protection of life, property, and the Work. Where close sheeting is necessary, drive to prevent adjacent soil from entering excavation. Remove close sheeting only when removal will not damage property or the Work. Sheeting left in place shall be cut off 5 feet below ground surface.

D. Preserve material below and beyond the lines of excavations.

E. Locate stockpiled excavated material at least 3 feet from edge of excavations to prevent cave-ins or bank slides.

3.6 AUTHORIZED OVER-EXCAVATION

A. Remove rock to a depth of 6 inches below the proposed excavation depth and backfill with bedding material.

3.7 UNAUTHORIZED EXCAVATION

A. Backfill unauthorized excavations with bedding material.

3.8 BACKFILL

A. Fill to lines and grades necessary to provide finish grades.

B. Use a placement method that does not disturb or damage other work or existing features.

C. Maintain fill materials within 3 percent of optimum moisture to attain required compaction density.

D. Place and compact material in equal continuous layers.

E. Maximum compacted depth shall be 12 inches for aggregate materials and soil materials, unless noted otherwise on the Drawings.

3.9 FLOWABLE FILL PLACEMENT

A. Provide batching equipment to obtain the proper weights of soil, cement, water, and admixtures. Measuring devices shall be sensitive to a 2 percent variation above or below the actual weights required. Volumetric batching may be used, provided the same accuracy required for weight batching is maintained.

B. Design and operate the mixers used for mixing the flowable fill so that the flowable fill, as discharged from the mixer, is uniform in composition and consistency throughout each batch.

C. Place the flowable fill so that it flows easily into all openings between the pipe and the excavated trench. In some cases, such as trenches on a slope, a stiffer mix may be required to prevent it from flowing down the trench. In this case, use vibration to ensure that the flowable fill completely fills all spaces.

D. Lay the pipe on the soil pads and place the flowable fill bedding as shown in the drawings. Place bedding under pipe from one side and vibrate so that it flows under the pipe until it appears on the other side. Then add flowable fill to both sides of the pipe and vibrate until it completely fills the space between the pipe and the excavated trench bottom. This operation shall follow as closely behind pipe laying operations as possible. Place flowable fill in such a way as to prevent uplift or buckling of the pipe. Deposit flowable fill as nearly as practicable in its final position. Do not disturb the pipe trench or cause foreign material to become mixed with the cement slurry.

E. Do not place backfill above the pipe until the flowable fill has reached the initial set. Place and maintain a 6-inch cover of moist backfill cover until additional backfill is placed. If the ambient temperature is 50 degrees F or less, place an additional 6-inch cover of backfill over the moist backfill cover prior to the end of the working day.

F. Whenever freezing temperatures are imminent, maintain the flowable fill at a temperature of not less than 50 degrees F for 24 hours after placement. The temperature of the mix shall be 50 degrees F or greater at the time of placement. Monitor the temperature by placing a thermometer in the flowable fill immediately after sampling at the placement site. When freezing weather appears imminent, make ready at the placement site materials that may be required for protection of the flowable fill. Delay placement of flowable fill until adequate provisions for protection against weather are made. Do not place flowable fill bedding in pipe trenches when the trench bottom or walls are frozen or contain frozen material. Backfill placed as cover over the flowable fill is prohibited from containing any frozen material.

3.10 COMPACTION

A. Compact to density specified for various types of material. Control moisture content of material being placed as specified, or if not specified, at a level slightly lower than optimum.

B. Compaction Density: Provide trench backfill densities according to Table 31 23 33-3. The values listed are minimum percentages, unless noted otherwise.

Table 31 23 33-3: Trench Backfill Density

Area	Percentage of Maximum Dry Density as defined by ASTM D1557 (Modified Proctor)
Trench Backfill (under pavement, slabs)	96
Trench Backfill (under structures or within 25 feet of structures)	96
Trench Backfill (through embankment)	98
Trench Backfill (under exterior concrete slab and sidewalks)	96
Trench Backfill (in open or grassed areas)	90

3.11 UTILITY IDENTIFICATION

A. Install marking tape over all non-ferrous utilities, 12 inches below finish grade.

B. Install trace wire at top center pull wire taut to remove any slack.

C. Extend trace wire to utility boxes, manholes and junctions to allow for connection to subsurface location equipment.

3.12 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements for general requirements for field inspection and testing.

B. Compaction shall be deemed to comply with the specifications when no more than one (1) test of any 3 consecutive tests falls below the specified relative compaction. The one test shall be no more than 3 percentage points below the specified compaction. Pay the costs for any retesting or additional testing of work not conforming to the specifications.

C. Where compaction tests indicate a failure to meet the specified compaction, if possible due to size of excavation, additional tests shall be taken every 25 feet in each direction until the extent of the failing area is identified. Rework the entire failed area until the specified compaction has been achieved.

D. Perform particle size distribution and gradation analyses using ASTM D422 and following standard practices in ASTM D421. Perform 1 test for every source and submit results to Engineer for acceptance. Repeat the moisture density test for every 5,000 cubic yards of material used.

E. Perform field density testing in accordance with ASTM D6938 and the MDOT Density Testing and Inspection Manual.

F. Evaluate field density test results in relation to maximum dry density as determined by testing material in accordance with ASTM D1557 (Modified Proctor).

G. Perform tests in accordance with ASTM D4318 to determine Liquid Limit, Plastic Limit and Plasticity Index and submit test results to Engineer for acceptance. Complete a minimum of one test per 5,000 cubic yards of soil for use as fill material and whenever classification of material is in doubt as determined by the Engineer.

H. Location of field density tests shall be mutually acceptable to testing laboratory and Engineer.

I. Frequency of field density tests:

1. At least one test shall be performed for every backfill installation including water main, water main structures, water services, sewers, sewer structures, and sewer lateral connections regardless of length of trench. The length requirements as listed below are only for continuous trenching and backfill installations.

Table 31 23 33-4	
Area	**Frequency**
Trench (Structural Areas)	1 per lift for each 250 linear feet of trench
Trench (Non-Structural Areas)	1 per lift for each 500 linear feet of trench
Regardless of the minimum testing frequency specified, field density tests shall be performed by the Contractor in sufficient number for the Contractor's quality control purposes to ensure that specified density is obtained.	

J. The Owner may retain the services of an independent testing laboratory to conduct confirmatory testing and inspection.

3.13 ADJUSTING

A. Shrinkage:

1. Backfill to a height above finished grade which will allow for the shrinkage or consolidation of material. Initially, provide at all points, an excess of at least one percent of total height of backfill measured from stripped surface to top of finished surface.
2. Supply specified materials and build up low places, without additional cost if embankment or backfilling settles to be below the indicated level for proposed finished surface at any time before final acceptance of the work.

3.14 PROTECTION

A. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.

3.15 CLOSEOUT ACTIVITIES

A. Provide in accordance with Section 01 70 00 – Execution and Closeout Requirements.

END OF SECTION 31 23 33

SECTION 31 24 00 - BIORETENTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Geotextiles.
2. Aggregate Layers.
3. Underdrainage Systems.
4. Drainage Overflow Structure.
5. Bioretention Soil Materials.
6. Stone Splash Pads.

B. Related Sections:

1. Section 31 05 17 – Aggregates for Storm Water Management.
2. Section 32 92 19 – Seeding**.**
3. Section 32 93 00 – Plants.
4. Section 32 93 90 – Green Infrastructure Maintenance.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M105 - Gray Iron Castings.

B. ASTM International:

1. ASTM D75 - Standard Practice for Sampling Aggregates.
2. ASTM D1883 - Standard Test Method for California Bearing Ration (CBR) of Laboratory Compacted Soils.
3. ASTM D4791 - Standard Test Method for Flat Particles, elongated Particles, or Flat and Elongated particles in Coarse Aggregate.
4. ASTM D5821 - Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
5. ASTM D5856 - Standard Test Method for Measurement of Hydraulic Conductivity of Porous Material using a Rigid Wall Compaction Mold Permeameter.
6. ASTM D2729 - Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
7. ASTM D3034 - Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.

1.3 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Aggregates: Prior to delivery of aggregates, the supplier must provide the following certificates:

1. Location of material source.
2. That stone is double washed.
3. Test results for gradation, smoothness, and percentage of wear.

C. Aggregate Samples: Prior to delivery of aggregates, take at least one initial sample in accordance with ASTM D-75. Collect each sample by taking three incremental samples at random locations from source material to make a composite sample. Repeat sampling procedure when source of material is changed or when deficiencies or variations from specified grading of materials are found in testing.

D. Stone Aggregates: Coarse aggregate used in the construction of the storage reservoir of bioretention systems shall be clean, double washed stone, defined as maximum wash loss of 0.5% when tested with AASHTO T-11. At least fourteen (14) working days before construction, the Contractor shall submit to Engineer for approval the product certificate including the AASHTO T-11 test results and gradation for the stone. AASHTO #3, AASHTO #5, and AASHTO #57 stone are acceptable gradations for the crushed stone reservoir.

E. Pea Gravel: Pea gravel used as the choker layer between the bioretention soil and the reservoir layer. Pea gravel is also used as the filter layer between the subgrade and the reservoir layer is meant to replace the need for geotextile. No geotextile fabric shall be used as horizontal separation at any level within bioretention systems. The pea gravel used in the construction of the storage reservoir of bioretention systems shall be clean, double washed stone, defined as maximum wash loss of 0.5% when tested with AASHTO T-11. At least fourteen (14) working days before construction, the Contractor shall submit to Engineer for approval the product certificate including the AASHTO T-11 test results and gradation for the stone. AASHTO #8 stone is the acceptable gradation for the filter layer.

F. Soil Samples: Submit, in air-tight containers, 5 lb. sample of each type of Bioretention Soil to testing laboratory.

G. Materials Source: Submit name of imported materials source.

H. Topsoil: Prior to delivery of topsoil, the supplier must provide the location where topsoil was originally harvested along with results of topsoil analysis and written recommendations by an independent laboratory or university laboratory recognized by the State Department of Agriculture with the experience and texting capability to conduct the topsoil testing indicated below.

I. Topsoil samples analyzed must be obtained for analysis from source location no earlier than ninety (90) days prior to the beginning of construction. Testing methods and written recommendations shall comply with USDA's Handbook No. 60 and shall include the following:

1. Percentages of organic matter as conducted in conformance with ASTM D2974 (loss on ignition test).
2. USDA gradation of sand, silt and clay content.
3. Cation exchange capacity (CEC).
4. Nutrient levels by parts per million including phosphorous, potassium, magnesium, manganese, iron, zinc, and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil for optimum growth of the plants specified.
5. Deleterious material.
6. Soluble Salt Content.
7. pH, buffer pH, and recommendations to obtain optimal pH factor.

J. Compost: At least fourteen (14) working days in advance of construction and before delivery of compost, Contractor must submit the following to the Engineer for approval:

1. Sample: A 1-gallon sample of compost that represents composed to be used on actual project in a sealed plastic bag.
2. Technical data sheet showing the following:
   a. Feedstock percentage in the final compost product.
   b. A statement that the compost meets federal and state health and safety regulations.
   c. A compost technical data sheet from the vendor of the compost. The analysis and report must be consistent with the sampling and reporting requirements of the US Composting Council Seal of Testing Assurance (STA) program as described herein and must demonstrate that the compost meets the physical requirements specified in Table 31 24 00-7 of this specification. The date of analysis shall be no more than ninety (90) calendar days prior to the date of submittal.

K. Engineered Bioretention Soil: Prior to delivery of the engineered bioretention soil mixture, the supplier must provide the following documentation to the Engineer for approval:

1. Results of the analysis on final engineered bioretention soil mixture, and written report by a qualified soil testing laboratory with the experience and testing capability to conduct the bioretention soil testing indicated below.
2. Particle gradation analysis as conducted in conformance with ASTM C117/C136 (AASHTO T11/T27). The gradation of the mixture shall meet the following gradation criteria using sieve sizes listed in the table below:

Table 31 24 00-1: Gradation Criteria

Sieve Size	Percent Passing
1 inch	100
#4	75-100
#10	40-100
#40	15-50
#100	5-25
#200	3-6

3. Percentages of organic matter as conducted in conformance with ASTM D 2974 (loss on ignition test), pH, and buffer pH.

L. Drainage and Erosion Control Geotextiles: Product certificates and manufacturer's information.

1.4 QUALITY ASSURANCE

A. Furnish each Bioretention material from single source throughout the Work.

B. Maintain one copy of certificates and documents on-site.

PART 2 - PRODUCTS

2.1 UNDERDRAINS AND APURTENANCES

A. PVC (perforated or non-perforated as specified in the Contract Drawings) shall be Schedule 40 for underdrains and pipe risers complying with ASTM F758.

1. Perforation Hole Size: 3/8" diameter.
2. Perforation Hole Spacing: 3" (+/- 1/4").

B. HDPE for underdrain pipe along curves, as indicated on the Contract Drawings.

C. Frame and Cover:

1. EJ Model V1610/V3610;
2. Neenah Item No. R-1792;
3. Or approved equal.

D. Screw Cap: Shall be threaded PVC with 2-inch square lug.

E. Cleanout: The Cleanout cover assembly in pavement shall be cast iron and have an adjustable housing with scoriated cast iron cover as indicated in the Contract Drawings.

F. Observation Well: 2-inch well test plug using EnviroTech Ergo Grip or approved equal with tethering eyelet.

G. Backflow Valve: Required between underdrain system and combined sewer connection. Shall be a backflow flapper Flex PVC Item No. S675P or approved equal.

H. Anti-Seep Collar: A waterproof collar required between bioretention system and connections to combined sewer system. Anti-seep collar is a water barrier that attaches to storm water conveyance pipe or underdrain. It is used to prevent water from traveling between a storm water

storage area to a combined sewer pipe through newly trenched and backfilled soils. Acceptable materials for anti-seep collar shall include HDPE or approved equal as indicated on Drawings.

I. Domed/Beehive Grate: To be used on the top of an emergency overflow drain. 12 to 30-inch diameter domed grate made of Cast Iron or Ductile Iron as shown on the Contract Drawings.

2.2 AGGREGATE LAYERS

A. Coarse aggregate shall be of the types designated in Contract Documents, and shall consist of clean, tough, durable fragments of crushed stone, or crushed gravel, conforming to the gradations in the following tables and shall also meeting the following:

1. Be double washed, sufficient to remove dust and other coatings, and defined as meeting <0.5 % wash loss when tested with AASHTO T-11.
2. Be free from clay balls, organic matter, and other deleterious substances.

Table 31 24 00-2: Gradation for Base Courses

Choker Layer	Bioretention Storage/Drainage Layer	Filter Layer
AASHTO No. 8	AASHTO No. 3, No. 5 or No. 57	AASHTO No. 8

Table 31 24 00-3: Crushed Stone Gradation Requirements for AASHTO #57

U.S. Standard Sieve Size	Percent Passing
1 ½” (37.5 mm)	100
1" (25 mm)	95-100
½" (12.5 mm)	25-60
No. 4 (4.75 mm)	0-10
No. 8 (2.36 mm)	0-5

Table 31 24 00-4: Gradation Requirements for AASHTO #5

U.S. Standard Sieve Size	Percent Passing
1 ½” (37.5 mm)	100
1" (25 mm)	90-100
¾” (19 mm)	20-55
½” (12.5 mm)	0-10

Table 31 24 00-5: Gradation Requirements for AASHTO #3

U.S. Standard Sieve Size	Percent Passing
2 ½" (63 mm)	100
2" (50 mm)	90-100
1 ½" (37.5 mm)	35-70
1" (25 mm)	0-15
½" (12.5 mm)	0-5

3. The Choker Layer and Filter Layer Courses: Pea Gravel to be used between the planting soil and reservoir course layer for bioretention systems shall be a clean, double washed pea gravel following AASHTO No. 8 gradation.

Table 31 24 00-6: Gradation requirements for AASHTO #8

U.S. Standard Sieve Size	Percent Passing
½" (12.5 mm)	100
⅜" (9.5 mm)	85-100
No. 4 (4.75 mm)	10-30
No. 8 (2.36 mm)	0-10
No. 16 (1.16 mm)	0-5

2.3 EXPANDED SHALE

A. Expanded shale aggregate may be used in the aggregate layers of bioretention areas to achieve higher performance removal of nutrients and pollutants, as long as the gradation for each layer meets the required values included in this specification. Expanded shale products may be Haydite as available from DiGeronimo Aggregates, LLC or approved equal.

2.4 ENGINEERED BIORETENTION SOIL

A. The engineered bioretention soil shall consist of a mixture containing the soil components and amendments listed below. The engineered bioretention soil shall be thoroughly mixed off site at a clean location. The material shall be well mixed, homogenous, loose friable, have no visible free water, and be free of wood pieces, plastic and other foreign matter. The soil mixture shall be protected from all sources of contamination, including weed seeds, while at the supplier, in conveyance and at the project site.

B. The soil mixture shall, with the addition of approved amendments, meet the following criteria:

1. Final organic matter content between 10 and 20 percent.
2. pH of 5.5 to 7.0.

3. Consist of a blend of the following components by volume:
    a. 60% Sand.
    b. 20% Topsoil / Loam.
    c. 10% Compost.
    d. 10% Shredded Wood.

C. Sand: Clean Natural Sand 2NS in accordance with the Aggregates section of the current MDOT Standard Specifications for Construction.

D. Topsoil/Loam:

1. Shall be free of subsoil, stones 1-inch or larger in any dimension, dense material, hardpan, slag, clay, cinders, sod, roots, sticks, poison ivy, crabgrass, cough grass, noxious weeds, and foreign matter including but not limited to glass, screws, asbestos, toxins, hazardous wastes, petroleum product contamination, lead and chemicals (such as atrazine and muriatic acid) that may be injurious to humans, animals and plant material.
2. Topsoil / Loam shall have a pH of 5.5 to 7.0, soluble salt content not to exceed 500 parts per million, and shall be composed of approximately 10% sand, 40% silt, 40% clay, with not more than 10% organic matter.

E. Compost:

1. Compost must be mature/stabilized, humus like material aged twelve (12) months and shall be the result of biological degradation and transformation under conditions designed to promote aerobic decomposition. The compost must have a dark brown or black color, be capable of supporting plant growth with ongoing addition of fertilizers or other soil amendments, must not have an objectionable odor and be stable with regard to oxygen consumption and carbon dioxide generation.
2. Compost feedstock may include, but is not limited to: agricultural, food, or industrial residuals, class A biosolids, as defined in the EPA CFR, Title 40, Part 503; yard trimmings, source separated municipal solid waste, or other material designated compostable as defined 1994 PA 451, Part 115 and must be in compliance with all federal and state laws.
3. Compost must be free of plastic, glass, metal and other physical contaminants, substances toxic to plants, over 5% sand, silt, clay, or rock, material by dry weight, as well as viable weed seeds and plant parts capable of reproducing (except airborne weed species).
4. The product must meet all applicable US EPA CFR Title 40, Part 503 Standards for Class A biosolids. The compost moisture content must be such that no visible free water or dust is produced when handling it. The preferred range of moisture content for finished compost is 40-50 percent.

Table 31 24 00-7: Compost Requirements

Parameters	Reported as (units of measure)(a)	Range (b)
pH	pH units (TMECC 04.11-A)	6.0 - 8.5
Soluble Salt Concentration *(electrical conductivity)*	dS/m (mmhos/cm) (TMECC 04.10-A)	maximum 5
Moisture Content	%, wet weight basis (TMECC 03.09-A)	30 – 60
Organic Matter Content	%, dry weight basis (TMECC 05.07-A)	30 – 65
Medium Grade Particle Size *(aggregate size)*	% passing a selected mesh size, dry weight basis (TMECC1 02.02-B)	2-inch 100% 1-inch 90% minimum ¾-inch 65% minimum ¼-inch 50% maximum
Fine Grade Particle Size *(aggregate size)*	% passing a selected mesh size, dry weight basis (TMECC1 02.02-B)	¾-inch or smaller 98% minimum
Stability Carbon Dioxide Evolution Rate	mg CO_2 -C per g OM per day (TMECC 05.08-B)	< 8
Maturity Seed Germination	%, compared to control (TMECC 05.05-A)	≥ 80%
Trace Elements/Heavy Metals	ppm (mg/kg) on dry weight basis (TMECC 04.06):	Meets or exceeds US EPA Part 503 EQ Concentration Limits
Arsenic	ppm (mg/kg) on dry weight basis (TMECC 04.06):	< 41
Cadmium	ppm (mg/kg) on dry weight basis (TMECC 04.06):	< 39
Copper	ppm (mg/kg) on dry weight basis (TMECC 04.06):	< 1,500
Lead	ppm (mg/kg) on dry weight basis (TMECC 04.06):	< 300
Mercury	ppm (mg/kg) on dry weight basis (TMECC 04.06):	< 17
Molybdenum	ppm (mg/kg) on dry weight basis (TMECC 04.06):	< 75
Nickel	ppm (mg/kg) on dry weight basis (TMECC 04.06):	< 420
Selenium	ppm (mg/kg) on dry weight basis (TMECC 04.06):	< 100
Zinc	ppm (mg/kg) on dry weight basis (TMECC 04.06):	< 2,800
Pathogens	MPN/4 grams or MPN/gram of total solids (TMECC 07.01-B)	Salmonella < 3 MPN/4 grams of total solids or Fecal Coliform <1000 MPN/gram of total solids
Inert contamination (man-made)	%, dry weight (TMECC 03.08-A)	< 1.0%(no visible plastic, glass or metal allowed)

a. Based on Test Methods for the Examination of Composting and Compost (TMECC) standard listed.
b. In the event that the requirements of any of the referenced standards and specifications conflict with each other, the more stringent requirement shall prevail.

2.5 GEOTEXTILES

A. Drainage Geotextile: For use as a soil separator. Nonwoven needle punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent meeting the requirements below:

1. Apparent Opening Size: No. 70 to 100 sieve, maximum ASTM D 4751.
2. Minimum Grab Tensile Strength: 200 lb.; ASTM D4632.
   Minimum Weight: 6 oz./sq. yd.

B. Erosion Control Geotextile: For use on side slopes to prevent surface erosion. Biodegradable Erosion Control Blanket (ECB) manufactured to provide erosion control and vegetation establishment. Includes manufacturer's anchoring system.

1. Woven lightweight jute or coconut fiber material.
2. Square matrix with 45-65 percent open area.
3. 100% Biodegradable.
4. Longevity: 1 to 2 years.
5. Product must be recommended for seeding and planting both before and after ECB installation.

2.6 TEMPORARY EROSION CONTROL SEED

A. Definition: A nurse or cover crop seed used to stabilize the soil surface to help mitigate erosion. Temporary erosion control seed should only be installed when finish grading occurs outside of the allowable planting/seeding period. Temporary erosion control seed may also be incorporated into the permanent seed mix if indicated on Drawings.

B. Product: Regreen

1. Short-lived (2-3 year) sterile hybrid species that is a cross between annual wheat and perennial wheatgrass. This product will not reseed itself and compete with species in permanent seed mix.
2. Seeding rate: 10 pounds per acre.

2.7 COBBLESTONE

A. Provide cobblestone in accordance with the Aggregates section of the current MDOT Standard Specification for Construction.

PART 3 - EXECUTION

3.1 OBSERVATION OF THE WORK

A. The Engineer shall be informed of the progress of the work so that the work may be observed at key critical stages of construction including completion of excavation and subgrade work, completion of installation of geotextile and double washed stone aggregate (crushed stone and pea gravel) and installation of planting soil. The Engineer shall be afforded a minimum of three (3) working days' notice to schedule visits to the site. Failure of the Engineer to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

3.2 SUBGRADE SOIL COMPACTION

A. It is very important to minimize compaction of both the base of the bioretention area and of the side-slopes of the excavation. Operate equipment adjacent to, and not within the footprint of the bioretention areas whenever possible. Equipment operation within the facility should be avoided to prevent soil compaction. If machinery must operate in the facility, use lightweight, low ground contact pressure equipment (no more than 4 psi) and ensure that existing ground infiltration rate has not been reduced as a result.

B. Use of equipment with narrow tracks or narrow tires, rubber tires with large lugs, or high-pressure tires will cause excessive compaction resulting in reduced infiltration rates and is not acceptable. Improper compaction will significantly contribute to design failure.

C. Compaction can be alleviated at the base of the bioretention areas by using a primary tilling operation such as a chisel plow, ripper, or subsoiler. These tilling operations are to refracture the soil profile through the 24-inch compaction zone. Substitute methods must be approved by the Engineer. Rototillers typically do not till deep enough to reduce the effects of heavy equipment.

D. No storage of equipment, materials, debris, or any other items shall be allowed in the areas designated as bioretention areas on the Drawings for any length of time.

E. Excavation or placement of material will not be allowed if any portion of the bioretention area is wet or saturated or has been subjected to more than ½ inch of precipitation within 48 hours prior to the proposed construction activities. The Engineer shall have final authority to determine if wet or saturated conditions exist.

3.3 EXCAVATION

A. Excavation:

1. Excavate bottom of bioretention areas to the depth shown on the Drawings. Do not use heavy equipment within any area designated as a bioretention area shown on the Drawings. The existing native subgrade material under all bed areas shall NOT be compacted or subject to excessive construction equipment traffic prior to stone bed placement.
2. Rototill or scarify surface of subgrade to a depth of 6 inches with the teeth of the backhoe or loader bucket, or other suitable device. Bring subgrade to line, grade, and elevations indicated. Fill and lightly regrade any areas damaged by erosion, ponding, or traffic compaction before the placing of the geotextile fabric.

3.4 UNDERDRAIN SYSTEMS

A. Perforated pipes. Minimum 6-inch size underdrain shall be placed with perforations down. Pipe shall be placed with the bell end on the upstream portion of the pipe. Pipe sections shall be joined with appropriate couplings. All terminal ends of underdrain pipe shall have cleanouts accessible from the surface for inspection and flushing.

B. Risers for Cleanouts/Observation Wells. Provide PVC slotted well casing, with well point, extending twelve inches into subgrade to match size of underdrain pipe. .

C. Provide screw cap covers. Covers shall be set 6 inches above final grade. Connect riser to underdrain pipe.

D. Backflow Preventer assembly to be located per the plans and as directed by the Engineer at a location upstream of proposed sewer field connection yet downstream of perforated underdrain pipe. Provide PVC riser pipe to protect PVC access sleeve pipe. Connect assembly to underdrain piping, using the appropriate reducer and tee fittings.

E. Anti-Seep Collar: Install anti-seep collars as per Drawings.

1. Anti-seep collars shall be installed at transitions between storm water storage areas and surrounding soils as depicted on the Drawings, or as directed by Engineer. Geotextile or impermeable liners in place at the interface shall be minimally cut to allow for the pass-through section and then sealed within the joint between the solid external sheets of the anti-seep collar. All fittings and seals shall be installed to manufacturer's specifications for a watertight seal.
2. All collars projecting from the side of the joint shall be protected from damage during construction and be free from defects. All waterstops shall be placed in the center of the joint, with 1/2 of the waterstop on each side of the joint.

3.5 OVERFLOW STRUCTURE

A. Provide domed risers for bioretention facilities as indicated in the Contract Drawings. Top of riser shall be set as specified in the Contract Drawings for ponding depth and a minimum of three (3) inches below adjacent sidewalk or top of curb. Connect riser to underdrain piping using the appropriate reducer fittings, tees, and/or elbows.

3.6 AGGREGATE LAYERS

A. Inspection: The contractor shall notify the engineer a minimum of seven (7) days prior to aggregate placement work to inspect the preparation of subgrade. The Engineer shall examine the site conditions and provide written approval that design conditions and elevations have been met.

B. Prior to aggregate installation the Contractor shall do the following:

1. Verify subgrade preparation, elevations, steepness of side slopes, basin dimensions and placement, overflow structure rim and invert elevations.
2. Do not install aggregates in overly wet conditions or when wet weather is anticipated within two (2) days.
3. Clean all construction debris and sediment within the placement area.

C. Immediately after approval of the subgrade, place geotextile along the sides of the excavation. Any accumulation of debris or sediment which has taken place after approval of subgrade shall be removed prior to installation of geotextile or aggregate at no extra cost to the Owner.

D. Install coarse aggregate (crushed stone and pea gravel) in lifts no greater than 8-inches. Lightly compact each lift with equipment, keeping equipment movement over storage bed subgrades to a minimum. Install aggregate to grades indicated on the Contract Drawings. Following placement of bed aggregate, the geotextile along the sides of the excavation shall be folded back along all bed edges to protect from sediment washout along bed edges. At least a four-foot edge strip shall be used to protect the filter bed from adjacent bare soil. This edge strip shall remain in place until all bare soils contiguous to beds are stabilized and vegetated. In addition, take any other necessary steps to prevent sediment from washing into beds during site construction.

E. Make adjustments in placing procedures or equipment to obtain true grades, minimize segregation and degradation to reduce or increase water content, and ensure a satisfactory aggregate base course.

3.7 PROTECTION

A. Runoff Control: Construction site runoff from disturbed areas shall not be allowed to enter the bioretention basins during construction. Contractor shall use sediment control measures and flow diversions as necessary to prevent construction site runoff from entering the bioretention basins during any of the construction phases until the bioretention system is finalized and stabilized.

B. Contractor shall not construct bioretention basins until all contributing drainage areas are stabilized to the satisfaction of the Engineer. Do not use the bioretention basins as temporary sediment control facilities during construction. Any sediment that enters the bioretention basins during construction shall be removed by the Contractor at no cost to the Owner. The double washed aggregate used within the bioretention system shall remain free of sediment.

3.8 BACKFILLING

A. Bioretention Soil: Place Engineered Bioretention Soil in 8" lifts over all areas designated as bioretention areas. Compact soil to a maximum of 75- 85% Proctor density according to ASTM D698. Compaction can be obtained by lightly tamping with bucket as necessary. Test planting soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D698.

B. Soil media will be considered defective if it does not pass tests and inspections and should be replaced or restored as directed by Engineer. Place soil with equipment located outside the bioretention excavation. No equipment shall be allowed to drive across installed locations. Any soil observed being driven on may be subject to removal and reinstallation at Contractor's own expense. Contractor shall gain approval from Engineer of installation method prior to beginning installation. Contractor shall provide three (3) working days' notice to Engineer prior to beginning installation.

C. Final Grading: Grade bioretention soil media to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. Stabilize in accordance with applicable local regulatory requirements. Avoid erosion of bioretention areas from overwatering, foot traffic, or machine compaction. Repair any damaged areas and areas that have the potential to cause erosion or have caused erosion at no cost to the Owner.

D. Stone Splash Pads: Install splash pad at all pipe or surface inlet locations as indicated on the Drawings.

E. Topsoil: Install topsoil per seeding specification on side slopes. Do not place topsoil over the bioretention soil.

F. Temporary Erosion Control Seeding: If final grading occurs outside of the recommended planting period, seed entire bioretention basin with temporary erosion control seed mixture as per seeding specification. Irrigate daily until vegetation germinates.

G. Erosion Control Geotextile: Install erosion control geotextile on all regraded side slopes surrounding all bioretention areas. Install geotextile immediately after finish grading is complete. Install geotextile per manufacturer's instructions.

H. Permanent Seeding: Seed as per plans and seeding specification during the designated spring or fall planting period.

I. Planting: Plant as per plans and plants specification during the designated spring or fall planting period. Protect all slopes and bottom surfaces of bioretention areas from erosion and rutting until planting can be completed. Bioretention areas shall have a minimum vegetation coverage of 75% where container plants are used.

J. Refer to Specification Section 32 93 00 - Plants for additional planting and mulching requirements.

3.9 TOLERANCES

A. Comply with Section 01 40 00 - Quality Requirements.

B. Finish Grades: Plus or minus 1/2-inch.

C. Overflow Riser Elevation: Plus or minus 1/2-inch.

3.10 TESTING AND ACCEPTANCE

A. When construction is complete, the Contractor shall test all completed underdrain systems for continuous, unimpeded flow.

1. Suggested test methods for each pipe run are as follows:
   a. At highpoint or upstream end of underdrain pipe, open cleanout and insert hose from water source.
   b. Turn on water.
   c. Acceptance pipe run consists of free flow of water through the drain outlet into the existing storm sewer system.

2. Any sections of the underdrain that are clogged or crushed shall be replaced or repaired at the Contractor's expense.
3. Installed work shall be reviewed and approved by Engineer, for acceptance.

3.11 PROTECTION OF INSTALLED WORK

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Prohibit construction traffic over topsoil.

END OF SECTION 31 24 00

SECTION 31 37 16.13 - RUBBLE-STONE RIPRAP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Riprap placed loose and grouted.

B. Related Requirements:

1. Section 31 23 33 – Trenching and Backfill
2. Section 33 42 13 – Stormwater Culverts

1.2 COORDINATION

A. Comply with Section 01 30 00 – Administrative Requirements.

1.3 SUBMITTALS

A. Submittal Requirements: Comply with Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit information regarding size distribution and types for rock for riprap.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. Submit analysis from an independent laboratory showing specific gravity, absorption, and durability of stone.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout Work of this Section.

B. Perform Work according to Michigan Department of Transportation (MDOT) Standard Specifications for Construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stone for riprap shall be quarry stone, well graded and angular. Stone shall be of such shape as to form a stable protection for the required section. Do not use flat or elongated shapes unless the thickness of the individual pieces is at least one-third the length. Material shall be clean and free from deleterious impurities including alkali, earth, clay, refuse, and adherent coatings.

B. Furnish materials according to MDOT Standard Specifications for Construction.

1. Grouted Riprap:
   a. MDOT type R3 or equal.
   b. Mortar.

2.2 QUALITY CONTROL OF STONE

A. Visual evaluation of the quarry, including examination of blast samples and diamond drill core samples and suitable tests and service records, may be used to determine the acceptability of the stone. Notify the Owner in writing of the intended source of stone at least 60 days prior to use.

B. To determine the required quality the contractor will provide specific gravity, absorption, and durability tests of stone as follows:

Test	Test Method	Requirement
Apparent Specific Gravity	AASHTO T85	2.50 minimum
Absorption	AASHTO T85	4.2% maximum
Durability	ASTM D3744	52 minimum

Based on the formula below, absorption may exceed 4.2% if the durability absorption ratio (DAR) is greater than 10. Durability may be less than 52 if DAR is greater than 24.

$$DAR = \frac{\text{Coarse Durability Index}}{\text{\% Absorption} + 1}$$

2.3 RUBBLE FOR RIPRAP

A. Rubble shall consist of broken concrete or of broken stone. Broken stone shall conform to the following requirements: The material shall be sound and durable, with a specific gravity of at least 1.90. It shall be free of cracks, soft seams, and other structural defects. The pieces shall be roughly angular and shall be reasonably free from thin flat or elongated pieces. Do not use flat or elongated shapes unless the thickness of the individual pieces is at least one-third the length.

B. Rubble shall be of a graded mixture, with individual pieces weighing, in general, from 20 to 300 pounds each. Not over 25% of the total volume shall be composed of pieces weighing less than 50 pounds each and at least 50% of the total volume shall be composed of pieces weighing 100 pounds or more.

PART 3 - EXECUTION

3.1 APPLICATION

A. Grade areas to a smooth surface.

B. Place geotextile fabric over substrate as specified on the Drawings.

C. Place riprap where indicated on Drawings.

D. Place riprap into position and remove foreign material from surfaces.

E. Do not place riprap over frozen or spongy subgrade surfaces. Place the riprap to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material.

F. Grouted Riprap:

1. The spaces between the stones shall be filled with MDOT type R3 or equal.
2. Mortar shall be placed from bottom to top and sufficient mortar shall be used and worked with suitable tools to completely fill all voids, except that the face surface of the stone shall be left exposed. Any excess mortar shall be removed with a stiff brush.

G. Average Installed Thickness:

1. Plain Riprap: 8 inches.
2. Grouted Riprap: 8 inches.
3. Heavy Riprap: 16 inches.

END OF SECTION 31 37 16.13

SECTION 31 41 16 - SHEET PILING

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes steel sheet piling for following:

1. Retaining Walls.
2. Weirs.
3. Caissons.
4. Cofferdams.
5. Bulkheads.

B. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete.
2. Section 31 50 00 – Excavation Support Systems.

1.2 STANDARDS

A. American Welding Society (AWS):

1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

B. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
4. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
5. ASTM A328/A328M - Standard Specification for Steel Sheet Piling.
6. ASTM A385/A385M - Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
7. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
8. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
9. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
10. ASTM A588/A588M - Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance.

11. ASTM A690/A690M - Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments.
12. ASTM A857/A857M - Standard Specification for Steel Sheet Piling, Cold Formed, Light Gage.
13. ASTM A913/A913M - Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST).
14. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
15. ASTM E376 - Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods.
16. ASTM F436 - Standard Specification for Hardened Steel Washers.

C. The Society for Protective Coatings (SSPC):

1. PA-1: Shop, Field, and Maintenance Painting of Steel.
2. PA-2: Measurement of Dry Paint Thickness with Magnetic Gauges.
3. SP-5: White Metal Blast Cleaning.
4. SP-6: Commercial Blast Cleaning.
5. Paint-16: Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint.

D. Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29: Subpart P - Excavations, Trenching and Shoring.

1.3 COORDINATION

A. Coordinate Work of this Section with earthwork, foundation, utility, and other associated Construction.

1.4 PRE-INSTALLATION MEETINGS

A. Convene minimum two (2) weeks prior to commencing Work of this Section.

1.5 SCHEDULING

A. Schedule Work of this Section to perform driving during hours of 8 AM and 5 PM, unless otherwise approved by Owner and Engineer.

B. Preconstruction Survey: Inventory and record the condition of adjacent structures, underground utilities, and other construction. The survey shall include photographs, drawings and measurement, as appropriate. Document conditions that might be misconstrued as damage caused by pile driving.

C. Schedule sheet-piling submittals sufficiently in advance of preinstallation meeting to ensure that Engineer's review has been completed.

1.6 SUBMITTALS

A. Product Data:

1. Submit material certification, details of sheet piling, mill test reports, piling driving equipment certification, and interlocking joint strength test procedure.
2. Submit manufacturer information for joint sealants.
3. Submit manufacturer data sheets about cranes and driving equipment.

B. Shop Drawings:

1. Indicate location and extent of sheet piling, details of top protection, tip reinforcement, splices, cutoff method, and corrosion protection details. Indicate welds by standard American Welding Society (AWS) symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
2. Indicate complete dimensions and details of sheet-piling sections.
3. Indicate sequence of driving and detailed drawings of templates or other temporary guide structures.
4. Indicate proposed procedures for removing driven sheet piling.
5. Indicate size of proposed equipment including cranes, barges, driving equipment, extractors, protection caps, and other installation and removal accessories.
6. Indicate detailed procedures and features for protection of existing structures or other installations.

C. Contingency Plans: Detailed procedures to remove major obstructions.

D. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous twelve (12) months.

E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions to support Contractor's sheet-piling design.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.
3. Welders: Qualify procedures and personnel according to AWS D1.1/D1.1M.

H. Mill Certificates for all Contractor supplied steel.

I. Pile-Driving Records: Submit within three days of driving each pile.

J. Baseline measurements and vibration reports as described in this specification.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five (5) years documented experience.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in the State of Michigan.

D. Welders: AWS qualified within previous twelve (12) months for employed weld types.

1.8 QUALITY ASSURANCE

A. Perform welding according to AWS D1.1/D1.1M.

B. Furnish each type of sheet piling from single source.

1.9 PROTECTION OF EXISTING STRUCTURES

A. Monitor the effect of piling operations on adjacent existing structures and utilities. Assess condition of structures and utilities and take necessary precautions to protect structures and utilities.

B. Monitor vibration levels at adjacent structures and utilities during driving. Perform baseline measurements at least one (1) week prior to start of driving operations. Retain services of a vibration consultant to develop monitoring program and analyze/report results. Do not exceed a vibration limit of 2 in/sec peak particle velocity. Vibration monitoring results shall be submitted daily to the Engineer. Modify driving operations if measured vibration levels exceed threshold limits.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver sheet piling with manufacturer's logo and mill identification mark on each sheet piling.
2. Inspect for damage.

B. Handling:

1. Use handling holes or lifting devices to prevent damage.
2. Lift sheet piling in a manner to prevent permanent deformation.

C. Storage:

1. According to manufacturer instructions.
2. Support on level racks spaced not greater than ten (10) feet apart, and not greater than 2 feet from ends.
3. Arrange supports for multiple lifts aligned vertically.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect sheet piling in a manner to prevent damage to coatings. Touch up damage to coatings before driving piles.
3. Provide additional protection according to manufacturer instructions.
4. Protect sheet piling with factory-installed joint sealant from exposure to water before installation.

1.11 FIELD CONDITIONS

A. Subsurface Conditions: A geotechnical report was prepared for this project and is available from Owner upon request. This data is being made available for the convenience of the Contractor, and represents only the conditions found at the locations, dates and times when the borings were performed. The data is not intended as a representation or warranty of continuity of subsurface conditions between soil borings. The Contractor shall verify and is responsible for all geotechnical information that it requires for construction. Additional test borings and other exploratory operations may be made by the Contractor at no cost to the Owner.

B. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

C. Protect structures, overhead and underground utilities, and other construction from damage caused by pile driving.

PART 2 - PRODUCTS

2.1 STEEL SHEET PILES

A. Structural Steel: ASTM A 572/A 572M, Grade 50 with sections as shown in the Drawings.

B. Interlock Strength: As indicated on Drawings.

2.2 MATERIALS

A. Splices and Other Fabricated Appurtenances:

1. Structural steel.
2. Splice Unit: Manufacturer's standard splice unit.
3. Headed Studs: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

B. Bolts, Nuts, and Washers:

1. Bolts:
   a. Comply with ASTM A307.
   b. Grade: A or B.

2. High-Strength Bolts: Comply with ASTM A325Type 1, unless otherwise shown on Drawings.

3. Nuts:
   a. Comply with ASTM A563.
   b. Type: Heavy hex.

4. Washers:
   a. Comply with ASTM F436.
   b. Type: 1.

C. Finishes: Where galvanizing is shown on Drawings, provide ASTM A123/A123M; hot-dip galvanized material.

D. Welding Materials:

1. Comply with AWS D1.1/D1.1M.
2. Type: As required for materials being welded.

E. Coating Materials: Comply with Paragraphs 1.2 C.1 thru 5 as appropriate.

2.3 JOINT SEALANTS

A. Two-component hydrophilic liquid-rubber sealant suitable for total immersion and capable of resisting 150-foothydrostatic head.

B. All sealants shall be pre-applied by Manufacturer unless otherwise approved by Engineer.

2.4 FABRICATION

A. Fabricate full-length piling to eliminate splicing during driving, with ends square, for sheeting used for staging purposes located upstream of the dam.

B. Sheet Piling and Specially Fabricated Sections:

1. Full length to eliminate splicing during driving, with ends square.
2. As indicated on Drawings.
3. Furnish standard pulling holes.

C. Tees, Wyes, Corners, and Cross Pieces:

1. Match sheet-piling sections.
2. Minimum Web Thickness: 1/2 inch.

D. Components to Receive Galvanized Coating: Comply with ASTM A385/A385M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that excavation is completed to working elevation, prior to pile driving.

B. Verify that equipment on Site complies with approved submittals.

C. Notify adjacent and affected land owners and building occupants minimum 14 days before proceeding with Work of this Section.

D. Verify that cranes will not affect overhead utilities.

E. Protect workers in all excavations in accordance with OSHA Standards and Regulations: Title 29.

F. Protect structures, including overhead and buried utilities, near the Work from damage.

G. Pre-Trenching: Prior to beginning pile driving activities perform test trench excavations along entire alignment of all permanent sheeting. Advance trenches minimum 18-inches wide and 8 ft deep. Remove obstructions identified within trenches prior to starting pile driving. Backfill trenches with excavation spoils generated, minus material that could obstruct pile driving.

H. Field Touchup of Sheet-Piling Coating:

1. Provide touchup system for repair of coating defects compatible with shop coating.
2. Before driving, touch up abraded surfaces in coating, and clean and touch up field welds.

3. Apply touchup coating to match shop coating in accordance with standards in Paragraphs 1.2 C.1 and C.2.

I. Leave permanent sheet piling in place as part of completed Work.

J. Remove temporary sheet piling when no longer required and remove from Site.

K. Mark each pile with horizontal lines at 12-inch intervals if using an impact hammer; if using a vibratory hammer: label the distance from pile tip at 5-foot intervals. Maintain markings on piles until driven.

3.2 DRIVING EQUIPMENT

A. Methods and equipment used in driving piles shall be subject to approval by the Engineer.

B. Templates: Provide template or driving frame suitable for aligning, supporting, and maintaining sheet piling in correct position during setting and driving.

1. Structural Frame: Sufficiently rigid to resist lateral driving forces.
2. Provide wood blocking to bear against webs of alternate sheet piling.
3. Provide outer restraints to prevent sheets from warping or wandering.
4. Provide visible markings on templates to verify correct sheet-piling location and direction.

C. Impact or vibratory hammers will be allowed, so long as they meet the requirements of this specification. Driving hammers shall be in good repair and operating condition and shall be capable of being operated at the manufacturer's rated number of blows per minute when driving piles, except when necessary to reduce the speed to avoid damage to the piles or adjacent structures. Contractor's driving operations shall not exceed threshold vibration values.

D. Hammer shall be of appropriate size/energy for driving sheet piles through the anticipated soil strata and to the elevations shown on the plans, without damaging them.

E. Use protective cap during driving to prevent damage to top of sheet piling.

F. Provide and maintain spill control equipment and supplies to contain and properly dispose of spilled fluids, lubricants, etc. Immediately remediate spills, and supply Engineer with records of any equipment spills or leaking equipment requiring cleanup.

G. Any equipment or methods that result in regular or repeated damage to piles during driving are detrimental to the final shape, alignment or verticality of the sheeting, or that creates excessive vibrations on and/or off property may be rejected by the Engineer. The Contractor will bear the cost of replacing damaged/rejected piles.

H. Use fixed leads to drive piles. Leads shall be of sufficient length that the use of followers is not necessary.

3.3 INSTALLATION

A. Alignment:

1. Maintain sheet piling vertical during driving.
2. Align top of sheet piling normal to driving force of piling, hammer, and leads, to minimize bowing of piling during impact of hammer ram.
3. If required, take corrective action to prevent observable impact bowing of piling at final driving resistance.

B. Piling Types:

1. Drive Z-type piling with male interlock forward or leading.
2. Drive Z- and U-type piling in pairs.

C. Sheet Piling:

1. Incrementally drive sheets or pairs of sheets such that tip of any sheet or pair is not more than 4 feet below adjacent sheet or pair.
2. For circular or other closed cofferdams, set all sheets in place before driving begins.
3. Jetting or predrilling of sheet piling is not permitted.
4. Drive sheet piling to minimum tip penetration and/or to driving resistance as indicated on Drawings.

D. Withdraw damaged or defective piles and piles that exceed driving tolerances and install new piles within driving tolerances.

E. Cut off tops of sheet piling to indicated elevations and prepare piling top to receive top finish construction as indicated on Drawings. Pile cut-offs shall become the property of the Contractor.

3.4 OBSTRUCTIONS

A. Prior to pile driving, remove surface and subsurface obstructions encountered, and any obstructions encountered during pre-trenching.

B. Minor obstructions: Should an obstruction stop the advancement of a pile, it will be classified as a minor obstruction unless the same obstruction also stops the advancement of a second pile adjacent to the first. No extra payment will be made for the removal of a minor obstruction.

C. Major obstructions are obstructions not classified as minor.

1. Immediately notify the Engineer if a major obstruction is encountered.
2. Demolition material, abandoned utilities, or other material or equipment placed by Contractor shall not be deemed a major obstruction.
3. Permanent work placed by the Contractor shall not be deemed a major obstruction.
4. Materials identified and removed as part of the pre-trenching operation shall not be considered obstructions.

3.5 WELDING AND SPLICING

A. Comply with AWS D1.1/D1.1M for shielded-metal arc welding.

B. Splicing of Sheet-Piling Sections:

1. Complete penetration butt weld unless otherwise indicated on Drawings.
2. Maintain full structural properties/capacity of pile across splice.

C. Use jig or alignment device during welding to maintain required shape and alignment.

D. When lifting holes are exposed on permanent sheeting, weld plates over each to close the opening and apply touch up coating on both sides.

E. Number, Type, and Location of Splices:

1. Not more than three splices for piles more than 100 feet long.
2. Not more than two splices for piles up to 100 feet long.
3. No splice closer than 25 feet from tip.

3.6 TOLERANCES

A. Location: 4 inches from location indicated after initial driving, and 6 inches after pile driving is completed.

B. Plumb: No greater than 0.5% out of plumb, measured when pile is aboveground in leads.

C. Alignment: Horizontal deviation no greater than 1 inch from the straight-line alignment or each straight-line segment shown on the drawings.

3.7 FIELD QUALITY CONTROL

A. Prepare test and inspection reports.

B. Inspection:

1. Inspect for imperfections in joint interlock capable of impeding installation.
2. Inspect for damage to shop coatings before installation.

C. Pile-Driving Records: Maintain a complete log of each pile length together with the driving log of same. Include the following information on logs:

1. Number of hammer blows per foot of pile penetration.
2. If vibratory hammers are used, time required to drive each 5 feet interval of the pile.
3. Final tip and top elevation of pile.

4. Location and description of obstructions encountered and description of removal/mitigation for obstruction.

D. Equipment Acceptance: Reject or repair damaged sheet-piling sections as required prior to installing.

3.8 DISPOSAL

A. Clean site and remove withdrawn piles and cutoff sections of piles from site, and legally dispose of from the Owner's property.

END OF SECTION 31 41 16

SECTION 31 50 00 - EXCAVATION SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The design, furnishing and installation of excavation support systems to maintain lateral support, prevent loss of ground, limit soil movements to acceptable limits and protect from damage existing and proposed improvements including pipelines, utilities, structures, roadways, railroads and other facilities.

B. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete.
2. Section 31 23 33 – Trenching and Backfill.

1.2 STANDARDS

Except as modified herein, comply with the following Standards:

A. American Concrete Institute (ACI):

1. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

B. ASTM International (ASTM):

1. ASTM A36 - Standard Specification for Structural Steel.
2. ASTM A416 - Standard Specification for Strand Steel, Uncoated Seven Wire for Prestressed Concrete.
3. ASTM A572 - Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel.
4. ASTM A615 - Standard Specifications for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
5. ASTM A722 - Specification for Uncoated High Strength Steel Bar for Prestressing Concrete.

C. American Wood Protection Association (AWPA) Standards:

1. P234 - Standard for Chromated Copper Arsenate Type C (CCA-C).
2. P50 - Standard for Fire Retardant FR-2 (FR-2).

D. American Welding Society (AWS):

1. AWS D1.1 - Structural Welding Code.

E. Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29: Subpart P - Excavations, Trenching and Shoring.

1.3 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Requirements:

1. Submit the following qualifications four (4) weeks prior to the construction:

   a. Qualifications of Contractor's excavation support system installer.
   b. Qualifications of Contractor's independent tieback testing if a tieback system is utilized.
   c. Qualifications of Contractor's excavation support system installation supervisor.
   d. Qualifications of vacuum excavation subcontractor if DMPs for utilities are utilized.

2. Submit an excavation support plan stamped and signed by a Registered Professional Engineer licensed in the State of Michigan at least two (2) weeks prior to start of the construction. Do not submit design calculations. The review will be only for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor remains responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include the following items as a minimum:

   a. Proposed excavation support system(s), details, location, layout, depths, extent of different types of support relative to existing features and the permanent structures to be constructed, and methods and sequence of installation and removal.
   b. Certificate of Design: Comply with certificate requirements in Section 01 33 00 – Submittal Requirements. Submit a certificate of design signed by the Registered Professional Engineer.
   c. A list of all design assumptions, including safety factors used for the excavation support system(s) and all lateral pressures used for each system.
   d. If utilizing a tieback system, include tieback installation procedures and criteria for acceptance of tiebacks for performance and proof tests. Submit the tieback testing results to the Engineer for information only.
   e. Requirements of dewatering during the construction.
   f. Minimum lateral distance from the edge of the excavation support system for use for vehicles, construction equipment, and stockpiled construction and excavated materials.
   g. List of equipment used for installing the excavation support systems.
   h. Monitoring schedule, installation procedures and location plans for vibration/noise monitoring, geotechnical instrumentation (deformation monitoring points and inclinometers) and observation wells/piezometers to monitor ground, excavation support system, adjacent structures and groundwater fluctuation during the entire construction period if required by the design.

3. Submit a Construction Contingency Plan specifying the methods and procedures to maintain excavation support system stability if the allowable movement of the adjacent ground and adjacent structures is exceeded.

4. Monitoring data within one (1) day of data collection from vibration and noise recording equipment, observation wells, and deformation monitoring points and offset lines if required by the design. Data shall include:

    a. Horizontal and vertical movements of geotechnical instruments and groundwater readings.
    b. New movements since the initial readings of the geotechnical instruments.
    c. Weekly summary in tabular and graphic form at the end of each week.
    d. A schematic plan of excavation and/or relevant construction activities at the time of monitoring.

5. For excavation support systems left in place, submit the following as-built information prior to backfilling and covering the excavation support systems:

    a. Survey locations of the excavation support systems, including coordinates of the ends and points of change in direction.
    b. Type of the excavation support system.
    c. Elevations of top and bottom of the excavation support systems left in place.

1.4 QUALITY ASSURANCE

A. Comply with Section 01 40 00 – Quality Requirements.

B. Comply with the requirements of the OSHA Standards and Interpretations: "Part 1926 Subpart P - Excavation, Trenching, and Shoring".

C. Construction operations shall comply with noise regulations provided in this Section.

D. If utilizing deformation monitoring points (DMPs) for utilities, vacuum excavation shall be performed by subcontractor having five (5) years of experience in non-destructive vacuum excavation methods for utilities.

E. Prepare design, including calculations and drawings, under the direction of a Professional Engineer registered in the state of Michigan and having the following qualifications:

1. Not less than ten (10) years of experience in the design of specific excavation support systems to be used.
2. Completed not less than five (5) successful excavation support system projects of equal type, size, and complexity within the last five (5) years.

F. Excavation Support System Installer's Qualifications:

1. Not less than three (3) year experience in the installation of similar types and equal complexity as the proposed system.
2. Completed not less than three (3) successful excavation support systems of similar type and equal complexity as the proposed system.

G. If utilizing a tieback system, employ an independent testing laboratory to test the tieback system with the following qualifications:

1. Be accredited by the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program.
2. Employ personnel conducting testing who are trained in the methods and procedures to test and monitor tieback systems of similar type and equal complexity, as the proposed system.
3. Have not less than five (5) years of experience in testing of tieback systems of similar type and equal complexity as the proposed system.
4. Have successfully tested at least three (3) tieback systems of similar type and equal complexity as the proposed system.

H. Install all excavation support systems under the supervision of a supervisor having the following qualifications:

1. Not less than five (5) years of experience in installation of systems of similar type and equal complexity as the proposed system.
2. Completed at least five (5) successful excavation support systems of similar type and equal complexity as the proposed system.

I. All welding shall be performed in accordance with AWS D1.1.

1.5 DESIGN CRITERIA

A. Furnish, install, and maintain excavation support systems for the protection of workers in trenches, and to support adjacent utilities and structures.

B. The requirement of specified excavation support systems in areas indicated on the drawings does not relieve the Contractor from the responsibility of furnishing and installing proper temporary excavation support systems in other areas.

C. Extraction of steel sheetpile wall, timber sheetpile wall, or solider piles are not permitted unless otherwise indicated, specified or approved by the Engineer.

D. Wherever the word "sheeting" is used in this section or on the contract drawings, it shall refer to any type of excavation support system specified except trench box.

E. Construction of the excavation support systems shall not disturb the existing structures or the completed proposed structures. Damage to such structures shall be repaired at Contractor's expense.

F. Adjacent structures are those that are bear upon soils above the proposed excavation depth and within a distance equal to twice the total depth of the excavation away from the closest edge of the excavation. Monitor and protect adjacent structures as specified and indicated.

G. Construction operations shall not exceed specified noise limits in the City of Detroit Code of Ordinances.

H. Correct any failure, damage, subsidence, upheaval or cave-ins resulting from improper installation, maintenance or design of the excavation support systems. Pay for all claims, costs, and damages that result from the Work performed at the Contractor's expense.

I. Design of excavation support systems shall meet the following minimum requirements:

1. Support systems shall be designed for earth pressures, hydrostatic pressure, equipment, temporary stockpiles, construction loads, roadways, railroads, and other surcharge loads.
2. Design a bracing system to provide sufficient reaction to maintain stability.
3. Limit movement of ground adjacent to the excavation support system to be within the allowable ground deformation as specified.
4. Design the embedment depth below bottom of excavation to minimize lateral and vertical earth movements and provide bottom stability. The toe of braced temporary excavation support systems shall not be less than 5 feet below the bottom of the excavation.
5. Design excavation support systems to withstand an additional 2 feet of excavation below proposed bottom of excavation without redesign except for the addition of lagging and/or bracing.
6. Maximum width of pipe trench excavation shall comply with Section 31 23 33 – Trenching and Backfill.
7. Do not cast permanent structure walls directly against excavation support walls.
8. The design location of the excavation support wall shall be determined such that the installed wall and bracing system components are all located outside the limits of the permanent structure. Construction tolerances (e.g., st. wall verticality) shall be considered in determining the plan location.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store sheeting and bracing materials to prevent sagging which would produce permanent deformation. Keep concentrated loads which occur during stacking or lifting below the level which would produce permanent deformation of the material.

1.7 PROJECT CONDITIONS

A. Subsurface Conditions: Refer to Section 31 23 33 – Trenching and Backfill.

B. For reference or information only: Where the Owner, Engineer, or their consultants have made investigations of subsurface conditions in areas where work is to be performed, such investigations were made only for the purpose of study and design. The conditions indicated by such investigations apply only at the specific locations of each boring or excavation at the time the borings or excavations were made. Where such investigations have been made, bidders or contractors may inspect the records to such investigations subject to and upon the conditions hereinafter set forth. The records of such investigations are not part of the contract and are shown solely for the convenience of the bidder or Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Steel: All soldier piles, wales, rakers, struts, wedges, plates, waterstop and accessory steel shapes shall conform to ASTM A36.

B. Steel Sheet Piling: ASTM A572, continuous interlocking type.

C. Timber Lagging Left in Place: Pressured treated per AWPA P23.

D. Tieback Tendons: Tieback tendons shall be high strength steel wire strand cables conforming to ASTM A416, or bars conforming to ASTM A722. Splicing of individual cables shall not be permitted.

E. Raker Ties: ASTM A615 Grade 60.

F. Cement Grout Materials and Admixtures for Tieback Anchorages: Grout cube strength shall be a minimum 3500 psi at 7 days and 5000 psi at 28 days.

G. Concrete: Section 03 30 00 – Cast-in-Place Concrete.

H. Tamping tools adapted for backfilling voids after removal of the excavation support system.

I. Provide specific trench box sizes for each pipe and utility excavation with structural capacity of retaining soil types as described in OSHA's 29 CFR Part 1926 Subpart P.

2.2 EQUIPMENT

A. A vibratory hammer shall be utilized for driving the sheet piling providing that such operations do not exceed vibration/noise requirements of the specifications. Impact hammer shall be utilized when vibratory hammer is unable to drive sheet piling to required depth and/or unable to meet vibration requirements. Do not exceed a vibration limit of 2 in/sec peak particle velocity.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the excavation support systems shall not commence until the related earth excavation and dewatering submittals have been reviewed by the Engineer with all Engineer's comments satisfactorily addressed.

B. Install excavation support systems in accordance with the excavation support plan.

C. If utilizing a tieback system, all performance and proof tests shall be conducted in the presence of the Engineer. Testing performed without the Engineer present is considered invalid. Repeat testing in the Engineer's presence at Contractor's expense.

D. Do not drive sheeting within 100 feet of concrete less than seven (7) days old.

E. Support excavations in such a manner as to prevent undermining or disturbing foundations of existing structures of Work ongoing or previously completed.

F. Bottom of the trench box excavation support system shall be above the pipe invert prior to installing the pipe.

G. Install and read geotechnical instrumentation in accordance with the excavation support plan. Notify the Engineer immediately if any geotechnical instrumentation is damaged. Repair or replace damaged geotechnical instrumentation at the sole option of the Engineer and at Contractor's expense.

H. Continuously monitor movements of the ground adjacent to excavation support systems and adjacent structures. In events of the measured movements approaching or exceeding the allowable movements, take immediate steps to arrest further movement by revising procedures such as providing supplementary bracing, filling voids behind the trench box, supporting utilities or other measures (Construction Contingency Plan).

I. Notify utility owners if existing utilities interfere with the excavation support system. Modify the existing utility with the utility owner's permission or have the utility owner make the modifications at Contractor's expense.

3.2 GROUND DEFORMATION ADJACENT TO EXCAVATION SUPPORT SYSTEMS

A. Allowable Vertical (heave/settlement) and Lateral Movements: 2 inches maximum for the trench box excavation support system, and 1 inch maximum for other types of excavation support systems at any location behind the excavation support system.

B. Monitoring personnel shall use a procedure for reading and recording geotechnical instrumentation data which compares the current reading to the last reading during data collection to eliminate spurious readings.

C. Plot the observed ground deformation readings versus time. Annotate the plots with construction loading and excavation events having an impact on the readings. Evaluate plots by means of secondary rate-of-change plots to provide early warning of accelerating ground movements.

D. Notify the Engineer when the allowable ground deformation is exceeded.

E. Implement Construction Contingency Plan under direction of the temporary excavation support system designer and the Engineer.

3.3 REMOVAL OF EXCAVATION SUPPORT SYSTEMS

A. Sheeting shall be left in place unless otherwise indicated on the Drawings.

B. The excavation support system left-in-place shall be cut-off a minimum of 2 feet below the bottom of the next higher foundation level or a minimum of 5 feet below finished grade.

C. When indicated on the Drawings, remove the excavation support system without endangering the constructed or adjacent structures, utilities, or property. Immediately backfill all voids left or caused by withdrawal of excavation support systems with bank-run gravel, screened gravel or select borrow by tamping with tools specifically adapted for that purpose.

D. When tiebacks are used, release tension in tiebacks as the excavation is backfilled. Do not leave tensioned tieback in place at the completion of the Work.

E. Conduct survey of the locations and final cut-off elevations of the excavation support systems left in place.

3.4 CONTRACT CLOSEOUT

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

END OF SECTION 31 50 00

SECTION 31 62 16 - STEEL PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Rolled-steel section piles.

B. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete.
2. Section 31 23 33 – Trenching and Backfill.

1.2 STANDARDS

A. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A252 - Standard Specification for Welded and Seamless Steel Pipe Piles.
3. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
4. ASTM A588/A588M - Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi Minimum Yield Point, with Atmospheric Corrosion Resistance.
5. ASTM A690/A690M - Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments.
6. ASTM A913/A913M - Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST).
7. ASTM A992/A992M - Standard Specification for Structural Steel Shapes.
8. ASTM D 1143 - Standard Test Methods for Deep Foundations Under Static Axial Compressive Load.
9. ASTM D4945 - Standard Test Method for High-Strain Dynamic Testing of Deep Foundations.

B. American Welding Society (AWS):

1. AWS D1.1/D1.1M - Structural Welding Code - Steel.
2. AWS D1.5/D1.5M - Bridge Welding Code.

C. The Society for Protective Coatings (SSPC).

1. PA-1: Shop, Field, and Maintenance Painting of Steel.
2. PA-2: Measurement of Dry Paint Thickness with Magnetic Gauges.
3. SP-5: White Metal Blast Cleaning.
4. SP-6: Commercial Blast Cleaning.

5. Paint-16: Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint.

1.3 PREINSTALLATION MEETINGS

A. Convene minimum two (2) weeks prior to commencing Work of this Section.

1.4 SCHEDULING

A. Schedule Work of this Section to perform driving during hours of 8 AM and 5 PM, unless otherwise approved by Owner and Engineer.

B. Schedule pile load testing at least seven days in advance of proposed test date.

C. Preconstruction Survey: Inventory and record the condition of adjacent structures, underground utilities, and other construction. The survey should include photographs, drawings and measurement, as appropriate. Document conditions that might be misconstrued as damage caused by pile driving.

D. Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of 6 to 12 inches above bottom of footing or pile cap.

E. Do not start production pile installation prior to completion of corresponding pile load testing and acceptance by Engineer.

F. If concrete is less than seven days old, do not drive piles closer to concrete than distance computed by following formula: D = 1/7 /$\sqrt{E}$, where E = energy of pile hammer in foot-pounds and D = distance in feet, and has attained at least 80% of its design strength.

1.5 SUBMITTALS

A. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professionals performing the wave equation analysis of pile driving (WEAP) and pile load testing.
2. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

B. Product Data: Submit manufacturer's information regarding collars, tips, splices, and cushion blocks.

C. Shop Drawings:

1. Indicate details and schedule of pile installation sequence.
2. Indicate design, details, and locations of all pile splices to be constructed.

D. Manufacturer's Certificate: Certify that products including the pile coating meet or exceed specified requirements.

E. Mill Test Reports: For steel H piles, steel pipe, steel castings, and steel plate, signed by manufacturer.

F. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

G. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion. Submit wave equation analysis of pile driving (WEAP).

H. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for selection of pile components, as required.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections including:

1. Pile load test details including: layout, equipment, instrumentation, and load reaction for static tests; high and low strain dynamic load test, equipment and typical interpretation methods of each test results.
2. Logs of geotechnical borings performed at each test pile location.
3. Daily pile load test records should include the following information:
    a. Project Name and date.
    b. Load Test Type.
    c. Name of testing laboratory technician.
    d. Name and signature of supervising geotechnical consultant.
    e. Pile location and number.
    f. Pile dimensions.
    g. Weather conditions.
    h. Description of load application apparatus, including jack capacity.
    i. Description of test instrumentation.
    j. Time, load and movement readings.
    k. Calibration data.
    l. Groundwater level.
    m. Unusual occurrences and conditions.
4. Static and Dynamic Pile Test Reports: Submit within three days of completing each test.
5. Pile-Driving Records: Submit within three days of driving each pile.

J. Certified Piles Survey: Submit within seven days of pile driving completion.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years documented experience.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in the State of Michigan.

D. Welders: AWS qualified within previous 12 months for employed weld types.

1.7 PROJECT CONDITIONS

A. Subsurface Conditions: A geotechnical report was prepared for this project and is available from Owner upon request. This data is being made available for the convenience of the Contractor, and represents only the conditions found at the locations, dates and times when the borings were performed. The data is not intended as a representation or warranty of continuity of subsurface conditions between soil borings. The Contractor shall verify and is responsible for all geotechnical information that it requires for construction. Additional test borings and other exploratory operations may be made by the Contractor at no cost to the Owner.

1.8 PROTECTION OF EXISTING STRUCTURES

A. Monitor the effect of piling operations on adjacent existing structures and utilities. Assess condition of structures and utilities and take necessary precautions to protect structures and utilities.

B. Monitor vibration levels at adjacent structures and utilities during driving. Perform baseline measurements at least one week prior to start of driving operations. Retain services of a vibration consultant to develop monitoring program, analyze/report results and establish the vibration threshold limits. Vibration monitoring results shall be submitted daily to the Engineer. Modify driving operations if measured vibration levels exceed threshold limits.

C. Temporarily relocate, repair or replace any damage caused to existing utilities and facilities as a result of piling operation. This work shall be done at the Contractor's expense.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on-site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Handling: Use nylon slings to handle coated piles.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Protect shop coated piles from damage to applied coating.
3. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drive piles to defined load supporting capacity shown on Drawings and verified by load testing, or to refusal of not less than 20 blows for 1-inch of penetration with less than ¼ inch rebound per blow and as approved by Engineer.

B. Engineer will establish final driving criteria on the basis of load testing as required herein.

2.2 PILES

A. Rolled HP Structural Steel Sections:

1. Comply with ASTM A572.
2. Minimum Yield Strength: 50 ksi.

B. Pipe Piles and Casings: ASTM A 252 Grade 2.

C. Sizes and Lengths: As indicated on Drawings.

D. Accessories Manufacturers:

1. Associated Pile Fittings Corp., Clifton, New Jersey.
2. Versa-Steel, Inc., Portland, Oregon.
3. J.C. McElroy Co., Inc., New York, New York.
4. Or Approved Equal.

E. Splice Unit: Manufacturer's standard splice unit, fabricated from two connected steel plates, of same material as steel H pile or material of equal strength, shaped to encase web and part of each flange.

F. In sea water or corrosive subsoil conditions, consider using corrosion protection. Examples of some common types of protective coatings are flame-sprayed aluminum, aluminum coating, organic and inorganic coatings, and concrete jacketing.

G. Accessories: Furnish points and driving cap to suit pile shape. Fit and weld driving points to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

2.3 PILE HAMMER

A. Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated, or as indicated on Drawings. An appropriate hammer shall be selected by the Contractor based on a WEAP.

B. Speed and Pressure:

1. As recommended by manufacturer.
2. Engineer may make occasional measurements of ramming speed.

C. If energy per blow is less than 80 percent of rated energy per blow as specified by manufacturer of pile hammer, make necessary repairs to improve energy output to value of at least 80 percent of rated energy per blow, or replace pile hammer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Obtain prior approval of hammer type to be used.

B. Use driving method which will not cause damage to nearby structures.

C. Notify adjacent and affected landowners and building occupants within 14 days before proceeding with Work of this Section.

D. Protect structures, including overhead and buried utilities near Work, from damage.

E. Mark each pile with horizontal lines at 12-inch intervals; label the distance from pile tip at 5-foot intervals. Maintain markings on piles until driven.

3.2 INSTALLATION

A. Unless otherwise approved, drive piles only in presence of Engineer or designated representative.

B. Continuously drive piles to elevations or penetration resistance indicated or established by static load testing of piles, or as directed by Engineer. Piles shall be driven to a penetration of at least 10 ft. below the bottom of footing/pile cap or below undisturbed earth, whichever is greater, regardless of other criteria.

C. If driving is interrupted before refusal, drive an additional 12 inches before resuming recording of performance data.

D. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

E. Jetting Piles: Do not jet piles unless approved by Engineer in writing.

F. Use rigid-frame, fixed-lead type driving equipment capable of supporting pile firmly in vertical position or to required batter. Establish and maintain axial alignment of leads and piles before and during driving.

G. Align top of pile normal to driving force of pile, hammer, and leads to minimize bowing of pile during impact of hammer ram.

H. Take corrective action, if required, to prevent observable impact bowing of pile at final driving resistance.

I. Pile Head Protection:

1. Use cap-block cushion consisting of alternate plates of phenolic laminate and aluminum, designed to prevent damage to piles while transmitting required hammer energy to pile top as indicated on Drawings.
2. Provide full bearing on pile butt for even distribution of hammer blow.
3. Deliver hammer blows to central axis of pile.

J. Do not damage piles during driving operations. Withdraw damaged or defective piles and piles that exceed driving tolerances and install new piles within driving tolerances. Fill holes left by withdrawn piles with clean sand as directed by Engineer.

K. If groups of piles are required by Project, drive center pile of group first and then drive remaining piles in group, progressing outward from center.

L. Re-drive piles which have lifted due to driving of adjacent piles or by soil uplift.

M. Cut off tops of piles to indicated elevations and prepare pile top to receive pile caps or grade beams.

N. If an impenetrable obstruction is encountered during pile driving, remove and reuse the pile or cut the pile off and drive a new pile.

1. If removing a pile, reuse as approved by the Engineer, adjust the pile laterally, and redrive.
2. If cutting off a pile, cut the pile at the lowest possible elevation and drive another pile, adjusted laterally.
3. If removing and adjusting or cutting off and adjusting a pile does not bypass the obstruction, remove the obstruction. Provide rock chisels, extractors, core barrels, or other equipment to clear obstructions.

O. Welding:

1. Perform shielded metal arc welding according to AWS D1.1/D1.1M.
2. Employ only welders qualified according to AWS D1.1/D1.1M.
3. Reinforce pile tips as indicated on Drawings.

P. Splicing:

1. Submit and obtain approval of all pile splicing details prior to construction.

2. Type:
   a. Unless otherwise shown on Drawings, complete penetration butt weld of flanges and web configured to develop the full structural strength of the pile section.
   b. Use only butt weld splices within 20 feet from pile cutoff elevation or design grade, whichever is lower.

3. Alignment:
   a. Use jig or alignment device during welding to maintain specified requirements.
   b. For splices made during pile installation, rigid frame pile leads may be used as jig.

4. Number and Location:
   a. Not more than three splices for piles more than 100 feet long.
   b. Not more than two splices for piles up to 100 feet long.
   c. No splice closer than 25 feet from tip.

3.3 TOLERANCES

A. Tolerance requirements: Section 01 40 00 - Quality Requirements.

B. Maximum Variation from Vertical for Plumb Piles: One in 48.

C. Maximum Variation from Required Angle for Batter Piles: One in 24.

D. Maximum Variation from Pile Cutoff Elevation: 4 inches.

E. Maximum Out-of-Position: 4 inches.

F. Maximum Variation in Centerline after Splicing: 3/8 inch in 40 feet for undriven portion.

G. Ensure a distance of at least 9 inches between the edges of piles and the outline of the superimposed concrete, or greater distance as shown on Drawings.

3.4 FIELD QUALITY CONTROL

A. Inspection:

1. Employ geotechnical engineer to monitor pile driving operations.
2. Prepare test and inspection reports and submit to Engineer.

B. Acceptance:

1. Piles will be considered defective if they do not pass tests and inspections.
2. Unacceptable/Defective Piles: Piles that fail tests, are placed out of position, are below cutoff elevations, or are damaged.
3. Provide additional piles or replace piles to meet specified requirements.

C. Pile-Driving Records: Maintain accurate driving records for each pile. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Pile location in pile group and designation of pile group.
4. Sequence of driving in pile group.
5. Pile dimensions.
6. Ground elevation.
7. Elevation of tips after driving.
8. Final tip and cutoff elevations of piles after driving pile group.
9. Records of redriving.
10. Elevation of splices.
11. Type, make, model, and rated energy of hammer.
12. Weight and stroke of hammer.
13. Type of pile-driving cap used.
14. Cushion material and thickness.
15. Actual stroke and blow rate of hammer.
16. Pile-driving start and finish times, and total driving time.
17. Time, pile-tip elevation, and reason for interruptions.
18. Number of blows for every 12 inches of penetration, and number of blows per 1 inch for the last 6 inches of driving.
19. Pile deviations from location and plumb.
20. Preboring, jetting, or special procedures used.
21. Unusual occurrences during pile driving.

D. Certified Piles Survey:

1. Engage a professional land surveyor licensed in the state of Michigan to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.
2. Notify Engineer when deviations from locations exceed allowable tolerances.

E. Load Testing:

1. Unless otherwise approved, perform all load testing only in presence of Engineer or designated representative. Provide a minimum 72-hour notice prior to beginning load testing.
2. Contractor shall perform one (1) geotechnical soil boring shall be performed adjacent to the location of each proposed test pile and submit log of boring to Engineer. Boring shall include Standard Penetration Test sampling, per ASTM D 1586.

3. Test Piles: Use test piles identical to those required for Project and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated.
4. Perform pile load testing of the type, at the locations, and at frequencies as indicated in the Drawings.
5. Dynamic Pile Testing:
    a. Perform and report dynamic pile testing according to ASTM D 4945 “Standard Test Method for High-Strain Dynamic Testing of Piles.”
    b. At each test pile, perform test during initial driving and during re-striking at least 48 hours following initial drive, or as required in the Drawings.

6. Static Pile Testing: Perform and report static load testing according to ASTM D 1143, “Standard Test Methods for Deep Foundations Under Static Axial Compressive Load.”
    a. Equip each test pile with two telltale rods, according to ASTM D 1143, for measuring deformation during load test.
    b. Provide pile reaction frame, anchor piles, equipment, and instrumentation with sufficient reaction capacity to perform tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.
    c. Allow a minimum of seven days to elapse after driving test piles before starting static pile testing, or as required in the Drawings.
    d. The allowable pile load as determined by the load testing shall be established based on the applicable current building code.

7. Test Pile-Driving Records: Prepare driving records for each test pile compiled and attested to by a qualified professional engineer. Include same data as required for driving records of permanent piles.
8. Accepted test piles that comply with requirements, including location tolerances, may be used in Work.

3.5 DISPOSAL

A. Clean up site, remove withdrawn piles and cutoff sections of piles from site, and legally dispose of them off Owner's property.

END OF SECTION 31 62 16

SECTION 32 11 23 - AGGREGATE BASE COURSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aggregate Subbase.
2. Aggregate Base Course.
3. Aggregate Surface Course.

B. Related Requirements:

1. Section 31 23 33 - Trenching and Backfill.
2. Section 31 37 16.13 - Rubble-Stone Riprap.
3. Section 32 12 16 - Asphalt Paving.
4. Section 32 13 13 - Concrete Paving.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.

B. ASTM International:

1. ASTM D75 - Standard Practice for Sampling Aggregates.
2. ASTM D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
3. ASTM D2940 - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.
4. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

C. City of Detroit, Department of Public Works, City Engineering Division:

1. Standard Specifications for Paving and Related Construction.
2. Street and Alley Standard Plans.

D. Michigan Department of Transportation (MDOT):

1. 2012 Standard Specifications for Construction.
2. Density Testing and Inspection Manual (rev. 2017).

1.3 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

PART 2 - PRODUCTS

2.1 AGGREGATE MATERIALS

A. Dense-Graded Aggregates for Base Course, Surface Course, Shoulders, Approaches and Patching: Class 21AA, 21A, 22A, 23A – MDOT 902.05. Aggregate base under bituminous shall be 22A, unless otherwise specified.

B. Open-Graded Aggregates for Earthwork, Open Graded Drainage Courses and Underdrains: Class 4G, 34G, and 34R – MDOT 902.06.

C. Granular Materials for Fill and Subbase: Class I, IIAA, II, IIA, IIAA, IIIA, III – MDOT 902.07.

D. Fine Aggregate for Portland Cement Concrete and Mortar: 2NS, 2SS, and 2MS – MDOT 902.08.

E. Aggregate General Requirements for HMA Mixtures: MDOT 902.09.

2.2 MATERIAL AVAILABILITY

A. Sufficient aggregate material to complete the work is not available at the site. Secure source of material and permits to complete the project requirements. Obtain material from offsite borrow areas.

2.3 WATER FOR COMPACTION

A. Water shall be free of organic materials and shall have a pH of 7.0 to 9.0, a maximum chloride concentration of 500 mg/L, and a maximum sulfate concentration of 500 mg/L.

B. Provide all water needed for earthwork. Provide temporary piping and valves to convey water from the source to the point of use. Obtain meter and backflow permit from DWSD.

2.4 ACCESSORIES

A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

1. Grab tensile strength (ASTM D1682): 100 lbs. minimum for a 1-inch grip.
2. Apparent opening size per ASTM D4751: 0.425 mm maximum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work. Comply with Section 01 30 00 – Administrative Requirements.

B. Verify that compacted substrate is dry and ready to support paving and imposed loads.

1. Proof roll substrate with a fully loaded tri-axle dump truck (weight bearing on two (2) rear axles) in minimum two (2) perpendicular passes to identify soft spots.
2. A fully loaded wheel loader may also be acceptable for smaller installation areas as approved by the Engineer.
3. Remove soft substrate and replace with compacted fill as specified in Section 31 23 33 – Trenching and Backfill.

C. Verify substrate has been inspected and gradients and elevations are correct.

3.2 PREPARATION

A. The finished subgrade shall be within the tolerances listed below of the grade and cross-section indicated, shall be smooth and free from irregularities, and shall be at the specified relative compaction. The subgrade shall extend over the full width shown in the cross-sections and standard details.

B. Remove soft material encountered and replace with structural backfill. Fill holes and depressions to the required line, grade, and cross-sections with structural backfill.

C. After excavation of existing material or removal of unacceptable material at the exposed subgrade, scarify the final subgrade surface to a depth of 12 inches and compact to 95% relative compaction.

D. Remove foreign materials and trash from the excavation before placing any fill material.

E. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

F. Do not place fill on soft, muddy, or frozen surfaces.

3.3 AGGREGATE PLACEMENT

A. If required, install geotextile fabric over subgrade according to manufacturer's instructions.

1. Lap ends and edges minimum six (6) inches.
2. Anchor fabric to subgrade when required to prevent displacement until aggregate is installed.

B. Place aggregate equal thickness layers to total compacted thickness indicated on Drawings.

1. Maximum Layer Compacted Thickness: 6 inches.
2. Minimum Layer Compacted Thickness: 4 inches.

C. Roller compact aggregate to 95 percent maximum density.

D. Level and contour surfaces to elevations, profiles, and gradients indicated.

E. Maintain optimum moisture content of fill materials to attain specified compaction density.

F. Use mechanical tamping equipment in areas inaccessible to compaction equipment. Do not operate earthmoving equipment within 5 feet of walls of concrete structures. Place and compact backfill adjacent to concrete walls with hand-operated tampers or other equipment that will not damage the structure.

3.4 MOISTURE CONTROL

A. During the compacting operations, maintain optimum practicable moisture content required for compaction purposes in each lift of the material. Maintain uniform moisture content throughout the lift. Insofar as practicable, add water to the material at the site of excavation. Supplement by sprinkling the material. At the time of compaction, the water content of the material shall be at optimum water content or within two (2) percentage points above optimum. Aerate material containing excessive moisture by blading, discing, or harrowing to hasten the drying process.

3.5 DISPOSAL OF EXCESS MATERIALS

A. Excess site excavated or wasted material shall be disposed of off-site by the Contractor at his expense. No prearranged disposal site or related permits have been determined or secured by the Owner.

3.6 TOLERANCES

A. Comply with Section 01 40 00 – Quality Requirements.

B. Maximum Variation from Flat Surface: 1/4 inch measured with 10-foot straight edge.

C. Maximum Variation from Thickness: 1/4 inch.

D. Maximum Variation from Elevation: 3/8 inch.

3.7 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements for field inspecting, testing, adjusting, and balancing.

B. Determine the density of soil in place by nuclear methods, ASTM D6938. Additional densities will be required if the backfill material is visually variable. Compaction tests will be performed for each lift or layer.

C. Determine laboratory moisture-density relations of soils per ASTM D1557. If nuclear methods are used for in-place density determination, the compaction test results for maximum dry density and optimum water content shall be adjusted in accordance with ASTM D4718. This will be required for determination of percent relative compaction and moisture variation from optimum.

D. Determine the relative density of cohesionless soils per the Michigan Cone Method.

E. Sample materials per ASTM D75.

F. "Relative compaction" is the ratio, expressed as a percentage, of the in-place dry density to the laboratory maximum dry density.

G. When tests indicate Work does not meet specified requirements, remove Work, replace and retest. Compaction shall be deemed to comply with the specifications when no more than one (1) test of any three consecutive tests falls below the specified relative compaction. The one (1) test shall be no more than three percentage points below the specified compaction. The Contractor shall pay the costs of any retesting of work not conforming to the specifications.

H. Frequency of Tests: Per MDOT Density Testing and Inspection Manual.

END OF SECTION 32 11 23

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphalt materials.
2. Aggregate materials.
3. Aggregate subbase.
4. Asphalt paving base course, binder course, and wearing course.
5. Asphalt paving overlay for existing paving.

B. Related Requirements:

1. Section 31 23 33 – Trenching and Backfill.
2. Section 32 11 23 – Aggregate Base Courses.
3. Section 33 01 30.81 – Manhole Rehabilitation.
4. Section 33 05 61 – Concrete Manholes.

1.2 STANDARDS

Except as otherwise specified herein, comply with the latest edition of the following standards:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
5. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.

B. City of Detroit, Department of Public Works, City Engineering Division:

1. Standard Specification for Paving and Related Construction.
2. Street and Alley Standard Plans.

C. Michigan Department of Transportation (MDOT):

1. 2012 Standard Specifications for Construction.
2. Density Testing and Inspection Manual (rev. 2017).
3. HMA Production Manual (rev. 2017).

D. Asphalt Institute:

1. AI SP-2 - Superpave Mix Design.

E. ASTM International:

1. ASTM D692 - Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
2. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
3. ASTM D977 - Standard Specification for Emulsified Asphalt.
4. ASTM D1073 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
5. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.
6. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
7. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.
8. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
9. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
10. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
11. ASTM D3515 - Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
12. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
13. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

1.3 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Manufacturer's Certificate: Certify Products meet or exceed specified requirements for the following materials:

1. Aggregate: Gradation.
2. Asphalt for Binder: Type and grade.
3. Prime Coat: Type and grade of asphalt.
4. Tack Coat: Type and grade of asphalt.

5. Seal Coat: Type and grade of asphalt.
6. Mixes: Conforms to job-mix formula.
7. Herbicide: Comply with Section 32 93 00 – Plants.
8. Paint for traffic and parking lot striping.
9. Pavement markers.

C. Submit test results for the following:

1. Mix Design:
   a. Aggregate gradation.
   b. Asphalt content.
   c. Stability number.

2. Uncompacted Mix:
   a. Asphalt content.
   b. Aggregate gradation.

3. Asphalt cement for binder.

1.4 QUALITY ASSURANCE

A. Mixing Plant: Conform to Michigan Department of Transportation (MDOT) Standard Specifications for Construction**.**

B. Obtain materials from same source throughout.

1.5 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum five (5) years documented experience.

1.6 TESTING FOR COMPACTION

A. Test for compaction as required by the MDOT Density Testing and Inspection Manual.

1.7 AMBIENT CONDITIONS

A. Comply with Section 01 52 00 – Temporary Facilities.

B. Do not place asphalt mixture between November 15 and May 5.

C. Do not place asphalt mixture when ambient air or base surface temperature is less than 40°F or surface is wet or frozen.

PART 2 - PRODUCTS

2.1 ASPHALT PAVING

A. Performance / Paving Design Criteria: Per Contract Drawings and Details.

B. Asphalt Materials:

1. Asphalt Cement: ASTM D946; penetration grade 85-100. Michigan Department of Transportation (MDOT) Standard Specifications for Construction.
2. Asphalt Binder: MDOT Standard Specifications for Construction.
3. Primer: MDOT Standard Specifications for Construction.
4. Tack Coat: In accordance with MDOT Standard Specifications for Construction.
5. Reclaimed Asphalt Pavement (RAP): Processed material obtained by milling or full depth removal of existing asphalt paving.

C. Aggregate Materials:

1. Comply with Section 32 11 23 – Aggregate Base Courses.
2. Coarse Aggregate: MDOT Standard Specifications for Construction.
3. Fine Aggregate: MDOT Standard Specifications for Construction.
4. Mineral Filler: ASTM D242; finely ground mineral particles, free of foreign matter.

2.2 MIXES

A. Use dry material to avoid foaming. Mix uniformly.

B. Asphalt Paving Mixtures: Designed in accordance MDOT Standard Specifications for Construction with maximum 15 percent by weight reclaimed asphalt pavement.

1. Base Course: As shown in the Contract Documents.
2. Binder Course: As shown in the Contract Documents.
3. Wearing Course: As shown in the Contract Documents.

C. Temporary Patching:

1. Cold patching or HMA mixture shall be approved by the Engineer prior to placement.
2. Cold patching mixture shall be composed of an asphaltic binder in combination with a crushed limestone aggregate with the following gradation:

Gradation	% Passing
Sieve ½”	100
Sieve 3/8”	95 – 100
Sieve #4	35 – 65
Sieve #8	0 – 25
Sieve #200	0 – 4
Bitumen, % by weight	5.5 – 7.0

3. HMA patching mixture shall be any of the mixtures specified in the MDOT Standard Specifications for Construction.

2.3 ACCESSORIES

A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

B. Sealant: ASTM D6690, Type II or Type III; hot applied type.

2.4 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements.

B. Submit proposed mix designs for review prior to beginning of Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.

C. Verify compacted subgrade subbase is dry and ready to support paving and imposed loads.

1. Proof roll subbase with a fully loaded tri-axle dump truck (weight bearing on two (2) rear axles) in minimum two (2) perpendicular passes moving slowly to identify soft spots.
2. A fully loaded wheel loader may also be acceptable for smaller installation areas as approved by the Engineer.
3. Remove soft subbase and replace with compacted fill as specified in Section 31 23 33 – Trenching and Backfill.

D. Verify gradients and elevations of base are correct.

E. Verify gutter drainage grilles and frames and manhole frames are installed in correct position and elevation.

3.2 PREPARATION

A. Prepare subbase in accordance with MDOT Standard Specifications for Construction**.**

3.3 DEMOLITION

A. Saw-cut and notch existing paving as indicted on Drawings. Initially cut asphalt concrete pavement with pneumatic pavement cutter or other equipment at the limits of the excavation and remove the pavement. After backfilling excavation, saw-cut asphalt concrete pavement to a minimum depth of 2 inches at a point not less than 9 inches outside the limits of the excavation or the previous pavement cut, whichever is greater, and remove the additional pavement.

B. Saw-cut concrete pavement, including cross gutters, curbs and gutters, sidewalks, and driveways, to a minimum depth of 1-1/2 inches at a point one (1) foot beyond the edge of the excavation and remove the pavement. The concrete pavement may initially be cut at the limits of the excavation by other methods prior to removal and the saw cut made after backfilling the excavation. If the saw-cut falls within three (3) feet of a concrete joint or pavement edge, remove the concrete to the joint or edge.

C. Make arrangements to dispose of the removed pavement.

D. Final pavement saw cuts shall be straight along both sides of trenches, parallel to the pipeline alignment, and provide clean, solid, vertical faces free from loose material. Saw cut and remove damaged or disturbed adjoining pavement. Saw-cuts shall be parallel to the pipeline alignment or the roadway centerline or perpendicular to same.

E. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.

F. Repair surface defects in existing paving to provide uniform surface to receive new paving.

3.4 INSTALLATION

A. Aggregate Subbase: Install as specified in Section 32 11 23 – Aggregate Base Courses.

B. Primer: Apply primer in accordance with MDOT Standard Specifications for Construction.

C. Tack Coat:

1. Apply tack coat in accordance with MDOT Standard Specifications for Construction.
2. Apply tack coat to contact surfaces of curbs and gutters.

3. Coat surfaces of manhole and catch basin frames with oil to prevent bond with asphalt paving. Do not tack coat these surfaces.

D. Single Course Asphalt Paving:

1. Install Work in accordance with MDOT Standard Specifications for Construction**.**
2. Place asphalt within 24 hours of applying primer or tack coat.
3. Place asphalt wearing course to thickness indicated on Drawings.
4. Compact paving by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
5. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

E. Double Course Asphalt Paving:

1. Place asphalt binder course within 24 hours of applying primer or tack coat.
2. Place binder course to thickness indicated on Drawings.
3. Place wearing course within 24 hours of placing and compacting binder course. When binder course is placed more than 24 hours before placing wearing course, clean surface and apply tack coat before placing wearing course.
4. Place wearing course to thickness indicated on Drawings.
5. Compact each course by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
6. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

F. Asphalt Paving Overlay:

1. Apply tack coat to existing paving surface at rate recommended by geotextile fabric manufacturer.
2. Install geotextile fabric in accordance with manufacturer's instructions to permit asphalt saturation of fabric. Lap fabric edge and end joints four (4) inches.
3. Place wearing course to thickness indicated on Drawings.
4. Compact overlay by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
5. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.5 TEMPORARY PATCHING

A. Construction:

1. When temporary patching of a pavement surface is required, the surface shall be cleaned. The bituminous mixture shall be compacted so the patch is flush with the adjacent pavement.

2. When patching is required for repairing a cut in the pavement, backfilled aggregate base course shall be compacted to not less than 95 percent of the Maximum Unit Weight. An aggregate base course of not less than 9-inch compacted thickness, or a bituminous base of the specified thickness, shall be used.
3. The top of the aggregate base course shall be 2 inches to 2½ inches below the surface of the adjacent pavement. The compacted surface of the bituminous patch shall be smooth and shall not vary more than 1/4-inch from the crown and grade of the adjacent pavement. Any variations over 1/4-inch from the established grade shall be corrected.

3.6 CONNECTIONS WITH EXISTING PAVEMENT

A. Where new paving joins existing paving, chip the existing surfaces 12 inches back from the joint line so that there will be sufficient depth to provide a minimum of one (1_ inch of asphalt concrete. Dispose of waste material offsite. Tack chipped areas prior to placing the asphalt concrete. Meet lines shall be straight and the edges vertical. Paint the edges of meet line cuts with liquid asphalt or emulsified asphalt prior to placing asphalt concrete. After placing the asphalt concrete, seal the meet line by painting with a liquid asphalt or emulsified asphalt and then immediately cover with clean, dry sand.

3.7 TOLERANCES

A. Comply with Section 01 40 00 – Quality Requirements.

B. Flatness: Maximum variation of 1/4-inch measured with 10-foot straight edge.

C. Scheduled Compacted Thickness: Within 1/4-inch.

D. Variation from Indicated Elevation: Within 1/2-inch.

3.8 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements.

B. Asphalt Paving Mix Temperature: Measure temperature at time of placement. It is the Contractor's responsibility to ensure that the mixture temperature is adequate for placement and compaction which for HMA shall not be below 250°F and not above 350°F.

C. Asphalt Paving Thickness: ASTM D3549; test one (1) core sample from every 1000 square yards compacted paving.

D. Asphalt Paving Density: ASTM D2950 nuclear method; test one location for every 1000 feet per width of 24 feet or less of compacted paving. HMA Paving shall be compacted to not less than 92 percent of the Maximum Unit Weight.

3.9 PROTECTION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Immediately after placement, protect paving from mechanical injury for eight (8) hours or until surface temperature is less than 140°F.

END OF SECTION 32 12 16

SECTION 32 12 17 – PERMEABLE ASPHALT PAVEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphalt Materials.
2. Aggregate Materials.
3. Asphalt Mix Additives.
4. Aggregate Subbase.
5. Underdrains (optional).

B. Related Requirement:

1. Section 31 05 17 – Aggregates for Storm Water Management.
2. Section 32 93 90 – Green Infrastructure Maintenance.
3. Section 33 05 61 – Concrete Manholes.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
5. AASHTOM288 - Standard Specification for Geotextile Specification for Highway Applications.
6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.
9. AASHTO T30 - Mechanical Analysis of Extracted Aggregate.
10. AASHTO T164 – Standard Method of Test for Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA).
11. AASHTO T283 - Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage.

B. National Asphalt Pavement Association:

1. IS 115 – Design, Construction and Maintenance of Open-Graded Friction Courses.

2. IS 131 – Design, Construction and Maintenance Guide for Porous Asphalt Pavements.

C. ASTM International:

1. ASTM C977 – Standard Specification for Quicklime and Hydrated Lime for Soil Stabilization.
2. ASTM D242 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
3. ASTM D390 - Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures.
4. ASTM D692 - Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
5. ASTM D977 - Standard Specification for Emulsified Asphalt.
6. ASTM D1073 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
7. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.
8. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
9. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.
10. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
11. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
12. ASTM D3385 - Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer.
13. ASTM D3515 - Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
14. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
15. ASTM D3910 - Standard Practices for Design, Testing, and Construction of Slurry Seal.
16. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
17. ASTM D6752 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

1. Preconstruction meeting shall be conducted at least six (6) weeks before beginning of construction of the permeable pavement, including all concerning parties.
2. Submit a list of materials proposed for work under this Section including the name and address of the materials producers and the locations from which the materials are to be obtained.
3. Submit certificates, signed by the materials producers and the relevant subcontractors, stating that materials meet or exceed the specified requirements, for review and approval by the Engineer. Materials submissions showing compliant asphalt mix design should be made six (6) weeks before installation.

4. Submit samples of materials for review and approval by the Engineer. For mix materials, samples may be submitted only to the QA inspector with the Engineer's approval. Submittal requirements for samples and certificates are summarized in Table 2 and discussed in further detail in the Materials section.

Table 2. Submittal Requirements

Material or Pavement Course*	Properties to be reported on Certificate**
choker course, reservoir course	gradation, max. wash loss, min. durability index, max. abrasion loss, air voids (reservoir course)
geotextile filter fabric	manufacturer's certification, AOS/EOS, tensile strength
striping paint	Certificate
Binder	PGAB certification
coarse aggregate	gradation, wear, fracture faces (fractured and elongated)
fine aggregate	Gradation
Silicone (optional)	manufacturer's certification
Fibers (optional/if needed)	manufacturer's certification
mineral filler (if needed)	manufacturer's certification
fatty amines (if needed, anti-strip)	manufacturer's certification
hydrated lime (if needed, anti-strip)	manufacturer's certification

* Samples of each material shall be submitted to the Engineer (or QA inspector for mix). These samples must be in sufficient volume to perform the standardized tests for each material.

** These are the minimum properties to be reported, additional material properties may be required (refer to Materials Section).

1.4 QUALITY ASSURANCE

A. Mixing Plant. Conform to Michigan Department of Transportation (MDOT) Standard Specifications for Construction**.**

B. Obtain materials from same source throughout the project. All materials, methods of construction, and workmanship shall conform to applicable requirements of AASHTO, ASTM Standards, MDOT Standard Specifications, latest revised (including supplements and updates), or other standards as specified.

C. Perform Work in accordance with Michigan Department of Transportation (MDOT) Standard Specifications for Construction**.**

D. Use appropriate equipment and adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work in this Section.

E. QC/QA requirements for mix production are discussed in the Materials Section, and for construction of the porous media beds and paving, in the Execution Section. Notify Engineer if quality issues arise.

1.5 QUALIFICATIONS

A. Installer. Company specializing in performing permeable pavement installations and who can show at least five (5) successful installations of similar permeable asphalt projects similar in scope and extent.

1.6 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Ambient conditions control facilities for product storage and installation.

B. Do not place asphalt mix between November 15 and March 15, or as approved by Engineer.

C. Do not place asphalt mix when the ambient air temperature at the pavement site in the shade, away from artificial heat is below 60 °F or when the actual ground temperature is below 50 °F. Only the Engineer may adjust this air temperature requirement, soil temperature requirement, or extend the dates of the paving season.

D. The Contractor shall not pave when surface is wet or frozen, or when rain is forecast for the day, unless a change in the weather results in favorable conditions as determined by the Engineer.

PART 2 - PRODUCTS

2.1 ASPHALT PAVING

A. Performance / Design Criteria:

1. Paving: Design for parking lots, residential streets, alleys, and sidewalks.

B. Permeable Asphalt Materials:

1. Mix Materials. Consist of performance grade asphalt binder (PGAB), coarse and fine aggregates, and required and optional additives such as polymer modified asphalt (PMA), fibers, or other select additives as stated on the plans. Materials shall meet the requirements of the NAPA's Design, Construction, and Maintenance of Open-Graded Friction Courses, Information Series 115 (2002) and Design, Construction, and Maintenance Guide for Porous Asphalt Pavements, Information Series 131, except where noted otherwise or approved in writing by the Engineer.

2. Polymer Modified PGAB. The asphalt binder shall be a polymer modified performance grade asphalt binder (PGAB) used in the production of Superpave Hot Mix Asphalt (HMA) mixtures as identified on the plans. The PGAB shall be two grades stiffer than that required for dense mix asphalt (DMA) parking lot installations, which is often achieved by adding a polymer and/or fiber. The PGAB polymer modifier shall be styrene butadiene styrene (SBS) or approved equal, applied at a 3% rate of the total weight of the binder. SBS is generally reserved for large projects as pre-blending is required. The binder shall be PG 76-22 and shall meet the requirements of AASHTO M320. The SBS will be supplied by an approved PGAB supplier holding a Quality Control Plan approved by the state DOT. A Bill of Loading (BOL) will be delivered with each transport of PG 76-22 SBS. A copy of the BOL will be furnished to the Engineer.

3. Quality control plans may always be altered at the discretion of the Engineer and based on feasible testing as suggested by the asphalt producer. Certain QC testing requirements during production may not be feasible for small projects in which limited asphalt is generated. Some testing methods cannot be completed during the time needed during small batch (less than approximately 50 tons of porous asphalt mix) production. The feasibility should be assessed with the Engineer and Producer.

Table 3: Post-Blended SBS/SBR Binder QC Plan Requirements

The QC Plan will Contain: 1. Company name and address. 2. Plant location and address. 3. Type of facility. 4. Contact information for the Quality Control Plan Administrator. 5. QC test to be performed on each PGAB. 6. Name(s) of QC testing lab to perform PC and process control testing. 7. Actions to be taken for PGAB and Polymer Modifier in non-compliance. 8. List of mechanical controls (requirements below). 9. List of process controls and documentation (requirements below).
List of Mechanical Controls: 1. Liquid Polymer Modifier no-flow alert system with an "alert" located in the control room and automatic documentation of a no flow situation on the printout. 2. Provide means of calibrating the liquid Polymer Modifier metering system to a delivery tolerance of 1%. 3. A batching tolerance at the end of each day's production must be within 0.5%. 4. Mag-flow meter (other metering system may be considered). 5. Method of sampling liquid Polymer Modifier.
List of Process Controls and Documentation: 1. Printouts of liquid Polymer Modifier and PGAB quantities must be synchronized within 1 minute of each other. 2. Polymer Modifier supplier certification showing the percent of Polymer Modifier solids in liquid Polymer Modifier. 3. Test results of a lab sample blended with the specified dosage of Polymer Modifier. At a minimum, provided the name of the PGAB and liquid Polymer Modifier supplies and

PGAB information such as grade and lot number and Polymer Modifier product name used for the sample.
4. MSDS sheet for liquid Polymer Modifier.
5. Handling, storage and usage requirements will be followed as required by the liquid Polymer Modifier manufacturer.
6. At a minimum, provide a table showing proposed rate of Polymer Modifier liquid (L/min) in relation to HMA production rate (tons per hour) for the percent solids in liquid Polymer Modifier, quantity of Polymer Modifier specified for HMA production and the specific gravity of the Polymer Modifier.
7. QCT or QC plan administrator must be responsible for documenting quantities and ensuring actual use is within tolerances. All printouts, calculations, supplier certifications, etc., must be filed and retained as part of the QCTs daily reports.
8. Method and frequency of testing at the HMA plant including initial testing and specification testing.

4. Anti-Stripping Mix Additives. The mix shall be tested for moisture susceptibility and asphalt stripping by water in accordance with ASTM D 3625 and ASTM D 1664. If the estimated coating area is not above 95%, anti-stripping agents shall be added to the asphalt mix. The amount and type of additive (e.g. fatty amines or hydrated lime) to be used shall be based on the manufacturer's recommendations, the mix design test results, and shall be approved by the Engineer prior to placement.

   Fibers may be added per manufacturer and *NAPA IS 115* recommendation if the drain down requirement cannot be met (<0.3% via ASTM D6390) provided that the air void content requirement is met (>18%, or >16% as tested with CoreLok device). The dosage of fiber additives shall be added at 1.5% by total mixture volume. Fibers are a simple addition either manually for a batch plant or automated for larger plants.

   Additives should be added per the relevant MDOT specification and *NAPA IS 115*.

5. Coarse Aggregate. Coarse aggregate shall be that part of the aggregate retained on the No. 8 sieve; it shall consist of clean, tough, durable fragments of crushed stone, or crushed gravel of uniform quality throughout.

   Coarse aggregate shall be crushed stone or crushed gravel and shall have a percentage of wear as determined by AASHTO T96 of not more than 40 percent. In the mixture, at least 75 percent, by mass (weight), of the material coarser than the 4.75 mm (No. 4) sieve shall have at least two fractured faces, and 90 percent shall have one or more fractured faces (ASTM D5821). Coarse aggregate shall be free from clay balls, organic matter, deleterious substances, and not more than 8.0% of flat or elongated pieces (>3:1) as specified in ASTM D4791.

   The course aggregate gradation is identified on the plans.

6. Fine Aggregate. The fine aggregate shall be that part of the aggregate mixture passing the No. 8 sieve and shall consist of sand, screenings, or combination thereof with uniform quality throughout. Fine aggregate shall consist of durable particles, free from injurious foreign matter. Screenings shall be of the same or similar materials as specified for coarse

aggregate. The plasticity index of that part of the fine aggregate passing the No. 40 sieve shall be not more than six (6) when tested in accordance with AASHTO T90. Fine aggregate from the total mixture shall meet plasticity requirements. The fine aggregate gradation is identified on the plans.

7. Recycled Asphalt (RAP). Recycled asphalt can be used to supplement, or in place of, fine aggregate. RAP should be a ½" minus or properly managed product with known asphalt content in quantities not to exceed more than 10% by weight.

8. Permeable Asphalt Mix Design Procedures. The mixture will be designed according to the NAPA IS 131, with the exception of testing for air void content. Bulk specific gravity (SG) used in air void content calculations shall not be determined and results will not be accepted using AASHTO T166 (saturated surface dry), since it is not intended for open graded specimens (>10% AV). Bulk SG shall be calculated using AASHTO T275 (paraffin wax) or ASTM D6752 (automatic vacuum sealing, e.g. CoreLok). Air void content shall be calculated from the bulk SG and maximum theoretical SG (AASHTO T209) using ASTM D3203.

   The materials shall be combined and graded to meet the composition limits by mass (weight) as shown on the plans.

9. Permeable Asphalt Mix Production.

   a. Mixing Plants. Mixing plants shall meet the requirements of hot mix asphalt plants as specified in the Michigan Department of Transportation (MDOT) Standard Specifications, unless otherwise approved by the Engineer. Table 4 below includes permeable mix design criteria to be met:

Table 4: Permeable Asphalt Mix Design Criteria

Sieve Size (inch/mm)	Percent Passing (%)
0.75/19	100
0.50/12.5	85-100
0.375/9.5	55-75
No.4/4.75	10-25
No.9/2.36	5-12
No.200/0.075 (#200)	2-4
Binder Content (AASHTO T164)	5.8-6.5%
Air Void Content (ASTM D6752)	16.0-22.0%
Draindown (ASTM D390)*	≤ 0.3%
Retained Tensile Strength (AASHTO 283)**	≥ 80%
Cantabro abrasion test on unaged samples	≤ 20%
Cantabro Abrasion test on 7-day aged samples	≤ 30%

*Cellulose, mineral, or polyester fibers may be used to reduce draindown.
**If the TSR (retained tensile strength) values fall below 80% when tested per NAPA IS 131 (with a single freeze thaw cycle rather than 5), then in Step 4, the contractor shall employ an antistrip additive, such as hydrated lime (ASTM C977) or a fatty amine, to raise the TSR value above 80%.

b. Preparation of Asphalt Binder. The asphalt material shall be heated to the temperature specified in the MDOT specification in a manner that will avoid local overheating. A continuous supply of asphalt material shall be furnished to the mixer at a uniform temperature.

c. Preparation of Aggregates. The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid damaging the aggregate and depositing soot or unburned fuel on the aggregate.

   Mineral filler, if required to meet the grading requirements, shall be added in a manner approved by the Engineer after the aggregates have passed through the dryer.

   The above preparation of aggregates does not apply for drum-mix plants.

d. Mixing. The dried aggregate shall be combined in the mixer in the amount of each fraction of aggregate required to meet the job-mix formula and thoroughly mixed prior to adding the asphalt material.

   The dried aggregates shall be combined with the asphalt material in such a manner as to produce a mixture that when discharged from the pug mill is at a target temperature in the range that corresponds to a recommended range supplied by the PGAB supplier.

   The asphalt material shall be measured or gauged and introduced into the mixer in the quantity determined by the Engineer for the particular material being used and at the temperature specified in the relevant specification.

   After the required quantity of aggregate and asphalt material has been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the asphalt material throughout the aggregate is secured and there is no residual moisture in the coated aggregate.

   All plants shall have a positive means of eliminating oversized and foreign material from being incorporated into the mixer.

e. QC During Production. The Contractor shall provide process control and/or QC test results to the Engineer or the Engineer's designee. The QC plan may be altered at the discretion of the Engineer and based on feasible testing as suggested by the asphalt producer. Certain QC testing requirements during production may not be feasible for small projects in which limited asphalt is generated. Some testing methods cannot be completed during the time needed during small batch production. The feasibility should be assessed with the Engineer and producer.

   The mixing plant shall employ a Quality Control Technician (QCT). The QCT will perform QC testing and will be certified in the discipline of HMA Plant Technician by the relevant certifying agency. The Contractor shall sample, test, and evaluate the mix in accordance with the methods and minimum frequencies in Table 5 and the Post-Blended SBR Binder Quality Control Plan (if applicable).

Table 5: QC/QA Testing Requirements During Production

Test	Min. Frequency	Test
Temperature in truck at plant	6 times per day	
Gradation	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	AASHTO T30
Binder Content	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	AASHTO T164
Air Void Content	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	ASTM D6752
Binder Draindown	Greater of either (a) 1 per 500 tons, (b) 1 per day, or (c) 1 per job	ASTM D6390

If an analyzed sample is outside the testing tolerances immediate corrective action will be taken by the contractor. After the corrective action has been taken the resulting mix will be sampled and tested. If the re-sampled mix test values are outside the tolerances the Engineer will be immediately informed. The Engineer may determine that it is in the best interest of the project that production is ceased. The Contractor will be responsible for all mix produced to meet Contract Documents.

f. Testing Tolerances During Production. Testing of the QC requirements shall be within the limits set in Table 6. The paving mixture produced should not vary from the design criteria for aggregate gradation and binder content by more than the tolerances in Table 6.

Table 6: QC/QA Testing Tolerances During Production

Sieve Size (inch/mm)	Percent Passing
1/2.5	-
0.75/19	-
0.5/12.5	± 6.0
0.375/9.5	± 6.0
0.187/4.75	± 5.0
0.093/2.36	± 4.0
0.0029/0.075	± 2.0
% PGAB	± 0.3

10. Plant Shutdown and Rejection of Mix. Should the permeable asphalt mix not meet the tolerances specified in this section upon repeat testing, the Engineer may reject all failed areas and further loads of defective mix. Mix that is loaded into trucks during the time that the plant is changing operations to comply with a failed test shall not be accepted and should be recycled at the plant.

11. Striping paint shall be latex, water-base emulsion, ready-mixed, and complying with pavement marking specifications PS TT-P-1952.

12. Use asphalt binder for superpave performance graded asphalt designs. Insert required performance grade expressed as PG HH-LL where HH equals the average 7-day maximum paving temperature in positive degrees C and LL equals the minimum paving temperature in minus degrees C. Available performance grades range from 52 to 70 for maximum temperatures and minus 10 to minus 46 for minimum temperatures, both in 6-degree increments.

C. Aggregate Subbase:

1. Below the permeable asphalt layer itself are located various layers intended for structure, hydrologic control, and water quality improvement as identified on the plans and listed below.

2. Material for the choker course and reservoir course shall consist of double washed AASHTO No. 57 and shall meet the requirements stated on the plans and listed below:

a. Maximum Wash Loss of 0.5%.
b. Minimum Durability Index of 35.
c. Maximum Abrasion Loss of 10% for 100 revolutions, and maximum of 50% for 500 revolutions:
   i. The reservoir course is located at the interface between native materials and the choker course. The reservoir course shall consist of double washed AASHTO No. 2 or 3 and shall meet the requirements stated on the plans and listed below.
   ii. Maximum Wash Loss of 0.5%.
   iii. Minimum Durability Index of 35.
   iv. Maximum Abrasion Loss of 10% for 100 revolutions, and maximum of 50% for 500 revolutions.

2.2 ACCESSORIES

A. Geotextile Fabric: Non-woven geotextile filter fabric shall be Mirafi 160N or approved equivalent. Mirafi ® 160N is a non-woven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. 160N is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

2.3 SOURCE QUALITY CONTROL

A. Section 014 0 00 - Quality Requirements: Testing, inspection and analysis requirements.

B. Submit proposed mix design for review prior to beginning of Work.

C. Test samples in accordance with AI MS-2 and per additional requirements included in this Specification.

2.4 UNDERDRAINS

A. PVC (perforated or non-perforated as specified in the Contract Drawings): Shall be Schedule 40 for underdrains and pipe risers.

B. HDPE for underdrain pipe along curves, as indicated on the Contract Drawings.

C. Frame and Cover: Shall be Neenah Item No. R-1792 or approved equal.

D. Screw Cap: Shall be threaded PVC with 2-inch square lug.

E. Cleanout: The Cleanout cover assembly in pavement shall be cast iron and have an adjustable housing with scoriated cast iron cover as indicated in the Contract Drawings.

F. Observation Well: 2-inch well test plug using EnviroTech Ergo Grip or approved equal with tethering eyelet.

G. Backflow Valve: Shall be a backflow flapper (6-inch), Flex PVC Item No. S675P or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination. The Engineer shall be notified at least 24 hours prior to all porous media bed and permeable pavement layer work.

B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.

C. Verify compacted subgrade subbase is dry and ready to support paving and imposed loads.

1. Proof roll subbase with per MDOT specifications to identify soft spots.
2. Remove soft subbase and replace with compacted fill. Notify Engineer prior to removal.

D. Verify gradients and elevations of subgrade are correct.

1. Establish and maintain required lines and elevations. The Engineer shall be notified for review and approval of final stake lines for the work before construction work is to begin. Finished surfaces shall be true to grade and even, free of roller marks, and free of puddle-forming low spots. All areas must drain freely. Excavation elevations should be within +/- 0.1 ft (+/- 3 cm).

2. If, in the opinion of the Engineer, based upon reports of the testing service and inspection, the quality of the work is below the standards which have been specified, herein, Contractor shall perform additional work and testing until satisfactory results are obtained.

3.2 PREPARATION

A. Prepare subbase in accordance with Michigan Department of Transportation (MDOT) Standard Specifications for Construction, and as follows:

B. The existing native subgrade material under all pavement bed areas shall NOT be compacted or subject to excessive construction equipment traffic prior to stone bed placement. Compaction is acceptable if an impermeable liner is under the stone reservoir layer of the permeable asphalt system where infiltration is not desired.

C. Where erosion of the native material subgrade has caused accumulation of fine materials and/or surface ponding at the base of the excavation, this material shall be removed with lightweight equipment and the underlying soils scarified to a minimum depth of 6 inches (15 cm) with a York rake or equivalent and lightweight tractor.

D. Bring subgrade of stone porous media bed to line, grade, and elevations indicated. Fill and lightly regrade any areas damaged by erosion, ponding, or traffic compaction before the placing of the stone. For parking lots all bed bottoms are level grade to promote uniform infiltration. For road applications, typically the slope of the bottom of excavation parallels that of the road surface. Interior berms in the stone layer may be necessary to prevent infiltrated water from flowing in the reservoir stone parallel to the road. When needed, interior berms should be almost as tall as the reservoir course thickness and made of relatively impermeable material (this may be accomplished with geomembrane, PVC sheets, or finer aggregate and soil materials). On the upstream side of the berm, water may infiltrate. If soil infiltration capacity is low, then a drainage pipe should be located on the upstream side of the berm to remove water from the reservoir course and drain (daylight) to natural receiving waters, wetlands, or plumbed into existing storm water drainage infrastructure (swales, catch basins, storm sewers).

3.3 UNDERDRAIN SYSTEMS

A. Perforated pipes. Shall be placed with perforations down. Pipe shall be placed with the bell end upgrade. Pipe sections shall be joined with appropriate couplings. The ends of underdrain pipe shall be plugged upgrade as directed by the Engineer.

B. Risers for Cleanouts/Observation Wells. Provide 2-inch PVC slotted well casing, with well point, extending twelve inches into subgrade. Set casing approximately 2 inches below finished pavement elevation to allow clearance for test plug and cleanout cap. Provide 4-inch diameter PVC outer casing extending through pervious pavement into subbase and install 4-inch flush mounted cast iron cleanout with brass cap solvent welded to outer casing. Provide 2-inch well test plug with tethering eyelet.

In paved areas provide frame and cover over cleanout and observation well riser pipes as indicated in the Drawings. For locations in permeable pavement, frames and covers shall be located within the permeable pavement area surrounded by edge curb. Cleanouts and Observation wells shall be encased in concrete as shown in the Drawings. Connect riser to underdrain piping.

In non-paved areas, provide screw cap covers. Covers shall be set 6 inches above final grade. Connect riser to underdrain pipe.

C. Backflow Preventer. Assembly to be located per the plans and as directed by the Engineer at a location upstream of proposed sewer field connection yet downstream of perforated underdrain pipe. Provide PVC riser pipe to protect PVC access sleeve pipe. Connect assembly to underdrain piping, using the appropriate reducer and tee fittings.

3.4 INSTALLATION

A. Aggregate Subbase: Install as specified in Section 31 05 17, and as follows:

1. Upon completion of subgrade work, the Engineer shall be notified and shall inspect at his/her discretion before Contractor shall proceed with the porous media bed installation.
2. Side slope geotextile and porous media bed aggregate shall be placed immediately after approval of subgrade preparation. Any accumulation of debris or sediment which has taken place after approval of subgrade shall be removed prior to installation of geotextile or porous media at no extra cost to the Owner.
3. Place side slope geotextile in accordance with manufacturer's standards and recommendations. Adjacent strips of geotextile shall overlap a minimum of sixteen inches (16" or 41 cm). Secure geotextile at least four feet (1.2 m) outside of the bed excavation and take any steps necessary to prevent any runoff or sediment from entering the porous media bed.
4. Install coarse aggregate in lifts no greater than 8-inches (20 cm). Lightly compact each lift with equipment, keeping equipment movement over porous media bed subgrades to a minimum. Install aggregate to grades indicated on the drawings.
5. Following placement of porous bed aggregate, the sideslope geotextile fabric shall be folded back along all porous bed edges to protect from sediment washout along bed edges. At least a four-foot (1.2 m) edge strip shall be used to protect beds from adjacent bare soil. This edge strip shall remain in place until all bare soils contiguous to porous beds are stabilized and vegetated. In addition, take any other necessary steps to prevent sediment from washing into the porous beds during site construction. When the site is fully stabilized, temporary sediment control devices shall be removed.
6. Install choker base layer (see Materials section) aggregate evenly over surface of filter layer, sufficient to allow placement of pavement, and notify Engineer for approval. Choker base layer thickness shall be sufficient to allow for even placement of the permeable asphalt but no less than 4-inches (10 cm) in depth.

B. QC/QA requirements for Porous Media Bed Construction. QC/QA activities are summarized in Table 7.

Table 7: QC/QA Requirements for Porous Media Bed Construction

Activity	Schedule
Contractor to notify engineer for approval	24 hours in advance of start of work
Contractor to employ soil inspector acceptable to engineer	NA
Contractor to employ staking and layout control inspector acceptable to engineer	NA
Contractor to employ site grading inspector acceptable to engineer	NA
Contractor to employ pavement work inspector acceptable to the engineer	NA
Contractor to notify engineer for approval	After subgrade preparation, before construction of porous media bed
Contractor to notify engineer for approval	After filter layer placement (if included in the design), before placement of choker layer and pavement to verify proper compaction of filter course by ASTM D3385

C. Permeable Asphalt Pavement Installation:

1. The mixing plant, hauling and placing equipment, and construction methods shall be in conformance with NAPA IS 131 and applicable sections of the MDOT's specification for asphalt mixes.

2. The use of surge bins is not permitted.

3. Hauling Equipment. The open graded mix shall be transported in clean vehicles with tight, smooth dump beds that have been sprayed with a non-petroleum release agent or soap solution to prevent the mix from adhering to the dump bodies. Mineral filler, fine aggregate, slag dust, etc. shall not be used to dust truck beds. The open graded mix shall be covered during transportation with a suitable material of such size sufficient to protect the mix from the weather and also minimize mix cooling and the prevention of lumps. When necessary, to ensure the delivery of material at the specified temperature, truck bodies shall be insulated, and covers shall be securely fastened. Long hauls, particularly those in excess of 25 miles (40 km), may result in separation of the mix and its rejection at no cost to the Owner.

4. Placing Equipment. The paver shall be a self-propelled unit with an activated screed or strike-off assembly, capable of being heated if necessary and capable of spreading and finishing the mix without segregation for the widths and thicknesses required. In general,

track pavers have proved superior for permeable asphalt placement. The screed shall be adjustable to provide the desired cross-sectional shape. The finished surface shall be of uniform texture and evenness and shall not show any indication of tearing, shoving, or pulling of the mixture. The machine shall at all times, be in good mechanical condition and shall be operated by competent personnel.

Pavers shall be equipped with the necessary attachments, designed to operate electronically, for controlling the grade of the finished surface.

The adjustments and attachments of the paver shall be checked and approved by the Engineer before placement of asphalt material.

5. Rollers. Rollers shall be in good mechanical condition, operated by competent personnel, capable of reversing without backlash, and operated at speeds slow enough to avoid displacement of the asphalt mix. The mass (weight) of the rollers shall be sufficient to compact the mixture to the required density without crushing of the aggregate. Rollers shall be equipped with tanks and sprinkling bars for wetting the rolls.

   Rollers shall be two-axle tandem rollers with a gross mass (weight) of not less than 7 metric tons (8 tons) and not more than 10 metric tons (12 tons) and shall be capable of providing a minimum compaction effort of 44 kN/m (250 pounds per inch) of width of the drive roll. All rolls shall be at least 1.1 m (42 inches) in diameter.

   A rubber tire roller shall not be used. Conditioning of Existing Surface. Contact surfaces such as curbing, gutters, and manholes shall be coated with a thin, uniform coat of Type RS-1, or equivalent emulsified asphalt immediately before the asphalt mix is placed against them.

6. Temperature Requirements. The temperature of the asphalt mix, at the time of discharge from the haul vehicle and at the paver, shall be between 135-163°C (275 to 325°F), within 6 °C (10 °F) of the compaction temperature for the approved mix design.

7. Spreading and Finishing. The permeable asphalt should be placed in two lifts at 2 inches (5 cm) minimum or as shown on the Contract Drawings or as directed by Engineer. One lift is **NOT ALLOWED** because uniform compaction is difficult to achieve. Great care must be taken to ensure that the permeable asphalt layers join completely. This means: keeping the time duration between layer placements minimal; keeping the first layer clear from dust and moisture and minimizing traffic on the first layer. However, care should be taken to allow sufficient time for the asphalt placement to set, generally the following day or when the surface temperature of the first lift cools to 38°C (100 °F). Two lifts afford better compaction of the entire lift, especially in colder weather and for large sites. Care must be taken to not damage or impair permeability of the base course if a multiple lift scenario is chosen. If significant site work will take place between placement of base and wearing courses higher durability mixes should be used for both layers.

   The Contractor shall protect all exposed surfaces that are not to be treated from damage during all phases of the pavement operation.

The asphalt mix shall be spread and finished with the specified equipment. The mix shall be struck off in a uniform layer to the full width required and of such depth that each course, when compacted, has the required thickness and conforms to the grade and elevation specified. Pavers shall be used to distribute the mix over the entire width or over such partial width as practical. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture shall be spread and raked by hand tools.

No material shall be produced so late in the day as to prohibit the completion of spreading and compaction of the mix during daylight hours, unless night paving has been approved and established for the project.

No traffic will be permitted on material placed until the material has been thoroughly compacted and has been permitted to cool to below 38 °C (100 °F). The use of water to cool the pavement is not permitted, other than that from drum rollers. The Engineer reserves the right to require that all work adjacent to the pavement, such as guardrail, cleanup, and turf establishment, is completed prior to placing the wearing course when this work could cause damage to the pavement. On projects where traffic is to be maintained, the Contractor shall schedule daily pavement operations so that at the end of each working day all travel lanes of the roadway on which work is being performed are paved to the same limits.

8. Compaction. Immediately after the asphalt mix has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. The compaction objective is 16% - 19% in place void content (Corelock).

   Breakdown rolling shall occur when the mix temperature is between 135-163°C (275 to 325°F). This is typically achieved with 1-2 passes with a 7.5 – 10-ton vibratory roller.

   Finish rolling shall occur when the mix temperature is between 66-93°C (150 to 200°F). This is typically achieved with a 1-ton roller with no vibratory compaction. Finish rolling is largely aesthetic and done for a smooth finished surface. Care should be taken so as to not continually roll the same location for instance back and forth to a water source.

   The cessation temperature occurs at approximately 79°C (175°F), at which point the mix becomes resistant to compaction. If compaction has not been performed at temperatures greater than the cessation temperature, the pavement will not achieve adequate durability. The temperatures referenced here are guidelines and have been used in the field to oversee successful permeable asphalt installations. Such situations where asphalt is placed will not be accepted by Engineer or Owner.

   The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking, or shoving.

   Rollers or oscillating vibratory rollers, ranging from 7.5 – 10 tons, shall be used for breakdown compaction. The number, mass (weight), and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Generally, one breakdown roller will be needed for each paver used in the

spreading operation.

To prevent adhesion of the mix to the rollers, rollers shall be kept moist with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot or lightly oiled hand tampers, smoothing irons or with mechanical tampers. On depressed areas, either a trench roller or cleated compression strips may be used under the roller to transmit compression to the depressed area.

Other combinations of rollers and/or methods of compacting may be used if approved in writing by the Engineer, provided the compaction requirements are met.

The speed of the roller shall be slow and uniform to avoid displacement of the mixture, and the roller should be kept in as continuous operation as practical. Finish rolling shall continue below the threshold temperature until all roller marks and ridges have been eliminated.

Rollers will not be stopped or parked on the freshly placed permeable asphalt.

It shall be the responsibility of the Contractor to conduct the process control necessary to achieve acceptable testing in accordance with the Contract Documents. Contractor to perform testing by an independent testing lab. The Engineer shall review and assess test results for conformance with contract documents.

Any mix that becomes loose and broken, mixed with dirt, or is in any way defective, shall be removed and replaced with fresh hot mix asphalt. The mix shall be compacted to conform to the surrounding area. Any area showing an excess or deficiency of binder shall be removed and replaced. These replacements shall be at no cost to the Owner.

If the Engineer determines that unsatisfactory compaction or surface distortion is obtained or damage to pavement components and/or adjacent property is occurring using vibratory compaction equipment, the Contractor shall immediately cease the Work and further using the equipment and proceed with the Work in accordance with the sixth paragraph of this subsection.

9. Joints. Joints between old and new pavements or between successive day's work shall be made to ensure a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mix to attain its initial stability, the paver shall be removed from the mat and a joint constructed.

Butt joints shall be formed by cutting the pavement in a vertical plane at right angles to the centerline, at locations approved by the Engineer. The Engineer will determine locations by using a straightedge at least 3 m (10 feet) long. The butt joint shall be thoroughly coated with Type RS-1 or equivalent emulsified asphalt just prior to

depositing the pavement mixture when pavement resumes.

Longitudinal joints that have become cold shall be coated with Type RS-1 or equivalent emulsified asphalt before the adjacent mat is placed. If directed by the Engineer, joints shall be cut back to a clean vertical edge prior to applying the emulsion.

10. Surface Tolerances. The surface will be tested by the Engineer using a straightedge at least 3 m (10 feet) in length at selected locations parallel with the centerline. Any variations exceeding 9.5 mm (3/8 inch) between any two contact points shall be satisfactorily eliminated. A straightedge at least 3 m (10 feet) in length may be used on a vertical curve. The straightedges shall be provided by the Contractor.

11. Work. Work performed shall be done expertly throughout, without staining or injury to other work. Transition to adjacent impervious asphalt pavement shall be merged neatly with flush, clean line. Finished pavement shall be even, without pockets, and graded to elevations shown on drawing.

12. Repair of Damaged Pavement. Any existing pavement on or adjacent to the site that has been damaged as a result of construction work shall be repaired to the satisfaction of the Engineer without additional cost to the Owner.

13. Striping Paint. Vacuum and clean surface to eliminate loose material and dust.

    Paint 4-inch wide (10 cm) parking striping and traffic lane striping in accordance with plan layouts. Apply paint with mechanical equipment to produce uniform straight edges. Apply in two coats at manufacturer's recommended rates. Provide clear, sharp lines using white traffic paint. Paint should conform with Federal Specification TT-P-85.

    Color for Handicapped Markings: Blue.

D. QC/QA for Paving Operations

1. The full permeability of the pavement surface shall be tested by application of clean water at the rate of at least 5 gpm over the surface, using a hose or other distribution devise. Water used for the test shall be clean, free of suspended solids and deleterious liquids and will be provided at no extra cost to the Owner. All applied water shall infiltrate directly without large puddle formation or surface runoff and shall be observed by the Engineer.

2. Testing and Inspection: Employ at Contractor's expense an inspection firm acceptable to the Engineer to perform soil inspection services, staking and layout control, and testing and inspection of site grading and pavement work. Inspection and list of tests shall be reviewed and approved in writing by the Engineer prior to starting construction. All test reports must be signed by a licensed engineer.

3. Test in-place base and surface course for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable work as directed by the

Engineer.

4. Surface Smoothness: Test finished surface for smoothness using a 3 m (10 foot) straightedge applied parallel with and at right angles to the centerline of the paved area. Surface will not be accepted if gaps or ridges exceed 9.5mm (3/8 inch).

5. Permeable pavement beds shall not be used for equipment or materials storage during construction, and under no circumstances shall vehicles be allowed to deposit soil on paved permeable surfaces.

6. QC/QA requirements during paving are summarized in Table 8.

Table 8: QC/QA Requirements During Paving

Activity	Schedule/Frequency	Tolerance
Inspect truck beds for pooling (draindown)	every truck	NA
Take temp of asphalt in truck	every truck	> 135°C (275°F)
Take temp of PA mix in the paver	each pull	within 6°C (10°F) of the recommended compaction temp
Consult with engineer to determine locations of butt joints	as needed	NA
Test surface smoothness and positive drainage with a 10' straightedge	after compaction	9.5 mm (3/8")
Consult with engineer to mark core locations	after compaction	NA
House test with at least 5 gpm water	after compaction	immediate infiltration, no puddling

E. Resurfacing

In cases where a permeable asphalt system was constructed, and the asphalt needs to be replaced, Contractor shall mill the older asphalt and resurface on the choker course rather than to use a tackifier and pave over the older asphalt.

1. Mill older asphalt down to choker course.
2. Restore the infiltration capacity with low angle pressure washing or air to a vacuum (for example the 15” vacuum attachment hose of a Tymco regenerative air vac).
3. Level and compact choker course.

3.5 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

C. Scheduled Compacted Thickness: Within 1/4 inch.

D. Variation from Indicated Elevation: Within 1/2 inch.

3.6 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting, testing.

B. Take samples and perform tests in accordance with AI MS-2.

C. Asphalt Paving Mix Temperature: Measure temperature at time of placement.

D. Asphalt Paving Thickness: ASTM D3549; test one core sample from every 1000 square yards compacted paving.

E. Asphalt Paving Density: ASTM D1188 or ASTM D2726; test one core sample from every 1000 square yards compacted paving.

3.7 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from mechanical injury for 8 hours or until surface temperature is less than 140 degrees F.

END OF SECTION 32 12 17

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aggregate base course.

2. Concrete paving for:
   a. Concrete residential streets.
   b. Concrete sidewalks.
   c. Concrete stair steps.
   d. Concrete integral curbs and gutters.
   e. Concrete parking areas.

B. Related Requirements:

1. Section 01 52 00 - Temporary Facilities.
2. Section 03 10 00 - Concrete Forming.
3. Section 31 23 33 - Trenching and Backfill.
4. Section 32 11 23 - Aggregate Base Courses.
5. Section 32 12 16 - Asphalt Paving.
6. Section 33 05 61 - Concrete Manholes.

1.2 STANDARDS

This Section is intended for work within the City of Detroit and is not intended to cover all standards and specifications of other jurisdictions. At a minimum, except as specified herein, comply with the latest version of the following standards:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
2. AASHTO Standard Practice MP 12-04 for Detectable Warning Surfaces.

B. American Concrete Institute (ACI):

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

C. ASTM International:

1. ASTM A184 - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
2. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
3. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
4. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
5. ASTM A775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
6. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
7. ASTM A934 - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
8. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
9. ASTM C33 - Standard Specification for Concrete Aggregates.
10. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
11. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
12. ASTM C136 - Standard Method for Analysis of Fine and Coarse Aggregate.
13. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
14. ASTM C150 - Standard Specification for Portland Cement.
15. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
16. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
17. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
18. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
19. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
20. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
21. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
22. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
23. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
24. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
25. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

D. City of Detroit:

1. Department of Public Works (DPW), City Engineering Division:
   a. Standard Specification for Paving and Related Construction.
   b. Street and Alley Standard Plans.

E. Michigan Department of Transportation (MDOT):

1. 2012 Standard Specifications for Construction.
2. Density Testing and Inspection Manual (rev 2017).

1.3 PRE-INSTALLATION MEETINGS

A. Comply with Section 01 30 00 – Administrative Requirements.

B. Convene Pre-Installation Meeting a minimum of two (2) weeks prior to commencing work of this Section.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit data on concrete materials, joint filler admixtures and curing compounds.

C. Design Data:

1. Submit concrete mix design on MDOT Form 1976 for each concrete strength. Submit separate mix designs when admixtures are required for hot and cold weather concrete work.
2. Identify mix ingredients and proportions, including admixtures.
3. Identify chloride content of admixtures and whether chloride was added during manufacture.
4. Submit finishing procedure for concrete hardscape located within local Historic District.

D. Source Quality Control Submittals: Indicate results of material source and batch plant tests and inspections.

1.5 QUALITY ASSURANCE

A. Perform Work according to MDOT Standard Specifications for Construction and this Section.

1.6 AMBIENT CONDITIONS

A. Do not place concrete when base surface is wet or frozen. Ambient temperature must be 32 degrees F and rising.

PART 2 - PRODUCTS

2.1 AGGREGATE BASE COURSE

A. Comply with Section 32 11 23 – Aggregate Base Courses.

2.2 CONCRETE PAVING

A. Form Materials:

1. Comply with ACI 301 and Section 03 10 00 – Concrete Forming.
2. Joint and joint filler materials for use in concrete pavements shall conform to the specific requirements of the current MDOT Standard Specifications for Construction, Section 914.

B. Reinforcement: Steel reinforcement for use in concrete pavements shall conform to the specific requirements of the MDOT Standard Specifications for Construction, Section 905.

C. Concrete Materials:

1. Concrete Materials: MDOT Standard Specifications for Construction, Section 901.
2. Cement: ASTM C150, Type I - Normal Type IA - Air Entraining Type III - High Early Strength Type IIIA - Air Entraining. MDOT Standard Specifications for Construction, Section 901.
3. Fine and Coarse Aggregates: MDOT Standard Specifications for Construction, Section 902.
4. Water: ASTM C94; potable, without deleterious amounts of chloride ions.
5. Air Entrainment: ASTM C260.
6. Chemical Admixtures: ASTM C494 (No admixtures shall contain calcium chloride).
   a. Type A - Water Reducing.
   b. Type D - Water Reducing and Retarding.
7. Fly Ash: MDOT Standard Specifications for Construction, Section 901.
8. Slag: MDOT Standard Specifications for Construction, Section 901.

2.3 MIXES

A. Concrete Mix - By Performance Criteria:

1. Mix and deliver concrete in conformance with MDOT Standard Specifications for Construction, Section 601.
2. Provide concrete to the following criteria:
    a. Detroit City Engineering Grade A:
        1) Compressive Strength: 4,000 psi at 28 days.
        2) Minimum Cement Content: 611 pounds/cu yd.
    b. MDOT Grade P-NC:
        1) Compressive Strength: 3,000 psi at 7 days.
        2) Compressive Strength: 3,500 psi at 28 days.
        3) Minimum Cement Content: 658 pounds/cu yd.
    c. MDOT Grade P-1M:
        1) Compressive Strength: 2,600 psi at 7 days.
        2) Compressive Strength: 3,500 psi at 28 days.
        3) Minimum Cement Content: 470 pounds/cu yd.
    d. MDOT Grade P1:
        1) Compressive Strength: 2,600 psi at 7 days.
        2) Compressive Strength: 3,500 psi at 28 days.
        3) Minimum Cement Content: 564 pounds/cu yd.
    e. MDOT Grade P2:
        1) Compressive Strength: 2,200 psi at 7 days.
        2) Compressive Strength: 3,000 psi at 28 days.
        3) Minimum Cement Content: 517 pounds/cu yd.
    f. Air Entrainment: 5.0 % to 8.5 % percent.
    g. Slump:
        1) Street Pavement: 3 inches.
        2) Alley Pavement and Curbs: 4 inches.
        3) Sidewalks and Driveways: 5 inches.

3. Limit the following cementitious materials to maximum percentage by mass of all cementitious materials:
    a. Fly Ash: 40 percent.
    b. Blast Furnace Slag: 40 percent.
    c. Fly Ash and Blast Furnace Slag (combined): 40 percent.

4. Use accelerating admixtures in cold weather only when approved by the Engineer in writing. Use of admixtures will not relax cold weather placement requirements.
5. Use calcium chloride only when approved by the Engineer in writing.
6. Use set retarding admixtures during hot weather only when approved by the Engineer in writing.

2.4 FINISHES

A. Shop Finishing - Reinforcement:

1. Epoxy Coated Finish for Steel Bars: MDOT Standard Specifications for Construction, Section 905.
2. Epoxy Coated Finish for Steel Wire: MDOT Standard Specifications for Construction, Section 905.

2.5 ACCESSORIES

A. Curing Compound: MDOT Standard Specifications for Construction, Section 903.

B. Joint Sealers: MDOT Standard Specifications, Section 914; hot applied type.

C. Detectible Warning Surface: Supply detectible warning surface materials in conformance with the AASHTO Standard Practice MP 12-04 for Detectable Warning Surfaces.

2.6 SOURCE QUALITY CONTROL

A. Testing and Inspection Services: Provide mix design for all concrete paving mixes and comply with Section 01 40 00 – Quality Requirements.

B. Submit proposed mix design of each class of concrete for review on MDOT Form 1976 prior to commencement of Work.

C. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements. Use materials only from MDOT Approved Sources.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Verify compacted subgrade or granular subbase is dry and ready to support paving and imposed loads.

1. Proof roll subbase with a fully loaded tri-axle dump truck (weight bearing on two rear axles) in minimum two perpendicular passes to identify soft spots.
2. Remove soft subbase and replace with compacted fill as specified in Section 31 23 33 – Trenching and Backfill.

C. Verify gradients and elevations of base are correct.

3.2 PREPARATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Moisten substrate to minimize absorption of water from fresh concrete.

C. Manholes, inlets, and other structures shall be set to grade and alignment prior to, or during placement of concrete.

D. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete paving.

E. Notify Engineer minimum 24 hours prior to commencement of concreting operations.

3.3 INSTALLATION

A. Aggregate Base Course: Install as specified in Section 32 11 23 – Aggregate Base Courses.

B. Forms:

1. Place and secure forms and screeds to correct location, dimension, profile, and gradient.
2. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Reinforcement:

1. Place reinforcing as indicated on drawings or standard details.
2. Place dowels to achieve paving and curb alignment as detailed.
3. Provide doweled joints as detailed on drawings or standard details.
4. Repair damaged epoxy coating to match shop finish.

D. Placing Concrete:

1. Place concrete using the slip form technique only if called for on the plans.
2. Do not disturb reinforcing, inserts, embedded parts, formed joints and dowel bars during concrete placement.
3. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
4. Concrete shall be distributed or spread as soon as placed. A mechanical concrete spreader may be used. Re-handling shall be kept to a minimum to avoid separation and segregation of materials.

E. Joints: Place and seal joints as called for by the City of Detroit, Department of Public Works, City Engineering Division Standard Specifications for Paving and Related Construction, and Street and Alley Standard Plans.

F. Finishing:

1. Sidewalk Paving: Light broom, and trowel joint edges, no greater than 1/4 inch radius.

2. Median Barrier: Light broom, and trowel joint edges, no greater than 1/4 inch radius.
3. Curbs and Gutters: Light broom.
4. Direction of Texturing: Transverse to paving direction.
5. Inclined Vehicular Ramps: Broomed perpendicular to slope.
6. Pedestrian Ramps: Broomed perpendicular to slope. Place detectible warning panels as shown in plans and standard details.
7. Place curing compound on exposed concrete surfaces immediately after finishing. Apply at rates specified in the MDOT Standard Specifications from Construction.
8. The installation of concrete hardscape within local historic districts shall not be a "bright white". Specifically, such concrete must be composed of an exposed aggregate, tinted grey, or finished with a clear or tinted grey curing compound.

G. Curing and Protection:

1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
2. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

3.4 STAMPED CONCRETE

A. Stamped Concrete shall be installed to match existing pattern and colors unless otherwise indicated by the Drawings.

B. All products and materials used in the stamped concrete including color, hardeners, release agents, curing compounds, and seals shall be per installed per manufacturer's instructions.

3.5 TOLERANCES

A. Comply with Section 01 40 00 – Quality Requirements and City of Detroit, Department of Public Works, City Engineering Division Standard Specifications for Paving and Related Construction, and Street and Alley Standard Plans.

B. Maximum Variation of Surface Flatness: 1/4-inch in 10 feet.

C. Maximum Variation from True Position: 1/4-inch.

3.6 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements.

B. Perform field testing according to ACI 301.

C. Inspect reinforcing placement for size, spacing, location, support.

D. Testing firm will take cylinders and perform slump and air entrainment tests according to ACI 301.

E. Strength Test Samples:

1. Sampling Procedures: ASTM C172.
2. Cylinder Molding and Curing Procedures: ASTM C31, cylinder specimens, standard cured.
3. Sample concrete and make one set of three cylinders for every 50 cu. yds or less of each class of concrete placed each day and for every 5,000 sf of surface area paving.
4. Make one additional cylinder during cold weather concreting, and field cure.

F. Field Testing:

1. Slump Test Method: ASTM C143.
2. Air Content Test Method: ASTM C231.
3. Measure slump and temperature for each compressive strength concrete sample.
4. Measure air content in air entrained concrete for each compressive strength concrete sample.

G. Cylinder Compressive Strength Testing:

1. Test Method: ASTM C39.
2. Test Acceptance: Average compressive strength of three consecutive test maximum 500 psi less than specified compressive strength.
3. Test one (1) cylinder at 7 days.
4. Test two (2) cylinders at 28 days.
5. Retain one (1) cylinder for 28 days.
6. Dispose remaining cylinders when testing is not required.

H. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.7 PROTECTION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

C. Do not permit pedestrian or vehicular traffic over paving for ten (10) days minimum after finishing.

END OF SECTION 32 13 13

SECTION 32 13 14 – PERMEABLE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Permeable Concrete paving for:
   a. Roadways.
   b. Alleys.
   c. parking areas.
   d. Sidewalks.
   e. Trails.

B. Related Requirements:

1. Section 31 05 17 – Aggregates for Storm Water Management.
2. Section 32 93 90 – Green Infrastructure Maintenance.

1.2 PRICE AND PAYMENT PROCEDURES

A. Section 01 20 00 - Price and Payment Procedures Contract Sum/Price.

B. Pervious Concrete Paving:

1. Basis of Measurement: By square yard.
2. Basis of Payment: Includes forms, aggregate base, concrete, accessories, placing, finishing, curing, and testing.

1.3 REFERENCE STANDARDS

A. American Concrete Institute:

1. ACI 522R-10 – Report on Pervious Concrete.
2. ACI 522.1-08 – Specifications for Pervious Concrete Pavement.
3. ACI 211.3R - Guide for Selecting Proportions for No Slump Concrete.

B. ASTM International:

1. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

2. ASTM C42- Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
3. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
4. ASTM C150 - Standard Specification for Portland Cement.
5. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
6. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
7. ASTM C1007 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction.
8. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete.
9. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
10. ASTM C1688 - Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete.
11. ASTM C1701 - Standard Test Method for Infiltration Rate of In Place Pervious Concrete.
12. ASTM C1754 - Standard Test Method for Density and Void Content of Hardened Pervious Concrete.
13. ASTM D994 - Standard Specification for Preformed Expansion Joint Filler for Concrete.
14. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction.
15. ASTM D 1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
16. MCA – Michigan Concrete Association.

1.4 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-Installation Meeting. Convene minimum one (1) week prior to commencing work of this Section.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Contractor Qualifications

1. Contractor shall submit name and qualifications of the previous concrete installer, providing written evidence of the following:
    a. Employment of at least one (1) Michigan Concrete Association (MCA) certified Pervious Concrete installer who shall be on site, overseeing each placement crew, during all concrete placement.

C. Concrete Producer Qualifications

1. Within seven (7) days after notice to proceed, Contractor shall furnish the name and location of an MDOT certified plant that will produce and provide pervious concrete.

D. Product Data:

1. Submit materials specifications for the concrete materials, aggregates, joint material, admixtures, pigments, and fibers.

E. Concrete Mix Design:

1. Not later than thirty-five (35) days before construction of pervious concrete, Constructor shall furnish:
   a. A proposed mix design with proportions of materials for acceptance as described in this specification, or otherwise specified in the Contract Documents. The data shall include unit weight, void ratio, and strength.

F. Test Panel: At least fifteen (15) working days before construction of pervious concrete, and following the Engineer's acceptance of the mix design, Contractor shall provide a test panel in accordance with this specification.

1.6 QUALITY ASSURANCE

A. Perform Work according to ACI 301, requirements of Section 03 10 00, Section 03 20 00, and Section 03 30 00.

B. Obtain cementitious materials from same source throughout.

C. Perform Work according to MDOT and MCA standards.

D. Maintain one copy of each document on site.

1.7 TEST PANEL

A. Section 01 40 00 - Quality Requirements: Requirements for mockup.

B. Contractor shall provide a minimum of one (1) test panel for acceptance. Place, joint, and cure the test panel, a minimum of 150 square feet in size, or as specified in the Contract Documents, at the required project thickness to demonstrate that in place void contents, unit weights, and infiltration rates can be met and to demonstrate effective jointing that does not compromise the cured concrete integrity.

C. Test Panel Infiltration: Test panels shall be tested for infiltration in accordance with ASTM C1701.

D. Test Panel Cores: Test panels shall have three (3) cores, each six (6) inches in diameter, taken from the panel a minimum of seven (7) days after placement of the pervious concrete. At least one core shall be taken within six (6) inches of a contraction joint. The cores shall be measured for thickness, void structure, and unit weight. Untrimmed, hardened core samples shall be used

to determine thickness in accordance with ASTM C 42. After thickness determination, the cores shall be trimmed and measured for unit weight in a saturated condition and void content in accordance with ASTM C 1754.

E. Test Panel Acceptance: Satisfactory test panels will be determined by:

1. Infiltration rate of at least 60 inches per hour.
2. Compacted thickness within ¼" of the specified thickness.
3. Void Content within two (2) percent of the design void content.
4. Unit weight within five (5) pounds per cubic foot of the design unit weight.

If the test panels meet the above-mentioned requirements, they can be left in place and included in the completed work. If test panels do not meet the above-mentioned requirements, they shall be removed and disposed of in an approved manner and replaced with an acceptable test panel at the contractor's expense.

F. Locate where directed by Engineer.

G. Remove Test Panel when directed by Engineer.

1.8 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Ambient conditions control facilities for product storage and installation.

B. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen. The concrete itself shall not be below fifty degrees Fahrenheit (50° F) at placement.

PART 2 - PRODUCTS

2.1 PERVIOUS CONCRETE

A. Form Materials:

1. Form Materials: Conform to ACI 301. As specified in Section 03 10 00.
2. Joint Filler: ASTM D1751; Asphalt impregnated fiberboard or felt, 1/4 inch thick.

B. Concrete Materials:

1. Cement: AASHTO M85 or ASTM C150, Portland type; gray color, unless otherwise specified on the plan.
2. Fine and Coarse Aggregates: ASTM C33, Class 4S.
   a. Coarse Aggregate Maximum Size: #8.

b. Fine aggregate should be a maximum 5-7% sand
c. Coarse and fine aggregate shall be double washed. Washing shall be sufficient to remove dust and other coatings.

3. Concrete Reinforcing Fibers: ASTM C1116, high strength industrial-grade fibers specifically engineered for secondary reinforcement of concrete. Tensile strength 130 > ksi; toughness 15 ksi; 3/4-inch-long fibers, 34 million/lb. fiber count.
4. Water: ASTM C94; potable.
5. Air Entrainment: ASTM C260.
6. Chemical Admixture: ASTM C49.
7. Color Pigment: ASTM C979; mineral oxides, alkali and fade resistant.
   a. Color: As per plan.

2.2 MIXES

A. Concrete Mix - By Performance Criteria:

1. Comply with ASTM C94 and develop a concrete mix design meeting the following requirements in accordance with ACI 211.3R, Appendix 6:
2. Select proportions for normal weight concrete according to ACI 301 Method 2.
3. Provide concrete to the following criteria:
   a. Minimum infiltration rate of 500 inches/hour. Testing in accordance with ASTM 1701.
   b. Void content: 18-22%.
   c. Compressive Strength: 2600 psi at seven (7) days.
   d. Compressive Strength: 3500 psi at twenty-eight (28) days.
   e. Combined coarse and fine aggregates gradation passing the #4 sieve shall be between 4% and 7%.
   f. Mix water quantity shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. Mix water yielding a cement paste with a dull dry appearance has insufficient water for hydration. Insufficient water results in inconsistency in the mix and poor bond strength between aggregate particles. High water content results in the paste reducing or eliminating the void system required for porosity.

4. Use accelerating admixtures in cold weather only when approved by the Engineer in writing. Use of admixtures will not relax cold weather placement requirements.
5. Use set retarding admixtures during hot weather only when approved by the Engineer in writing.
6. Use accelerating admixtures in cold weather when temperatures are below 40 degrees F. Use of admixtures will not relax cold weather placement requirements.
7. Use set retarding admixtures during hot weather when temperatures are above 90 degrees F.

2.3 ACCESSORIES

A. Curing Material:
   1. Six (6) mil thick polyethylene sheet.
   2. Alternative curing materials may be used as approved by the Engineer.

B. Joint Sealers: AASHTO M324, Type II hot applied type.

2.4 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and Inspection Services: Submit proposed mix design of each class of concrete to appointed firm for review prior to commencement of Work.

B. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.

C. Test samples according to ASTM C94 ACI 301.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify compacted aggregate base is dry and ready to support paving and imposed loads.

C. Verify gradients and elevations of base are correct.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Moisten substrate to minimize absorption of water from fresh concrete.

C. Notify Engineer minimum twenty-four (24) hours prior to commencement of concreting operations.

3.3 INSTALLATION

A. Install Aggregate Reservoir and Choker Layer per Section 31 05 17 – Aggregates for Storm Water Management.

B. Forms:
   1. Place and secure forms and screeds to correct location, dimension, profile, and gradient.
   2. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Placing Concrete:
   1. Place concrete according to MDOT 602 standards, and:
      a. Deposit concrete onto pre-wetted sub-grade either directly from transporting equipment or by conveyor, mixer truck chute, or buggy. Pervious concrete is not pumpable.
      b. Discharge shall be completed within sixty (60) minutes of the introduction of mixture water to the cement. Increase time to ninety (90) minutes when using an extended set control admixture. Water addition is permitted at the point of discharge.

D. Joints

   1. Contraction joints shall be installed at locations and spacing shown in the contract Documents at one quarter (1/4) the depth of the thickness or a maximum of one and a half (1-1/2) inches for roadway and alley pavements, and at one half inch (1/2") for sidewalks and trails. Allowable methods for joint placement, as directed by the Engineer include:
      a. Rolled Joints: Shall be formed in plastic concrete using a steel pipe roller to which a beveled fin with the required diameter to achieve the joint depth has been attached around the circumference of the roller. Roller joints are formed immediately after roller compaction and before curing. Sidewalks and trails shall have rolled joints.
      b. Sawed Joints: Shall be constructed as soon as the pervious pavement can be sawed without raveling the sawed edge and before initial cracking occurs, using a wet saw or an early entry saw. Sawed joints shall typically be constructed between twenty-four (24) hours and forty-eight (48) hours after concrete placement, depending on side conditions. At no time during the sawing process shall more pavement surface be exposed than that needed for sawing. Any dust or slurry generated during sawing shall be immediately removed during the sawing operation.

   2. Construction joints shall be installed at locations and spacing shown in the Contract Documents and whenever concrete placement is suspended for a sufficient length of time that concrete may begin to harden.
   3. Expansion joints shall be installed when pervious concrete will abut existing concrete slabs or other structures such as walls, footings, columns, catch basins, stairs, light poles, and other points of restraint.

4. To reduce raveling at joints, or where pervious concrete meets impervious pavement, finishing may be necessary.

E. Finishing:

1. Rolling compaction shall be achieved using a motorized or hydraulically actuated, rotating; weighted tube screed that spans the width of the section placed and exerts a minimum vertical pressure of 10 psi on the concrete. Alternatively, a steel pipe roller meeting the same criteria may be used.
2. Rolling shall be performed using a roller specifically designed to smooth and compact pervious concrete. Lawn rollers are not allowed.
3. Place curing compound on exposed concrete surfaces immediately after finishing.

F. Curing and Protection

1. Immediately after placement protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
2. The pavement surface shall be entirely covered with polyethylene sheet (within maximum twenty (20) minutes). Sheeting shall be cut to a minimum of the full lane width and pavement shall remain covered for at least seven (7) uninterrupted days.
3. Prior to covering, an evaporation retardant such as soy bean oil may be sprayed onto the pavement from both sides of the paving operation. Follow manufacturer's recommendations for application rate
4. Alternative curing materials may be used as approved by the Engineer.
5. Curing sheets shall be secured and kept secure at all times without using dirt.
6. Hot Weather Curing. A fog shall be sprayed above the surface, before cover, when required due to hot weather conditions. Equipment must include fog nozzles that atomize water using air pressure to create a fog blanket over the slab.
7. Cold Weather Curing: Curing shall be in accordance with MDOT 602.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Thickness: + 3/4 inch; - ¼ inch.

C. Elevation: + or – ½ inch.

D. Contraction joint depth: + ¼ inch, -0 inches.

3.5 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Perform field inspection and testing according to MDOT 602.

C. Testing firm will take cylinders and perform slump and air entrainment tests according to ACI 301.

D. Conduct tests in accordance with ASTM C1688 at the beginning of each pervious concrete placement operation for each batch, or for every 50 cubic yards (maximum), or a minimum of one (1) test for each day's placement, to verify fresh density and void content.

E. A minimum of seven (7) days following each placement, three (3) cores, and six (6) inches in diameter shall be taken. The cores shall be measured for thickness, void content, and unit weight determined using the methods in the Test Panel section of this specification. Satisfactory test panels will be determined by:
   1. Compacted thickness + 3/4", - ¼" of the specified thickness.
   2. Void content + or - the two (2) % of the specified void ratio.
   3. Unit weight + or - five (5) pounds per cubic foot the design unit weight.

F. If pervious concrete fails to meet the above requirements, the Engineer shall make a determination of acceptance, rejection, or acceptance at a reduced price.

G. The infiltration of the pavement surface shall be tested in accordance with ASTM C 1701. All applied water shall infiltrate directly with puddle formation or surface runoff, and the testing shall be observed by the Engineer. A minimum infiltration rate of 60 inches per hour shall be achieved.

H. Submit all test results to the Engineer.

I. Core holes shall be filled with standard concrete.

3.6 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

C. Do not permit pedestrian traffic over paving for seven (7) days minimum after finishing.

D. Do not permit vehicular traffic over paving for fourteen (14) days minimum after finishing.

END OF SECTION 32 13 14

SECTION 32 13 15 – PERMEABLE RUBBER PAVEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Permeable Rubber Pavement.
2. Subbase.
3. Root Barrier Fabric.
4. Underdrains (Optional).

B. Related Requirement:

1. Section 31 05 17 – Aggregates for Storm Water Management.
2. Section 32 93 90 – Green Infrastructure Maintenance.

1.2 UNIT PRICE AND MEASUREMENT

A. Permeable Rubber Pavement System:

1. Basis of Measurement: By square yard.
2. Basis of Payment: Includes backfill, compaction, permeable rubber pavement, root barrier fabric, geotextile, aggregate subbase, and all labor, tools, equipment and incidentals necessary to complete the work.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T-180 – Standard Method of Test for Moisture-Density Relations of Soils.

B. ASTM International:

1. ASTM C33 - Standard Specification for Concrete Aggregates.

2. ASTM D3385 – Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit product information for permeable rubber pavement materials and all products.
2. Submit proposed design mix with laboratory test results supporting design.

C. Samples for Verification:

1. Permeable Rubber: Provide two (2) 6 in. diameter samples, in specified color, full thickness.
2. Root Barrier Fabric: 2 ft. x 2 ft. sample.

1.5 QUALITY ASSURANCE

A. Perform Work according to DWSD standards.

B. Obtain materials from same source throughout.

C. Prior to installation, hold a Pre-Construction Meeting with the Engineer, owner representatives, the contractor and any other pertinent parties.

1.6 QUALIFICATIONS

A. Manufacturer Qualifications - Within seven (7) days after notice to proceed, the Contractor shall furnish the name and location of the manufacturer, and:

1. Submit a list of materials proposed for work under this Section including the name and address of all material sources and all bituminous mixing plants.
2. Submit certificates, signed by the material sources and the relevant subcontractors, stating that the materials meet or exceed the specified requirements.

B. Installer Qualifications:

1. Permeable Flexible Pavement installer shall be currently certified by the Manufacturer and have successfully installed a minimum of 10,000 square feet.
2. Permeable Flexible Pavement installer shall employ no less than two Manufacturer certified Permeable Flexible Pavement technicians on staff who directly oversee and perform the installations during all Permeable Rubber Pavement placement, unless otherwise specified.
3. Installer must provide a list of successful Permeable Flexible Pavement projects, including the address, square footage and photographs for each project. Manufacturer's certifications must be presented.

PART 2 - PRODUCTS

2.1 SUBBASE

A. Base aggregates shall be AASHTO No. 57 coarse aggregate (3/4" to 1 ½") with no fines, defined as <0.5% wash loss when tested with ASTM T-11, and shall meet the durability requirements of ASTM C33.

2.2 PERMEABLE RUBBER PAVEMENT

A. Bonding: Have the capacity to bind with: wood; steel; concrete; aluminum; compacted aggregate; enamel tile; or fiberglass.

B. Resistance to degradation: Resistance to degradation: Resistant to: chlorine; ozone; bromine; muriatic acid; salt water; oil; transmission oil, and; hydraulic oil.

C. Aggregate: Triple-washed coarse chipped granite aggregate (3/8 to 1/2 inch) per ASTM C 33.

1. Nominal maximum aggregate size shall not exceed 1/3 of the specified pavement thickness.

D. Rubber: Recycled passenger tires ground to 3/8" nominal with the wire remnants removed. Colorizing performed at the factory as tested and certified by Manufacturer.

E. Binding agent: Urethane liquid prepolymer based upon Diphenylmethane-Diisocyanate as tested and certified by the Permeable Flexible Pavement Manufacturer.

F. Air Entraining Agents: Prohibited.

G. Mix Design: Using materials acceptable to the Manufacturer design a tentative mix and test for the consistency intended for use on the work and specified.

1. The volume by weight of aggregate per cu. yd. shall be 50% of the total dry mix.
2. The volume by weight of the rubber product per cu. yd. shall be 50% of the total dry mix.
3. Permeability: Pervious infiltration rate of 2,000 gallons/square foot/hour.

H. Color: As specified in Contract Documents.

2.3 ROOT BARRIER FABRIC

A. Material that is used to prevent infiltration of plant and tree roots into Permeable flexible pavement.

2.4 UNDERDRAINS

A. PVC (perforated or non-perforated as specified in the Contract Drawings): Shall be Schedule 40 for underdrains and pipe risers.

B. HDPE for underdrain pipe along curves, as indicated on the Contract Drawings.

C. Frame and Cover:

1. EJ Model V1610/V3610;
2. Neenah Item No. R-1792;
3. Or approved equal.

D. Screw Cap: Shall be threaded PVC with 2-inch square lug.

E. Cleanout: The Cleanout cover assembly in pavement shall be cast iron and have an adjustable housing with scoriated cast iron cover as indicated in the Contract Drawings.

F. Observation Well: 2-inch well test plug using EnviroTech Ergo Grip or approved equal with tethering eyelet.

G. Backflow Valve: Shall be a backflow flapper (6 inch), Flex PVC Item No. S675P or approved equal.

PART 3 - EXECUTION

3.1 PROJECT SITE CONDITIONS

A. Minimize exposure to wind and heat before curing materials are applied.

B. Avoid placing if rain, snow, or frost is forecast within twenty-four (24) hours unless measures are taken as described later. Always protect fresh paving from moisture and freezing.

3.2 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify subgrade is dry and ready to support paving and imposed loads.

C. Verify gradients and elevations of base are correct.

3.3 SUBGRADE PREPARATION

A. Prepare subgrade as specified in the Contract Documents.

B. Construct subgrade to ensure that the required paving thickness is obtained in all locations.

C. Keep all traffic off of the subgrade during construction to the maximum extent practical. Regrade subgrade disturbed by delivery vehicles or other construction traffic, as needed.

D. Compact the material added to obtain final subgrade elevation.

E. Determine subgrade permeability in accordance with ASTM D3385 before permeable paving placement. Confirm that subgrade permeability meets requirements of Contract Documents.

3.4 UNDERDRAIN SYSTEMS

A. Perforated pipes. Shall be placed with perforations down. Pipe shall be placed with the bell end upgrade. Pipe sections shall be joined with appropriate couplings. The ends of underdrain pipe shall be plugged upgrade as directed by the Engineer.

B. Risers for Cleanouts/Observation Wells. Provide 4-inch PVC slotted well casing, with well point, extending twelve inches into subgrade. Set casing approximately two (2) inches below finished pavement elevation to allow clearance for test plug and cleanout cap. Provide 4-inch diameter PVC outer casing extending through pervious pavement into subbase and install 4-inch flush mounted cast iron cleanout with brass cap solvent welded to outer casing. Provide 2-inch well test plug with tethering eyelet.

In paved areas, provide frame and cover over cleanout and observation well riser pipes as indicated in the Drawings. For locations in permeable pavement, frames and covers shall be located within the permeable pavement area surrounded by PCC edge curb. Cleanouts and Observation wells shall be encased in concrete as shown in the Drawings. Connect riser to underdrain piping.

In non-paved areas, provide screw cap covers. Covers shall be set six (6) inches above final grade. Connect riser to underdrain pipe.

C. Backflow Preventer assembly to be located per the plans and as directed by the Engineer at a location upstream of proposed sewer field connection yet downstream of perforated underdrain pipe. Provide PVC riser pipe to protect PVC access sleeve pipe. Connect assembly to underdrain piping, using the appropriate reducer and tee fittings.

3.5 SUBBASE

A. Prepare subbase in accordance with Contract Documents, with 95% compaction per AASHTO T-180, installed over a Type 1 Geotextile.

B. Install root barrier fabric where called for on Contract Documents.

3.6 SETTING FORMWORK

A. Set, align, and brace forms so that the hardened paving meets the tolerances specified herein. Forms shall be clean and free of debris of any kind, rust, and hardened concrete.

B. Apply form release agent, either bio-diesel or vegetable oil coating to the form face which will be in contact with permeable paving, immediately before placing paving.

C. The vertical face of previously placed concrete may be used as a form.

1. Protect previously placed paving from damage.
2. Do not apply form release agent to previously placed concrete.
3. Apply bonding agent to face of surfaces when adhesion is desired. Placement width shall be as specified in Contract Documents.

3.7 BATCHING, MIXING, AND DELIVERY

A. Batch and mix on site in compliance with Manufacturer's written specifications, except that discharge shall be completed within five (5) minutes of the introduction of urethane to the dry products.

3.8 PLACING AND FINISHING PAVING

A. Do not place permeable paving on frozen or wet subgrade or subbase.

B. Deposit permeable paving either directly onto the subgrade or subbase by wheelbarrow or by material handler onto the subgrade or subbase, unless otherwise specified.

C. Permeable paving has a thickness of 2", over a minimum thickness of four (4) inches of Clean Coarse Aggregate (#57 stone) with 95% compaction per AASHTO T-180, or over other approved types of sub-base structural soil as shown in the Contract Documents.

D. Deposit permeable paving between the forms to an approximately uniform height.

E. Spread the permeable paving using a come-along, short-handle, square-ended shovel or rake.

F. Use steel trowels to finish to the elevations and thickness specified in Contract Documents.

3.9 FINAL SURFACE TEXTURE

A. Final surface of permeable paving shall be smoothed with bull float and magnesium trowels.

3.10 EDGING

A. When forms are not used, bevel the edge of the top surface to a 45° slope.

3.11 CURING

A. Begin curing within twenty (20) minutes of paving discharge, unless longer working time is accepted by the Manufacturer.

B. Completely cover the paving surface with a minimum 4 mil thick polyethylene sheet only if rain or sprinklers are imminent within twenty (20) minutes. Cut sheeting to a minimum of a full placement width.

1. Cover all exposed edges of paving with polyethylene sheet.
2. Secure curing cover material without using dirt.

C. Cure paving for a minimum of twenty-four (24) uninterrupted hours, unless otherwise specified.

3.12 HOT AND COLD-WEATHER CONSTRUCTION

A. In cold weather when temperatures may fall below freezing just after an installation, utilize a fan to maintain airflow over permeable paving during the curing process.

B. Permeable flexible pavement may be installed in warm weather with temperatures up to 95 degrees Fahrenheit without any special procedures.

C. Do not open the paving to light vehicular or pedestrian traffic until the permeable flexible pavement has cured for at least twenty-four (24) hours during warm weather, and 48 hours during very cold temperatures at or near freezing.

END OF SECTION 32 13 15

SECTION 32 13 16 – PERMEABLE GRASS PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Permeable Grass Pavement System.
2. Turf Conditioner.
3. Lawn Seeding.

B. Related Sections:

1. Section 31 05 17 – Aggregates for Storm Water Management.
2. Section 32 92 19 – Seeding.
3. Section 32 93 90 – Green Infrastructure Maintenance.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Permeable Grass Pavement System:

1. Basis of Measurement: By square yard.
2. Basis of Payment: Includes furnishing and placing turf conditioner, permeable grass pavement rings, sand filler material, aggregate subbase layer, base layer, seeding and all labor, tools, equipment and incidentals necessary to complete the work.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M6 Standard Specification for Fine Aggregate for Hydraulic Cement Concrete.

B. ASTM International:

1. ASTM F 1951-08 Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment.
2. ASTM D 638-10 Standard Test Method for Tensile Properties of Plastics.
3. ASTM C33 - Standard Specification for Concrete Aggregates.
4. ASTM C136 – Method for Sieve Analysis for Fine and Coarse Aggregates.

1.4 SYSTEM DESCRIPTION

A. The permeable grass pavement system provides vehicular and pedestrian load support for grass areas, while protecting grass roots from harmful effects of traffic.

B. Major Components of the System include:

1. Grass pavement units, typically assembled in rolls.
2. Engineered sand and gravel base course.
3. Soil amendment and fertilizer.
4. Sand fill.
5. Topsoil.
6. Lawn Seed and associated mulching.

C. Permeable grass paving units, sand, base course work together to support imposed loading.

D. Permeable grass paving units, sand fill, and soil amendments contribute to vegetation support.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate on shop drawings layout of permeable grass pavement units and submit design details showing proper cross-section of system.

C. Product Data: Submit data on characteristics of permeable grass pavement units. Manufacturer's product data and installation instructions.

D. Samples: Submit manufacturer's sample of unit and associated materials for Engineers approval.

E. Sieve analysis per ASTM C136 for the base course and sand fill materials.

1.6 QUALITY ASSURANCE

A. Perform Work according to DWSD standards.

B. Manufacturer Quality Certification: ISO Certification certifying manufacturer's quality management system is registered to ISO 9001: 2008 quality standards.

C. Manufacturer's Material Certification: Product manufacturers shall provide certification of compliance with all applicable testing procedures and related specifications upon written request. Request for certification shall be submitted by the purchasing agency no later than the date of order placement.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three (3) years' experience producing products for permeable pavement systems.

B. Installer: Contractor shall submit the name and qualifications of the permeable grass pavement system installer, providing written evidence of project experience and proficiency in successfully completing permeable grass pavement construction including a minimum of three (3) completed projects, total square footage to exceed the project quantities with owner information, addresses of each project.

PART 2 - PRODUCTS

2.1 PERMEABLE GRASS PAVEMENT UNITS

A. High density polyethylene (HDPE) grid.

B. Color: Black.

C. Color Uniformity: Uniform color throughout all unit rolls.

D. Ultraviolet light stable.

E. Required loading Capacity: 4000 psi (when filled with sand).

F. Tensile strength, pull-apart testing: Minimum 400lbf/in per ASTM D638 Modified.

G. System Permeability: Minimum 10 inches of water per hour.

H. Wheelchair Access testing for ADA Compliance: Passing ASTM F 1951-08.

I. Wheelchair Access testing for ADA Compliance: Passing Rotational Penetrometer testing.

2.2 SAND FILL MATERIALS

A. Sand for filling Permeable Grass Pavement Rings: Coarse, well-draining sand (washed concrete sand – AASHTO M6 or ASTM C-33), as required by manufacturer of the permeable grass pavement system.

2.3 TURF CONDITIONER

A. A natural humate-based soil additive which absorbs water and dissolved nutrients. Ingredients should include gypsum, sulfur, and oxidized lignate carbonaceous shale. Provide as recommended by and supplied by manufacturer.

2.4 AGGREGATE SUBBASE

A. A free-draining material of stone meeting the gradation of AASHTO No.57 stone and installed per requirements included in Section 31 05 17 - Aggregates for Storm Water Management.

2.5 AGGREGATE BASE:

A. A free-draining, pea gravel meeting the gradation of AASHTO No. 8, and installed per requirements included in Section 31 05 17.

B. pH range from 6.5 to 7.2 to provide adequate root zone development for turf.

2.6 SEEDING

A. See Specification 32 92 19: Seeding for hydroseeding and mulching requirements.

B. Use seed materials, of the preferred species for local environmental and projected traffic conditions, from certified sources. Wear-resistant, short-growth grass species including bluegrass/rye/fescue are recommended for this application. Seed shall be provided in containers clearly labeled to show seed name, lot number, net weight, % weed seed content, and guaranteed % of purity and germination. Pure Live Seed types and amount shall be as shown on plans.

C. Mulch – needed only for hydroseeding: Wood or paper cellulose commercial mulch materials compatible with hydroseeding operations. Mulch depth according to mulch manufacturers' recommendation. DO NOT use mulch of straw, pine needles, etc., because of their low moisture holding capacity.

D. Topsoil – needed only for seeding, recommended for hydroseeding: Obtain specified topsoil for a light "dusting" (no more than ½" or 13mm) above rings filled with sand for seeding germination.

E. Fertilizer - a commercial starter type with guaranteed analysis of 17-23-6 (nitrogen-phosphorus-potassium) or as recommended by local grass seed supplier may be used for rapid germination and root development. Fertilizer shall not be applied in excess of necessary quantities to promote the initial stabilization of vegetation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and Project Conditions.

B. Notify Engineer twenty-four (24) hours in advance of installation to allow verification substrate is ready to support pavers and imposed loads.

C. Verify gradients and elevations of substrate are correct.

3.2 SUBGRADE PREPARATION

A. Prepare subgrade per permeable grass paving system manufacturer's instructions and per Construction Drawings.

B. Proper subgrade preparation will enable permeable grass paving system to connect properly and remain level and stationary after installation.

C. Excavate area allowing for unit thickness, the engineered base depth (where required), and 0.5 inch for depth of topsoil germination area.

D. Provide adequate drainage from excavated area if area has potential to collect water, when working in-place soils that have poor permeability.

E. Uniformly grade base. Level and clear base of large objects, such as rocks and wood.

3.3 INSTALLATION

A. Place aggregate subbase course material over prepared subgrade to grades shown on plans, in lifts not to exceed 6", compacting each lift separately to 95% Proctor.

B. Place aggregate base course material over prepared subbase to grades shown on plans, in lifts not to exceed 6", compacting each lift separately to 95% Proctor. Leave sufficient available depth for permeable grass pavement unit and sand/sod fill to Final Grade, as per unit dimension and per Construction Drawings.

C. Spread all turf conditioner (spreader rate = 10 lbs. per 1076 ft2) evenly over the surface of the base course with a hand-held, or wheeled, rotary spreader. The mix should be placed immediately before installing the permeable grass pavement units to assure that the polymer does not become wet and expanded when installing the units.

D. Install the permeable grass pavement units by placing units with rings facing up, and using pegs and holes provided to maintain proper spacing and interlock the units. Units can be easily shaped with pruning shears or knife. Units placed on curves and slopes shall be anchored to the base course, using 40d Common nails with fender washer, as required to secure units in place. Tops of rings shall be between 0.25" to 0.5" below the surface of adjacent hard-surface pavements.

E. Install sand in rings as they are laid in sections by "back-dumping" directly from a dump truck, or from buckets mounted on tractors, which then exit the site by driving over rings already filled with sand. The sand is then spread laterally from the pile using flat bottomed shovels and/or

wide “asphalt rakes” to fill the rings. A stiff bristled broom should be used for final “finishing” of the sand. The sand must be “compacted” by using water from hose, irrigation heads, or rainfall, with the finish grade no less than the top of rings and no more than 0.25” above top of rings.

F. Install specified topsoil for a light “dusting” (no more than ½” or 13mm) above rings filled with sand for seeding germination.

G. Hydroseed/hydro-mulch specified lawn seed. Seed mixture to be sprayed onto site at rates shown on plans or per manufacturer’s recommendations. Coverage must be uniform and complete. Following germination of seed, areas lacking germination larger than 8 in x 8 in must be reseeded immediately. Seeded areas must be fertilized and kept moist during development of turf plants. Do not drive on system.

H. System must be protected from traffic for a period of 6 to 8 weeks until root system is established.

3.4 FIELD QUALITY CONTROL

A. Remove and replace segments of permeable grass pavement units where three or more adjacent rings are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent.

3.5 CLEANING

A. Perform cleaning during the installation of work and upon completion of the work. Remove all excess materials, debris, and equipment from site. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

3.6 MAINTENANCE

A. Maintain grass in accordance with manufacturer’s instructions and as specified in Section 32 93 90 - Green Infrastructure Maintenance.

B. Lawn Care: Normal turf care procedures should be followed, including dethatching.

C. DO NOT AERATE. Aerator will damage the paver units. Aeration in not necessary in a sand root zone.

D. When snow removal is required, keep a metal edged plow blade a minimum of ¾ inch (17 mm) above the surface during plowing operations to avoid causing damage to the paver units, or

1. Use a plow blade with a flexible rubber edge, or;
2. Use a plow blade with skids on the lower outside corners set so the plow blade does not come in contact with the units.

END OF SECTION 32 13 16

SECTION 32 14 17 – PERMEABLE BRICK UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes permeable clay paver units and the following:

1. Permeable Joint Aggregate - Void Filler.
2. Permeable Setting Bed Aggregate (Open-graded).
3. Permeable Base Aggregate (Open-graded).
4. Permeable Subbase Aggregate (Open-graded).

B. Related Requirements:

1. Section 31 05 17 – Aggregates for Storm Water Management.
2. Section 32 93 90 – Green Infrastructure Maintenance.

1.2 REFERENCES

A. ASTM International:

1. ASTM C902 – Standard Specification for Pedestrian and Light Traffic Paving Brick.
2. ASTM C1272 – Standard Specification for Heavy Vehicular Paving Brick.
3. ASTM C136 – Method for Sieve Analysis for Fine and Coarse Aggregate.
4. ASTM C67 – Method of Sampling and Testing Brick and Structural Clay Tile.
5. ASTM D448 – Standard Classification for Sizes of Aggregates for Road and Bridge.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Basis of Measurement: By square foot.

Basis of Payment: Includes preparation of subgrade and installation of base course materials, geotextile fabric, setting bed, clay pavers, aggregate joint materials and all other items necessary for the complete in place installation of the unit pavers.

1.4 DEFINITIONS

A. Base Course: Layer of open-graded washed aggregate beneath the bedding course comprised of small to medium particle-sized crushed stone. The recommended depth of the base layer shall be a minimum of 4” but shall not exceed 6”.

B. Bedding Course: Commonly called the setting bed is the layer of open-graded washed aggregate directly beneath the clay paver units comprised of small particle-sized crushed stone chips. Recommended depth of setting bed is 2".

C. Laying Face: The working edge of the pavement where the laying of the pavers is occurring.

D. Method Statement: The paver installer's and manufacturer's plan for construction and quality control of the pavers.

E. Spacer Bars: Small protrusions on the sides of pavers, which are used to create uniform joint spacing between pavers and minimize chipping.

F. Subbase Course: Layer of open graded washed aggregate beneath the base course comprised of large particle-sized crushed stone. Recommended depth will vary depending on site conditions such as frost depth, traffic loads, and specific water detention volume requirements. Minimum depth of subbase course shall be 12".

G. Joint aggregate - Void Filler: Open-graded aggregate used to fill the joints between pavers. The bedding course aggregate may be used as the void filler. Smaller particle-sized stone chips (1/8" to ¼") are preferable if available.

H. Wearing Course: The top surface of the paver.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Submit permeable clay paver product data:

1. Manufacturer's product catalog sheets with specifications.
2. Three representative full-size samples of each paver type, thickness, and color. Submit samples indicating the range of color expected in the finished installation.
3. Accepted samples become the standard of acceptance for the work of this Section.
4. Laboratory test reports certifying compliance of the clay pavers with ASTM C 902 or C1272.
5. Manufacturer's material safety data sheets for the safe handling of the specified materials and products.

C. Submit sieve analysis for grading of subbase, base, and bedding materials per ASTM C136 and wash loss per ASTM T11.

D. Submit text results for compliance of paving unit requirements to ASTM C 902 or ASTM C1272 from an independent testing laboratory.

E. Submit installer qualifications: Provide satisfactory evidence that the installer complies with the qualifications set out in this Specification.

1. The installer shall provide installation history, including references from a minimum of three (3) projects of a similar size and complexity in writing along with contact information, demonstrating the owner's satisfaction with their ability to perform the paver installation and related work indicated in the plans and specifications.

2. The installer shall have experienced personnel and management capability to execute the work detailed in the project drawings and specifications. The installer's foreman should have a minimum of five (5) years' experience in the installation of unit pavers including clay pavers.

F. Schedule & Work Plan: submit a detailed schedule and work plan.

G. Mock ups

1. Install a 10 ft. x 10 ft. paver area. This area will be used to determine surcharge of the bedding layer, joint sizes, lines, laying pattern(s), color(s), and texture of the job. This area shall be the standard from which the work will be judged.

1.6 QUALITY ASSURANCE

A. Comply with Section 01 40 00 – Quality Requirements.

B. Paver Installation Subcontractor Qualifications:

1. Utilize an installer having successfully completed permeable paver installation similar in design, material and extent indicated on this project.
2. Utilize an installer holding a completion certificate from the Pave Tech School for Advanced Segmental Paving Permeable Paving Systems course or equivalent.

C. Manufacturer's quality control plan.

D. Paver installation subcontractor's Method Statement and Quality Control Plan.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver brick pavers to the site in steel banded, plastic banded or wood wrapped cubes or on pallets capable of transfer by fork lift or clamp truck. Unload pavers at job site in such a manner that no damage occurs to the product.

1.8 SCHEDULING

A. Contractor shall contact paver's manufacturer to determine necessary lead-time to produce unit material order. Schedule manufacture and delivery of paver materials to coincide with construction schedule to prevent storage for extended periods.

1.9 PROJECT CONDITIONS

A. Do not install bedding or pavers during heavy rain or snowfall.

B. Do not install on frozen bedding.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Permeable clay brick pavers shall be used with spacer bars between each unit. These insure a minimum joint width between each unit in which the aggregate is placed. Spacer bars help prevent contact of the edges with adjacent pavers and subsequent chipping.

B. Clay pavers shall have the dimensions shown on the drawings.

C. Pavers shall meet the following requirements of ASTM C 1272 Specification for Heavy Vehicular Paving Brick and shall conform to the PX standard.

1. Minimum average compressive strength of 10,000 psi.
2. The average cold-water absorption shall not be greater than 6% with no individual unit testing greater than 7%. Absorption test results may not be achieved through the use of sealers or other products applied to the clay paver.
3. Resistance of 50 freeze-thaw cycles, when tested in accordance with ASTM C67. In addition, the clay paver must pass CSAA231.2 freeze thaw test in saline solution without the use of sealers or other products applied to the paver. A test report must be submitted by the manufacturer.
4. Dimensional tolerances should meet the PX (Pedestrian Extreme) standard of Brick Industry Association. In addition, the dimensional tolerances around the mean values for length, width, and depth shall be 1/16".
5. The pavers should be solid units without core holes or other perforations.
6. The contractor shall ensure that the manufacturer conducts a test sampling of 24 pavers every 50,000 pavers manufactured to determine the pavers compliance with dimensional and water absorption characteristics. The 24 paver samples shall be representative of the color mix in the typical finished package and chosen on a consistent basis from one kiln car.

2.2 AGGREGATE MATERIALS

A. All aggregate material shall be washed and clean of any debris, dirt or other undesirable material and fines before it arrives to the site, defined as < 0.5% wash loss when tested with ASTM T11.

B. Bedding Course and Void Filler Material: Double washed AASHTO #8 aggregate.

C. Base Course Aggregates: Aggregate shall be double washed AASHTO #57 stone in accordance with Section 31 05 17 – Aggregates for Stormwater Management. Aggregate shall be used as the finish (top) 4 to 6-inch layer of stone directly under the pavers and bedding course. Recycled aggregate material is not allowed.

D. Subbase Course Aggregate: Aggregate shall be double washed AASHTO #2 or #3 stone in accordance with Section 31 05 17 – Aggregates for Stormwater Management. Aggregate shall be installed below the Base Course Aggregate in a thickness as indicated by cross-sections, not less than 12 inches, as indicated on the Construction Drawings.

PART 3 – EXECUTION

3.1 GENERAL

A. Areas on which permeable unit paving are to be placed shall be constructed to the lines and grades shown on the Drawings and to the tolerances specified in this section and approved by the Engineer. The horizontal separation between the pavers and the aggregates gradation shall meet manufacturer's specification. All permeable pavers installed along a designated accessible route shall maintain horizontal gap separation between pavers within 10% of the manufacturer recommendation, and adjacent vertical changes in level shall not exceed 1/4 inch.

3.2 SUBGRADE

A. The inspecting engineer shall verify that the subgrade has been scarified to a depth of 4-inches, shaped and graded according to the plans. No compaction shall be performed.

B. If necessary, site grades can be raised using the same material as the largest base course being used on the project. The stone should be laid in 6" lifts and consolidated using a walk behind plate compacter.

C. Underdrains shall be installed as noted in the Construction Drawings.

D. When possible, subgrade shall be level. Where the slope of the ground exceeds 5%, the subgrade shall be terraced to provide a level bottom.

3.3 SUB-BASE COURSE

A. The sub-base shall consist of a minimum thickness as noted on the Construction Drawings and be consolidated using a walk behind vibratory plate compactor. It shall be installed in lifts not to exceed 6-inches.

3.4 EDGE RESTRAINTS

A. All edge restraints shall be constructed as shown on the plans and in place prior to the installation of the base course, bedding course and pavers.

3.5 BASE COURSE

A. The base course shall consist of a minimum thickness of four inches and a maximum thickness of 6" of aggregate placed in one lift and consolidated using a walk behind plate compactor until there is no visible movement. The base course shall be installed to the elevation and cross section per the Construction Drawings. Notify Engineer twenty-four (24) hours in advance of installation to allow verification with Contract Documents.

3.6 BEDDING COURSE

A. The bedding course shall be spread loose in a uniform layer to give a depth after compaction of the pavers of two inches, plus or minus ½". The contractor shall screed the bedding course using either a mechanical screed beam apparatus or by the use of screed guides and boards.

B. The screeded bedding aggregate shall not be subjected to any traffic by either mechanical equipment or pedestrian use prior to the installation of the pavers. The voids left after the removal of the screed rails shall be filled with loose aggregate as the paver bedding course proceeds.

3.7 PERMEABLE CLAY UNIT PAVERS

A. The pavers should be installed according to the information on the cube tag. The pavers should be laid from several cubes throughout the installation.

B. Lay pavers in the pattern as shown on the Construction Drawings.. Lay pavers away from the existing laying face or edge restraint in such a manner as to ensure that the pattern remains square. Chalk lines (use a heavier chalk cord) shall be used upon the bedding course to maintain straight lines. Joint spacing between pavers shall be between 1/8" and 1/4"; however the joint width may be increased up to 3/8" to maintain straight lines. Lines and grades shown on the plans shall be established and maintained during the installation of the pavers.

C. Pavers should be cut according to the instructions on the cube tag. Pavers shall be cut using a table mounted masonry wet saw.

D. Once the pavers have been placed upon the bedding course and all cut pavers have been inserted to provide the complete surface, inspect the pavers for damaged units and remove and replace those units. Once all pattern lines have been straightened, the void filler shall then be placed into the paver openings to the top of the chamfer on the pavers and the surface swept broom clean.

E. The pavement surface shall be compacted to achieve consolidation of the bedding course and pavers and brought to design levels and profiles by two passes of a suitable plate compactor. Compaction of the pavers shall be accomplished by the use of a vibratory plate compactor capable of a minimum of 4,500 pounds of compaction force. No compaction shall be permitted within three feet of unrestrained edges of the pavement. After compaction, inspect the pavers for damaged units and remove and replace those units.

F. After completing compaction, the surface tolerances shall be flush with finished grades. The pavers shall be flush with edge restraints. Additional void filler material shall be swept into the joints as required, to within ½" from the bottom of the chamfer on the paver. Upon completion, the pavement surface shall be swept clean of all excess materials. Remove excess material from site.

3.8 SPACERS

A. Spacers shall be used where specified on construction drawings.

3.9 AGGREGATE INSTALLATION

A. Install and compact Subbase Aggregate in 6 to 8-inch lifts with a roller, to the depth indicated on the Drawings. Aggregate installation shall not damage nor dislodge the geotextile. Install Base Course Aggregate directly on top of Subbase Aggregate in one lift. Grade to a smooth plane surface; roll and compact with a plate compactor in both the perpendicular and parallel directions in the area of coverage.

3.10 GEOTEXTILE SEPARATOR

A. Install geotextile along the sides of the installation to prevent contamination of clean base stone. Geotextile shall be placed free of wrinkles and overlapping a minimum of 12 inches.

3.11 EDGE RESTRAINTS

A. Install all concrete edge restraints as shown on Drawings after placing the Subbase Aggregate according to the Drawings and Specifications.

3.12 FINISHING

A. The joints between the pavers may or may not require backfilling with smaller aggregates or sand in order to function properly, depending on the type of paver units. While the pavers are not themselves permeable, the joints should maintain sufficient open space to meet the manufacturer infiltration rates for the pavement throughout the life of the system; this includes following all maintenance procedures.

3.13 PROTECTION

A. Once installed, the pavers must be protected from sediment contamination from vehicular tracking, construction runoff, and other construction- related sources. Any sediment/debris found in the pavers' joints that are finer than the designed aggregate fill must be removed by manufacturer approved methods prior to Post Installation Certification. All Work associated with the paver installation (sub-base, stone, and block) needs to be protected in all phases of the construction until the project is complete.

3.14 POST INSTALLATION CERTIFICATION

A. Upon completion of the pavers installation, the surface infiltration rate of the pavement shall be verified by ASTM C1781 to confirm the required infiltration rate of the pavement of minimum 500 in/hr. If the system fails to perform as required, it shall be removed and replaced at the Contractor's cost. The expenses associated with this pavement shall be verified by ASTM C1781 to confirm the required infiltration rates

3.15 INSPECTION AND MAINTENANCE PERIOD

A. Within 6 to 8 months of completion, the manufacturer's representative shall provide a minimum 36-month maintenance program; including a visual inspection report with photos and recommended cleaning schedule. The expenses associated with this inspection report and maintenance schedule are included in the cost of the permeable system.

Maintenance utilizing a combination sanitation vactor truck with the permeable pavement vac head will be quoted and supplied by others based on the maintenance program. Maintenance shall be required when either of the following conditions are met:

1. The surface infiltration rates of more than 75 percent of the total permeable surface falls below 10 percent of the initial infiltration rates as determined in the post installation infiltration certification as required by this specification.
2. Ponding remains for twenty-four (24) hours in an area greater than ten (10) square feet of the permeable surface.

END OF SECTION 32 14 17

SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fence framework, fabric, and accessories.
2. Excavation for post bases.
3. Concrete foundation for posts.
4. Manual gates and related hardware.

B. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete.
2. Section 31 23 33 – Trenching and Backfilling.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. ASTM International:

1. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
5. ASTM A491 - Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
6. ASTM A817 - Standard Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire.
7. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
8. ASTM B429/B429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
9. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
10. ASTM F552 - Standard Terminology relating to Chain Link Fencing.
11. ASTM F567 - Standard Practice for Installation of Chain-Link Fence.
12. ASTM F626 - Standard Specification for Fence Fittings.

13. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
14. ASTM F900 - Standard Specification for Industrial and Commercial Swing Gates.
15. ASTM F934 - Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
16. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
17. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
18. ASTM F1183 - Standard Specification for Aluminum Alloy Chain Link Fence Fabric.
19. ASTM F1184 - Standard Specification for Industrial and Commercial Horizontal Slide Gates.
20. ASTM F1345 - Standard Specification for Zinc - 5% Aluminum - Mischmetal Alloy-Coated Steel Chain-Link Fence Fabric.

B. Chain Link Fence Manufacturers Institute (CLFMI):

1. CLFMI - Product Manual.

C. Michigan Department of Transportation (MDOT):

1. MDOT 2012 Standard Specifications for Construction, Section 808, Fencing.

1.3 SYSTEM DESCRIPTION

A. Fence Height: Fabric height shall be 4 feet, 6 feet, 8 feet, 10 feet, or 12 feet accordingly, unless specified otherwise in the Drawings.

B. Line Post Spacing: At intervals not exceeding 10 feet.

C. Fence Post and Rail Strength: Conform to ASTM F1043 Light Industrial Fence quality.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings:

1. Locations of fence, each gate, posts, rails, and tension wires and details of extended posts, extension arms, gate swing, cantilever gate or other operation, hardware, and accessories.
2. Indicate materials, dimensions, sizes, weights, and finishes of components.
3. Include plans, elevations, sections, gate swing, and other required installation and operational clearances, and details of post anchorage, attachments, and bracing.

C. Product Data:

1. Fence and gate posts, rails, and fittings.
2. Chain-link fabric.
3. Gates and hardware.
4. Material certifications and test documentation.

D. Samples: For the following products, showing the full range of color, texture, and pattern variations expected. Mark or tag each sample. Prepare samples from the same material to be used for the Work.

1. Provide a 1 sq. ft. piece of steel wire (for fabric).
2. Provide a 6-inch piece of post and rail materials, unless directed otherwise by the Engineer.
3. Provide 1 sample of each: latch type and locking assembly.
4. Provide 1 sample of each: stop, drop rod assembly and keeper(s).
5. Submit all samples in a single sample submission at least 30 days prior to erection of fence, unless directed otherwise by the Engineer.

1.5 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

1.6 QUALITY ASSURANCE

A. Supply material according to CLFMI - Product Manual.

B. Complete installation according to ASTM F567, unless specified otherwise.

1.7 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum 3 years documented experience.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.

B. Identify each package with manufacturer's name.

C. Store fence fabric and accessories in secure and dry place.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: Match existing height unless otherwise listed on the Drawings.

2. Steel Wire for Fabric: Wire diameter of 0.148-inch (9-gauge).
   a. Mesh Size: 2 inches, diamond, interwoven.
   b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 2, 2.0 oz./sq. ft. with zinc coating applied after weaving.
   c. Aluminum-Coated Fabric: ASTM A 491, Type, I, 0.40 oz./sq. ft.

3. Salvage:
   a. 4 ft. Fence Height and Under: Knuckled selvage on top and twisted selvage on bottom.
   b. 6 ft. Fence Height and Taller: Twisted selvage on top and bottom.

2.2 TERMINAL, CORNER, AND PULL POSTS

A. Round steel pipe: ASTM F1083 Schedule 40 standard weight pipe, 2.0 oz./sq. ft. hot dip galvanized zinc exterior and 2.0 oz./sq. ft. hot dip galvanized zinc interior coating. Regular Grade: Minimum steel yield strength 30,000 psi.

1. Fence Height 6 ft. or shorter: 2-3/8-inch diameter O.D. 3.65 lb./ft.
2. Fence Height Over 6 ft. to 8 ft.: 2- 7/8-inch diameter O.D. 5.80 lb./ft.
3. Fence Height Over 8 ft. to 12 ft : 4-inch diameter O.D. 9.12 lb./ft.

B. Length: A minimum of 3'-6" longer than the specified height of the fence.

2.3 LINE POSTS

A. Round steel pipe: ASTM F1083 Schedule 40 standard weight pipe, 2.0 oz./sq. ft. hot dip galvanized zinc exterior and 2.0 oz./sq. ft. hot dip galvanized zinc interior coating. Regular Grade: Minimum steel yield strength 30,000 psi.

1. Fence Height 6 ft. or shorter: 1-7/8-inch diameter O.D. 2.72 lb./ft.
2. Fence Height Over 6 ft to 8 ft: 2-3/8-inch diameter O.D. 3.65 lb./ft.
3. Fence Height Over 8 ft to 12 ft: 2-7/8-inch diameter O.D. 5.80 lb./ft.

B. Length: Line post length shall be in accordance with the footing requirements under Section 2.4.

2.4 LINE POST FOOTING

A. Post shall be driven with a total length below finish grade according to the following:

1. Fence Height = 4’: 4’ below finish grade.
2. Fence Height = 6’: 4’-6” below finish grade.
3. Fence Height = 8’: 6’ below finish grade.
4. Fence Height = 10’: 6’ below finish grade.

2.5 TERMINAL, CORNER, AND GATE POST FOOTINGS

A. In accordance with ATM F567 except:

1. For fence heights 8 ft. and under: Concrete footings shall be 12-inch diameter and a minimum 42 inches deep.
2. For fence heights Over 8 ft. to 12 ft.: Concrete footings shall be minimum 18-inch diameter and a minimum 54 inches deep.

B. Footing hole shall have a uniform vertical surface to the bottom of the footing.

2.6 PULL POST FOOTINGS

A. In accordance with ASTM F567, except concrete footing(s) shall be 10-inch diameter and a minimum of 42 inches deep with a uniform and plumb vertical surface.

2.7 TENSION WIRE

A. Metallic Coated Steel Marcelled Tension Wire:

1. 7-gauge Marcelled wire complying with ASTM A 824.
2. Type II Zinc-Coated, ASTM A 817 Class 5 – 2.0 oz./sq. ft.

2.8 BARBED WIRE

A. Metallic Coated Steel Barbed Wire:
1. Comply with ASTM A 121, Design Number 12-4-5-14R, double 12-1/2-gauge twisted strand wire, with 4-point 14-gauge round barbs spaced 5 inches on center.
2. Match coating type to that of the chain link fabric.
3. Coating type Z- Zinc-Coated: Strand wire coating Type Z, Class 3, 0.80 oz./sq. ft., barb coating 0.70 oz./sq. ft.

2.9 FITTINGS

A. Tension and Brace Bands: Galvanized pressed steel complying with ASTM F 626, minimum steel thickness of 12-gauge, minimum width of 3/4-inch and minimum zinc coating of 1.20 oz./sq. ft. Secure bands with 5/16-inch galvanized steel carriage bolts.

B. Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves: In compliance with ASTM F 626, pressed steel galvanized after fabrication having a minimum zinc coating of 1.20 oz./sq. ft.

C. Truss Rod Assembly: In compliance with ASTM F 626, 3/8-inch diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.2 oz./sq. ft., assembly capable of withstanding a tension of 2,000 lbs.

D. Tension Bars: In compliance with ASTM F 626. Galvanized steel one-piece length 2 inches less than the fabric height. Minim zinc coating 1.2 oz./sq. ft. Bars for 2-inch mesh shall have a minimum cross section of 3/16-inch by ¾-inch.

E. Barbed Wire Arms: In compliance with ASTM F 626, pressed steel galvanized after fabrication, minimum zinc coating of 1.20 oz./sq. ft., capable of supporting a vertical 250 lb. load.

1. Typical Fence Line: Type I – three strand 45-degree arm.
2. Typical Gate: Type II – three strand vertical arm.

F. Tie Wire and Hog Rings for fabric attachment: Rings shall be 6-gauge galvanized steel. Tie wires shall be 6-gauge galvanized steel.

2.10 SWING GATES

A. Include the entire assembly to construct the gate system to match existing height or at the height indicated on the Drawings to match gate fabric to that of the fence system specified (refer to Article 2.1).

1. Swing gate shall be hot dip galvanized steel pipe, welded fabrication in compliance with ASTM F 900. Gate frame members shall be a minimum of 2-inch diameter O.D. schedule 40 galvanized steel pipe, in compliance with ASTM F 1083.
2. Frame members shall be spaced no greater than 8 feet apart vertically and horizontally.
3. After fabrication protect the welded areas by applying zinc-rich paint in accordance with ASTM practice A780 per the manufacturer's specifications.
4. Fabric: Identical to that used on the fence assembly. Stretcher and tension bars, wire, rings, and clips shall be identical to the fence fabric.
5. Hinges, Stops, Center Drop Rod and Keepers: Items shall be of structural steel and shall be of appropriate size and quality to accomplish hinges from not twisting and turning, including holding the gate in alignment with the rest of the fence. Latches shall keep the gates even with each other and in alignment with the fence line. Stops, center drop rod, and

keepers shall prevent the fence from going in undesired areas and directions for the purpose intended. All appurtenances shall match color of fence fabric.

6. Latches: Provide commercial galvanized steel latches permitting operation from both sides of gate. Latches shall have integral eye openings for padlocking option. (Padlock by others).
   a. Basis of Design for Single-leaf:
      1) Strong Arm Walk Gate Latch: Heavy duty galvanized steel manufactured by: DAC Industries, Inc., 615 Eleventh Street NW, Grand Rapids, MI 49504; (800) 888-9768.
      2) Or approved equal.

   b. Basis of Design for Double-leaf:
      1) Strong Arm Double Gate Latch: Commercial galvanized steel manufactured by: DAC Industries, Inc., 615 Eleventh Street NW, Grand Rapids, MI 49504; (800) 888-9768.
      2) Or approved equal.

7. Single Swing Gate Posts: ASTM F1083 Schedule 40 standard weight pipe, 2.0 oz./sq. ft. hot dip galvanized zinc exterior and 2.0 oz./sq. ft. hot dip galvanized zinc interior coating. Regular Grade: Minimum steel yield strength 30,000 psi.

   a. For gate openings less than 13 ft.: 4” O.D. 9.12 lbs./ft.
   b. For gate openings 13 ft. to 18 ft.: 6-5/8” O.D. 18.99 lbs./ft.
   c. For gate openings 19 ft. to 20 ft.: 8-5/8” O.D. 28.58 lbs./ft.

8. Double Swing Gate Posts: ASTM F1083 Schedule 40 standard weight pipe, 2.0 oz./sq. ft. hot dip galvanized zinc exterior and 2.0 oz./sq. ft. hot dip galvanized zinc interior coating. Regular Grade: Minimum steel yield strength 30,000 psi.

   a. For gate leafs 13 ft. to 3 ft.: 4” O.D. 9.12 lbs./ft.
   b. For gate leafs 14 ft. to 17 ft.: 6-5/8” O.D. 18.99 lbs./ft.
   c. For gate leafs 18 ft. to 20 ft.: 8-5/8” O.D. 28.58 lbs./ft.

9. When Double Gates are required: Provide and install the following

   a. Drop rod to hold gate leaf closed. To hold gate leaf in closed and secured drop rod to pavement, provide galvanized steel “U” channel 12” long securely positioned in the pavement, directly below the drop rod in the closed position, and that is parallel to the closed gate, and flush with pavement.
   b. Gate stop to engage gate when in open position.

2.11 HORIZONTAL SLIDING GATES:

A. Type I-Overhead Slide Gates: ASTM F 1184 Type I. Gate framing shall be welded construction, minimum of 2-inch diameter O.D. schedule 40 galvanized steel pipe, in compliance with ASTM F 1083.

1. Frame members shall be spaced no greater than 8 feet apart vertically and horizontally.
2. After fabrication protect the welded areas by applying zinc-rich paint in accordance with ASTM practice A780 per the manufacturer's specifications.
3. Positive locking latch, pressed steel, galvanized after fabrication. Galvanized steel drop bars shall be provided with double gates.
4. Chain-link Fabric: Identical to that used on the fence assembly.
5. Manufacturer's standard overhead beam/structure, track, rollers, and accessories designed to support the load of the gate panel taking into consideration wind load and possible icing. The support beam/structure shall be galvanized or receive proper corrosion protection.
6. Gate posts shall be in compliance with ASTM F 1083 schedule 40 galvanized steel pipe.
    a. For gate openings 10 ft. and less: Gate posts shall be 2-7/8" O.D. 5.80 lb./ft.
    b. For gate openings 24 ft. and greater than 10 ft: Gate posts shall be 4" O.D. 9.12 lb./ft.
    c. For gate openings up to 40 ft. and greater than 24 ft.: Double gate posts shall be 4" O.D. 9.12 lb./ft.

B. Cantilever Slide Gates:

1. Class 1 – External Roller Design: Horizontal top and bottom steel track members shall be 2-3/8" O.D 3.65 lb./ft. Vertical and internal members, 1-7/8" O.D. 2.72 lb./ft. in compliance with ASTM F 1083 schedule 40 galvanized steel pipe.

    a. Gate frame shall be fabricated by welding, vertical and horizontal members installed no greater than 8 ft. apart.
    b. Welded joints shall be protected by applying zinc-rich paint in accordance with ASTM Practice A780.
    c. Gates designed to open or close by applying an initial pull force no greater than 40 lbs.
    d. Chain-link Fabric: Identical to that used on the fence assembly.
    e. Positive locking pressed steel latch, galvanized after fabrication. Galvanized steel drop bars shall be provided with double gates.
    f. Gate posts, 4" OD schedule 40 per ASTM F 1083 Provide safety protective guards for the top and bottom external rollers following ASTM F 1184 guidelines.

2. Class 2-Internal Roller Design: Gate frame shall be fabricated by welding vertical and horizontal members installed no greater than 8 ft. apart. Class 2 cantilever slide gates shall comply with the performance deflection criteria listed in ASTM F 1184. Gates designed to open or close by applying an initial pull force no greater than 40 lbs. Internal truck assemblies designed to handle the forces required for gate size opening and height. Match chain link fabric to that of the fence system. Gate posts, 4" O.D. schedule 40 pipe per ASTM F 1083.

a. Aluminum Frame Design: Aluminum rectangular members of various shapes and wall thickness per manufacturers design for gate opening and height. Top horizontal member shall be one-piece extruded section having an integral internal track to accommodate truck assemblies.

C. Electrically operated horizontal slide gates must be manufactured and installed to comply with safety requirements of ASTM F 2200 and UL 35.

2.12 CAST-IN-PLACE CONCRETE

A. Materials: Portland cement complying with ASTM C150, Type 1, aggregates complying with ASTM C 33, and potable water for ready-mixed concrete in accordance with ASTM C94.

1. Concrete Mix: Normal weight concrete, air entrained, with not less than 3,500 psi compressive strength (28 days).

B. Materials: Dry-packaged concrete mix complying with ASTM C 387 for normal-weight concrete mixed with potable water according to the manufacturer's written instructions.

1. Concrete Mix: Normal weight concrete, with not less than 3,500 psi compressive strength (28 days).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by the Engineer.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, underground lawn sprinkler system, underground structures, benchmarks, and property monuments.

B. Anchorages, footings or fence appurtenances shall not extend beyond the limits of the right-of-way, or private property, without the written consent of the abutting property owner.

3.3 CHAIN-LINK FENCE INSTALLATION

A. General: Install framework, fabric, accessories, and gates according to ASTM F567 with the exceptions specified herein.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect above ground portion of posts from concrete splatter.
    a. Exposed concrete shall be flush with the grade; shape and smooth to slope to shed water away from the post.

D. Line Post Spacing: Set first corner, gate and pull posts first. Space line fence posts equally not exceeding 10 feet on center.

E. Corner, Gate, Terminal, and Pull Post Footing: Install terminal pull posts at changes in horizontal or vertical alignment of 30 degrees or more, or at any abrupt change in grade, and at intervals not greater than 500 feet. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

1. Corner, Gate, and Terminal post footings: Only concrete footings shall be used and shall be minimum 12-inch diameter x a minimum of 42 inches deep. 2 inches of concrete shall be placed below the bottom of the post.
2. Pull post footings shall be minimum 10-inch diameter x a minimum 42 inches deep.

F. Line Post Footings: Shall be driven to the proper depth depending on the height of the fence to match existing or as indicated on the Drawings.

G. Post Bracing and Intermediate Rails:

1. Maintain plumb position and alignment of fence posts.
2. Diagonally brace terminal posts to adjacent line post with truss rods and turnbuckles.
3. Install braces at end and gate post and at both sides of corner and pull posts.
4. Locate horizontal braces at mid-height of fabric with 72 inches or higher, on fences with top rail, and at 2/3 fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

H. Top Rail: Maintain plumb position and alignment of fence posts. Run rail continuously (21 ft. lengths) through line post caps or barb arm loop tops, bending to radius for curved runs, and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Bottom Rails: Secure to posts with fittings.

J. Fabric: Install fabric to the secure side of fence, outer side of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released. If new fabric abuts existing fabric, the new fabric shall be woven into the existing fabric at both ends of the 2 sections.

1. Bottom clearance: Leave approximately 2 inches between the finish grade and bottom selvage.

K. Tie Wires: Manually or power fastened ties configured to wrap a full 360 degrees around a rail or post and a minimum of 1 complete diamond of fabric. Twist ends one and one-half machine twists or three full manual twists and cut off protruding ends to preclude untwisting by hand.

1. Tie fabric to line posts with ties space at not more than 12 inches o.c.
2. Tie fabric to tension wire with hog ring ties on 24 inches o.c.

L. Tension or Stretcher Bars: Pull fabric taut, thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c. One tension bar for each terminal and 2 for each corner or pull post.

M. Tension Wire: When indicated in the Drawings, in lieu of top rail, attach directly to the fabric not less than 3 inches or more than 6 inches from the top of the fabric. Tension wire shall be stretched taut, independently and prior to the fabric, between the terminal posts and secured to the terminal post using a brace band. Secure the tension wire to each line post with a tie wire.

1. Bottom Tension Wire (Optional): attach 6 inches from the bottom of the fabric with appropriate steel clips to match the fabric.
2. For fences with barbed wire and no top rail: Install top tension wire through the barb arm loop.

N. Tension Bands: Secure to terminal and corner posts using 5/16” carriage bolts at 15 inches on center.

O. Barbed Wire: Install barbed wire uniformly spaced, to match existing or as indicated on Drawings. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

3.4 GATE INSTALLATION

A. Install gate posts in accordance with manufacturer’s instructions and as specified in Article 3.3, E. Set keepers, stops, sleeves, and other accessories into concrete and position out of the way of normal traffic, but located to provide reliable performance.

B. Install gate plumb, level and secure for full operation without interference.

C. Attach hardware by means which will prevent unauthorized removal.

D. Adjust hardware for smooth operation and lubricate moving parts where necessary. Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.5 ADJUSTING

A. Fence and accessories shall be installed to match existing conditions or in strict accordance with the Drawings and Specifications in a workmanlike manner. Finished fence shall be in proper alignment with posts plumb, and fabric, tension, and barb wires taut.

3.6 CLEANING

A. Fence installation will not be considered complete until excess excavated materials, cut wires, spilled concrete, and other debris, including existing fence to be removed, resulting from the fence construction, is removed and legally disposed of.

END OF SECTION 32 31 13

SECTION 32 31 29 - WOOD FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fence framework, pickets, gates, and accessories.
2. Excavation for post bases.
3. Concrete foundation for posts.
4. Manual gates and related hardware.
5. Removal of existing fence.

B. Related Requirements:

1. Section 03 20 00 - Concrete Reinforcing.
2. Section 03 30 00 - Cast-in-Place Concrete.
3. Section 31 10 00 - Site Clearing.
4. Section 31 23 33 - Trenching and Backfilling.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. ASTM International:

1. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
2. ASTM C150 - Standard Specification for Portland Cement.
3. ASTM C387 - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar.
4. ASTM D245 - Standard Practice for Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber.
5. ASTM F537 - Specification for Design, Fabrication, and Installation of Fences Constructed of Wood and Related Materials.
6. ASTM F1667 - Specification for Driven Fasteners: Nails, Spikes, and Staples.

B. American Association of State Highway and Transportation Officials (ASHTO):

1. AASHTO M133 - Standard Specification for Preservatives and Pressure Treatment Processes for Timber.

C. Michigan Department of Transportation (MDOT):

1. MDOT 2012 Standard Specifications for Construction, Section 808.

1.3 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Manufacturer's printed product information indicating material compliance and specified options are to be submitted prior to installation. Submit manufacturer's product data sheets on each product to be used.

C. Shop drawings shall include plans, elevations, sections, details, and attachments to other work. Drawings must be submitted for approval and be approved prior to installation.

D. Submit samples for initial color selection. Submit samples of each specified finish.

1. Product Data: Submit manufacturer's installation instructions and procedures, including details of fence and gate installation.
2. Product literature, technical data and specifications, material of construction, etc.

1.4 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

1.5 QUALIFICATIONS

A. Manufacturing company with engineering and fabrication of custom fencing and gate systems for a minimum of three (3) years.

B. Installation company with experience in manufacturer's products for a minimum of five (5) years. The Contractor shall provide trained laborers with prior experience in the type of construction involved as well as experience installing the material and techniques specified.

C. Obtain each fence system and gate through one source from a single manufacturer.

1.6 QUALITY CONTROL

A. The supplier is responsible for quality control and inspection of material. Material shall be graded before shipment in accordance with the grading rules of ASTM D245 and marked with the approved grading agency stamp showing the mill origin, species, and grade. The required grading agency stamp or marking must be legible on a wide face at the trimmed end before and after treating.

1.7 WARRANTY

A. Manufacturer's Warranty: Provide manufacturer's standard ten-year (10) limited warranty, from the date of purchase, against defects in materials and workmanship including projection against cracking, peeling, blistering, and corrosion (rusting).

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver fence materials and accessories in packed cartons or pallets.

B. Identify each package with manufacturer's name.

C. Store fence materials and accessories in secure and dry place.

D. Upon delivery to the jobsite, inspect all materials for damage that might have occurred during shipment.

E. Handle and store materials in manufacturer's packaging until materials are ready to be installed. Store materials in such a way as to prevent damage and theft.

1.9 PROJECT CONDITIONS

A. Verify actual locations of walls and other construction contiguous with fencing and gates by field measurements before fabrication and indicate measurements on shop drawings. Provide allowance for trimming and fitting onsite.

1.10 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for fencing and gates. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete or masonry. Deliver such items to the Project Site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support systems temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 WOOD MATERIALS

A. All wood materials shall be treated wood, or wood of natural resistance to decay. Materials shall be free from loose knots, cracks, and other imperfections.

B. Wood Boards or Slats:

1. Wood boards or slats shall be of cedar, redwood, combed spruce or similar.
2. Wood boards or slats shall be between 3/8 inches and 5/8 inches thick and no greater than 6 inches wide unless otherwise noted or approved by the Engineer.
3. Posts:
    a. Wood posts shall conform to the details and dimensions indicated on the Drawings, or in the case of replacement as found in the field to best match the existing fence.
    b. Wood posts shall be straight, sound, seasoned with ends sawed off square or as indicated. All knots shall be trimmed flush with the surface.
    c. Wood posts shall be peeled and treated with preservative in accordance with AASHTO M133. When native cedar posts are called for on the Drawings, the requirements for peeling and for treating may be omitted.

4. All dimension timber and lumber required for fences or gates shall be sound, straight, and free from knots, splits, and shakes. It shall be of the species and grades indicated on the Drawings, or in the case of replacement as found in the field to best match the existing fence.
5. Concrete posts shall be made of concrete of the class specified and shall contain steel reinforcement as shown on the Drawings.
6. Posts shall be pressure treated redwood, Douglas fir-larch, cedar or similar.
7. Fence and gate posts shall be 4-inch by 4-inch unless otherwise noted or approved by the Engineer.
8. Buried post ends should be treated with an approved wood preservative product.
9. Truck Gate posts shall be at minimum dual 6-inch by 6-inch or as recommended by manufacturer.

C. Gates:

1. Provide additional horizontal, vertical, and diagonal members to ensure proper gate operation and for attachment of wood, hardware and accessories. Consult manufacturer as necessary.
2. Gate stops, latches and locks shall be accessible from either side of gate.
3. Openings shall be a minimum of 3-feet wide.
4. Types: Man Gates and Truck Gates.

2.2 HARDWARE

A. Gate Hardware:

1. Gate hardware including, but not limited to, latches, hinges, stops and bolts shall be stainless steel, powder coated black, or galvanized.
2. Hinges and Pins shall be heavy duty and sized as per manufacturer's recommendations.
3. For truck gates (double-leaf), a drop rod or stop shall be installed on one (1) leaf, include at least one (1) guide and shall extend into concrete base or similarly solid base.

4. Dual access (accessible and lockable from either side) latch and lock systems are required on all gates.

2.3 CAST-IN-PLACE CONCRETE

A. Materials: Portland cement complying with ASTM C150, Type 1, aggregates complying with ASTM C 33, and potable water for ready-mixed concrete in accordance with ASTM C94.

1. Concrete Mix: Normal weight concrete, air entrained, with not less than 4,000 psi compressive strength (28 days).

B. Materials: Dry-packaged concrete mix complying with ASTM C387 for normal-weight concrete mixed with potable water according to the manufacturer's written instructions.

1. Concrete Mix: Normal weight concrete, with not less than 4,000 psi compressive strength (28 days).

PART 3 - EXECUTION

3.1 GENERAL

A. Perform such clearing and grubbing as may be necessary to construct or replace the fence to the required grade and alignment as shown on the Drawings or to match existing conditions as found in the field.

B. At locations where breaks in a run of fencing are required, appropriate adjustments in fence alignment and/or post spacing shall be made to satisfy requirements or conditions encountered.

3.2 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by the Engineer.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Call Local Utility Line Information service Miss Dig (811) at 1-800-482-7171 not less than three full working days, excluding Saturdays, Sundays, and holidays, but not more than fourteen (14) calendar days before digging operations are scheduled to begin.

B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500-feet or line of sight between stakes.

C. Indicate locations of utilities, underground lawn sprinkler system, underground structures, benchmarks, and property monuments.

D. Anchorages, footings or fence appurtenances shall not extend beyond the limits of the right-of-way, or private property, without the written consent of the abutting property owner.

3.4 FENCE INSTALLATION

A. Comply with the manufacturer's recommendations.

B. Use workers knowledgeable in the building of wood privacy fences.

C. Install fences in accordance with manufacturer's instructions.

D. Where clearing for fence is required, clear the fence line.

E. Place posts in the ground a minimum of 30-inch or as shown on the plans. Excavate post holes a minimum of 12-inch in diameter. Set posts upright and plumb and fill the holes with concrete to within 4-inch of the top of the ground, unless otherwise directed by the Engineer. Place soil on top of the concrete to make the area level with the surrounding soil. Place posts at 8-feet on center. Terminate concrete 6 inches below grade.

F. Make all splices only at the posts.

G. The pickets shall be screwed to the rails with galvanized wood screws of appropriate size, as approved by the Engineer. Fasten pickets with two (2) screws at each rail. Make the fence so that the pickets form one continuous wall on the front side and posts and rails are visible only on the back side.

H. Tighten all screws so that the heads are flush with the face of the picket.

I. Post and rail connections must be approved by the Engineer prior to beginning work.

J. Set finished height of posts slightly above the top rail so that they cannot be seen from the front side of the fence. Do not use pickets with open or loose knot holes, cracks, stains, warps or other visible defects. Do not use any warped or structurally unsuitable rails.

K. Construct fence so that it is plumb, vertically straight and the top of the pickets will form a continuous line with no dips or abrupt vertical changes.

3.5 INSTALLATION POSTS

A. Posts shall be set true to line and grade.

B. Set posts in 12-inch diameter concrete footings extending at least 30-inch into undisturbed natural ground or properly compacted fill.

3.6 GATE INSTALLATION

A. Install gate posts in accordance with manufacturer's instructions. Set keepers, stops, sleeves, and other accessories into concrete and position out of the way of normal traffic, but located to provide reliable performance.

B. Install gate plumb, level and secure for full operation without interference. Install ground-set items in concrete for anchorage as recommended by the fence manufacturer.

C. Attach hardware by means which will prevent unauthorized removal.

D. Lubricate moving parts where necessary. Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

E. Man Gates:

1. Shall be installed on all enclosed or fenced-in areas or to replace an existing man gate when other work has been completed.
2. Shall be configured to allow resident or Owner to enter or exit the enclosed area.
3. Once gate is installed coordinate with Engineer or resident on lock installation.

F. Truck Gates:

1. Shall be installed at the request of the Engineer and shall be at no additional cost to the Owner.
2. Shall open/close in direction as directed by Engineer.
3. Shall be configured to allow Owner or resident vehicles to enter the enclosed area to perform work or park.
4. Once gate is installed coordinate with Engineer or resident on lock installation.

3.7 REMOVAL OF EXISTING FENCE

A. All rails, braces, posts, and the like shall be removed and disposed of or salvaged by Contractor to allow construction of the Project. Confirm salvageability of a particular segment of fence with the Engineer.

3.8 ADJUSTING

A. Fence and accessories shall be installed to match existing conditions or in strict accordance with the Drawings and Specifications in a workmanlike manner. Finished fence shall be in proper alignment with posts plumb.

3.9 PROTECTION

A. Protect finishes from damage during construction period with temporary protective coverings approved by manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in field to shop, make required alterations and refinish entire unit, or provide new units.

3.10 CLEANING

A. Remove cutting and drilling chips that are attachment to the fencing, post, brackets, or additions to prevent corrosion.

B. Repair scratches and other installation-incurred damage using manufacturers recommended paint. Use paint of the appropriate color with a zinc additive to prevent rust from forming.

C. Clean up debris, unused material, and remove from Site.

END OF SECTION 32 31 29

SECTION 32 91 14 – STRUCTURAL CELLS FOR URBAN TREES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural Cell System.
2. Subbase.
3. Geotextile Fabric.
4. Root Barrier.
5. Planting Soil.
6. Underdrains (optional).
7. Trees.

B. Related Requirements:

1. Section 31 05 17 – Aggregates for Storm Water Management.
2. Section 32 93 00 – Plants.

C. Applications and Uses:

1. Structural cells are intended to provide planting soil and/or storm water management facilities below pavements (sidewalks, plazas, driveways, parking lots). Structural cells are not intended for use beneath roadways.
2. For structural cells intended for storm water management, water shall be transferred into the cells via porous pavements or by directing surface flow into points of infiltration such as tree cutouts or swales, as indicated on drawings.
3. Structural cells to be filled with soils and/or aggregate materials as indicated on drawings.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Structural Cells System:

1. Basis of Measurement: By cubic yard.
2. Basis of Payment: Includes preparation, excavation, furnishing and installing structural cell systems, planting soils, geotextile fabric, aggregate base, concrete curbs for tree grate or tree area, backfilling, and for furnishing all equipment, tools, labor, and incidentals required to complete the work.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO H-20.

B. American Society of Testing Materials (ASTM):

1. ASTM D448-12, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
2. ASTM D698-12e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 [600 kN-m/m^3]).
3. ASTM D1241-07, Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses.
4. ASTM D3786/D3786M-13, Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
5. ASTM D4491-99a(2014)e1, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
6. ASTM D4533-D4533M-15, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
7. ASTM D4632-D4632M-15, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
8. ASTM D4751-12, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
9. ASTM D4833/D4833M-07(2013)e1, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
10. ASTM D5262-07(2012), Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics.
11. ASTM D6241-14, Standard Test Method for Static Puncture Strength of Geotextile and Geotextile-Related Products Using a 50mm Probe.
12. ASTM D6637-11, Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer’s product data, storage and handling requirements and recommendations, installation methods and available colors, styles, patterns and textures.

C. Shop Drawings: Submit manufacturer’s shop drawings, including plans and elevations, indicating overall dimensions.

D. Samples for Verification: Submit manufacturer’s samples of materials, finishes, and colors.

E. Warranty: Manufacturer’s standard warranty.

1.5 QUALIFICATIONS

A. Installer Qualifications: Structural cells and related products shall be installed by a qualified installer whose work has previously resulted in successful installation of planting soils and planter drainage systems, underground piping, chambers and vault structures.

1. Submit list of completed projects of similar scope and scale to the Owner, demonstrating capabilities and experience.
2. The installer and the field supervisor shall have a minimum of five (5) years successful experience with construction of similar scope in dense urban areas.
3. Installer's Field Supervision: Installer is required to maintain an experienced fulltime supervisor on Project site when work is in progress. This person shall be identified during the Pre-installation Conference, with appropriate contact information provided, as necessary. The same supervisor shall be utilized throughout the Project, unless a substitute is submitted and approved in writing by the Owner.

PART 2 - PRODUCTS

2.1 SUBBASE

A. Base aggregates shall be #57 washed coarse aggregate (3/4" to 1 ½") with no fines, defined as less than 0.5% wash loss when tested with AASHTO T-11, and shall meet the durability requirements of ASTM C33.

2.2 GEOTEXTILE FABRIC

A. Geotextile shall be nonwoven polypropylene fibers, inert to biological degradation and resistant of naturally occurring chemicals, alkalis and acids.

1. Grab Tensile Strength: 200 lbs. (900 N) minimum *(ASTM D 4632 test method).*
2. Elongation: 50% minimum *(ASTM D 4632 test method).*
3. Trapezoid Tear Strength: 80 lbs. (350 N) minimum *(ASTM D 4533 test method).*
4. Mullen Burst Strength: 350 psi (2400 kPa) minimum *(ASTM D 3786 test method).*
5. Puncture Strength: 110 lbs. (490 N) minimum *(ASTM D 4833 test method).*
6. CBR Puncture Strength: 500 lbs. (2225 N) minimum *(ASTM D 6241 test method).*
7. Apparent Opening Size: 80 sieve (0.18mm) maximum *(ASTM D 4751 test method).*
8. Flow Rate: 90 gal/min/ft2 (3870 l/min/m2) minimum *(ASTM D 4751 test method).*

2.3 ROOT BARRIER FABRIC

A. Recyclable, black, injection molded panels manufactured with a minimum 50 percent post-consumer recycled polypropylene plastic with UV inhibitors, and integrated zipper joining system which allows instant assembly by sliding one panel into another; for redirecting tree roots down and away from hardscapes.

2.4 STRUCTURAL CELL SYSTEM

A. The term structural cell shall be used to refer to a single structural cell or a stack of structural cells.

B. Structural cells shall be modular structural systems.

C. Each structural cell shall be structurally-independent from all adjacent cells.

D. Structural cells shall be specifically designed and tested for the purpose of growing healthy trees and providing storm water management.

E. Structural cells shall be capable of supporting loads up to and including AASHTO H-20 when used in conjunction with approved pavement profiles.

F. Structural cells shall be open on all vertical faces and horizontal planes (that connect stacked cells) and shall have no interior walls or diaphragms. Structural cells shall be capable of providing a large, contiguous, continuous volume of planting soil or aggregate that does not inhibit or prevent the following:

1. Movement and growth of roots within the provided soil volume.
2. Movement of water within the provided soil volume, including lateral capillary movement.
3. Placement of planting soil.
4. Compaction testing of planting soil, once in place.
5. Installation and maintenance of utilities within, adjacent to, or below the soil cell.

G. Structural cells shall be capable of being filled with bioretention soil and/or aggregate as indicated on drawings.

H. Manufacturers:

1. Silva Cells by Deep Root Green Infrastructure, LLC – 101 Montgomery Street, Suite 2850, San Francisco, CA 94104; Tel: 800.458.7668; Website: www.deeproot.com.
2. Green Blue Urban – 71 Bysham Park Drive, Woodstock, ON N4T 1P1, Canada; Tel: 866.282.2743; website: www.greenblue.com.
3. Stratacell, by Citygreen USA, 515 Flower Street, 36th Floor, Los Angeles, CA 9007, Tel 888.999.3900; website: citygreen.com.
4. Or Approved Equal by Engineer.

2.5 ANCHORING SPIKES

10 in. long x 19/64 in. diameter, spiral, galvanized timber spikes. Utilize 4 spikes in each frame on the first layer of Structural Cells to anchor the frames to the aggregate sub base.

2.6 PLANTING SOIL

Planting Soil shall be an engineered soil mix consisting of 80% sand and 20% compost, with less than 5% fines (#200 sieve).

2.7 TREES

Trees shall be in compliance with Section 32 93 00 - Plants.

2.8 UNDERDRAINS

A. PVC (perforated or non-perforated as specified in the Contract Drawings): Shall be Schedule 40 for underdrains and pipe risers.

B. HDPE for underdrain pipe along curves, as indicated on the Contract Drawings.

C. Frame and Cover:

1. EJ Model V1610/V3610;
2. Neenah Item No. R-1792;
3. Or approved equal.

D. Screw Cap: Shall be threaded PVC with 2-inch square lug.

E. Cleanout: The Cleanout cover assembly in pavement shall be cast iron and have an adjustable housing with scoriated cast iron cover as indicated in the Contract Drawings.

F. Observation Well: 2-inch well test plug using EnviroTech Ergo Grip or approved equal with tethering eyelet.

G. Backflow Valve: Shall be a backflow flapper (6 inch), Flex PVC Item No. S675P or approved equal.

H. Domed/Beehive Grate: 12 to 30” diameter domed grate made of Cast Iron, Ductile Iron, or High-Density Polyethylene as shown on the Contract Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Take proper precautions as necessary to avoid damage to existing improvements and plantings and existing or proposed utilities.

B. Prior to the start of work, layout and stake the limits of excavation and horizontal and vertical control points sufficient to install the complete soil cell system.

C. Coordinate installation with other trades that may impact the completion of the work.

3.2 TEMPORARY PROTECTION

A. Protect open excavations and structural cell system from access and damage with highly visible construction tape, fencing, or other means until related construction is complete.

B. Do not drive vehicles or operate equipment over the cell system until the structural cells have been inspected by a certified manufacturer's representative and the final surface material has been installed.

3.3 EXCAVATION

A. General: Excavate to the depths and shapes indicated on the drawings. Provide smooth and level excavated base; free of lumps and debris.

B. Confirm that the depth of the excavation is accurate and includes the full section of materials required to place the subbase aggregate, soil cell, and pavement profile as indicated on the drawings.

C. Over-excavate beyond the perimeter of the structural soil cell system to allow for:

1. The extension of aggregate subbase beyond the soil cell layout as shown on the drawings.
2. Provide adequate space for proper compaction of backfill around the structural soil cell system.

D. If unsuitable subgrade soils are encountered, notify Engineer for directions on how to proceed.

E. If conflicts arise during excavation, notify the Engineer in writing for directions on how to proceed.

3.4 SUBGRADE COMPACTION

A. Compact subgrade to a minimum of 95 percent of maximum dry density at optimum moisture content in accordance with ASTM D698, Standard Proctor Method, or as approved by the Owner's geotechnical representative.

B. Do not exceed 7 percent slope for subgrade profile in any one direction. If the 7 percent slope is exceeded, contact manufacturer's representative for directions on how to proceed.

3.5 INSTALLATION OF GEOTEXTILE OVER SUBGRADE

A. Install geotextile over compacted subgrade. Lay geotextile flat with no folds or creases. Install the geotextile with a minimum joint overlap of 18 inches.

3.6 UNDERDRAIN SYSTEMS

A. Perforated pipes. Shall be placed with perforations down. Pipe shall be placed with the bell end upgrade. Pipe sections shall be joined with appropriate couplings. The ends of underdrain pipe shall be plugged upgrade as directed by the Engineer.

B. Risers for Cleanouts/Observation Wells. Provide 2-inch PVC slotted well casing, with well point, extending twelve inches into subgrade. Set casing approximately 2 inches below finished pavement elevation to allow clearance for test plug and cleanout cap. Provide 4-inch diameter PVC outer casing extending through pavement into subbase and install 4-inch flush mounted cast iron cleanout with brass cap solvent welded to outer casing. Provide 2-inch well test plug with tethering eyelet.

In paved areas provide frame and anchored/bolted cover over cleanout and observation well riser pipes as indicated in the Drawings. For locations in permeable pavement, frames and covers shall be located within the permeable pavement area surrounded by precast concrete edge curb. Cleanouts and Observation wells shall be encased in concrete as shown in the Drawings. Connect riser to underdrain piping.

In non-paved areas provide screw cap covers. Covers shall be set 6 inches above final grade. Connect riser to underdrain pipe.

C. Backflow Preventer assembly to be located per the plans and as directed by the Engineer at a location upstream of proposed sewer field connection yet downstream of perforated underdrain pipe. Provide PVC riser pipe to protect PVC access sleeve pipe. Connect assembly to underdrain piping, using the appropriate reducer and tee fittings.

3.8 INSTALLATION OF STRUCTURAL CELLS

A. Aggregate Sub Base Below Structural Cell Bases:

1. Install washed stone aggregate subbase to the depths indicated on the Drawings and according to specifications included in Section 31 05 17 – Aggregates for Storm Water Management.
2. Extend subbase aggregate a minimum of 6 inches horizontally beyond the base of the structural cell layout.
3. Compact aggregate subbase to a minimum of 95 percent of maximum dry density at optimum moisture content in accordance with ASTM D698, Standard Proctor Method, and to a depth as shown on Drawings.
4. Do not exceed 7 percent slope on the surface of the subbase. Where proposed grades are greater than 7 percent, step the soil cells to maintain proper relation to the finished grade.

B. Structural Cell System Base Installation:

1. Install the structural cell system in strict accordance with manufacturer's instructions and as specified herein; where requirements conflict or are contradictory, follow the more stringent requirements.

2. Establish the location of the tree openings in accordance with the drawings. Once the trees are located, mark the inside dimensions of the tree openings on the prepared subbase.
3. Place the cell bases on the compacted aggregate subbase. Start at the tree opening and place cell bases around the tree openings as shown on the drawings.
4. Maintain spacing no less than 1-inch and no more than 4 inches apart.
5. Level each structural cell base as needed to provide full contact with subbase.
6. Anchor structural cell base with 2 crossbar/pin assemblies per base.

C. Installation of Structural cells, Geotextile Backfill, and Planting Soils:

1. Install strong backs on top of the structural cell posts by snapping into place over installed posts prior to installing planting soil and backfill.
   a. Strong backs are required only during the placement and compaction of the planting soil and backfill.
   b. Move strong backs as the work progresses across the installation.
   c. Remove strong backs prior to the installation of the cell decks.

2. Install geotextile around the perimeter of the structural cell system where the compacted backfill and planting soil interface.
   a. Do not place geotextile between the edge of the structural cells and adjacent planting areas.
   b. Cut the geotextile to allow for a 6-inch overlap at the cell base and a 12-inch overlap at the soil cell deck.
   c. Provide a minimum 12-inch overlap between adjacent sheets of geotextile.
   d. Secure geotextile with cable ties below the top of the posts, along the post ridges.

3. Place the first lift of backfill material loosely around the perimeter of the structural cell system, between the geotextile and the sides of the excavation. Place backfill in lifts not to exceed 12 inches or approximately the midpoint of the soil cell post. Do not compact.

4. Place the first lift of planting soil in the structural cell system to approximately the midpoint of the cell post.
   a. Level the planting soil throughout the system.
   b. Walk-through the placed planting soil to remove air pockets and settle the soil. Do not compact greater than 80 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method.

5. Check placed soil for compaction with a penetrometer or densitometer or similar.
6. Compact the first lift of backfill material around the structural cell system, previously spread, to 95 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method or in accordance with project specifications for hardscape areas, whichever is greater.
7. Add and compact additional backfill material around the structural cell system so that the final finished elevation is at approximately the same level of the placed planting soil within the soil cells.

8. Maintain the geotextile between the cell system and the surrounding backfill material at all times.
9. Place the second lift of backfill material loosely around the perimeter of the cell system, between the geotextile and the sides of the excavation so that the material is 2 to 3 inches below the top of the posts. Do not compact.
10. Place the second lift of planting soil inside of the structural cell to the bottom of the strong backs.

D. Installation of Structural Cell Deck:

1. Obtain final approval by the Engineer of planting soil installation prior to installation of the cell decks.
2. Remove strong backs, level out the planting soil, and immediately install decks over the posts below. Place deck over the top of the posts. Push decks down until the deck clips lock into the posts, snapping the deck into place.
3. Fold the 12 inches of geotextile onto the top of the decks.

E. Final Backfill Placement and Compaction:

1. Place and compact final lift of backfill material around the structural cells system to 95 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method, such that the backfill is flush with the top of the installed deck. Do not allow compacting equipment to come in contact with the decks.

F. Installation of Geotextile and Aggregate Base Course over the Deck:

1. Place geotextile over the top of the deck and extend to the edge of the excavation. Overlap joints a minimum of 18 inches. Leave enough slack in the geotextile for the aggregate base course to push the geotextile down in the gaps in between the decks.
2. Install the aggregate base course (including aggregate setting bed if installing unit pavers) over the geotextile immediately after completing the installation of the fabrics. Work the aggregate from one side of the layout to the other so that the fabric and aggregate conform to the structural cell deck contours.
3. Maintain equipment used to place aggregate base course completely outside the limits of the structural cell excavation area to prevent damage to the installed system.
4. For large or confined areas, where aggregate cannot easily be placed from the edges of the excavated area, obtain approval for the installation procedure and types of equipment to be used in the installation from the soil cell manufacturer.
5. Compact aggregate base course(s) to 95 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method. Utilize a vibration or plate compactor with a maximum weight of 800 lbs.
6. Do not drive vehicles or operate equipment over the completed aggregate base course.

G. Installation of Concrete Curbs at Tree Openings, Aggregate Subbase, and Pavement above the Structural Cell System:

1. Place concrete curbs along planting areas and tree openings as shown on the drawings to retain the aggregate base course from migrating into the planting soil.

2. When staking concrete forms (e.g. curbs around the tree openings), prevent stakes from penetrating the structural cell decks.
3. Turn down edge of concrete paving to the structural cell deck along the edges of tree openings or planting areas to retain the aggregate base course material.
4. When paving type is a unit paver or other flexible material, provide a concrete curb under the paving at the edge of the structural cell deck to retain the aggregate base course material at the tree opening.
5. Place paving material over structural cell system in accordance with the drawings.
6. Use care when placing paving or other backfill on top of structural cell system to prevent damage to the soil cell system or its components.

H. Installation of Root Barriers: Install root barrier in accordance with manufacturer's installation instructions.

I. Installation of Planting Soil within the Tree Planting Area:

1. Remove rubble, debris, dust and silt from the top of the planting soil within the tree opening that may have accumulated after the initial installation of the planting soil within the cells.
2. Install additional planting soil within the tree openings to the depths indicated on the drawings. Use the same soil used within the cells for planting soil within the tree openings.
3. Compact planting soil under the tree root ball to a consistency between 85 and 90 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method, to prevent settlement of the root ball.

J. Install trees in compliance with specification Section 32 93 00 – Plants.

END OF SECTION 32 91 14

SECTION 32 91 15 – STRUCTURAL SOIL FOR URBAN TREES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural Soil materials to be used for urban trees and storm water management under sidewalks and pavements.

B. Related Requirements:

1. Section 32 11 23 – Aggregate Base Courses.
2. Section 32 93 00 – Plants.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Structural Soil:

1. Basis of Measurement: By cubic yard for Structural Soil material.
2. Basis of Payment: Includes supplying aggregate materials and stockpiling, subgrade preparation and testing necessary to achieve required placement, and all labor, materials, tools, equipment and incidentals necessary to complete the work as specified herein.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T88 – Standard Method of Test for Particle Size Analysis of Soils.
2. AASHTO T-99 – Moisture – Density Relations of Soils.

B. ASTM International:

1. ASTM C33 – Standard Specification for Concrete Aggregates.
2. ASTM D422 – Standard Test Method for Particle Size Analysis of Soils.
3. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
4. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
5. ASTM D2344 – Standard Test Method for Permeability of Granular Soils (Constant Head).
6. ASTM D2488 – Recommended Practice for Description of Soils.
7. ASTM D2922 – Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Source Approval: At least 30 days prior to ordering materials, submit certificates, manufacturer's literature, certified tests, and/or proof of licensure for materials to be supplied. No materials shall be ordered until the required certificates, manufacturer's literature, test results, or proof of licensure have been reviewed and approved by the Engineer. Approval shall not constitute final acceptance. The Engineer reserves the right to reject, on or after delivery, any material that does not meet the manufacturer's or supplier's specifications.

Sample: Prior to production and delivery of Structural Soil, submit one (1) initial sample to the Engineer.

1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Soil:

1. Structural Soil shall be CU – Structural Soil, a patented soil mix, obtained from a producer licensed by AMEREQ Inc. (Tel 800 832-8788) CU – Soil Division.
2. Haydite Expanded Shale Structural Soil by Digeronimo Aggregates (Tel 216 524-2950).
3. Stalite Expanded Shale Structural Soil by Carolina Stalite Company (Tel 800 898-3772).
4. Or approved equal.

2.2 SOURCE QUALITY CONTROL

A. Comply with testing, inspection, and analysis requirements in Section 01 40 00 – Quality Requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hauling

1. Trucks meeting the same cleanliness requirements of the double washed materials shall be used during hauling. Trucks shall be inspected and cleaned prior to each use.

B. Stockpiling

1. Stockpile only in approved areas as shown on the plan or approved by Engineer in sufficient quantities to meet Project schedule and requirements.
2. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

C. Placing, Shaping and Compacting

1. Upon completion of sub-grade work, the Engineer shall be notified and shall inspect the sub-grade before the Contractor continues installation. Engineer shall have the option to perform infiltration testing on the subgrade to verify minimum infiltration rates, at the Contractor's expense where specified on the contract documents.
2. Any accumulation of debris or sediment which takes place after approval of sub-grade shall be removed prior to installation continuing at no extra cost.
3. Place geosynthetics, pipe, and aggregate if required on the contract documents immediately after approval of sub-grade in accordance with the standards specifications.
4. Plant trees as per Specification 32 93 00 – Plants.

3.2 CLEANING

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Stockpile:

1. Remove stockpile and restore disturbed area to original condition.
2. Grade Site surface to prevent freestanding surface water.

END OF SECTION 32 91 15

SECTION 32 92 19 - SEEDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fertilizing.
2. Seeding.
3. Hydroseeding.
4. Mulching.
5. Sodding.
6. Native Seeding.
7. Maintenance.

B. Related Requirements:

1. Section 31 24 00 – Bioretention.
2. Section 32 93 00 – Plants.
3. Section 32 93 90 – Green Infrastructure Maintenance.

1.2 DEFINITIONS

A. Finish Grade: Elevation of finished ground surface of planting soil after construction.

B. First Hard Frost: Temperatures falling below 28 degrees Fahrenheit for more than two hours.

C. Inert Matter: Soil particles, stones, chaff, stems, leaves, flowers, cone scales, pieces of bark, pieces of resin, etc. Pieces of broken and damaged seed units of crops which are half the original size or less. Damaged weed seed with over half the embryo missing.

D. Other Crop Seed: Seed of plants grown as crops (other than the kind or cultivar included in pure) shall be considered other crop seeds, unless recognized as weed seeds by laws, regulations, or by general usage. Further classification of species is determined with the use of the reference, AOSA Rules for Testing Seeds Volume 3. Uniform Classification of Weed and Crop Seeds, AOSA 2013.

E. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

F. Pure Seed: Includes all seeds of each kind and/or cultivar under consideration which are present in excess of 5% of the whole (whole meaning the sum of the four (4) components).

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete or top surface of a fill or backfill before planting soil is placed.

H. Weeds: Vegetative species other than specified species to be established in given area.

I. Weed Seed: Seeds, florets, bulblets, tubers, or sporocarps of plants recognized as weeds by laws, regulation or by general usage shall be considered weed seeds. Further classification of species is determined with the use of the reference, AOSA Rules for Testing Seeds Volume 3. Uniform Classification of Weed and Crop Seeds, AOSA 2013.

1.3 STANDARDS

A. ASTM International:

1. ASTM C602 - Standard Specification for Agricultural Liming Materials.

B. Association of Official Seed Analysts (AOSA).

C. Michigan Department of Transportation (MDOT) - "Standard Specifications for Construction," Current Edition.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data:

1. Within four (4) weeks following the issuance of Notice to Proceed, submit seed supplier and certifications including: name and location of seed supplier(s) and a complete list of each seed mix by weight and proportion that is being supplied before the seed mix is ordered.
2. Seed Labels: Submit seed labels from bags showing mix composition.
3. Sod: Submit name of sod grower and product data.
4. Fertilizer.
5. Herbicides and Pesticides.
6. Seed and mulch equipment.
7. Turf maintenance equipment.

C. Source Quality Control:

1. Certifications:
   a. Lawn Seed: Certification from seed vendor for each grass seed mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging. Include identification of source and name and telephone number of supplier.

b. Pest Applicator: State commercial pesticide business license and commercial pesticide application certification.
c. Fertilizer: Submit two (2) copies attesting to the fertilizer composition for review.

1.5 CLOSE-OUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Maintenance Data: Prior to the issuance of substantial completion, submit recommended procedures for the Owner to implement for maintenance of turf after Final Acceptance during a calendar year.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All seed shall comply with applicable sections of the following references:
   a. Federal Seed Act.
   b. Michigan Seed Law Act 329 of 1965.
   c. Association of Official Seed Analysts (AOSA): “Rules for Testing Seed.”

B. Required Topsoil Testing:

1. The Contractor shall engage an approved agronomic soil-testing laboratory and an approved physical analysis-testing laboratory. The cost of testing to be borne by the Contractor.
2. All agronomic soil sampling and testing shall comply with procedures specified in the United States Department of Agriculture Ag. Handbook 60: Diagnosis and improvement of Saline and Alkali Soils.
3. Required Tests:
   a. Chemical analysis indicating:
      1) Fertility: pH, nitrate, nitrogen, ammonia nitrogen, phosphate, phosphorous, potassium, calcium, magnesium.
      2) Nutrient data shall be provided in parts per million (ppm).

   b. Physical properties including:
      1) Organic content.
      2) Particle size distribution.
      3) Saturated hydraulic conductivity in one (1) hour.

   c. Amendment recommendations from testing laboratory for providing ideal soils for intended vegetative uses.

1.7 QUALIFICATIONS

A. Installer Qualifications: The Work of this Section shall be performed by a contractor with a minimum of five (5) years of documented experience and specializing in seeding lawn installations and turf maintenance.

1.8 DELIVERY, STORAGE, AND HANDLING

A. All seeds shall be packaged and kept dry to ensure adequate protection against damage and to maintain dormancy while in transit, storage, or during planting operations. Replace any seed damaged during transit and storage.

B. All seed mixture(s) shall be delivered to the site in vendor's sealed containers and labeled, in compliance with the Federal Seed Act and applicable State laws.

C. Seed shall not be delivered and stored longer than nine (9) months prior to date of installation.

D. Herbicides and other chemicals delivered to the site must be in clearly labeled, unopened containers showing weight, analysis, and name of manufacturer.

E. Fertilizers and other chemicals delivered to the site must be in clearly labeled, unopened containers showing weight, analysis, and name of manufacturer.

F. Straw mulch shall be stored off the ground under a cover that provides protection from moisture and humidity.

G. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, that block walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate material certificates.

1.9 SCHEDULING

A. Seeding Season: Seed during one (1) of the following periods. Coordinate seeding periods with initial maintenance periods to implement timely maintenance from the date of Substantial Completion.

1. Allowable seeding and sodding periods:
   a. Spring Seeding: April 15 until June 1.
   b. Fall Seeding: September 1 – November 1.

B. Seeding outside of the calendar windows noted above or for temporary seeding establishment will only be permitted if approved in writing by the Engineer prior to installation.

C. Weather Limitations: Proceed with seeding only when current and forecasted weather conditions permit seeding and sodding to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions and in accordance with the manufacturer's written specifications and as per Engineer's acceptance.

1.10 WARRANTY

A. Notify the Engineer in writing when the Work is complete. The Engineer will inspect the Work and prepare and issue date to start the turf establishment period and the warranty period.

B. The Contractor shall establish and maintain all turf in a vigorous, well-kept condition and warrant them against defects including death, improper maintenance, and unsatisfactory growth for a period of one (1) year.

1. The Contractor will not be responsible for defects resulting from neglect by the Owner, abuse or damage by others, or unusual phenomena or incidents beyond the landscape installers control which result from natural causes such as floods, lighting, storms, freezing rains, winds over 60 miles per hour, fires, or vandalism.

C. Final Inspection: Final Inspection and Acceptance will be at the end of the turf establishment period. Acceptance will be based on the required Work having uniform finished grades conforming to the drawings and vigorous complete ground cover of species established, free of weeds, and conditions inconsistent with the installation specified. For any area identified without a uniform density of at least 80 percent grass cover, or bare spots greater than one (1) foot by one (1) foot, as determined by Engineer, Contractor shall reseed as originally specified. The Contractor shall provide materials and labor necessary to correct any deficiencies in accordance with the original Specifications during the warranty period. Make replacements/repairs as soon as is seasonally acceptable. Fully restore areas damaged by replacement operations to their original specified condition.

1. If, in the opinion of the Engineer, it is advisable to extend the warranty, an inspection at the end of the warranty period will be made to determine acceptability of all items involved.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Topsoil which has been stripped from on-site may be utilized as topsoil on the project provided it is pulverized, tested, and therefore meets the requirements of these specifications and any necessary amendments added per the recommendations of the testing results.

B. Topsoil required shall be furnished as specified below:

1. A fertile, friable, loamy surface soil without admixture of subsoil, free of stones, stumps, root, trash, debris, and other materials deleterious to plant growth.
2. The pH range shall be 6.0 to 7.0. Topsoil that does not meet this pH range shall not be approved by the Engineer.
3. Nutrient data in parts per million (ppm) dry soil.

Phosphorus	Min. 75 lb./Ac
Potassium	Min. 300 lb./Ac
Calcium	Min. 1,500 ppm
Magnesium	Min. 100 ppm
Cation Exchange Capacity	Min. 20 mea/100g
Soluble Salt	Max. 1,000 ppm

4. Organic content shall be greater than 3 percent and less than 10 percent determined by loss through ignition.
5. Gradation:
   a. All topsoil imported, or on-site reused materials, shall be pulverized and screened.
   b.

Sieve Designation	Percent Passing
1" screen	100
¼" screen	97 – 100
No. 10 U.S.S. mesh sieve	95 – 100
No. 140 U.S.S.	60 – 90

   c. Clay content determined by Bouyoucous Hydrometer Test shall range between 5 percent and 15 percent.
   d. Percentages shall be based on dry weight of the sample.

2.2 SEED MIXTURE

A. Lawn Seed: Seed shall be fresh, clean, dry, new-crop seed complying with the AOSA's "Rules for Testing Seed," tested for purity and germination tolerances. Seed mixtures shall have a maximum weed seed content of 0.5 percent, with no noxious weed seed, and shall be composed of certified seed of the purity, germination and proportion by weight as indicated in the following table:

MDOT Type THM Seed Mixture			
Species	Minimum Purity (percent)	Germination (percent)	Seed Mixing Proportions (percent by weight)
Kentucky Blue Grass	98	85	30
Perennial Rye Grass	96	85	20
Creeping Red Fescue	97	85	50

B. Bioretention Area Lawn Seed: When low maintenance is desired for a bioretention system, short growth grass with a dense root zone may be specified as vegetative cover for the infiltration bed and side slopes instead of perennials and shrubs. The seed mix for grassed bioretention areas shall be:

Bioretention Seed Mixture			
Species	Minimum Purity (percent)	Germination (percent)	Seed Mixing Proportions (percent by weight)
Perennial Rye Grass	98	85	40
Annual Rye Grass	96	85	30
Creeping Red Fescue	97	85	30

C. Native Area Seeding: Species as specified on design plans.

D. Seeding Rates:

1. Lawn Seeding: Sow the seed mix uniformly at a rate of 6 lbs./1000 square feet (260 lbs./acre).
2. Native Seeding: As recommended by seed manufacturer.

E. Substitutions: Other cultivars of grass species may be substituted for approval by the Engineer, but they must be newer, more improved cultivars than what is listed.

2.3 SOD

A. Sod shall be palletized small roll (2 feet x 5 feet; 10 square feet per roll).

B. Sod shall be certified blend of at least two blue grass varieties with at least 30 percent creeping red fescue densely rooted sod in accordance with MDOT 917.13 and as approved by the Engineer for use in establishing grass on lawn areas.

C. Sod shall be grown and harvested from a sod nursery at an average soil thickness of 1/2 inch to 3/4 inch thick.

D. Sod must be installed within 24 hours of harvesting.

2.4 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew-and seed-free, slat hay or threshed straw of wheat, rye, oats, or barley. Straw mulch shall be baled, air-dry, clean, mildew and seed free, salt hay or threshed straw of wheat, rye, oats, or barley. Material for anchoring mulch shall be as per Division 9 of the current MDOT Standard Specifications for Construction.

B. Non-Asphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

C. Wood Excelsior:

1. Green wood fibers, baled or blanket of type and manufacture acceptable to the Owner.
2. Wood excelsior shall be made of green timber fiber baled so that the bales weigh 80 to 90 pounds at the time of manufacture.
3. Wood excelsior blankets shall be made of a uniform web of interlocking fibers with a backing of fabric netting on one (1) side only. The fabric net shall have a mesh size not exceeding 1-1/2 inches x 3 inches and shall be a woven of either cotton cord, twisted paper cord or a synthetic biodegradable fiber. Blankets shall be produced in the form of a tightly compressed roll 36 inches +/- 1 inch wide and approximately 120 feet long. Blanket shall have a fiber net on the outside of the fiber mat. Blanket roll weight, when manufactured shall average 85 pounds +/- 10%. Each roll shall have separator sheets of 40-pound Kraft paper placed at the beginning and at the end of each roll to facilitate unrolling and handling at the job site. The Kraft paper sheet at the end of each roll shall also form a wrapper for the roll.

D. Netting:

1. Twisted Kraft paper or synthetic fiber, biodegradable woven mesh net material suitable for the application and acceptable to Owner.
2. The net shall consist of a biodegradable mesh with openings not to exceed 1-1/2 inches x 3 inches.
3. The net shall be furnished in widths not less than 35 inches.

E. Proprietary Mulch Material: Biodegradable natural and synthetic materials suitably fabricated and acceptable to the Owner.

2.5 MULCH ANCHORING MATERIAL

A. Emulsified Asphalt: ASTM D977, Rapid Setting (R.S. 1 or 2), Medium Setting (M.S. 2 or 2h) or Slow Setting (S.S.1).

B. Mulch Anchoring Tool: Suitable unit having a series of flat, notched discs for punching and anchoring mulch in soil, or a regular farm disc weighted and set nearly straight as an alternative.

C. Latex Base Adhesive: Latex base adhesive mixed with water at a ratio of 25 gallons of water to 1-gallon adhesive with 25 pounds of recycled newsprint as a tracer.

D. Recycled Newsprint: Mix 7 pounds of newsprint with 7 gallons of water.

E. Guar Gum: Mix 1 pound of dry adhesive with 26.5 gallons of water with 5 pounds of recycled newsprint as a tracer.

2.6 FERTILIZER

A. The percentages by weight shall be determined per recommendations of the soil testing reports for lawns.

B. Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer confirming to the following:

1. Type A: Starter Fertilizer containing 20% nitrogen, 26% phosphoric acid, and 6% potash by weight, or similar approved composition.
2. Type B: Secondary fertilizer containing 31% nitrogen, 3% phosphoric acid, and 10% potash by weight, or similar approved composition.

C. Fertilizer for hydraulic seeding shall be soluble or ground to a fineness that will permit complete suspension of all insoluble particles in the slurry.

D. No fertilizers other than compost (as specified in Section 31 24 00 – Bioretention) shall be applied within a bioretention system or other green storm water infrastructure system, and within 50 feet of any drainage areas draining to such system.

2.7 METAL EDGING

A. Metal edging shall comply with ASTM A1000, sized 3/16-inch thick x 4 inches wide x 16 feet length, made of steel, colored black, fabricated in sections with stake pockets stamped, punched, or welded to face of sections approximately 30 inches apart, with 3/16-inch x 16-inch long stakes, as manufactured by J.D. Russell Co., or approved equal.

2.8 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb./sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

2.9 WATER

A. Source: Water shall be provided by the Contractor unless otherwise approved by the Engineer.

B. Quality: Water shall be clean, potable, and free of substances harmful to plant growth.

1. Water shall be free of wastewater effluent or other hazardous chemicals.

2. Lawn watering equipment, hoses or other methods of water transportation shall be furnished by the Contractor.

2.10 PESTICIDES AND HERBICIDES

A. Pesticides and herbicides shall be registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by the manufacturer for each specific problem and as required for the project conditions and application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Prior to seeding or sodding, the Contractor shall examine and verify the acceptability of the job site. Notify the Engineer if conditions are detrimental to plant growth are encountered such as rubble fill, adverse drainage conditions, or obstructions. Do not proceed with the Work until unsatisfactory conditions have been corrected or resolved in writing by the Engineer.

C. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

D. Coordination is required to ensure rainfall/groundwater seepage does not result in soil moisture conditions that will cause excessive rutting during lawn installation operations. Suspend soil spreading, grading and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

E. Utilities: Have all underground utilities located by servicing agencies. In the vicinity of utilities, hand excavate to minimize possibility of damage.

F. Coordination with Other Work:

1. The Contractor shall coordinate his/her work with other contractors or trades to determine the appropriate sequence of lawn installation with respect to other work on the site.
2. Work installed out of construction sequence which is disturbed by the completion of Work by other trades shall be repaired at no cost to the Owner.
3. Maintain grade stakes set by others until removal is mutually agreed upon by all parties concerned.

3.2 SITE PROTECTION

A. Protect existing grounds, plants, lawns, and vegetation to remain.

1. Protect existing trees to remain in place against unnecessary cutting, breaking, skinning, or bruising of roots and bark, smothering of trees by compaction or stockpiling construction materials or excavated materials within five (5) feet of outer edge of drip line.
    a. Erect minimum of four (4) foot high fence five (5) feet outside drip line of trees to remain.
    b. Erect tree protection before starting site work of any kind. Maintain fencing during construction period.
    c. Interfering branches may only be removed with prior consent from the Engineer.
    d. Identify any trees the Engineer would like mulched, vertically, trimmed or repaired as a result of construction impact at end of project. All Work shall be performed by a certified arborist approved by the Engineer.

2. Contractor is responsible for all damage to plants that shall remain. Cost for tree replacement shall be determined in accordance with the "Guide for Plant Appraisal" by the Council of Tree and Landscape Appraisers (International Society of Agriculture, Publication #P1209).

B. Temporary Construction Access: Project site access and equipment access routes within the project site must be approved by the Engineer prior to commencement of Work. Any temporary gravel path or access way must include a geotextile fabric separator to ensure full removal of gravel/stone from project site at the project completion.

3.3 STRIPPING AND STORAGE OF EXISTING TOPSOIL

A. Strip topsoil to its full depth at areas impacted and at all areas that will be regraded or resurfaced.

B. Stop topsoil stripping outside drip line of trees to remain/do not strip as to impact root line of trees to remain.

C. Dispose of roots, stone, and other debris; store topsoil in piles within the work limits.

1. Obtain approval of Engineer prior to establishing topsoil storage areas.
2. Grade and slope stockpiles for proper drainage and to prevent erosion.

D. The reuse of stockpiled topsoil within the project site must be approved for placement by the Engineer.

3.4 PREPARATION OF SEED BED/SODDED AREAS

A. De-compaction: De-compact areas trafficked by construction activities to a minimum depth of 12 inches.

B. Rough Grading: Grade surfaces to assure drainage away from structures and to prevent ponding and pockets of surface drainage. Provide subgrade free from irregular surface changes and as follows:

1. Rough grade shall equal plus/minus 0.20 feet, subgrade tolerance shall be free of exposed boulders or stones exceeding 1 inch in greatest dimension.
2. Fill in all areas of settlement to proper grade before subsequent placement of topsoil.

C. Topsoil Depths: Lawn areas to receive sod or seed must have between 4 and 6 inches of topsoil placed.

D. Topsoil Spreading and Fine Grading: Grade area to a smooth, free draining even surface with a loose, moderately coarse texture. Roll, scarify, rake and level as necessary to obtain a true, even lawn surface and fill depressions as required to drain. Seed bed shall be approximately ½ inch to 1 inch below all sidewalks, curbs, and metal edging if used. Do not move heavy power equipment except necessary lawn installation equipment over the lawn areas after the soil is prepared unless it is loosened and re-graded. Restore prepared areas to specified condition if eroded, settled, or otherwise disturbed after fine grading.

E. Fertilizing:

1. Apply Type A / starter fertilizer to indicated turf areas at a rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. or as directed.
2. Apply fertilizers by mechanical drop or rotary distributor, thoroughly and evenly incorporated with soil to a depth of 3 inches by disking or other approved method. Fertilize areas inaccessible to power equipment with hand tools and incorporate into soil.

3.5 SEEDING

A. Do not sow seed when weather conditions are unfavorable, such as during drought or high winds. Perform seeding operations when soil is dry and when winds do not exceed 15 miles per hour.

B. Perform seeding work only after planting and other work affecting the ground surface have been completed. Limit preparation of seed areas to those ready for immediate seeding.

C. Prior to placing seed materials, water topsoil to a depth of four (4) inches at least 48 hours prior to seeding operations to obtain a loose friable seed bed. Time and depth of watering operations shall be varied at the direction of the Engineer for varying conditions at the site of the Work. Watering shall be performed in sufficient durations and intervals such that the seeded area thrives and shall be approved upon final inspection.

D. Seed immediately after preparation of bed.

E. Seed shall be applied uniformly at a rate of 6 lbs./1,000 square feet. All areas shall be seeded in at least two directions, spreading one (1) half of the specified amount in one (1) direction and then seeding the remaining one (1) half of the seed at right angles to the first seeding pattern using the same method. Turf grass seeds shall not be covered by more than ¼ inch. The seeding device shall lightly roll the seed bed to provide good moisture contact between the seed and soil.

F. Apply hydro-mulch with hydro-mulch equipment immediately after seeding. Slurry shall be composed of clean water and mulch. Apply mulch slurry at a minimum rate of 1,500 pounds to 2,000 pounds per acre on slopes steeper than 4:1. Direct slurry to evenly cover designated seed areas. Repair ruts, depressions, and all damage caused by hydro-mulching equipment.

G. Immediately reseed and reapply hydro-mulch to areas that show poor germination.

H. The Contractor shall keep the freshly applied seeded areas moist, through daily watering if necessary, to assure germination of the grass seeds. The lawn areas shall be maintained by watering, mowing, trimming, weed control application, fertilizing and any other maintenance necessary.

I. The Contractor shall provide all maintenance of the seeded lawns as described above for at least two weeks after completion of the repair operation.

J. Any part of any area that fails to show a uniform germination shall be reseeded and such reseeding shall continue until a dense lawn is established.

3.6 SODDING

A. Perform sodding work only after planting and other work affecting the ground surface have been completed. Limit preparation of sodded areas to those ready for immediate sodding.

B. Sod immediately after preparation of bed.

C. Sod must be installed within 24 hours of harvesting.

D. Install initial row of sod in a straight line, beginning at the bottom of slopes, perpendicular to direction of the sloped area. Place subsequent rows parallel to and tightly against previously installed row.

E. Lay sod to form a solid mass with tightly fitted joints. Sod strips shall butt close together with no voids between the pieces. Care shall be exercised to ensure that the sod is not stretched or overlapped. Lateral joints shall be staggered. Remove excess sod to avoid smothering of adjacent grass. Provide sod pad top flush with adjacent curbs, sidewalks, drains, and seeded areas.

F. To enhance rooting, moisten the soil to a depth of four (4) to six (6) inches twenty-four hours before laying sod. Do not lay sod on a hot dry soil surface.

G. Do not lay, place or install dormant sod pads on saturated or frozen soil.

H. Peg sod on slopes greater than 3:1 to prevent slippage at a rate of two (2) stakes per yard of sod. Space pegs no greater than 24 inches apart and drive flush with the sod surface.

I. Water sod thoroughly with a fine spray immediately after laying/installation. Tamp or roll sod immediately after it is laid. The finished surface shall be true to grade, smooth, even, and equally firm at all points.

J. Tamp or roll sod with light lawn roller immediately after it is laid to ensure contact with subgrade. The finished surface shall be true to grade, smooth, even, and equally firm at all points.

K. Begin watering sod within 30 minutes of installation and water daily for the first two weeks; twice a day in hot dry weather. Keep soil in sodded areas moist but not soaked to 1.5 inches below sod. After sod is installed, re-sod all areas which have browned out or fail to show a uniform stand of grass. Repair cracks or gaps in sod more than one (1) quarter at no additional cost to the owner.

3.7 HYDROSEEDING

A. Hydroseeding shall be performed using suitably acceptable hydraulic seeding equipment and a homogeneous slurry solution of water, seed, fertilizer and suitable mulch material as approved by the Engineer. Seed slurry mixture shall be distributed uniformly at a rate approved by the Engineer for the seed materials, fertilizer, and mulch materials used to suite the seed application rate. Seed application rate shall be 300 lbs. per acre.

3.8 TEMPORARY SOIL STABILIZATION

A. On disturbed areas that will not receive final landscape/plant material installation or final seeding within two weeks of being disturbed, the Contractor shall provide temporary soil stabilization. Contractor shall apply straw mulch to all exposed areas after scarifying and fine grading takes place.

B. Spread a loosely applied layer of clean, chopped straw at the rate of 2 tons/acre (90 lbs./1000 square feet) to form a continuous blanket 1-1/2" in loose thickness.

3.9 MULCHING

A. Mulching shall consist of placing a mulch material on areas that have or are to be seeded. Mulch shall be placed in a loose enough condition to allow penetration of sunlight and circulation of air, but thick enough to shade the ground, reduce rate of water evaporation and prevent or reduce erosion by wind or water. Mulch shall be secured with suitably acceptable anchoring material.

B. On slopes steeper that 6H:1V, reinforcement mats shall be used. Satisfactory mulching materials include the following:

1. Straw or grass hay applied a 1-1/2 to two (2) tons per acre, anchored with asphalt or netting tie down.
2. Asphalt emulsion alone at 600 to 1,200 gallons per acre.
3. Commercially available erosion control netting of jute, paper or biodegradable synthetics.
4. Continuous filament fiberglass at 1,000 pounds per acre anchored with 150 gallons of asphalt emulsion.
5. Anchor straw or hay mulch by the methods as specified herein.
6. Wood chips will not need anchoring when used on workable slopes.

C. Commercially manufactured netting and/or fiberglass materials shall be anchored in accordance with the manufacturer's printed instructions for the material used.

D. Punch and or anchor mulch material into soil using mulch anchoring tool. Soil must be moist, free of stones and loose enough to permit disc penetration to a depth of three (3) inches.

E. Blow on liquid or emulsified asphalt materials with the straw or hay mulch or spray or sprinkle asphalt tie down materials immediately after mulch is spread.

F. Apply emulsified asphalt at 0.04 gallons per square yard. Do not apply emulsified asphalt during freezing weather since is contains approximately 50% water. Apply liquid (cut back) asphalt at approximately 0.10 gallons per square yard. Liquid asphalt may be applied during freezing weather since it is cut back with kerosene.

3.10 TURF RENOVATION

A. Paved areas over which hauling operation have been conducted shall be kept clean. Promptly remove materials spilled on pavement.

B. Repair existing lawns damaged by construction operations. Repair shall include finish grading, seeding, as required to match existing grade and lawn, and maintenance of repair areas.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil. Upon completion of lawn installation, remove from the site and legally dispose of the following:

1. Surplus subgrade material.
2. Stone and foreign matter.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

J. Apply seed and hydroseed as required for new turf.

K. Water newly planted areas and keep adequately watered through establishment period.

3.11 CLEAN-UP AND PROTECTION

A. Promptly remove soil and debris resulting from lawn installation Work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off the Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove non-degradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 19

SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparation of Subsoil and Topsoil.
2. Trees, Plants, and Ground Cover.
3. Mulch.
4. Fertilizer.
5. Pruning.
6. Landscape Edging.
7. Maintenance.

B. Related Requirements:

1. Section 32 92 19 – Seeding.

1.2 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI A300 - Tree Care Operations - Tree, Shrub and Other Woody Plant Maintenance - Standard Practices.
2. ANSI Z60.1 - Nursery Stock.

B. Forest Stewardship Council (FSC):

1. FSC Guidelines - Forest Stewardship Council Guidelines.

1.3 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area.

B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

C. Backfill: The earth used to replace or the act of replacing earth in an excavation.

D. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than sizes indicated; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

E. Container Grown Stock: Healthy, vigorous, well rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Growing Season: April 1 to First-Frost in Autumn.

H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

I. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. Pests included insects, mites, grubs, mollusks, (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

J. Planting Area: Areas to be planted.

K. Planting Soil: Existing, on site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. Plant: Plants; Plant material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. Root Flare: Also called “trunk flare.” The area at the base of the plant’s stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

O. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit product data for the following items:

1. Plant material including quantities, sizes, and source.
2. Fertilizers.
3. Pesticides.
4. Anti-desiccants.
5. Landscape edging.
6. Tree staking and guying materials.
7. All other planting accessories indicated on Drawings.

C. Plant Materials: Include species, cultivar names, quantities, sizes, quality, and sources for plant materials.

D. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the project.

E. Qualification Data: For Landscape Installer. Include the following:

1. A list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons. Installer must have minimum five (5) years' experience.
2. Name, years of experience, and certifications for the construction supervisor or foreman that will be supervising work. Supervisor/Foreman must have minimum five (5) years' experience.

F. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

G. Samples: 1-pint volume of Shredded Hardwood Bark Mulch in sealed plastic bag.

1.5 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Operation and Maintenance Data: Summary of maintenance activities including frequencies and quantities performed during establishment period including schedules.

1.6 QUALITY ASSURANCE

A. Tree Pruning: ANSI A300 Pruning Standards for Woody Plants.

B. Perform Work according to the State of Michigan requirements.

C. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five (5) years' experience in landscape installation in addition to requirements in Section 01 40 00 "Quality Requirements".
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one (1) of the following categories from the Professional Landcare Network:
    a. Certified Landscape Technician – Exterior, with installation and maintenance specialty area(s), designated CLT – Exterior.
    b. Certified Ornamental Landscape Professional designated COLP.
    c. Pesticide Applicator: State licensed, commercial.

D. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required size.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches of roots tip to tip. Take caliper measurements six (6) inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

E. Plant Material Observation:

1. Engineer may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality.
2. Engineer may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease, symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work.
3. Remove rejected trees or shrubs immediately from Project site.
4. Notify Engineer of sources of planting materials 3 days in advance of delivery to site.

F. Required Topsoil Testing:

1. The Contractor shall engage an approved agronomic soil-testing laboratory and an approved physical analysis-testing laboratory. The cost of testing to be borne by the Contractor.
2. All agronomic soil sampling and testing shall comply with procedures specified in the United States Department of Agriculture Ag. Handbook 60: Diagnosis and improvement of Saline and Alkali Soils.
3. Required Tests:
    a. Chemical analysis indicating:

1) Fertility: pH, nitrate, nitrogen, ammonia nitrogen, phosphate, phosphorous, potassium, calcium, magnesium.
2) Nutrient data shall be provided in parts per million (ppm).

b. Physical properties including:
1) Organic content
2) Particle size distribution
3) Saturated hydraulic conductivity in one (1) hour.

c. Amendment recommendations from testing laboratory for providing ideal soils for intended vegetative uses.

1.7 PRE-INSTALLATION MEETINGS

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Convene minimum one (1) week prior to commencing work of this Section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

B. Protect and maintain plant life until planted.

C. Deliver plant life materials immediately prior to placement. Keep plants moist.

D. Plant material damaged as a result of delivery, storage or handling will be rejected.

E. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws is applicable.

F. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion control measures to prevent erosion or displacement of bulk materials; discharge of soil bearing water runoff; and airborne dust reaching adjacent properties, water conveyance, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

G. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

H. Contractor to provide the Engineer at least 48 hours' notice before making any delivery of plant material. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

I. All planting stock shall be handled by the container or the root ball and never by any part of the plant itself.

J. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two (2) weeks after planting.

K. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

L. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container grown stock from containers before time of planting.
3. Water root systems of plants stored on site deeply and thoroughly with a fine mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Engineer or Owner no fewer than two (2) days in advance of proposed interruption of each service or utility.

2. Do not proceed with interruption of services or utilities without Owner's written permission.

C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: April 15 - June 1.
2. Fall Planting: September 1 – November 1.

D. Weather Limitations:

1. Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained.
2. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
3. Do not install plant life when ambient temperatures may drop below 40 degrees For rise above 90 degrees F within 48 hours of planting.
4. Do not install plant life when wind velocity exceeds 25 mph.

E. Coordination with Seeding Areas:

1. Plant trees, shrubs, and other plants after finish grades are established.
2. It is preferred that plants be installed before seed.
3. If plants are installed after seed, protect seed and promptly repair damage due to planting operations.

1.10 WARRANTY

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Special Warranty: Installer agrees to repair or remove, furnish and replace plantings and accessories that fail in materials, workmanship, or growth within the specified warranty period.

1. Planting failures include, but are not limited to, the following as determined by the Engineer:
   a. Plants that are more than 25 percent dead.
   b. Plants that have clear evidence of disease.
   c. Unsatisfactory growth.
   d. Structural failures including broken limbs, branches, or stems or plantings that have fallen or blown over.
   e. Damaged or broken limbs, bark, or trunk.
   f. Faulty performance of tree stabilization.

2. Warranty Periods: From date of the projects Substantial Completion:
   a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
   b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

C. Final Warranty Inspection: At the conclusion of the warranty period the Contractor and Engineer or Engineer shall conduct a final warranty inspection at a time mutually agreeable and during the growing season. It will be the Contractor's responsibility to notify the Engineer in writing requesting the inspection.

1. Engineer must provide in writing a list or drawing that identifies all plant material that has failed and requires replacement.

2. Contractor shall provide replacement plant material for all plants which has deemed to have failed. Any necessary repairs under the warranty shall be made within thirty (30) days after receiving notice of need, weather permitting. In the event the contractor does not make repairs accordingly, the owner, without further notice, may provide materials and labor to make such repairs at the expense of the contractor. The replacement shall be on the same variety, size and character as specified for original planting, unless Engineer specifies a substitute.

D. Extended Warranty for Replacement Plantings: All replacement plant material shall receive an extended warranty equal to the original warranty period, at no additional cost to the owner.

1.11 MAINTENANCE SERVICE

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Maintain plant life immediately after placement. Continue maintenance until termination of warranty period.

C. Maintenance includes:

1. Cultivation and weeding plant beds and tree pits.
2. Applying herbicides for weed control. Remedy damage resulting from use of herbicides.
3. Remedy damage from use of insecticides.
4. Irrigation sufficient to saturate root system.
5. Pruning, including removal of dead or broken branches.
6. Disease control.
7. Maintaining wrapping, guys, and stakes.
8. Replacement of mulch.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well shaped, fully branched, healthy, vigorous stock,

densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scale, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut off limbs more than ¾ inch in diameter; or with stem girdling roots are unacceptable.
2. Collected Stock. Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z 60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Engineer, with a proportionate increase in size of roots or balls.

C. Root Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSIZ60.1. Root flare shall be visible before planting.

D. Labeling: Label each tree/shrub and one (1) of each massing of groundcovers or perennial. Label shall identify variety size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant. Shipped product shall be accompanied by a packing slip that clearly lists shipped species by scientific and common name, and the number of each species shipped.

E. Provide healthy, disease free plants of species and variety shown or listed, with well-established root systems reaching to the sides of container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

2.2 TOPSOIL

A. Topsoil which has been stripped from on-site may be utilized as topsoil on the project provided it is pulverized, tested, and therefore meets the requirements of these specifications and any necessary amendments added per the recommendations of the testing results.

B. Topsoil required shall be furnished as specified below:

1. A fertile, friable, loamy surface soil without admixture of subsoil, free of stones, stumps, root, trash, debris, and other materials deleterious to plant growth.
2. The pH range shall be 6.0 to 7.0. Topsoil that does not meet this pH range shall not be approved by the Owner's Project Representative.
3. Nutrient data in parts per million (ppm) dry soil.

Phosphorus	Min. 75 lb./Ac
Potassium	Min. 300 lb./Ac
Calcium	Min. 1,500 ppm
Magnesium	Min. 100 ppm
Cation Exchange Capacity	Min. 20 mea/100g

Soluble Salt	Max. 1,000 ppm

4. Organic content shall be greater than 3 percent and less than 10 percent determined by loss through ignition.

5. Gradation:
   a. All topsoil imported, or on-site reused materials, shall be pulverized and screened.
   b.

Sieve Designation	Percent Passing
1" screen	100
¼" screen	97 – 100
No. 10 U.S.S. mesh sieve	95 – 100
No. 140 U.S.S.	60 – 90

   c. Clay content determined by Bouyoucous Hydrometer Test shall range between 5 percent and 15 percent.
   d. Percentages shall be based on dry weight of the sample.

2.3 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.4 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.5 FERTILIZERS

A. Planting Tablets: Tightly compressed chip type, long lasting, slow release, commercial grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
   1. Size: 10-gram tablets.
   2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

B. Engineered planting soils used in bioretention systems and other similar green storm water infrastructure systems shall not be treated with fertilizers, except by addition of compost amendments as specified for the planting mix. When additional organic matter is necessary or recommended by Engineer, compost shall be added only within the root zone of the planting soil, and not throughout the entire soil depth.

2.6 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

   1. Type: Triple-shredded, 100% organic hardwood mulch.
   2. Mulch Length: 3 inches maximum.
   3. Mulch Particle Size: shall pass through a #3 sieve and be sized between 3/8” and 1/2".
   4. Depth: As indicated on Drawings.
   5. Color: Natural Dark Brown. No dyes or chemicals.

6. Shredded former wood products are not allowed (ex. wood pallets).
7. Mulch must be aged six weeks and not longer than twelve months.

2.7 PESTICIDES

A. Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction. Do not use herbicides in storm water management areas. Pre-emergent herbicides are not allowed.

B. Post Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated. Do not use herbicides unless authorized in writing by Engineer and by authorities having jurisdiction.

2.8 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2 by 2-inch nominal by length indicated, pointed at one end. Stakes shall be lodge pole stakes free of knots and of diameters and lengths appropriate to the size of the plant as required to adequately support the plant.
2. Wood Deadmen: Timbers measuring 8 inches in diameter and 48 inches long, treat with specified wood pressure preservative treatment.
3. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles.
4. Guys and Tie Wires: Tree guying shall be flat woven polypropylene material, 3/4-inch wide, and 900-pound break strength.
5. Tree Tie Webbing: UV resistant polypropylene or nylon webbing with brass grommets.
6. Guy Cables: Five strand, 3/16-inch diameter, galvanized steel cable, with zinc coated turnbuckles, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.
7. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
8. Proprietary staking and Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by plant stem; sized as indicated and per manufacturer's written recommendations.
    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
        1) Arborbrace; ArborBrace Tree Guying System.
        2) Decorations for Generations, Inc; Reddy Stake or Meta Stake System.

2.9 SUBSTITUTIONS

A. Plant material may be substituted due to lack of availability only after approval from the Engineer. Contact the Engineer immediately if a particular species or cultivar is unavailable and submit a request for substitution accompanied with a list of nurseries contacted in the search for the required plant material and a record or other attempts to locate the required material. Requests shall also include sources of plants found that may be of a smaller or larger size, or of a different shape or habit than specified, or plants of the same genus and species but different cultivar origin, or which may otherwise not meet the requirements of the specifications but are available for substitution. Failure to notify the Engineer in a timely manner does not relieve the Contractor from providing the plant materials specified.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting location adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until the moisture control reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable, or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion control measures to prevent erosion or displacement of soils and discharge of soil bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Engineer's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations direct by Engineer. Stake locations of individual trees and shrubs and outline areas for mass perennial or groundcover plantings.

E. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two weeks after planting.

F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 TREE PLACEMENT

A. Plant trees in locations designated on drawings. Trees being replaced in kind shall be planted in as close to the original location as possible. All newly planted trees shall meet the below requirements.

B. Trees shall not be planted directly above existing or proposed water or sewer lines. Place trees with the following offset requirements, measured from the center of the trunk to the edge of the utility.

1. Water Lines: 5-foot minimum separation.
2. Sewer Lines: 5-foot minimum separation.

C. Trees shall have the following minimum clearances from streets and sidewalks, as measured from the center of the trunk to the edge of pavement.

1. Streets: 3-foot minimum clear.
2. Sidewalks: 3-foot minimum clear.

D. If proposed tree planting locations conflict with the above requirements, consult Engineer for alternative tree planting locations.

3.4 PLANTING AREA SOIL PREPARATION

A. Subgrade:

1. Bring subsoil to required levels, profiles and contours suitable for receiving the required finish surfaces. Make changes in grade gradual. Blend slopes into level areas.
2. Loosen subgrade of entire planting area to a minimum depth of 12 inches. Remove stones larger than 1-inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

3. Apply superphosphate fertilizer directly to subgrade before loosening.

B. Topsoil:

1. Contractor shall re-use existing site topsoil where possible. If existing topsoil is not available or does not meet topsoil requirements, contractor shall provide imported topsoil.
2. Amend topsoil as required by topsoil testing.
3. Topsoil Depth in all planted areas shall be 6 inches.
4. Spread approximately one-half the topsoil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade.
5. Spread remaining topsoil to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

D. Before planting, obtain Engineer's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.5 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three (3) times as wide as ball diameter for balled and burlapped stock and container stock.
3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected overnight.
9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

10. Planting Pits within Bioretention Planting Areas and other green infrastructure storm water management systems: Planting soils within the bioretention planting areas shall be field compacted per Section 31 24 00 - Bioretention. Planting pits in bioretention areas shall be manually dug only. Compact the area under the plant by lightly tamping to provide a stable base for the shrubs or perennials in order to prevent settling. Add only approved planting soil shall be used for backfilling in lightly compacted layers of not more than nine inches (9") and each layer watered sufficiently to settle before the next layer is put in place. Compact as necessary to ensure the root flare will be at or above adjacent grades after planting as shown on Drawings.
11. When working in bioretention filled with engineered soils, the Contractor shall make all efforts to not destroy soil structure by excessive traffic, working, or compacting the soil throughout the planting operation. Utilize the smallest practicable piece of low ground pressure mechanical equipment in the adjacent areas. To prevent potential for plant settlement, do not over excavate prior to planting.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

C. Obstructions:

1. Notify Engineer if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
2. Hardpan Layer: Drill 6-inch diameter holes, 24 inches apart, into free-draining strata or to a depth of 10-feet, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Engineer if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.6 TREE AND SHRUB PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

D. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.

1. Use planting soil for backfill.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about one (1) inch from root tips; do not place tablets in bottom of the hole. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Set container-grown stock plumb and in center of planting pit or trench with root flare two (2) inches above adjacent finish grades.

1. Use planting soil for backfill.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.
6. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.7 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Engineer.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Engineer, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

A. General Requirements:

1. All staking materials must be approved by the Engineer prior to installation.
2. Guying shall be tied in such a manner as to create a minimum 12-inch loop to prevent girdling.
3. Stakes shall be driven to a sufficient depth to hold the tree rigid.
4. Remove guys and stakes after one (1) year.

B. Conditions Warranting Tree Stabilization: Do not provide tree stabilization unless one (1) of the following conditions is met.

1. Large Caliper Trees. Stake and guy trees more than 14 feet in height and more than three (3) inches in caliper unless otherwise indicated on Drawings. Securely attach no fewer than three guys to stakes 30 inches long, driven to grade.
2. Steep Slopes. Stake and guy all trees located on slopes exceeding 4H:1V.
3. Abnormal Site Conditions. Sites with soft soils, windy conditions, wet sites, or other special conditions may require staking and guying. Initially plant trees with no stakes and guys to test stability. If trees will not stay plumb, then add stakes and guys as needed or as directed by the Engineer.

C. Staking:

1. Upright Staking and Tying: Use a minimum of two (2) stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches or one-third of trunk height above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Use two stakes for trees up to 12-feet high and 2-1/2 inches or less in caliper; three (3) stakes for trees less than 14-feet high and up to four (4) inches in caliper. Space stakes equally around trees.
3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
4. Support trees with two (2) strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

D. Staking and Guying:

1. Site-Fabricated Staking-and-Guying Method:
   a. For trees more than six (6) inches in caliper, anchor guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle and compression spring for each guy wire and tighten securely.
   b. Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle and compression spring. Allow enough slack to avoid rigid restraint of tree.

c. Support trees with strands of cable or multiple strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle and compression spring. Allow enough slack to avoid rigid restraint of tree.
d. Attach flags to each guy wire, 30 inches above finish grade.
e. Paint turnbuckles and compression springs with luminescent white paint.

2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

E. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.

1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of the vertical stakes.
a. Install stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation. Saw stakes off at horizontal stake.
b. Install screws through horizontal hold-down and penetrating at least (one) 1 inch into stakes. Predrill holes if necessary to prevent splitting wood.
c. Install second set of stakes on other side of root trunk for larger trees as indicated.

2. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.9 GROUND COVER AND HERBACEOUS PLANTING

A. Set out and space ground cover and plants other than trees and shrubs as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots. Use soil excavated from planting holes for backfill.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two (2) nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.10 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees in Turf Areas: Apply mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within three (3) inches of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within three (3) inches of trunks or stems.

3.11 LANDSCAPE EDGING

A. Install edging where indicated on Drawings according to manufacturer's written instructions. Anchor with stakes per manufacturer's written instructions.

3.12 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Maintain plantings by pruning, cultivating, watering, weeding, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

D. For bioretention systems and other vegetated storm water management systems, all chemicals used during the maintenance period must be approved by the Engineer for suitability before application.

E. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease.

1. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
2. Pesticides used in storm water treatment areas shall be applied such that no pesticide comes in contact with the soil and shall be applied only during dry periods. All pesticides must be submitted to Engineer for approval.

3.13 PESTICIDE AND HERBICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective):

1. Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.
2. Herbicides used in storm water treatment areas shall be applied such that no herbicide comes in contact with the soil and shall be applied only during dry periods. All herbicides must be submitted to Engineer for approval.

3.14 REPAIR AND REPLACEMENT

A. Repair or replace trees and plants that are damaged by construction operations in a manner approved by Engineer.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Furnish and replace trees and plants that have failed (as defined in Section 1.11), as determined by Engineer. Replacements shall comply with this Section.
4. 100% of plant material must be alive and healthy prior to the start of the warranty period.

B. Warranty Period:

1. At the conclusion of the warranty period, plants shall be evaluated by the Engineer to determine if any plants have failed.
2. Replace all trees and plants that have failed as determined by the Engineer. Replacement trees and plants of same size and species as those being replaced. Substitutions may occur if approved in by Engineer.
3. Provide extended warranty for period equal to original warranty period for replaced plant material.

3.15 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.16 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: Twelve (12) months from date of Substantial Completion.

B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: Twelve (12) months from date of Substantial Completion.

C. Prune only injured, dying or dead branches from trees and shrubs. Do not prune to shape.

END OF SECTION 32 93 00

SECTION 32 93 90 – GREEN INFRASTRUCTURE MAINTENANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Maintenance of Bioretention.
2. Maintenance of All Permeable Pavement Types.
3. Maintenance of Urban Storm Water Trees in Structural Cells or Structural Soil.

B. Related Sections:

1. Section 31 24 00 – Bioretention.
2. Section 32 12 17 – Permeable Asphalt.
3. Section 32 13 15 – Permeable Rubber Paving.
4. Section 32 14 14 – Permeable Concrete Unit Paving.
5. Section 32 13 16 – Permeable Grass Paving.
6. Section 32 14 14 – Permeable Concrete Paving.
7. Section 32 14 17 – Permeable Brick Unit Paving.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Plants:

1. Basis of Measurement: By Lump Sum for the specified Maintenance period.
2. Basis of Payment: Includes the specified maintenance tasks for Bioretention or Permeable Pavements.

1.3 REFERENCES

A. American National Standards Institute:

1. ANSI A300 - Tree Care Operations - Tree, Shrub and Other Woody Plant Maintenance - Standard Practices.
2. ANSI Z60.1 - Nursery Stock.

1.4 DEFINITIONS

A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit list of plant material sources, and other accessories.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Operation and Maintenance Data: Include pruning objectives, types and methods; types, application frequency, and recommended coverage of fertilizer.

1.7 QUALITY ASSURANCE

A. Tree Pruning: ANSI A300 Pruning Standards for Woody Plants.

B. Perform Work according to MDOT standards.

1.8 QUALIFICATIONS

A. Installer: Company specializing in installing and maintaining planting areas with minimum of three years of experience.

B. Tree Pruner: Company specializing in performing work of this section with minimum of three years of experience.

1.9 PRE-INSTALLATION MEETINGS

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Convene minimum one week prior to commencing work of this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect and maintain plant life until planted.

B. Deliver plant life materials immediately prior to placement. Keep plants moist.

C. Plant material damaged as a result of delivery, storage or handling will be rejected.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Do not install plant life when ambient temperatures may drop below 35 degrees F or rise above 90 degrees F.

B. Do not install plant life when wind velocity exceeds 20 mph.

1.12 COORDINATION

A. Comply with coordination requirements in Section 01 30 00 - Administrative Requirements.

B. Maintenance Contractor to obtain as built plans for any prior installed underground irrigation system piping, watering heads and other underground utilities**.**

1.13 WARRANTY

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Furnish one-year manufacturer warranty for trees, shrubs, plants, and ground cover.

1.14 MAINTENANCE SERVICE BY CONTRACTOR

A. Comply with maintenance requirements in Section 01 70 00 - Execution and Closeout Requirements.

B. Maintain Permeable Pavements as specified in Maintenance Agreement.

C. Maintenance of Permeable Pavement Agreement shall include:
1. Inspection once per quarter and after each storm event exceeding one half inch.
2. Pavement sweeping or vacuuming at least 2 times per year.
3. Leaf removal.
4. Sediment removal.
5. Stabilize contributing drainage area.
6. Mow grass in grass paver installations.
7. Manual methods for weed control.

D. Maintain Bioretention System as specified in Maintenance Agreement.

E. Maintenance of Bioretention includes:

1. Inspection once per quarter (spring, summer, fall) and after each storm event exceeding one half inch.
2. Cultivation and weeding plant beds and tree pits.
3. Plant replacement as required to maintain plant density.
4. Replace stone as needed.
5. Use manual methods for weed control.

6. Watering during drought periods defined as more than 10 days without measurable rain.
7. Pruning, including removal of dead or broken branches.
8. Replacement of mulch, as needed.
9. Removal or sediment.

PART 2 - PRODUCTS

2.1 TREES, SHRUBS, PLANTS, AND GROUND COVER

A. All landscape materials shall conform to MDOT 917.

B. Planting Stock:

1. Species: According to Standardized Plant Names, official code of American Joint Committee on Horticulture Nomenclature.
2. Identification: Label individual plants or each bundle of plants when tied in bundles.
3. Plants: No. 1 Grade conforming to "American Standard for Nursery Stock" of American Association of Nurserymen (AAN); well-branched, vigorous and balanced root and top growth; free from disease, injurious insects, mechanical wounds, broken branches, decay and other defects.
4. Trees: Furnish with reasonably straight trunks, well balanced tops, and single leader.
5. Deciduous plants: Furnish in dormant state, except those specified as container grown.

C. Trees, Shrubs, Plants, Perennials, and Ground Cover: Species and size identifiable in plant schedule, grown in climatic conditions similar to those in locality of the Work.

2.2 SOIL MATERIALS

A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; minimum pH value of 5.4 and maximum 7.0; organic matter to exceed 1.5%, magnesium to exceed 100 units; phosphorus to exceed 150 units; potassium to exceed 120 units; soluble salts/conductivity not to exceed 900 ppm/0.9 mmhos/cm in soil.

2.3 SOIL AMENDMENT MATERIALS

A. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials.

B. Water: Clean, fresh, and free of substances or matter capable of inhibiting vigorous growth of plants.

2.4 MULCH MATERIALS

A. Mulching Material: Composted, double shredded hardwood bark, natural wood color with no dyes.

2.5 PLANT SOIL MIX

A. Plant Soil Mix: Comply with Section 31 24 00 - Bioretention.

2.6 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Test and analyze imported topsoil. Test must be within 6 months of topsoil placement.

C. Analyze to ascertain percentage of nitrogen, phosphorus, potassium, soluble salt, organic matter, and pH value.

D. Provide recommendation for fertilizer and soil amendment application rates for specified planting as result of testing.

E. If required by Engineer, Contractor shall submit test results to a qualified testing laboratory for analysis. Indicate, by test results, information necessary to determine suitability.

PART 3 - EXECUTION

3.1 MAINTENANCE OF PERMEABLE PAVEMENTS

A. Inspection. In the first year following completion of construction warranty, routinely inspect the practice and contributing drainage once per quarter each year, and after storm events that exceed one half (1/2) inch of rainfall. Check for standing water remaining on the surface of the pavement after a precipitation event within 30 minutes. Conduct any other needed repairs or stabilization.

B. Mechanically sweep hard pavements with a regenerative street sweeper, or a vacuum sweeper to remove sediment twice a year in the spring and fall. Use of a power washer or compressed air blower at an angle of 30 degrees or less can be effective, particularly in combination with a vacuum or vacuum sweeper. For grassed pavers, mow and reseed as needed.

C. Replace any necessary joint material.

D. Stabilize pervious run-on contributing drainage area within public lands to prevent siltation of permeable pavements. Vacuum any adjacent non-permeable pavement that runs-on onto the permeable pavement area. Remove any soil or sediment deposited on pavement. Replace or repair any pavement surfaces that are degenerating or spalling. Blow out underdrain cleanouts

using compressed air, high pressure water hose, or drain snake in practices that show evidence of clogged underdrain as needed.

E. Mow grass in permeable grass paver when the grass reaches 3 inches during the growing season. Bag grass clippings and remove from the site.

F. Remove weeds in permeable grass paver practices annually.

3.2 MAINTENANCE OF BIORETENTION

A. Inspection: Conduct a maintenance inspection every three months to identify maintenance tasks required. Check curb cuts and inlets for accumulated sediment, leaves, and debris. Check for erosion, bare areas, and where mulch needs to be applied. Confirm there is not standing water still present in bioretention after 48 hours. Inspect inlets and outlets to ensure good condition and no evidence of deterioration. Check to see if high-flow bypass is functioning.

B. Maintenance: Maintain bioretention every three months between March and November. Remove trash and animal waste. Remove any dead or diseased plants and replace with similar. Remove any remaining stakes, wires, or tags. Remove sediment in pretreatment cells and inflow points. Water plants thoroughly during droughts, more than ten (10) days of no measurable rain. Mow grass filter strips and bioretention with turf cover. Bag and remove grass clippings from site.

C. On an Annual basis, remove invasive plants using recommended control methods. Cut back dead stems of herbaceous plants in the spring. Add or replace planting as per plant specification to maintain desired vegetation density. Replace stone at curb curbs, inflow, weirs, and check dams. Blow out cleanouts using compressed air, high pressure water hose, or drain snake in practices that show evidence of clogged underdrain. In bioretention areas planted with turf, reseed or stabilize bare spots exceeding two (2) square feet square of vegetated area to prevent erosion. In bioretention areas planted with perennial vegetation, Mulch with one (1) inches of shredded hardwood mulch.

D. Remove any accumulated sediment in pretreatment cells and run-on points at least once per year.

3.3 PLANT RELOCATION AND RE – PLANTING

A. Relocate plants as directed by Engineer or as indicated on landscape plans.

B. Ball or pot removed plants when temporary relocation is required.

C. Replant plants in pits or beds, back fill with prepared planting soil mixture. Remove burlap, ropes, and wires, from top half of root ball.

D. Saturate soil with water when pit or bed is half full of topsoil and again when full.

3.4 TREE AND SHRUB PRUNING

A. When pruning trees and shrubs is required, lightly prune according to ANSI A300 Maintenance Pruning Type: Crown Cleaning.

3.5 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements for field inspecting, testing, adjusting, and balancing requirements.

B. Plants are considered dead when more than one half of plant is diseased, damaged, or dead.

END OF SECTION 32 93 90

SECTION 33 01 10.58 - DISINFECTION OF WATER UTILITY PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Disinfection of potable water distribution system in accordance with AWWA C651 and the following options and restrictions.
2. Testing and reporting of results.

B. Related Requirements:

1. Section 33 14 13 – Public Water Utility Distribution Piping.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Water Works Association (AWWA):

1. AWWA B300 - Hypochlorites.
2. AWWA B301 - Liquid Chlorine.
3. AWWA C651 - Disinfecting Water Mains.
4. AWWA C655 – Field Dechlorination.

1.3 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Disinfection Procedure: Submit description of procedure, including type of disinfectant and calculations indicating quantities of disinfectants required to produce specified chlorine concentration.

C. Product Data: Submit manufacturer information for proposed chemicals and treatment doses.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Test and Evaluation Reports: Indicate testing results comparative to specified requirements.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Disinfection Report:

1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and completion.
3. Test locations.
4. Name of person collecting samples.
5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
6. Date and time of flushing start and completion.
7. Location of water disposal site.
8. Disinfectant residual after flushing in ppm for each outlet tested.

1.5 QUALITY ASSURANCE

A. Perform Work according to the current edition of AWWA C651 as amended herein.

PART 2 - PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals:

1. Hypochlorite: Comply with AWWA B300.
2. Liquid Chlorine: Comply with AWWA B301.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Verify that piping system has been cleaned, inspected, and pressure tested.

C. Verify that access fittings have been installed under Section 33 14 13 – Public Water Utility Distribution Piping.

D. Perform scheduling and disinfecting activity with initial flushing and water pressure testing.

3.2 INSTALLATION

A. Provide required equipment to perform Work of this Section. Any additional taps, outlets, piping, valves, temporary flushing hydrants, and appurtenances (including but not limited to excavation, backfill, compaction, temporary pavement, and restoration) required for pressure testing, flushing, and disinfection shall be the responsibility of the Contractor at no additional cost to the Owner.

B. Introduce treatment into piping system via either the continuous feed, tablet/granule, or slug method of chlorination described below.

C. Continuous Feed Method:

1. The continuous feed method consists of completely filling the main with potable water to remove all air pockets, flushing the completed main to remove particulates, and then refilling the main with potable water that has been chlorinated to 25mg/l. After a 24-hour holding period in the main, there shall be a residual of not less than 10 mg/L free chlorine in collected samples.
2. The flushing velocity in the main shall be not less than 3 ft/sec unless the Engineer determines that conditions do not permit the required flow to be discharged to waste.
3. Potable water may be supplied from a temporary backflow-protected connection to the existing distribution system or other approved supply sources. The cross-connection control device shall be consistent with the degree of hazard for backflow protection of the active distribution system. The flow shall be at a constant, measured rate into the newly installed water main. In the absence of a meter, approximate the rate by placing a pitot gauge in the discharge or measuring the time to fill a container of known volume. The main should undergo hydrostatic pressure testing prior to disinfection.
4. At a point not more than 10 feet downstream from the beginning of the new main, dose the water entering the new main with chlorine fed at a constant rate such that the water will have not less than 25 mg/L free chlorine. Measure the chlorine concentration at regular intervals to ensure that this concentration is provided. Measure chlorine in accordance with the procedures described in the current edition of the AWWA Manual M12.
5. Table 33 01 10.58-1 below gives the amount of chlorine required for each 100 feet of pipe of various diameters to produce a 25 mg/L concentration. Solutions of 1 percent chlorine may be prepared with calcium hypochlorite. The solution requires 1 pound of calcium hypochlorite in 8 gallons of water.

Table 33 01 10.58-1

Pipe Diameter (inches)	100% Chlorine (lb)	1% Chlorine Solution (gallons)
6	0.030	0.36
8	0.054	0.65
10	0.085	1.02
12	0.120	1.44
16	0.217	2.60

6. During the application of chlorine, position valves so that the strong chlorine solution in the main being treated will not flow into water mains in active service. Do not stop the chlorine application until the entire main is filled with heavily chlorinated water. Keep the chlorinated water in the main for at least 24 hours. During this time, operate all valves and hydrants in the section treated in order to disinfect the appurtenances. At the end of this 24-hour period, the treated water in all portions of the main shall have a residual of not less than 10 mg/L free chlorine.
7. Hypochlorite solution may be applied to the water main with a gasoline or electrically powered chemical feed pump designed for feeding chlorine solutions. Feed lines shall be of such material and strength as to safely withstand the corrosion caused by the concentrated chlorine solutions and the maximum pressures that may be created by the pumps. Check all connections for tightness before the solution is applied to the main.

D. Tablet/Granule Method of Chlorination:

1. Place calcium hypochlorite granules at the upstream end of the first section of pipe, at the upstream end of each branch main, and at 500 ft. intervals. Quantity of granules shall be as shown in Table 33 01 10.58-2.

    a. Tablets/Granules method is not to be used for solvent-welded plastic or screw joint pipe. Tablets/Granules could react with solvents or joint compounds and cause an explosion.

Table 33 01 10.58-2

Pipe Diameter (d), in.	Calcium Hypochlorite Granules (oz.)
4	1.7
6	3.8
8	6.7
10	10.5
12	15.1
14 and greater	$(d/12)^2$ x 15.1

2. Alternatively, place calcium hypochlorite tablets (5 grams each) in the upstream end of each section of pipe to be disinfected, and at branch lines using an NSF 61 approved adhesive on the crown of the pipe, per manufacturer recommendations, and Table 33 01 10.58-3. Tablet count is calculated to provide for a dose of 25 mg/L. If the tablets are attached before the pipe is installed, their positions shall be marked on the pipe exterior to indicate that the tablets have been installed on the top.

Table 33 01 10.58-3

Pipe Diameter, d (in)	Length of Pipe Section (ft)				
	13 or less	18	20	30	40
4	1	1	1	1	1
6	1	1	1	2	2
8	1	2	2	3	4
10	2	3	3	4	5
12	3	4	4	6	7
16	4	6	7	10	13

3. Fill the installed main with water at a velocity no greater than 1 ft/s to avoid breaking the tablets loose from the pipe or washing the granules down the pipe.
4. Maintain disinfectant in system for 24 hours. If the water temperature is less than 41°F, maintain the disinfectant in the system for 48 hours.

E. Slug Method of Chlorination:

1. Before chlorinating the main it shall be filled with potable water and flushed to eliminate air pockets and remove particulates. Flushing rate shall be no less than 3 ft/s.
2. At a point not more than 10 ft. from the end of the new main, a "slug" of water with a free chlorine of 100 mg/L shall be developed and allowed to flow through the main at a rate such that all interior surfaces of the main are in contact with the 100 mg/L "slug" for at least 3 hours.
3. Free chlorine residual shall be monitored as the "slug" passes through the main. If at any time the residual drops below 50 mg/L, the injection equipment shall be moved to this location, and chlorine applied to restore the 100 mg/L.

F. The disinfecting solution should not contain more than 12 percent of active chlorine. Prolonged exposure to highly concentrated disinfection chemicals may damage the inside surface of HDPE pipe and is to be avoided.

G. During disinfection, all valves and hydrants shall be operated to ensure that all appurtenances are disinfected.

H. Flush, circulate, and clean until required disinfectant quality standard has been achieved using municipal domestic water. Sample as described below.

I. Before placing a new main in service, two (2) consecutive samples shall indicate the absence of coliform bacteria.

J. Once accepted, replace permanent system devices that were removed for disinfection.

3.3 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements.

B. Disinfection, Flushing, and Sampling:

1. There shall be no water in trenches up to the connection for sampling. The sampling piping shall be clean, disinfected, and flushed prior to sampling.
2. Disinfect pipeline installation according to AWWA C651.
3. Collect two sets of samples per AWWA C651 and in conformance with R325.11110, 1976 PA 399 as amended (Michigan Safe Drinking Water Act). Provide a sketch of the sampling points and deliver along with the samples to a certified laboratory within six hours of obtaining the samples and obtain a bacteriologic quality test to demonstrate the absence of coliform organisms in each separate section of the pipeline and in each structure after chlorination and refilling. Collect at least one set of samples from every 1,200 feet of the new water main and line stopping insertion point, plus one set from the end of the pipeline and at least one set from each branch. At each connection to an existing pipeline, take two additional samples. Use pipeline blowoffs or dedicated sampling ports for obtaining samples.
4. At each location, two sets of samples are collected at least 24 hours apart..
5. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving new water main pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use. DWSD standard is less than 4 ppm.

3.4 DISINFECTION OF VALVES, BLIND FLANGES, AND APPURTENANCES

A. During the period that the chlorine solution or slug is in the section of pipeline, open and close valves to obtain a chlorine residual at hydrants and other pipeline appurtenances. Swab exposed faces of valves and blind flanges prior to bolting flanges in place with a 1% sodium hypochlorite solution.

3.5 DISINFECTION OF CONNECTIONS TO EXISTING PIPELINES

A. Disinfect isolation valves, pipe, and appurtenances per AWWA C651. Flush with potable water until discolored water, mud, and debris are eliminated. Swab interior of pipe and fittings with a 1% sodium hypochlorite solution. After disinfection, flush with potable water again until water is free of chlorine odor.

3.6 REPETITION OF PROCEDURE

A. If the initial chlorination fails to produce required residuals and bacteriologic tests, repeat the chlorination and retesting until satisfactory results are obtained.

3.7 DISPOSAL

A. Comply with AWWA C655 – Field Dechlorination.

B. Schedule the rate of flow and locations of discharges in advance to permit review and coordination with Owner and Michigan Department of Environment, Great Lakes and Energy (EGLE), Wayne County, or other regulatory authorities.

C. Discharge of chlorinated water into watercourses or surface waters is regulated by the National Pollutant Discharge Elimination System (NPDES). Disposal of the chlorinated disinfection water and the flushing water is the Contractor's responsibility. Dechlorinate the disinfection water such that the chlorine residual complies with EGLE regulations and NPDES General Permit MIG670000, Wastewater Discharge from Potable Water Supply.

D. After final flushing and before pipeline is connected to existing system or placed in service, certify that disinfectant level meets quality standards of DWSD.

3.8 PIPING TEST FACILITY REMOVAL

A. After satisfactory disinfection, disinfect and replace air valves, restore the pipe coating, and complete the pipeline where temporary disinfection or test facilities were installed.

END OF SECTION 33 01 10.58

SECTION 33 01 12.11 – WATER MAIN LEAK DETECTION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Provide all equipment, tools, labor, materials, and incidental services necessary to perform all work for leak detection survey of the DWSD water distribution system as indicated and in compliance with the Contract Documents.

B. The work to be performed under this contract is for inspecting the potable water distribution system for leaks using computerized leak detection services. The purpose of the leak detection is to identify specific points of leakage within the DWSD piping system network such that system rehabilitation can be undertaken, and water loss reduced.

C. The Contractor shall conduct the leak detection inspection with limited disruption to the current operations of the Owner's water distribution system. Contractor shall coordinate the survey with Owner or Engineer.

1.2 REFERENCES

A. American Water Works Association (AWWA):

1. AWWA M36 Water Audits and Loss Control Programs.

B. International Organization for Standardization (ISO):

1. ISO 2859-1 Sampling procedures for inspection by attributes

C. American National Standards Institute (ANSI) / American Society for Quality (ASQ)

1. ANSI/ASQ Z1.4 Level 1 Sampling Procedures and Tables for Inspection by Attributes

1.3 DEFINTIONS

A. Contractor: The term "Contractor" is defined as the firm (and/or any of its Contractors) retained to perform these services by the Owner.

B. Engineer: The term "Engineer," as used in this scope of services, shall be defined as the Owner's designated representative.

C. Owner: The term "Owner," as used in this scope of services, shall be defined as the City of Detroit.

D. Water Distribution System: The term "Water Distribution System," as used in this scope of services, shall mean a water system carrying potable water flow to City of Detroit customers.

E. Valve Box: The term “Valve Box”, as used in this scope of services, shall mean an access point to a water distribution valve. “Valve box” may be used to identify either a 5 ½ inch valve box or an access valve manhole.

F. Service: The term “Service,” as used in this scope of services, shall mean a pipe connecting the DWSD mainline water pipe to a customer’s residence or place of business.

G. Curb Stop: The term “Curb Stop,” as used in this scope of services, shall mean a shut-off valve for a customer’s service.

1.4 SUBMITTALS

A. Bid Submittals:

1. Contractor shall submit a detailed project schedule for completion of work.
2. Contractor shall submit a written description of procedures to be used, including product literature for all testing equipment and typical reports from projects of similar scope and complexity.

B. Leak reports summarizing source of leak and leakage rate (daily volume) shall be submitted digitally. Digital submittal shall be linked to an existing asset ID (CIPMOID) as determined by the GIS system. Contractor shall utilize electronic field equipment to collect data and create reports with GIS app (i.e., ARC Collector) which shall be uploaded at the end of each work day.

1. The Engineer will provide the Contractor with electronic mapping products (ESRI Geodatabase, ESRI Shapefile, KML/KMZ, etc.) which define assets to be tested/inspected. Information provided by the Engineer will also include electronic templates and/or access to web-based data-entry forms to be used when submitting data. The Engineer will assign a unique Asset Identifier (CIPMOID) to each hydrant, valve, and pipe segment scheduled for inspection and will identify all hydrants, valves, and pipe segments in the mapping resources provided. The Contractor shall use these unique asset identifiers when collecting and managing all leak data. If any system differences are observed in the electronic mapping and field observations, the Contractor shall notify the Engineer with the use of an Asset Change Form as indicated in Part 3 of this specification.

C. Contractor shall standardize based on example report included as attachment to this specification.

D. Contractor shall submit leak reports as indicated in Part 3 of this specification.

E. Submit Traffic Control Plan to Owner or Engineer for review. Upon review from Owner or Engineer, Contractor shall submit to agency with jurisdiction for approval. Contractor shall receive approved Traffic Control Plan prior to start of testing.

F. Submit Health and Safety Plan (HASP) to Owner or Engineer prior to start of testing. Contractor shall be responsible for the health and safety of all workers on-site during testing.

G. Submit Security Plan to Owner or Engineer prior to the start of testing. Comply with Section 01 57 33 – Temporary Security Measures.

1.5 EXPERIENCE

A. The Contractor shall submit documentation for Owner approval to demonstrate the following experience as a business engaged in leak detection of municipal water mains.

B. The Contractor shall be in good standing under local contracting requirements or otherwise properly registered, licensed or permitted by law to carry on business within the State of Michigan and Wayne County, throughout the term of the Contract, and shall provide the Owner with evidence thereof as per contract documents.

C. At any time during the term of the Contract, the Owner may, at its sole discretion and acting reasonably, request updated evidence of good standing. A Contractor who fails to provide satisfactory evidence will not be permitted to continue to perform any Work.

D. The Contractor and/or any proposed Subcontractor, for the portion of the Work proposed to be contracted to them, shall:

1. Have a minimum of three (3) years of experience in the field of municipal water main leak detection by means of acoustic detection and have the required capital, organization, and equipment to perform the Work in strict accordance with the terms and provisions of the Contract Documents.
2. Have successfully carried out work similar in nature, scope and value to the Work and demonstrate that within the past three (3) consecutive years prior to the bid, as a prime Contractor, the Contractor has successfully performed in a timely manner at least five projects similar in scope and type.

E. Inspection of new infrastructure for acceptance purposes shall not be deemed as representative experience. For each project submitted to meet the experience requirements, indicate the following:

1. Name and location of project.
2. Name, address, and telephone number of Owner or Construction Manager.
3. Brief description of work to include length and diameter of water mains inspected.
4. Amount of contract.
5. Date of Completion – state if project was completed on time.

F. Be fully capable of performing the Work required in strict accordance with the terms and provisions of the Contract Documents.

1.6 QUALITY ASSURANCE

A. Contractor shall provide a QA/QC plan specific to water main leak detection.

B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. The Contractor shall submit a list describing all equipment to be used for review and approval of the Owner or Engineer.

B. The Contractor shall submit the following information:

1. Manufacturer/vendor.
2. Model.
3. Design and type including method for detecting and quantifying leaks.
4. Submit equipment calibration charts if applicable.

C. Minimum requirements for leak detection equipment:

1. Capable of accurately locating leaks (within 5 feet with 90% accuracy).
2. Capable of locating leaks on metallic and non-metallic piping including, but not limited to: asbestos cement (AC), cast iron, concrete, ductile iron, high-density polyethylene (HDPE), polyvinyl chloride (PVC), and steel.

D. Minimum requirements of data delivery services:

1. Data delivery to be provided as authorized.
2. Field equipment shall be capable of uploading digital leak detection reports to GIS system in real-time.

PART 3 - EXECUTION

3.1 LEAK DETECTION INSPECTION

A. Prior to Work, Contractor shall provide detailed work plans including equipment and personnel requirements for water main leak detection. Work plans shall include at a minimum the following:

1. Description of operational and testing methods.
2. List of personnel (Contractor and Owner personnel).
3. List of equipment.

4. Data collection protocols and procedures.
5. Safety protocols.
6. Leak reporting protocol.
7. Emergency contact plan.
8. Testing QA/QC plan and equipment calibration plan.
9. Schedule.

B. The Contractor shall utilize equipment and methodology to listen and identify potential leaks on Owner's water distribution system. All equipment used will be non-intrusive. The leak detection survey shall include all located water mains, valves, hydrants, services, and curb stop boxes. Contact shall be made with pipe appurtenances at intervals no greater than 500 feet on metallic pipes and 300 feet on AC and concrete pipe types, where contact points are available and accessible. Hydrants and accessible main line valves shall be listened to. On PVC and HDPE water mains, hydrants, valves, and water services shall be listened to, including 100% of exposed curb stop boxes.

C. The Contractor shall coordinate with the Engineer to ensure that no other activities are planned in the vicinity of the leak detection activities that could interfere with the ability of the leak detection equipment to locate leaks.

D. The Contractor shall be responsible for pumping out valve boxes as required to connect and facilitate listening devices.

E. A "Leak" log shall be maintained indicating all areas where suspected leak noise was heard. When leak noise has been detected and or suspected, the Contractor shall verify the suspected area a second time to confirm the noise. At least four hours shall pass between the initial listening of the area before a second listen and confirmation is attempted.

F. The Contractor shall conduct the leak detection survey with minimal disruption to traffic. Contractor personnel shall comply with traffic control plan.

G. With prior approval, the Contractor is permitted to perform the leak detection survey during weekends and outside of normal working hours of 6:00 AM to 5:30 PM, to avoid heavy traffic and/or noise. Note that the Owner is only available to provide guidance and answer questions during normal working hours of Monday-Friday, 7:00 AM to 3:00 PM.

H. With prior consent from Owner and homeowner, when a leak is suspected on a water service, the Contractor shall turn off the water at the curb stop box and the Contractor shall listen to determine if the leak is on the homeowner's side of the curb stop.

I. Contractor shall provide daily reports to the Owner for each day field work is performed. The Daily Reports shall provide the following information: number of potential leaks, number of pinpointed leaks, number of contacted listening points, survey time, and the area surveyed. Daily Reports shall be included in the Final Report.

J. Digital Leak Reports shall be submitted as leaks are correlated and pinpointed. The Digital Leak Report shall include a sketch showing the precise location of the leak, including nearby

valves, hydrants, curb stops or other system components, in order that the Owner's personnel will be able to easily identify the location of the pinpointed leak. Distances from a known and easily identifiable point shall be included, as well as references to addresses if needed. The Digital Leak Report shall include an estimate of lost water in gallons per day. Digital Leak Reports shall be uploaded to Owner or Engineer's GIS system with the associated asset ID for the hydrant, valve, or pipe segment. The Digital Leak Report will also be included in the Final Report.

K. If the Owner's Contractor repairs the leaks during the Contractor's testing, then the Contractor shall resurvey that section of the water system to provide verification of leak mitigation and/or further trouble-shooting support.

L. Contractor shall prepare an inventory of defective system components such as valves, hydrants, meters, curb stops or other system appurtenances, which are noted during the field investigation and activities. A complete list of defective system components shall be provided in the final report. Defective system components shall be noted digitally with GIS interface equipment with Asset ID included.

M. The Contactor shall submit an Asset Change Form to the Owner or Engineer when encountering any differences in GIS system mapping and the field observations. Use of the form would include: identifying existing assets that are not on the current GIS system mapping, nonexistent assets that should be removed, or any other changes that may be needed in order to show proper location of the system assets.

N. The Contractor shall immediately report any leak that is found to DWSD.

3.2 FINAL REPORT

A. The Contractor shall prepare a final report showing the results of the leak detection and location survey. The report shall include the following:

1. A summary of the project.
2. Quantities and types of pipes tested for leaks.
3. A list of leakage located by type, location, and estimated quantity of leakage.
4. A list of defective system components.
5. Daily Reports of areas surveyed.
6. Interim Leak Reports.
7. Recommendations for future work based on the results of the survey.

3.3 QUALITY CONTROL

A. The Engineer shall be entitled to audit the collected data and be present when tests are being executed. In accordance with ISO 2859-1 and ANSI/ASQ Z1.4 Level 1 requirements, the Engineer will randomly observe five (5) out of every thirty (30) tests. If two (2) or more tests are not in conformance with the QA/QC Plan specified in Paragraph 1.6.A or the Work Plan specified

in Paragraph 3.1.A, all tests performed by the Contractor will be rejected, and the Contractor, without any additional compensation, shall correct deficiencies and repeat the tests.

B. Operate a quality control system that will effectively gauge the accuracy of inspection reports produced by the operator. Quality control system shall also include calibration records and scheduled maintenance as recommended by the manufacturer. At a minimum, the leak correlator should be calibrated annually. Documentation of calibration shall be provided prior to starting the leak detection survey.

END OF SECTION 33 01 12.11

SECTION 33 01 15.71 – CURED-IN-PLACE WATER MAIN LINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cleaning and flushing of existing water main as preparation for lining.
2. Taking video of existing water main to confirm pipe condition.
3. Field verification of size and length of water main to be lined.
4. Temporary potable water system plan.
5. Installing a resin-impregnated tube pipe liner.
6. Reestablishing service connections.

B. Related Requirements:

1. Section 01 51 36 – Temporary Water Service.
2. Section 01 78 39 – Electronic Project Record Documentation.
3. Section 31 23 33 – Trenching and Backfill.
4. Section 31 50 00 – Excavation Support Systems.
5. Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.
6. Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
7. Section 33 14 13 – Public Water Utility Distribution Piping.
8. Section 33 14 17 – Water Services.
9. Section 33 14 17.81 – Lead Service Line Replacement.
10. Section 33 14 19 – Valves and Hydrants for Water Utility Service.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. ASTM International:

1. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.
2. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics.
3. ASTM D903 – Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
4. ASTM D2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
5. ASTM D2992 – Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings.
6. ASTM D5813 – Standard Specification for Cured-in-Place Thermosetting Resin Sewer Piping Systems.

7. F1216 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
8. F1743 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP).
9. F2019 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled-in-Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP).

B. American Water Works Association (AWWA):

1. AWWA C600 – Installation of Ductile Iron Water Mains and their Appurtenances, Section 5.2: Pressure Testing.
2. AWWA C651 – Disinfecting Water Mains.

C. NSF International:

1. NSF 61: Drinking Water System Components – Health Effects.

1.3 COORDINATION

A. Comply with Section 01 30 00 – Administrative Requirements.

B. Coordinate Work of this Section with users connected to system. Notify homeowners and businesses as listed in Section 33 01 30.18 – Security Clearances and Communications.

C. Provide and maintain temporary facilities, including piping, to meet these requirements.

1.4 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 – Administrative Requirements.

B. Convene meeting a minimum two weeks prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Contractor's Qualifications: Submit a copy of the Manufacturer's licensee certificate with the Bid. Submit list of ten (10) similar jobs in Michigan, Ohio, Illinois, or Indiana within the past three (3) years as well. Provide project information including length of project, pipe diameter, date complete, and project cost.

C. Product Data:

1. Submit manufacturer information regarding liner material, curing chemicals, and lubricants.
2. Submit Manufacturer's Material Safety Data Sheets (MSDS).
3. Submit liner manufacturer's detailed installation procedures including:
    a. Detailed description of liner placement and curing procedures for pipes.
    b. Complete description of proposed wet-out procedures.
    c. Description of procedures for sealing liner material at manholes and reestablishing service connections.

4. Submit the resin manufacturer's recommended curing cycle as well as the recommended cooling rate.
5. Submit manufacturer's requirements for receiving, handling, and storage of materials.
6. Submit the liner manufacturer's recommended storage and delivery procedures. Include storage and delivery temperatures, as well as maximum time from wet-out to installation.
7. Submit written certification from the manufacturer that all materials used in the work were manufactured and tested in accordance with this Specification and are being used or installed in conformance with the manufacturer's recommendations.
8. Submit current NSF-61certification for the products used.
9. Submit two samples of liner material in both uncured and cured state.

10. Test Results:
    a. Prior to use of any materials, submit testing results of the proposed materials by an independent laboratory in conformance with these specifications. All submitted test data shall have been performed on field-installed samples within the last twelve (12) months. Any material not meeting the requirements of these specifications shall be completely removed from the Project. Materials acceptable to the Engineer shall be substituted for rejected items at no additional expense to the Owner.
    b. Testing by an independent laboratory shall verify that the products to be used meet all minimum strength standards as set forth in ASTM F-1216, Table 1. Testing shall be in accordance with Section 7.2.1 of ASTM F-1743 and shall verify that any product to be used on the Project meets the minimum chemical resistance requirements as established in ASTM F-1743, Table 2, as well as the water treatment chemicals listed in this specification.

11. Materials Resources Certificates:
    a. Certify recycled material content for recycled content products.
    b. Certify source for regional materials and distance from Project Site.

D. Working Drawings:

1. Temporary Potable Water System Plan: Submit a system layout drawing to the Engineer for review showing proposed bypass water mains and services, pipe fittings, temporary hydrant locations, water source feed locations, backflow protection, open and closed valves, pipe sizes, and out-of-service hydrant locations.

2. Disinfection Plan: Submit plan showing application fill, source and discharge points for the temporary system, and the rehabilitated water distribution system.
3. Indicate liner dimensions for each pipe size to be relined.
4. Submit liner thickness calculations for each water main section and furnish them to the Engineer with supporting assumptions. Calculations shall be done after cleaning, televising, and other field inspections have been accomplished. Design parameters given in this specification shall be used in calculations.
5. Submit plans showing points of insertion and methodologies.

E. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

F. Digital video media and logs:

1. Pre-lining video and logs: Submit digital recording of the pre-lining video and two (2) copies of the logs to the Engineer that document existing conditions after the Contractor has cleaned the line.
2. Post-lining video and logs: Submit digital recording of the post-lining video and two (2) copies of the cure logs for each water main section installation. Each cure log shall clearly indicate the project name, project number, and the section that was lined.
3. Final video inspection: Submit digital video recording of the rehabilitated water main along with the location of the water service connections.
4. Video media shall be as specified in Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.

G. Source Quality-Control Submittals: Submit results of shop tests and inspections.

H. Field Quality-Control Submittals:

1. Submit results of all tests and inspections.
2. Submit a copy of the cure logs for each water main section installation. Each cure log shall clearly indicate the project name, project number, and the section that was lined.
3. Submit temperature logs for the liner from time of wet-out to installation. Submit to the Engineer at time of installation.

I. Repair Methods: Submit written descriptions of the methods and equipment used for repair of defects in the CIPP liner observed during the post-installation inspection. Defects are defined as dry spots, lifts, delaminating, tears, holes in liner wall, and wrinkles in the liner greater than 5 percent of the inside diameter.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of each service connection.

1.7 QUALITY ASSURANCE

A. Provide Certificates of Compliance from the Manufacturer certifying that products meet the respective requirements listed in Standards.

B. Water Sampling: Comply with Section 33 01 10.58 – Disinfection of Water Utility Piping Systems. Upon adequate notice, the Detroit Water and Sewerage Department will make all bacteriological tests, at no charge to the Contractor.

C. Owner will mark or otherwise locate existing curb stop locations if requested by the Contractor.

D. Sample and test lining materials as specified herein.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years documented experience in installation of liner materials.

C. Licensed Professional: Professional Engineer experienced in design of specified Work and licensed in State of Michigan.

D. Pipeline Assessor: Person specializing in assessing condition of water pipelines prior to and following relining.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. CIPP material shall be delivered to the job site in an insulated, covered truck to prevent exposure to sunlight.
2. Materials shall be delivered while maintaining temperatures within the Manufacturer's recommendations.
3. Delivery of material shall be coordinated with other trades to avoid delays.
4. Pipe preparations and field inspections shall be completed prior to delivery of liner to site.

B. Storage of Materials:

1. Material shall be stored in the delivery truck in order to prevent exposure to sunlight and to maintain temperature of the product within the Manufacturer's recommendation to avoid premature curing.
2. No material shall be stored in the open or in contact with the ground.

3. Temperature logs of liner from time of wet-out to installation shall be submitted to the Engineer on-site at the time of installation.

C. Handling and Inspection: Handle all products with care and inspect for damage. Only sound, undamaged products will be accepted.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication including size and length of water main to be lined.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The cured-in-place pipe liner shall be composed of two concentric, tubular, felt or woven polyester jackets with a polymeric membrane bonded to the interior. The polymeric inner membrane shall be designed to ensure water tightness. The full cured CIPP lining shall provide a watertight seal between the existing host pipe and the liner at the insertion and termination points without the use of a mechanical/gasket seal.

B. The fully cure-in-place pipe liner shall conform to the minimum structural standards as follows:

1. Tensile Strength at yield: 3,000 psi (ASTM D-638).
2. Flexural Strength: 4,500 psi (ASTM D-790).
3. Flexural Modulus: 250,000 psi (ASTM D-790).

C. Resin System: The thermosetting resin system shall be vinyl ester resin and catalyst system compatible with the insertion process. The resin system shall withstand the corrosive effects of normal existing chemical additives to the water supply. The resin shall be able to cure in the presence of water, and the initiation temperature for cure shall be less than 150 degrees Fahrenheit. The thermosetting epoxy resin shall be delivered to the site in their appropriate containers that clearly show the product has NSF-61 approval.

D. The tube shall be vacuum impregnated with resin (wet-out) under controlled conditions. The volume of resin used shall be sufficient to fill all voids in the tube material at nominal thickness and diameter and an allowance for migration of resin into the cracks and joints in the host pipe. A roller system shall be used to uniformly distribute the resin throughout the tube.

E. Inverting/Curing Medium: Potable water or other water source accepted by Engineer shall be utilized. If a private water source is proposed for use, a written agreement shall be obtained

from the owner of the private water source and a copy of said agreement given to the Engineer, and the water shall meet the requirements of the Michigan Public Health Code.

2.2 EQUIPMENT

A. All equipment required for installation of the temporary potable water system, as well as for the installation and curing of the resin impregnated flexible fabric tube, including cables, sleeves, rollers, compressors, generators, pumps, valves, gauges, water heaters, and accessories required for complete installation shall be in accordance with tube manufacturer's recommendations.

2.3 DESIGN PARAMETERS

A. ASTM F-1216– Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.

B. AWWA Structural Class – Class IV fully structural:

1. 150 psi at 50-year design life internal burst strength, when tested independently from the host pipe.
2. Survive any dynamic loading or other short-term effects associated with sudden failure of the host pipe.

C. The CIPP tube shall be impregnated with epoxy resin system that is compatible for the installation process being used.

D. The CIPP tube shall be fabricated to dimensions such that when installed will fit tightly to the internal circumference of the host pipe.

E. The epoxy resin shall not leach any organic compounds into the potable water system.

F. The CIPP liner system, when cured, shall be chemically resistant to additives used in drinking water such as fluoride, chlorine, aluminum sulfate, phosphoric acid, etc.

G. The CIPP tube shall have a uniform thickness that when compressed at installation pressures will meet or exceed the design thickness.

H. The wall color of the interior pipe surface of the CIPP liner shall be a light color.

I. Assume for design that the ovality of the existing pipe: 2 percent, minimum.

J. Design Factor of safety: 2.0, minimum.

K. Live load: AASHTO HS20-44, Loading under roadway.

L. Soil unit weight: 125 pcf, minimum (if no boring data are available in vicinity).

M. Creep reduction factor: 50 percent, maximum.

N. Internal working pressure: 100 psi.

O. Internal design pressure: 150 psi.

P. Depth of cover: 5 feet, minimum, or as shown on the plans.

2.4 INVERTED, RESIN-IMPREGNATED TUBE PIPE LINER

A. Fabric Tube:

1. One or more layers of absorbent, non-woven felt fabric, felt/fiberglass, or fiberglass.
2. Comply with ASTM D5813, F1216, F1743, and F2019.
3. Capable of absorbing and carrying resins.

B. Resin:

1. Corrosion-resistant vinyl ester resin and catalyst system.
2. Comply with ASTM F1216, F1743, and F2019 as applicable.
3. Comply with NSF 61.

C. Wet-Out Fabric Tube: Furnish uniform thickness and excess resin distribution that, when compressed at installation pressure, will meet or exceed design thickness after cure.

D. Curing Medium: Potable water, steam, or another water source approved by the Engineer shall be utilized.

E. Equipment: All equipment required for the installation and curing of the resin impregnated flexible fabric tube, including cables, sleeves, rollers, compressors, generators, pumps, valves, gauges, water heaters, and accessories required for complete installation shall be in accordance with manufacturer’s recommendations.

2.5 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least fourteen (14) days before inspections and tests are scheduled.

C. Certificate of Compliance: Submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Verify location of piping to be relined.

C. All water main pipe liner materials shall be carefully inspected for defects prior to installation. The liner shall be homogeneous throughout, uniform in color, free from tears, holes, foreign materials, blisters, or other deleterious faults.

D. Any material found during the progress of the work to have flaws or defects shall be rejected. All defective materials furnished or installed shall be promptly removed from the project site. Replace all such material found defective in manufacture or damaged in handling or installation.

3.2 PREPARATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

C. Cleaning: Clean existing water pipes of debris, sedimentation, and mineral deposits with high-velocity cleaner, bucket and scraper, root saws, rolling or balling units.

D. Initial Video Inspection and Repair:

1. If not provided by the Owner with the bid documents, conduct inspection of water main by method of:
   a. Closed-circuit video inspection.
   b. Alternatively: Multi-Sensor Inspection (MSI).

2. Determine condition of existing piping, degree of offset of joints, and locations of crushed walls and obstructions.
3. Determine sizes and locations of service connections.
4. Evaluation of pipe conditions performed by pipeline assessor.
5. Clear obstructions, service piping protrusions, and other materials along existing pipe to ensure that inserted pipe liner directly contacts existing pipe wall.

3.3 TEMPORARY POTABLE WATER SYSTEM

A. Furnish, install, and maintain a temporary potable water supply system as specified in Section 01 51 36 – Temporary Water Service.

3.4 CLEANING AND INSPECTION

A. Cleaning of water main pipe:

1. Immediately upon opening the host main at the liner insertion points and prior to installation of liner, cover the ends of the adjacent existing water main that are not to be lined at the insertion/extraction points so that no debris or animals shall enter the pipe during reconstruction work.
2. Remove all internal debris out of the water main that will interfere with the installation. Clean the pipe with high-velocity jet cleaners, mechanically powered equipment, cable-attached devices, or fluid-propelled devices (e.g., pipe pigs).
3. The cleaning method shall remove all rust, scales, tuberculation, deposits, loose or deteriorated remains of any original coatings and other foreign materials from the inside of the pipe to produce a smooth metal surface finish that will allow the new composite liner to adhere to the existing host pipe creating a bond between the liner and pipe material.
4. Lawfully dispose of all materials removed from the pipe during the cleaning operation approved by the Owner or at an off-site location and pay all associated landfill fees and taxes.
5. Immediately notify the Engineer of any evidence of contamination in excavated materials.
6. Cleanup any soil contamination caused by or discovered during the excavation or water main lining process.
7. The Owner will assume responsibility for legally required cleanup of any pre-existing soil contamination discovered during this Project.

B. CCTV Inspection of water main pipe:

1. The water pipe shall be clean (free of debris and standing and flowing water) prior to the CCTV Inspection.

2. Existing Water Main Field Measurements:
   a. Obtain the internal pipe diameter by Laser Profiling the continuous length of pipe to determine the internal diameter variance.
   b. Determine measurements prior to installation of the proposed liner to determine the proper size.

3. Confirm that the CCTV distance counting meter (location/distance) device is operational prior to commencement of the CCTV Inspection.
4. Verification of readiness to install liner shall be performed by experienced personnel trained in locating services, breaks, obstacles, etc. This may include pipe mandrels or other devices up to and including closed-circuit television or man entry. The interior of the pipeline shall be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube. These conditions shall be noted and brought to the attention of the Engineer so that they may be corrected. Copies of CCTV inspection video media and related reports shall be made available to the Engineer as soon as possible, at no additional charge, for review prior to commencement of corrective work.

5. Accuracy of the distance counting meter shall be checked by use of a walking meter, roll-a-tape, or other suitable device, and the accuracy shall be satisfactory to the Engineer. The CCTV counting meter shall be used for internal purposes only and may not accurately represent the actual verified measurement of the pipe run length.
6. A thorough examination of the route of the existing water main shall be made before cutting of the water main. This shall include a pipeline location survey with equipment for locating any changes in direction, valves, bends, intrusions, and other fittings that may impede the insertion and/or proper inflation of the cured-in-place-pipe liner.
7. Remove any obstructions that might prevent the liner installation. The Owner shall have the right to make corrective repairs using in-house staff or a third-party contractor if it is deemed to be in the Owner's best interest to do so, or the Engineer may authorize Contractor to make repairs that are billable under the terms of this contract.
8. Report to the Owner any external water leaking back into the existing water main, which shall be repaired at the leak source so as not to interfere with the proper installation and cure of the water main liner. Any additional water remaining in the water main after the repair shall be removed prior to lining to ensure proper installation and cure of the water main liner.
9. Field verify the length of water main sections to be cleaned and lined.
10. Flush the host pipe with clean water to remove any loose debris from the interior surface of the pipe and remove all standing water from the inside surfaces of the cleaned water main by passing a sufficient number of oversized foam swabs through the main or use a progressive expansion method to remove standing water.
11. Perform CCTV inspection of existing water mains at intervals specified below. The CCTV inspection video media shall be submitted to the Engineer and Owner at least two working days prior to the beginning of the next interval. Do not proceed to the next interval without written authorization from the Engineer. The intervals are as follows:
    a. Post cleaning and prior to water main lining.
    b. Post lining and prior to service reinstatement.
    c. Post service reinstatement once completely finished. Provide the Engineer with a complete set of all photos and video media. Information shall identify the water main section as it is identified on the plans, direction of travel, and the date of inspection.

12. The camera shall be moved through the line in either direction at a moderate rate, stopping when necessary to permit documentation of the water main condition. In no case, shall the television camera be pulled at a speed greater than 15 feet per minute. The camera shall stop at each water service tap for 5 seconds.
13. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the water main conditions shall be used to move the camera through the water main.
14. The camera inspection shall be started outside the pipe to get a clear view of the pipe opening.

C. Inspection Documentation:

1. Television Inspection Logs: Location records shall be documented, printed, and transmitted to the Owner as specified herein. Records shall clearly show the location of each service connection in relation to an adjacent gate well or hydrant observed during

inspection. In addition, other points of significance such as locations of unusual conditions, presence of scale and corrosion, and other discernible features shall be recorded.

2. Photographs: Take digital photographs of the television picture showing areas of concern upon request of the Engineer.
3. Video Recordings: Extent of recording shall be as is delineated by record drawings. The purpose of digital video recording shall be to locate and supply a visual and audio record of problem areas of the lines that will be relined or replaced.
    a. Supplied on Digital Video Disc (DVD), Universal Serial Bus (USB), or other electronic media acceptable to the Owner.
    b. File format shall be AVU, FLV, WMV, MOV, MP4, or other format acceptable to the Owner.
    c. Video formats shall be 1080 line High-Definition (HD) color video.
    d. Display the following information:
        1) Date and time.
        2) Footage counter.
        3) Upstream gate valve and well number.
        4) Downstream gate valve and well number.
        5) Pipe diameter size.

4. Make all recordings and necessary playback equipment readily accessible for review by the Engineer during the Project.

3.5 GIS DOCUMENTATION – AS-BUILT DRAWINGS

A. Provide the Owner with as-built drawings. The Owner will furnish an electronic version of the original Bid drawings in CAD or PDF format upon request. Transfer all the electronic format as-built information to those Bid drawings.

B. The as-built drawings shall include the exact location of all valves, hydrants, tees, services, corporations, stop boxes installed, new and all parts replaced, including sideline valves. Deliver GIS data in the format required by Section 01 78 39 - Electronic Project Record Documentation.

3.6 CIPP LINING

A. Site Preparation:

1. Temporary Water Supply Section shall be installed per Section 01 51 36 – Temporary Water Service. Temporary system shall be operational.
2. Curb stops: Existing curb stops shall be operational and set in the "closed position" or the service meter may be temporarily removed to create an air gap.

B. Excavation:

1. Excavate and adequately shore the excavation to allow access of cleaning and lining equipment and material. Remove water from the access hole. Excavate a minimum of one

(1) foot below the level of the water main for a sump. Suitable pumps shall be provided to remove water. Backfill the shoring or trench box with clear stone in order to stabilize the shoring. The excavated areas shall be bedded with a minimum of four (4) inches of clear stone to provide a clean work area around the open exposed water main.

2. Remove the excavated spoils from the pit area as part of the excavation. Suitable backfill may be salvaged off-site, stockpiled, and reused as backfill in appropriate areas in accordance with Section 31 23 33 – Trenching and Backfill.

C. Resin Impregnation:

1. If the CIPP process where the liner is vacuum-impregnated prior to installation is utilized, allow the Engineer to inspect and witness the materials and procedures used to vacuum-impregnate the tube. If done on-site, the impregnation shall be done in an enclosed vehicle. On-site impregnation in the open is not acceptable.
2. If the process where the tube is impregnated (wet out) with resin under controlled conditions, and brought to the site impregnated, allow the Engineer to inspect and witness the materials and procedures used to wet-out the tube; giving 2 weeks' notice to the Engineer of the time and place of the wet-out process.
3. The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and loss of resin through cracks and irregularities in the original pipe wall.

D. Installation of CIPP:

1. A CIPP is formed by the insertion of a resin-impregnated flexible felt tube into the existing pipe. The liner tube shall consist of two concentric, tubular, felt or woven polyester jackets with a watertight polymeric membrane bonded to the interior, which has been saturated with a thermosetting resin. The liner shall be inserted into the existing water main either by direct inversion (ASTM F1216) using a head of water, pressurized steam, or by pulling the tube into place by winching and then inflating it by inversion of a calibration hose or using the pull-in method (ASTM F1743). The shaping of the liner may be achieved by pushing a pig through the hose using water pressure. The thermosetting resin shall then be cured by circulating hot water or steam through the tube to cure the resin into a hard, impermeable pipe.
2. The finished product shall be a seamless, structural pipe that is formed and bonded to the existing host pipe. Once the lining has been completed, cap the water main using standard mechanical end caps.
3. See the Drawings for replacement of specified water main valves, hydrants, and fittings in conjunction with the CIPP lining installation. Within the project area, there are known service connections on the water main pipeline to be reinstated, which will require a temporary water distribution system to be installed. Comply with Section 01 51 36 – Temporary Water Service.
4. The wet-out tube shall be inserted through an approved access point by means of a pull-in place method, or a direct inversion process, or a combination of the two.
    a. Pull-in place method - Insertion of Pull-in Liner: A power winch shall be used to pull the wet-out fabric tube into the existing pipe. The tube shall be connected to the winch cable as recommended by the liner manufacturer. After pulling in the liner, the pulling connection shall be dismantled. If a pulling manifold is used, it

shall be attached to the end of the liner with sufficient strength to transfer the pulling force. Puller unit/winch cable shall be equipped with a manufacturer recommended calibrated tension gauge and shall be smooth running and capable of operation at variable speeds. A swivel connection to the pulling cable shall be added to avoid twisting the liner. The longitudinal elongation shall not be more than 3% of the overall length measured after the calibration hose has been installed.

b. Direct inversion process:
   1) Insertion of Inverted Liner: Before starting insertion, submit the minimum pressure required to hold the tube tight against the host pipe and maximum allowable pressure so as not to damage the tube to the Engineer 48 hours prior to installation. The pressure shall be maintained between the minimum and maximum pressures until the installation has been completed.
   2) Submit pressure log during installation with the cure logs.
   3) Lubricant used during installation, if needed, shall be non-toxic and NSF 61 certified.
   4) If air pressure is selected to invert the water main lining, it shall be sufficient to fully extend the tube to the next designated access pit or termination point.
   5) The tube shall be connected so that a leak proof seal is created and with the impermeable plastic membrane side out. As the tube enters the guide chute the tube shall be turned inside out. The inversion air pressure shall be adjusted to be of sufficient pressure to cause the impregnated tube to invert from point of inversion to point of termination and hold the tube tight to the pipe wall, producing dimples at branch mains and service connections.

c. Inverting / Inflating Tube Pressure: The pressure head used during the installation process shall be sufficient and between the minimum and maximum pressure to hold the liner tight against the pipe wall and prevent it from forming wrinkles in the cured line. The pressure head shall be maintained for a sufficient duration to push out all pockets of water, and to prevent lifts in the liner and resin washout. If at any time during the installation the pressure head reading violates the manufacturer's required maximum pressures, remove the tube from the host pipe and dispose of it off-site. The head used to extend the liner tube though the length of pipe being rehabilitated shall be sufficient to fully extend the tube both circumferentially and longitudinally.

d. Temperature monitoring: During curing process, the heat source shall be fitted with suitable calibrated monitors to gauge the temperature and pressure of the incoming and outgoing heat exchanger circulating heat medium. The thermocouples, temperature gauges or infra-red gun shall be used at inserting and extraction point to determine and record the temperature of the liner and time of exotherm.

e. A combination of the two methods may be allowed.

E. Curing:

1. After liner expansion or inversion is completed, supply a hot water or steam heat source. The equipment shall be capable of delivering hot water or steam to the far end of the liner

to uniformly raise the temperature in the entire liner above the temperature required to initiate and effect curing of the resin system. The temperature shall be determined by the resin/catalyst system employed.

2. The heat source shall be fitted with suitable monitors to gage the temperature and pressure of the incoming and outgoing heat exchanger circulating heating medium. Thermocouples or temperature gages or infra-red gun shall be used at insertion and extraction points to determine and record the temperature of the liner and time of exotherm.
3. Initial cure is deemed to be completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature shall be held at the post-cure temperature for a period as determined by the Manufacturer's specifications. The curing process shall consider the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

F. Cool Down: Once the cure is complete, cool the hardened liner to a temperature below 100 degrees Fahrenheit before relieving the internal pressure. Cool down shall be accomplished as recommended by the manufacturer taking into consideration post cure times necessary to obtain original working pressure strengths not less than 12 hours. Care shall be taken in the release of the internal pressure so that a vacuum will not develop that could damage the newly installed liner.

G. Inspection and Testing:

1. Costs related to destructive liner testing specified herein shall be included in the base unit price per linear foot.
2. After the liner has been cooled down and before opening the service connections, a preliminary television inspection of the newly installed liner shall be performed to confirm that the liner is properly installed.
3. The finished lining shall be continuous over the entire length and be free from visual defects such as foreign inclusions, lifts, pinholes and delamination. The lining shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to the inside of the lined pipe.
4. If the CIPP does not fit tightly against the host pipe at the water services or termination points, the space between the pipes should shall be sealed by filling with a NSF/ANSI 61 certified resin mixture compatible with the CIPP. Product shall be approved by the Engineer prior to use.
5. Sampling:
    a. Cut samples from the cured CIPP for testing in accordance with ASTM F1216 Section 8.0.
    b. Pipe samples shall be taken from the lined water mains to check the structural lining performance. A minimum of two pipe samples for the first 1,000 L.F. thence; two samples per 3,000 L.F. lined pipe shall be removed for inspection purposes. The timing and location of the samples within these lengths will be at the Engineer's discretion.
    c. Arrange for and pay the cost of the laboratory testing for the destructive and tensile strength tests on a minimum of one (1) and maximum of six (6) — two (2) foot

sections of pipe. All lining defects including incorrect application and faults in the curing of the material shall be corrected at no additional cost to the Owner before returning the water main to service.

d. The samples shall be properly labeled and indicate the installation date and project number.

6. Conduct the following tests for each fully cured CIPP inversion length installed:
   a. Short-Term Flexural (Bending Properties) – ASTM D790.
   b. Tensile Properties – ASTM D638.
   c. CIPP Wall thickness – ASTM D5813.

7. Perform hydrostatic pressure tests on all lined water main sections, which shall be completed after inspection but before the reinstatement of service connections.
   a. Pressure test completed liner installation in accordance with Section 8.3 of ASTM F1216. Test at twice the known working pressure or at the working pressure plus 50 psi, whichever is less, for a duration of two (2) hours.
   b. Leakage testing shall adhere to AWWA C600 requirements and the minimum duration shall be one (1) hour. Prior to conducting hydrostatic pressure testing, obtain approval from the Owner to apply testing requirements listed in this section. The pressure test and leakage test may be performed simultaneously.

H. Service Connections:

1. Water Main Service Taps:
   a. The water service connections shall be re-established from inside of the structurally lined pipe, using a mechanical robot equipped with a camera and activated by an operator using a remote control and CCTV unit. The robot shall be equipped with a tool that allows the operator to reinstate the service in the precise location of the connection. After opening the connections, the rehabilitated pipe shall be flushed clean and restored to service.
   b. The reinstated connection shall remain water tight without the use or need of a mechanical seal and/or other secondary device. Products that cannot remain water tight without such secondary devices shall not be considered acceptable.
   c. Locate and successfully reinstate the existing service connection without damaging the lining. Any damage to the service connection or the lining caused by the reinstatement process will require immediate corrective action at no additional cost to the Owner.
   d. If unable to reconnect a service connection from the inside, excavate to access the water main tap and disconnect the existing copper pipe and reconnect the copper piping with approved fittings. If unable to effectively reconnect the service connection, re-tap the water main using an approved service saddle at no additional cost to the Owner.

2. Prior to installation of the liner, locate all existing service connections and plug or prepare the corporation valve connections as recommended by the manufacturer.
   a. Prior to installation of the liner, locate all existing service connections.
   b. The locations shall be documented in a log and in the CCTV inspection video.
   c. Prepare all service connections as recommended by the lining manufacturer.

d. Plugs shall be sized for the respective water taps and shall be compatible with the lining process.
e. Existing Water Service Tap: Prior to the structural lining, plug each water service (ranging in sizes from 1/2" to 2") using an approved mechanical robot "plug" system. The service plugs used in this process shall be able to withstand temperatures of up to a minimum of 300 degrees Fahrenheit and must be NSF-61 approved for potable water systems.
f. If it is determined during the inspection process that a service cannot be corked or plugged due to a pre-existing condition, report the condition to the Engineer to determine a resolution to reinstate the service.

3. After the lining is complete and following successful pressure testing, reconnection of existing services shall be done from the interior of the water main using a television camera directed robotic cutting device that removes a small, circular section of the liner to expose the corporation valve opening. Furnish and maintain available on-site, an infra-red camera to assist in determining existing service locations.
4. Reconnections shall be free of restrictions preventing free water flow and shall be opened to the size of their original diameter and to a depth required to completely open the water service connection to the residence or business served.
5. All service reconnections shall provide a water tight seal between the host pipe and the liner pipe.
6. Water main taps:
   a. Hot tapping procedure shall be part of the project submittals.
   b. Any services not reinstated internally and requiring an external excavation shall be reinstated through open-cut installation. All costs of external reinstatement and restoration shall be included in the bid price.

7. If a water service reinstatement cannot occur internally as part of the CIPP lining process and open-cut method is required to reinstate the service, the excavation limits will be marked by Engineer prior to pavement or boulevard removals. Construct a buried water service in accordance with Section 33 14 17 –Water Services and the following items:
   a. Brace open excavations, utilizing at minimum an OSHA-approved trench box/bracing/shoring/other to minimize the footprint of construction impact to adjacent pavements or turf.
   b. Backfill excavations at the end of each workday to existing grade elevation. At no time will an excavation be allowed to be open overnight.
   c. No excavation shall be left unattended without safety fence and barricades unless otherwise approved by Engineer.
   d. Restore all excavated areas within 10 days after the first water service open-cut excavation is reinstated unless otherwise approved by the Engineer. Aggregate base surfacing will be considered an acceptable temporary restoration within the 10-day period prior to bituminous or concrete placement.

I. Acceptance of Completed Work:

1. Provide the Engineer and Owner with copies of the CCTV inspection video media.
2. Provide the Engineer and Owner with copies of all test results and certifications whether required by regulatory agencies or by this Specification as soon as they become available.

3. Correct all defects in materials and workmanship at no additional cost to the Owner. Remove and replace the entire section of lining, if defective.
4. After acceptance of completed work, return the piping system to service by closure of all liner insertion pits with appropriate pipe spools, valves, and other relevant pipe fittings.
5. Obtain samples and arrange and pay for all testing and reports prior to placing the water main back in service.
6. Provide record drawings detailing the location of all linings, piping, valves, and appurtenances installed under this contract.

J. Disinfection of Water Mains:

1. Notify the Owner at least 48 hours prior to flushing. New water main valves, including pressure tap valves, connected to an existing water main, and existing water main valves shall only be operated by the Owner or Owner's appointed personnel.
2. Disinfect all newly installed water mains, appurtenances, and services in accordance with AWWA C651, and Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.

K. Reinstallation of Appurtenances:

1. Ductile iron pipe (DIP) tees and other fittings shall be installed using approved mechanical joint materials (Megalug by EBAA Iron or equal) with thrust blocks sized in accordance with Standard Details.
2. Hydrant tees and or existing hydrant bends and hydrants shall be reinstalled per standard details. Megalug fittings shall be used with thrust blocks sized in accordance with Standard Details.

L. New Gate Valve and Wells: Gate valve and wells shall be constructed in accordance with Municipal standards. Gate valve and wells shall be installed as shown on the drawings.

3.7 START-UP / FINAL ACCEPTANCE

A. Before Mainline Reconnection:

1. CCTV System for base recordation and visual acceptance.
2. Pressure test and chlorinate system for acceptance.

B. Mainline Reconnection:

1. Chlorinate all sleeves and closure fittings prior to placement.
2. Chlorinate and test the existing pipeline between the connection point and the existing terminus gate valve if the distance is greater than ten (10) feet.

C. Adjusting:

1. Water Service/Curb Stop:
   a. Open curb stops and bleed-off existing water service prior to reconnection.
   b. Reconnect the existing water services at the residential meter.

c. Remove temporary supply system.
d. Clean and restore all disturbances caused by placement of the temporary water supply.

3.8 TOLERANCES/TESTING AND INSPECTION

A. After the system has set hard to the touch it shall be inspected via closed-circuit camera.

B. A final visual inspection will be made by the Engineer. Any deficiencies in the finished system will be identified and shall be repaired.

C. The system may be put back into operational service as soon as the final inspection has taken place and local test criteria has been met and approved by the Engineer.

3.9 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements.

B. Testing of Completed Pipe Liner: Test as specified in ASTM D790 – Short-Term Flexural (Bending Properties), ASTM D638 – Tensile Properties, and ASTM D5813 – CIPP Wall Thickness.

C. Manufacturer Services: Furnish services of manufacturer's representative, who is experienced in installation of products furnished under this Section, for not less than 2 days on-site for installation, inspection, and field testing.

D. Liner Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Liner shall be free of dry spots, wrinkles, lifts, and delamination.
3. If liner fails to form, remove failed liner and install new liner in a manner acceptable to the Owner.
4. Conduct closed-circuit video inspection of the completed relining Work, confirming there are no visual defects, including foreign inclusions, dry spots, pinholes, cracks, or delamination.
5. Confirm that service connections are complete and unobstructed.
6. Make final adjustments to liner per manufacturer's instructions.
7. Any liner installation not meeting the testing requirements of this Specification shall be removed and replaced with a product acceptable to the Owner at no additional expense to the Owner. The re-inspection requirements as listed above shall apply to this re-installed section of line.

E. Furnish installation certificate from manufacturer's representative attesting that liner has been properly installed and is ready for startup and testing.

END OF SECTION 33 01 15.71

SECTION 33 01 30.10 – FLOW MONITORING OF SEWER SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Provide and install all equipment, tools, labor, materials, and incidental services necessary to perform all Work for accurate flow measurements in sanitary, combined or storm sewer systems for the full range of flow conditions; cover low flow, full flow, and/or surcharged conditions for a wide range of pipe sizes, shapes/configurations, environments, flows and depths.

B. Provide and install rain gauges/radar or other means to supplement rain gauge data and associated equipment and installation within one (1) mile of the average weighted mean monitor location distribution.

C. Provide services for all maintenance on equipment, data editing, and data delivery during Contract period.

D. All equipment shall be properly installed to withstand surcharge risk. Owner or Engineer will not assume any responsibility for any damage to or loss of any equipment.

1.2 SUBMITTALS

A. Comply with the requirements of Section 01 33 00 – Submittal Procedures.

B. Contractor shall submit a project schedule during bid for implementation of all equipment and services. Information shall include the following milestones:

1. Duration for all equipment to be installed upon notice to proceed.
2. Client data availability for real-time access via telemetry as authorized.

C. Prior to Work, submit to Owner a written description of procedures to be used, including product literature for all flow monitoring equipment and rain gauge equipment to be utilized.

D. Contractor shall provide charts, hydrographs, tabulations, scattergraphs, and reports of edited raw data as specified below:

1. Schedule: Monthly when data delivery services are not included at the end of the contracting period.

2. Deliverables:
   a. Raw and edited level (inches), velocity (feet per second) and flow (gallon per day) data in five (5)-minute increments. Raw rain data (inches) in five (5)-minute increments.

b. Report: Summary report of the monitoring performed to include duration, equipment used, monitoring location summary, installation sheets as authorized.
c. Hydrographs: Flow (gallons per day) plotted against time on a weekly interval on the lower horizontal axis with rain levels (inches) on the upper horizontal axis.
d. Table: One (1) Excel document per meter with data in five (5)-minute increments. Data to include: level (in), velocity (feet per second), flow (gallons per day), and rain (in) accumulation per five (5) min increments. the table shall be processed to not include any time stamp gaps between five (5) min increments.
e. Scattergraphs to include: plot of depth (inches) on the y-axis and velocity (feet per second) on the x-axis.
f. Flow Monitoring and Rain Gauge Installation Reports for each site as described in Installation section in Part 3. Engineer will provide fillable form.

E. Submit electronic copies of monitoring and rainfall data and data analysis report complying with Data Collection and Review Section in Part 3.

1.3 QUALITY ASSURANCE

A. Comply with the requirements of Section 01 40 00 – Quality Requirements.

B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the Work.

C. Installation and calibration of flow monitoring equipment shall be by qualified Contractor.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. The Contractor shall submit a list describing all equipment to be used for review and approval of the Owner or Engineer.

B. The Contractor shall submit the following information:

1. Manufacturer/vendor.
2. Model.
3. Design and type.
4. Safety (intrinsically safe flow meters shall be used in sewer systems with (H2S) gas concentration above safety limits or other potentially explosive atmosphere).
5. Power supply/source (to efficiently operate continuous monitoring/telemetry and high frequency of data upload; for example, five (5)-minute interval of data recording).
6. Data recording (shall be real time).
7. Accuracy of depth and velocity sensors, temperature range, functionality with multi-sensors.
8. Lifespan.

9. Software used for data retrieval.

C. Minimum requirements for flow metering equipment:

1. Capable of accurately measuring flows (within +/- 5%) in circular sanitary sewers between flow depths of 0 inch and 48 inches (with accuracy of +/- 0.1-inch) and velocities from 0.5 ft/s to 20 ft/s at five (5)-minute intervals.
2. All monitors shall be able to function with multi-sensors, measure both level and velocity, and have telemetry with wireless communication.
3. Include the option of non-contract flow sensor equipment that is mounted above, not submerged in, the flow stream.
4. Each flow monitor shall be networked into a system to provide vital information, including alarms to Owner or Engineer as authorized.

D. Minimum requirements for rain gauge equipment:

1. Shall be tipping bucket style rain gauge capable of accurately measuring rainfall depths of +/- 0.01 inches.
2. Each rain gauge shall be 99% accurate for rainfall up to 2-inches per hour.
3. All rain gauges shall be capable of networked connection to Owner's system.
4. All rain gauges shall be capable of battery and wired power connections.

E. Minimum requirements of data delivery services:

1. Data delivery to be provided as authorized.
2. Each flow monitor and rain gauge shall be networked into a system to provide vital information, including alarms to Owner or Engineer as authorized.
3. Raw and edited flow monitoring and rain gauge data, both graphical and tabular formats that can be downloaded by the Owner or Engineer on a variety of intervals.
4. 24/7 password protected access to flow data via web interface.
    a. SQL database preferred.
    b. Report generator.
    c. Flow analysis and computation utility.
    d. Web server application for sharing data across an Intranet or the Internet.
    e. Daily back-ups.

5. The Owner or Engineer requests access to data twenty-four (24) hours a day, Monday through Sunday, excluding periods of routine planned maintenance and upgrade services and emergency services, with ninety percent (90%) uptime, but no more than 14 days continuous down time at any one (1) site during upgrades or planned maintenance. The Contractor shall provide 48-hour notification of maintenance and upgrades to the Data Delivery Services, including Owner's Web Page, and provide data backup services.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contractor is responsible for coordinating and receiving owner approval for the installation of rain gauge equipment on all property. Owner or Engineer is not responsible for any damages to property or equipment.

B. Engineer will provide locations for flow monitoring and rain gauge installations.

1. Contractor is responsible for verifying flow monitoring and rain gauge sites are accessible and adequate for flow monitoring.
    a. Sites identified as not accessible shall be communicated to the Owner or Engineer by including a list of structures by ID and address along with a request of the correct measure needed.
    b. Flow monitoring sites deemed not conducive for flow monitoring shall be documented to include the monitoring location and a description of the reason the monitoring cannot be completed. A list of sites shall be provided to the Owner or Engineer for alternative monitoring location.
    c. A new location cannot be used unless approved by the Engineer.
    d. Rain gauges shall be installed in secure, tamper resistant locations. Rain gauges shall have clear view of the sky, at least 20-degrees from edge of bucket. If rain gauge is installed on a roof, it shall be at least 10 feet from the edge and be located such that it can be safely accessed.

C. After installation, Contractor shall submit Installation Reports for selected flow monitoring and rain gauge sites (examples attached at end of specification).

1. Flow monitoring installation reports must include, at a minimum, the following:
    a. Date of installation.
    b. Equipment description and serial number of equipment used.
    c. General site location map.
    d. Basic connectivity sketch with all pipe sizes.
    e. Manhole depth.
    f. Installation sketch:
        1) Sensor position/offset.
        2) Calibration data to verify monitor setup.
        3) Explanation of any variance from manufacturer recommended procedures.

    g. Physical sewer pipe characteristics in which the sensors are installed:
        1) Pipe size and shape.
        2) Pipe material.
        3) Depth of silt.
        4) Depth of flow.

    h. Site photographs:
        1) Street view.

2) Monitor installation.
3) Sensor installation.

i. Weather conditions at time of installation.
j. Description of any adverse hydraulic conditions.
k. Adjustment due to initial calibration.

2. Rain gauge installation reports must include, at a minimum, the following:
   a. Location description and site photo(s).
   b. Contact information and instructions for access.
   c. Rain gauge information.

D. The Contractor shall physically install all rain gauges and flow meters, provide electrical connections (where required and possible) and shall follow the manufacturer's installation guidelines and procedures recommended for the type of gauge, meter, flume, weir or other primary device to be used in each of the locations. Health and Safety Requirements, Environment, Confined Space Entry and Traffic Control and Spill Response Requirements shall be followed as required per the Contract Documents.

E. The Contractor shall visually inspect all parts and equipment and replace immediately any damaged equipment observed prior to installation.

F. Prior to the start of the field installation, a meeting shall be held with the Owner or Engineer to agree on the installation procedure and set-up a work protocol. Access to sanitary sewer maintenance holes for the installation of flow monitors shall be carried out in the presence of the Owner and/or Engineer as required.

G. The installation of flow monitors at sites with manhole access in busy highways or roads shall be undertaken during periods of off-peak traffic flow. Where the proposed site is within road allowance then a Traffic Control Plan shall be provided to the Owner. All traffic control requirements shall be provided by the Contractor and shall conform to MDOT Standards at no extra cost to the Owner.

H. All meters shall be calibrated in-house under controlled conditions prior to each installation and in the field after installation to ensure accurate measurements.

3.2 NOTIFICATIONS

A. Contractor shall notify the Owner or Engineer within 24 hours of any observation that may affect the safety of the public or negative impacts to the environment during access to the collection system.

B. All repairs and maintenance to the flow meters during Contract period shall be the responsibility of the Contractor. Any costs associated with repairs and/or maintenance shall be paid by the Contractor and will not be incurred by the Owner or Engineer.

C. The Contractor must be able to respond to data delivery and maintenance issues within 48 hours of equipment nonperformance.

D. The Contractor must be able to respond to scheduled equipment downtime within 48 hours. This includes times when Owner personnel need to maintain the sanitary sewer system (jetting, cleaning, etc.) and the flow monitoring equipment needs to be removed by the Contractor. The Owner will not pay additional charges for equipment removal and replacement during maintenance. Re-installation and recalibration of the equipment will be at no additional charge to the Owner. All costs must be included in the Bid price.

3.3 FIELD VERIFICATION

A. Field verification procedures for the flow meters, weirs or flumes recommended and the determination of deviation from standard conditions shall be reviewed and approved by the Owner/Engineer prior to performing any field verification and depending on meter, weir or flume type.

B. All field verifications shall be recorded and documented in a complete inspection and activity log; a form or site-check sheet with results of each site calibration/verification shall be submitted. Information entered into the site's inspection and activity log form shall include at a minimum: date and time of site visit, site name and meter/sensor serial number, installation/removal date, inspection, maintenance, calibration, alarming, images from the site, site conditions and observed problems. Field verification shall consist of manually measuring depth and velocity at the monitoring site and comparing these readings with real-time readings from the meter. Accuracy of desktop information (for example location, access, pipe diameter etc.), hydraulic calculations, flow obstructions, sediments or debris, gas levels, and battery voltage level should also be part of the field verification.

C. The Contractor shall complete the following tasks, as a minimum, for all flow and rainfall monitoring sites:

1. Weekly data review to ensure that flow meter sensors are operating correctly and to look for invalid data resulting from sensors affected by debris. Invalid depth or velocity readings shall be recorded.
2. Weekly, in person, confirmations to ensure proper operation of sensors for monitoring that does not include telemetry, and monthly confirmations for monitoring equipment that is remotely reviewed for data quality using telemetry on an ongoing basis. The Contractor shall check at a minimum:
    a. The accuracy of each flow monitor by using an alternate instrument such as a portable flow velocity meter and ruler.
    b. A series of velocity output readings shall be taken from the flow monitor immediately after the actual flow velocity measurement to generate an accurate velocity profile. The results shall be recorded and compared to verify the flow monitor velocity accuracy.
    c. Approaches to determine validation of meter and field velocity readings shall follow manufacturer's recommendations and shall be pre-approved by the Owner or Engineer for all types of meters.

d. In addition to the in-situ depth and velocity checks performed, the general serviceability of instrument, battery, the correct operation of the instrument's data recorder/memory, and site hydraulic conditions shall be checked.
e. A site check sheet shall be completed and included in the activity and inspection log as part of the monthly report to the Owner or Engineer.
f. The Contractor shall record on the site check sheet any adverse hydraulic conditions noted during the site visit, and the Contractor shall inform the Owner if the Contractor cannot overcome the problem.

3. Quarterly site maintenance to clean sensors; where debris is discovered to be an issue, more frequent site maintenance visits will be required.
4. Site visits as required when automated diagnostic input from the monitor indicates problems.
5. Battery replacement.
6. Failed sensor replacement.
7. Copies of the log sheets used for checking the accuracy of the flow monitors shall be provided to the Owner or Engineer upon request.

3.4 DATA COLLECTION AND REVIEW

A. Time and Date: All times and dates shall be reported in local time, synchronized to coordinated universal time and without an adjustment for daylight savings time. The Contractor shall ensure that all monitoring instruments follow the same universal clock time.

B. Data Recording Interval: Flow monitor and rainfall data recording and presentation shall be instantaneous or five (5)-minute average intervals and recording on the five (i.e., 12:00, 12:05, 12:10, 12:15, etc.) to facilitate post processing.

C. Data Accuracy: The Contractor shall perform rigorous quality assurance/quality control procedures to ensure data accuracy as follows:

1. Continuous data monitoring and regular site visits; data collected wirelessly shall be screened and reviewed for degradation or loss at least once a week. Alarms shall be programmed to thresholds specific to site conditions. The Consultant shall respond to alarms within 48 hours and provide necessary support to resolve the issue. Where data connectivity issues prevent wireless transmission, the Contractor shall download site data on a weekly basis.
2. Instantaneous data graphed from data collected wirelessly or in the field to determine any anomalies and problems.
3. Check of battery level, memory card, etc., to ensure reliability of the monitor.
4. Check of data accuracy and integrity by performing in-situ checks for depth and velocity.

In general, an accuracy of ± 10% shall be obtained from the flow monitoring results and ± 2% from the rainfall monitoring results from a 1-inch/hr. to 2-inch/hr. event unless otherwise determined by the Owner. The Contractor shall notify the Owner immediately with a reason if such accuracy cannot be obtained at a specific location.

3.5 QUALITY CONTROL

A. The Contractor must guarantee a minimum 90% data up-time and "no lost data" at each and every metering site each month or the Owner or Engineer will not be required to make payment at the given site for the given month. Data shall have 90% uptime and not exceed 24 hours in downtime unless extended time is documented and approved by the Owner or Engineer to include the following: new equipment delivery and ongoing attempts to correct for unique site characteristics.

B. The City or City's Representative shall be entitled to audit the monitoring system and be present when assessments of the equipment are being determined. When requested by the Engineer in writing, forward to the Engineer sufficient details and information for such audit assessment. Should any report fail to achieve a margin that the Engineer deems satisfactory, the Contractor, without any additional compensation, shall recode and resubmit any data or reports that the Engineer deems necessary.

3.6 CLOSEOUT ACTIVITIES

A. Provide in accordance with Section 01 70 00 – Execution and Closeout Requirements.

Example Flow Monitor Installation Report

Flow Monitor Installation Report

Site ID: _____ Site Location: _____

Installation Date: _____ Manhole Location: Street Grass Other

Removal Date: _____ Manhole Depth: _____ ft

Purpose for Metering: _____ Rim Elevation: _____

Type of Sewer Storm Sanitary Combined Rung Condition: _____

Additional Setup Information: _____

Installer: _____ Crew: _____

Pipe Monitored	Inlet	Outlet	Overflow
Pipe Sizes:			
Pipe Shape:			
Pipe Material:			
Details of Installation:			

PLAN VIEW

N

Flow Meter Information

Meter Make/Model: _____

Meter ID or Serial #: _____

Sensor #1 Type: _____

Sensor #1 Location: _____

Sensor #2 Type: _____

Sensor #2 Location: _____

Real Time Readings at Installation

	Meter	Manual
Time:		
Depth (in.):		
Velocity (fps):		
Flow (mgd):		
Silt Depth:		

Metering Information: _____

STREET VIEW PHOTO	MONITOR INSTALLATION PHOTO	SENSOR INSTALLATION PHOTO

SITE ID: _____

VICINITY MAP	SITE LOCATION

Additional Site Photos:

Example Rain Gauge Installation Report

RAIN GAUGE INSTALLATION REPORT

Project Name: _____ Install Date: _____
Site ID: _____ Time: _____
Location: _____ Installers Initials: _____
Removal Date:

Location Description: _____

GPS Coordinates:

Building Contact Person: _____
Title: _____ Telephone #: _____
Additional instructions for access: _____

Rain Gauge Hardware Information	LOCATION MAP
Rain Gauge Make/Model: _____	N ⇧
Rain Gauge Serial #: _____	
Data Collection Interval: _____	

Site/Installation Photos:

Rain Gauge Setup

END OF SECTION 33 01 30.10

SECTION 33 01 30.16 - SANITARY SEWER PIPELINE INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Specification covers inspection of gravity sewers using internal video and other multi-sensor inspection technologies (MSI) such as LASER and SONAR for the purposes of assessing thoroughness of cleaning, observing and recording structural mainline and lateral defects, construction, operational and miscellaneous features of existing sewer assets and to verify rehabilitated or new sewer construction prior to acceptance.

B. Provide all equipment, tools, labor, materials, and incidental services necessary to perform all Work for closed circuit television (CCTV) and other MSI inspections of sewer lines as indicated and in compliance with the Contract Documents.

C. Types of Cleaning shall be undertaken in accordance with Section 33 01 30.19 - Sanitary Sewer Pipeline Cleaning Specification in order to be able to conduct a NASSCO compliant inspection, that provides Specifications for Cleaning, Excessive Grease and Root Removal, Physically Attached Solid Debris Cutting and Removal of Intruding Taps.

D. Inspections may be witnessed by the Engineer according to the Quality Assurance Section.

E. In addition to standard NASSCO inspection, the Contractor shall also be required to record and locate any sinkholes or cave-ins along the pipe alignment for up to twenty (20) feet on either side of the pipe that are greater than six (6) inches deep and two (2) feet wide within the public right of way or easement prior to performing the CCTV inspection.

F. Related Requirements:

1. Section 33 01 30.17 - Manhole Panoramic Inspection.
2. Section 33 01 30.19 - Sanitary Sewer Pipeline Cleaning.

1.2 DEFINITIONS

A. CCTV Inspection: Operation necessary to complete a high-definition, true-color, audio-visual inspection for verification of existing internal sewer line conditions.

B. Moving Pictures Expert Group (MPEG): Family of international standards used for coding audio-visual information in a digital compressed format.

C. AVI: AVI, which stands for Audio Video Interleave, developed by Microsoft© is the acronym given to a family of multimedia container formats as part of its video for Windows© software.

D. MOV: MOV file, a common multimedia container file format developed by Apple© for use and compatible with both Macintosh© Quicktime and Windows© platforms. MOV files commonly use the MPEG-4 codec for compression.

E. Portable Hard Disk Drive (HDD): For the purposes of this Specification, HDD shall be written in accordance with the ISO-9660 Level 2 Specifications.

F. Engineer: The Engineer is defined as the Director of DWSD or their representative which may include a DWSD Engineer , a Field Inspector, or an Owner's third party Representative.

1.3 STANDARDS

A. National Association of Sewer Service Companies (NASSCO):

1. Pipeline Assessment and Certification Program (PACP) Reference Manual.
2. Manhole Assessment and Certification Program (MACP) Reference Manual.

1.4 SUBMITTALS

A. Sample Inspection Report: The Contractor shall submit to the Engineer the following documentation to ensure quality and conformity requirements of this Contract:

1. Provide a sample report of a sewer inspection for a pipe of height of 35" or less and for a pipe greater than 72" in height, including digital data files, of an actual sewer performed by each device to be used on this Contract for review at least one (1) month before beginning the inspection work.

    a. Submit two (2) copies of visual recording to the Engineer. The Engineer will review the inspections for completeness and accuracy of content, to ensure that the required information is provided, and the recording quality is acceptable. If the Engineer determines that the recording is defective or not of adequate quality, the Contractor shall re-perform CCTV inspection at the Contractor's expense.
    b. Submit one (1) PACP (version 7.0.0 or newer) compliant Microsoft Access, CCTV inspection Databases containing inspection and defect information. Sewer condition coding shall be submitted as a PACP.mdb file accordingly.
    c. Submit a pdf copy of the television inspection logs to the Engineer. Logs shall record defects according to NASSCO's PACP.
    d. Submit sample observation photos in the sample submittal.
    e. Submit the submittal tracking spreadsheet in the sample submittal.

2. Provide a sample report of a LASER and SONAR sewer inspection, including all digital files representative of the deliverables performed by each device to be used on this Contract for review at least one (1) month before the beginning of the inspection work.

3. If Side Wall Scanning technologies are to be used by the Contractor, the Contractor shall provide a sample report of a sewer inspection, including all digital files representative of the deliverables performed by each device to be used on this Contract for review at least one (1) month before the beginning of the inspection work.
4. Provide a sample "empty header" or "0-ft MSA" inspection for a sewer segment that cannot be inspected.
5. Clearly identify the equipment make, model and serial number for the sample and all submittals.
6. Demonstrate the resolution of each camera using the recording resolution specified herein.
7. If the Engineer determines that the recording is defective or not of adequate quality, the Contractor shall correct deficiencies and re-perform sewer inspection at the Contractor's expense.
8. Use the report submission accepted by the Engineer as a benchmark for subsequent inspection report submissions.
9. No inspection work is to be performed until the sample inspection reports have been accepted by the Engineer.

B. Inspection reports shall be completed within two (2) weeks of the completion of a Work area or intermittent submittals as approved by the Engineer.

C. Submit copies of current NASSCO PACP certifications for all Inspectors and Reviewers who shall perform the Contracted Work in accordance with NASSCO requirements having attained and retained their PACP certifications.

D. Submit a written description of procedures to be used to the Engineer, including product literature for all digital video equipment per the equipment section of this Specification including, but not limited to cabling, camera, monitor, footage counter, digital video titling device, and recorder.

E. For the bi-weekly data submittals, submit two (2) copies of visual recording to the Engineer. The Engineer will review the inspections for completeness and accuracy of content, to ensure that the required information is provided, and the recording quality is acceptable. If the Engineer determines that the recording is defective or not of adequate quality, the Contractor shall re-perform CCTV inspection at the Contractor's expense.

F. For the bi-weekly data submittals, submit one (1) PACP (version 7.0.0 or newer) compliant Microsoft Access, CCTV inspection Database containing inspection and defect information. Sewer condition coding shall be submitted as a PACP.mdb file accordingly. Name the PACP database according to the following file specification: **[Contractor Name]_[Contract Number]_PACP_Submittal ##**.mdb.

G. For the bi-weekly data submittals, submit a submittal tracking spreadsheet to the Engineer.

H. For the bi-weekly data submittals, submit a pdf copy of the television inspection logs to the Engineer. Logs shall record defects according to NASSCO's PACP.

I. Prior to initiating cleaning or inspection efforts, the Contractor shall submit an Emergency Plan that outlines proposed methods for recovering their cleaning or inspection equipment that has become lodged, lost or uncontrollable within the manhole or sewer, including confined space entry procedures.

J. Contractor is to provide a daily schedule to DWSD with planned inspection locations.

1.5 QUALITY ASSURANCE

A. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the Work.

B. The inspections shall be performed one pipe segment at a time as per NASSCO requirements.

C. Inspection shall be performed in accordance with most current NASSCO's Pipeline Assessment and Certification Program (PACP).

D. Inspection shall be performed by certified operators in accordance with NASSCO having attained and retained their PACP certification. Contractor shall ensure each operator is fully trained and certified in all aspects of sewer inspection and capable of making accurate observations and coding / recording all conditions that may be encountered in the sewers.

E. Coding accuracy will be a function of the number of defects or construction features not recorded or omitted as well as of the correctness of the coding and classifications recorded. Coding accuracy is to satisfy the following requirements:

1. Header accuracy: 95%.
2. Detail / defect coding accuracy: 85%.

Inspections failing to meet these criteria will be rejected, re-inspected if required, recoded, and resubmitted at no additional cost to the Owner.

G. Contractor shall implement a formal coding accuracy verification system before starting the Work.

1. Verify coding accuracy on a random basis on a minimum of 10% of the inspection reports. Submit coding accuracy checks with the corresponding video recording. The Contractor shall complete the CCTV Contractor Data Submittal and a QA Review Report documenting the results of the coding accuracy verification, attached separately, and include it with each respective data submission. Where QA has been undertaken by the Contractor, PACP Section Header Fields 3 and 4 must be populated by the Contractor.

2. Re-code inspections not satisfying the accuracy requirements and verify the accuracy of the inspection immediately preceding and immediately following the non-compliant inspection. Repeat the process until the preceding and subsequent inspections meet the accuracy requirements.

H. The Contractor shall maintain an up to date Progress Log that tracks the progress of the Work and status of inspections. The Engineer should be provided with this information upon request. The log should document the following information at a minimum:

1. Asset ID.
2. Upstream and Downstream Manholes.
3. Date of inspection.
4. Date of data submission.
5. Status of data acceptance / rejection.
6. Date of data acceptance / rejection.
7. Date of segment re-inspection (as required).
8. Date of data resubmittal (as required).
9. Date of resubmitted data acceptance (as required).

I. In accordance with ISO 2859-1 and ANSI/ASQ Z1.4 Level I requirements, the Engineer will randomly observe two (2) out of ten (10) inspections performed over one (1) or two (2) consecutive days to verify field results. The Engineer shall view the coded video within the CCTV truck while the inspection work is being performed. If one (1) or more tests significantly differ from those obtained by the Contractor for the Mandatory Field Data QC Items or items are found not to be recorded, all ten (10) inspections performed by the Contractor will be rejected.

J. The Mandatory Field Data QC Items are as follows:

1. Asset ID.
2. Test Completed.
3. Header Information Correct.
4. Camera Lens Clean.
5. Camera Speed Adequate.
6. All Dimensions are Recorded.
7. Panning and Tilting Occurring at all Notable Observations.
8. All Observations are Coded to NASSCO Standards.

K. The Engineer shall be entitled to an audit of the control system and be present when assessments of the sewer integrity are being determined. When requested by the Engineer in writing, forward to the Engineer sufficient details and information for such audit assessment. Should any report fail to achieve a margin that the Engineer deems satisfactory, the Contractor, without any additional compensation, shall recode and resubmit any data or reports that the Engineer deems necessary.

L. All submittals will be subjected to an independent Quality Control/Quality Assurance (QA/QC) audit by the Engineer. Where inconsistencies are noted, Contractor shall be responsible, where necessary and at no additional cost to the Engineer, for corrections including, re-inspection, recoding and entering additional information.

1.6 QUALIFICATIONS

A. The Contractor shall submit documentation for Engineer approval to demonstrate the following experience as a business engaged in the CCTV inspection of sewer lines per the Contract Documents:

1. The Contractor shall be in good standing under local contracting requirements or otherwise properly registered, licensed or permitted by law to carry on business within the State of Michigan, County of Wayne throughout the term of the Contract, and shall provide the Engineer with evidence thereof per the Contract Documents.

2. At any time during the term of the Contract, the Engineer may, at their sole discretion and acting reasonably, request updated evidence of good standing. A Contractor, who fails to provide satisfactory evidence, will not be permitted to continue to perform any Work.

B. The Contractor and/or any proposed Subcontractor, for the portion of the Work proposed to be contracted to them, shall meet the minimum qualifications as listed in the bidding documents.

C. The Contractor shall provide the Engineer with a complete list of Subcontractors whom the Contractor proposes to use prior to the commencement of Work.

D. The Contractor shall be fully capable of performing the Work required in strict accordance with the terms and provisions of the Contract Documents.

E. The Contractor shall submit, for Engineer's approval, documentation to demonstrate the following experience of the staff proposed for this project:

1. Operator certification documentation of each CCTV operator's NASSCO PACP certificate and for manhole inspectors, MACP certificate. The PACP and MACP certificate for all Operators performing Work on this project shall be current on the day of the Contractor's submission and shall remain current throughout the performance of this Work.
2. Documentation of supervisors' and operators' training certifications, listing of completed projects, and a minimum of five (5) years of experience in the internal inspection of sewers using CCTV, LASER, and SONAR inspection technologies.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish the television inspection studio, television camera, audio-visual digital encoding equipment/software, and other necessary equipment, materials, electricity, labor, technicians, as may be needed to perform the television inspection.

2.2 EQUIPMENT

A. The Contractor shall submit a list describing all equipment to be used for review and approval by the Engineer.

B. Sewer and manhole inspection units are to consist of a self-contained vehicle with separate areas for viewing and storage complete with the following equipment as a minimum.

1. Cellular telephone and suitable communication system linking all crew members.

2. Fans and blowers capable of removing fog that may be present in sewers at the time of the inspection.

3. Video cameras, lighting, cables and power source.

4. Video monitor and digital video recorder.

5. Computer system with video capture card or dedicated unit and other related equipment.

6. Temporary manhole covers to provide fall-in protection while performing Work.

C. Sewer CCTV Video Inspection Equipment:

1. A complete closed-circuit color television system, including a camera, lighting, electronic footage counter, television monitor, mobile television studio, and digital video recorder/player used for the televising operations shall be specifically designed and constructed for sanitary, storm, or combined sewer inspections. Video inspection is to consist of the following:

a. Video camera capable of panning 360° and tilting 270° with optimum picture quality provided by focus and iris adjustment. Focal range to be adjustable from 3 inches to infinity.
b. For pipes with a height of 35” or less, the inspection equipment shall be capable of inspecting up to 1,000 linear feet of sewer line without access to a manhole in between.
c. For pipes with a height of 36” or greater, the inspection equipment shall be capable of inspecting up to 2,000 linear feet of sewer line without access to a manhole in between.
d. The inspection equipment shall be capable of clearly televising the interior of 6-inch to 180-inch height sewer sizes.
e. The camera should be specifically designed and constructed for such sewer inspections and shall have above ground control for forward and backward movement in the sewer using tracked, wheeled, or tethered skid or flotation devices.
f. CCTV camera equipped with a locating sonde, designed for locating deep utilities and sewers, 10 feet deep or greater or buried structures and junctions that cannot be located or accessed from ground surface.

g. Capture the inspections in digital format in color from the live video source on archival grade HDD to the following minimum requirements:

   i. MPEG-2 or MPEG-4 format (MPEG-4 preferred).
   ii. Picture Size:
      One. Pipe Diameters with a height of 35" or less – 720x480 (or greater) @ 29.97 frames per second.
      Two. Pipe Diameters with a height of 36" or greater – 1920x1080 (or greater) @ 29.97 frames per second.

   iii. Data/Bit Rate: 6.0Mbit/sec.

h. Lighting for the camera shall be waterproof and suitable to allow a clear picture of the entire periphery of the pipe. The camera shall be operative and provide a clear picture in 100 percent humidity conditions. Lighting shall be adjustable to allow an even distribution of light around the sewer perimeter without loss of contrast, flare out of picture, or shadowing. Lighting shall illuminate the sewer or manhole ahead of the camera to be able to determine general condition, features and upcoming defects.

   i. An unclear picture due to excessive lighting (image flare), the lack of lighting or the presence of fog, steam, or excessive humidity will be considered unsatisfactory. The Contractor is responsible for identifying and implementing corrective actions to obtain suitable video quality, such as using fans or ventilation systems to dissipate the fog or by the heating of incoming air to mitigate fog.
   ii. A blurred picture due to fats, oil or grease will be considered unsatisfactory. The Contractor is responsible for identifying and implementing corrective actions to obtain suitable video quality, such as cleaning the sewer mainline, having the camera lens cleaned prior to reinspection of the mainline.
   iii. The Contractor is responsible for presenting issues regarding questionable video quality immediately to the attention of the Engineer.
   iv. Light heads shall be changed upon the request of the Engineer.

i. Picture quality and definition shall be to the satisfaction of the Engineer and if unsatisfactory, equipment shall be removed from the sewer, and no payment shall be made.
j. Video overlay equipment capable of superimposing a minimum of 15 lines with up to 30 characters per line of alphanumeric information onto the video recording.
k. The focal length is the intersection point between the camera lenses widest horizontal viewing angle and the pipe's side periphery (03 or 09 o'clock) when the camera is level and looking forward. The rear of the camera must be positioned at the start of the pipe where the camera's physical distance is added to the focal length. This total distance is known as the cable calibration distance. Record the distance from the manhole to pipe interface to the cable calibration distance at the start of the inspection and adjust the distance reading so that zero is at the manhole to start of pipe interface.

l. Smaller height sewers of 35 inches and less shall be inspected with equipment which shall:

i. Have self-propelled rubber tired or crawler tractor capable of passing over minor surface imperfections including but not limited to broken joints and solid debris up to four (4) inches in height for pipe heights up to 35-inch.

m. Larger height sewers of 36 inches and greater shall be inspected using an in-line inspection platform, which shall:

i. Be capable of inspecting a minimum of 2,000 linear feet of sewer line without access to a manhole in between.
ii. Have independently controlled drive tracks that enable the platform to maneuver around bends and climb over debris up to twelve (12) inches in height.
iii. Be operable under partially or fully submerged flow conditions.
iv. Be operable in sewers of various cross-sections, and constructed of standard pipe materials including, but not limited to, brick, clay, concrete, PVC, HDPE, and steel.
v. Be tethered to facilitate extraction of the platform from the sewer, without causing damage to the sewer infrastructure, in the event the equipment fails or otherwise becomes uncontrollable within the sewer.
vi. Be equipped with sufficient high intensity lighting to illuminate the sewer for visual inspection.
vii. Have capability for simultaneous data collection from multiple inspection sensors/technologies including, but not limited to, CCTV video inspection, LASER and SONAR scanning.
viii. Transport equipment must be capable of allowing for adjustable camera height to be centered within pipe heights of up to and including 180 inches.
ix. The use of Side Wall Scanning technologies resolution shall be at a level of resolution as per 2.2.C.1.g.ii to ensure pipe wall loss clarity is provided within the imagery. Viewing software shall be provided at no cost to the Owner or the Engineer to ensure the user has full autonomy when viewing the sewer pipe. Pre-recorded video shall also be submitted for Side Wall Scanning technologies in addition to specialty autonomous viewing software and data. No water droplets, debris marks or similar shall exist on the lens that would cause image blur or inhibit the clear and uninterrupted view of the pipe during the inspection. Side Wall Scanning technology platforms shall be used having sufficient illumination within given diameters as per the camera manufacturer's recommendations, such as 48" or less.

n. Minimum requirements of in-line inspection sensors / technologies: CCTV video inspection equipment shall conform to the requirements of the Contract Documents, and as modified herein:

i. Equipment shall be capable of continuously capturing digital video from first generation recordings with no frame loss, regardless of the progression of the inspection for the entire length being inspected.
ii. Incorporate a suitable distance-reading device to measure the location of the equipment in the pipe, to an accuracy of ±0.5% of the length of the inspection.

2. An electronic footage counter shall accurately measure the distance of the CCTV inspection equipment from the centerline of the starting manhole within +/- 2-ft. This measurement shall be displayed on the monitor and recorded on the video at all times. The importance of accurate distance measurements is emphasized.

3. In areas where self-propelled track-mounted platforms are not practical given the conditions of the sewer during inspections, the inspections shall be performed using alternate methods including tethered float or skid systems, jetter assistance or by man-entry methods. The Contractor shall notify the Engineer prior to the use of alternate inspection platforms as means of establishing tethers for floatation or skid systems where consensus on the appropriate methods of platform conveyance must be agreed.

D. Sewer Three-Dimensional (3D) LASER Scanning Inspection:

1. "Three-Dimensional (3D) Light Amplification by Stimulated Emission of Radiation Scanning" (LASER) is a technique to determine the surface profile of mainline pipes using a three-dimensional (3D) LASER on the entire circumference above fluid level of the pipe which does not need to be attached to the CCTV inspection equipment.
2. LASER scanning equipment shall provide an accurate determination of pipe geometry (features and defects) above the fluid level.
3. LASER scanning shall be conducted on identified sewer pipe entities and be conducted from access point to access point.
4. Minimum equipment requirements are:

a. The provision of LASER scanning Internal Diameter and Deflection graphs will be used to quantify internal pipe wall material loss/gain or deformation (ovality and deflection) at a given location. Pipe cross-sections obtained from high resolution scans will be used to provide quantitative information regarding internal pipe diameter, including ovality. Precision Scans are produced with multi-color indication depicting deviations from as built conditions as well as localized material gain and/or loss.
b. The LASER shall be Class 1; eye-safe for operator safety.
c. Surface corrosion measurements accurate to 13/64 inch at 9 feet in 48 inch pipes and larger.
d. Precision ovality / deflection detailed range LASER measurement scans accurate to ±1%.
e. LASER equipment shall be moved through the pipeline on a transport vehicle capable of supporting the LASER inspection equipment above the water level.

f. LASER scans shall produce a point cloud with a maximum distance between points of 3/8 inch in the transverse direction and 1 1/2 inch in the longitudinal direction. The rate of scan shall not exceed 18 feet / minute.

E. Sewer SONAR Scanning Inspection:

1. Sound Navigation and Ranging (SONAR) scanning equipment shall accurately measure the depth to sediment or pipe surface below the fluid level at regular intervals throughout the inspection.
2. SONAR scanning shall be conducted on identified sewer pipe entities and be conducted from access point to access point.
3. Minimum equipment requirements:

a. SONAR equipment must be programmable multi-frequency profiling SONAR specifically adapted to using sound waves to locate and map subaqueous sewer irregularities by creating continuous SONAR images recorded in "real time" mode.
b. SONAR equipment shall be digital and support a range of frequencies from 600 kHz to 2.25 MHz to minimize noise.
c. The range resolution measurement error shall be no greater than 5/64 inch from distances of 3 to 12 feet, and no greater than 13/32 inch from distances of beyond 15 feet.
d. The minimum detectable range for the SONAR unit shall be three (3) inches.

PART 3 - EXECUTION

3.1 PREPARATION

A. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

B. Working hours shall be in accordance with Section 01 14 00 – Work Restrictions.

C. Sewers and associated upstream and downstream manholes and/or catch basins shall be cleaned of loose and settled debris including sludge, dirt, sand, gravel, rocks, bricks, roots, grease and other solid and semi-solid materials and removed from the sewer with the equipment detailed in this Specification.

D. It shall be the responsibility of the Contractor to locate manholes and/or catch basins by use of a CCTV camera and sonde locator and in conjunction with the use of a metal detector.

1. Should the Contractor be unable to find the manhole, they shall notify the Engineer immediately. The Engineer will then direct the Contractor regarding whether they should continue to search for the manhole. Time spent searching for a manhole is incidental to the cost for cleaning and inspection of manholes and sewers.

2. The Contractor will edit the as-builts or provide the Engineer with a legible sketch drawing to identify the approximate location of any manholes, structures, or piping that are not accurately depicted on the mapping (more than ten feet from the location shown in the mapping, outside of the ROW or easement shown on the mapping), does not exist, or is not shown on the mapping. The Contractor shall GPS survey the newly found manholes or manholes not accurately depicted to submeter accuracy. Markups will be confirmed with the Engineer and should be legibly recorded in the as-builts. The edited as-builts or sketches will be provided to the Engineer with each bi-weekly inspection submittal or upon request. Markups will be confirmed with the Engineer and should be legibly recorded in the as-builts. The edited as-builts will be provided to the Engineer at the conclusion of the Work or upon request.

    a. The Engineer will communicate the methodology and application of temporary or new asset ID for new manholes and sewers located during the Work that conforms to the Engineer's requirements.
    b. The Contractor shall notify the Engineer and DWSD if a manhole is not accessible due to bury depth or other factors.

E. Sewers and manholes may be located in easements, through public or private property, City owned parklands and rights-of-way and restricted alleyways where no paved access may exist, or paved access is obstructed to the extent that would inhibit equipment and materials mobilization. It will be the Contractors responsibility to identify these sewers and arrange for access using "Door Hanger" notifications as necessary and to restore any surface damage to private and City owned property to the satisfaction of the Engineer.

F. Where access routes to various manhole locations must be cleared of heavy vegetation, the Contractor shall perform the clearing of pathways and alleyways to the extents necessary to facilitate mobilization of cleaning and internal sewer inspection equipment. The Contractor shall not remove vegetation on private property or outside of the sewer easement or right of way.

1. Any vegetation or other debris cleared by the Contractor shall be removed and disposed of properly by the Contractor, and the site restored by the Contractor as approved by the Engineer.
2. Trees larger than 6" in diameter measured at a point 4.5' (diameter at breast height) above grade will not be removed as part of the pipeline inspection. Notify the Engineer of site conditions that will impede the completion of the Work.
3. Trees smaller than 6" in diameter measured at a point 4.5' (diameter at breast height) above grade will be removed as part of the Work and shall be incidental to the Contract.

G. The Contractor shall remove and clear restricted alleyways or easements to enable the mobilization of inspection and cleaning equipment. This Work shall be incidental to the sewer cleaning and inspection activities.

H. The Contractor shall schedule, maintain, and coordinate all activities and shall cooperate with the Engineer such that a minimum of interruption to the services results. The Contractor shall not operate existing system valves, controls, or other appurtenances at any time, but when the

same is needed to facilitate and accommodate activities, shall request such operation from the Engineer. The Contractor shall provide the Engineer with 48- hour advance notice for such assistance.

I. The Contractor is hereby made aware no flow shall be discharged to the river, streams, banks, or any other storm outlet during cleaning or inspection operations. Additionally, no sewage shall be permitted to surcharge to the point that it overflows to any of the above or back into private buildings through lateral connections. The Contractor must notify the Engineer immediately of any spill event. Any damage or fines resulting from such occurrences are the sole responsibility of the Contractor.

J. The Contractor shall notify the Engineer 96 hours prior to mobilizing for internal inspection or cleaning activities.

3.2 FLOW CONTROL

A. Undertake flow control measures such as working during off-peak hours, the use of sewer cleaning equipment to lower downstream flow levels or blocking/plugging if sewer flows are hampering effective sewer cleaning.

B. Provide the Engineer with at least 48 hours' notice and proposed method of flow control before undertaking flow control measures for sewers larger than 18 inches in height.

C. Use sewer plugs to stop or reduce sewer flow that tether to and are removable from the ground surface.

D. Monitor flow levels upstream of a plugged sewer at all times to ensure flooding of public or private property does not occur.

E. The Contractor must, at a minimum, make reasonable effort to control the flow by using pipe-cleaning equipment to temporarily retain flow or to remove standing water.

F. The Contractor must also consider weather conditions and low diurnal flow patterns to obtain the best video image of the sewer. This may require the Contractor to schedule video work to times that are after major rain events or to overnight shifts when the sewer system attains a lower dry weather flow environment. These inspections need to be coordinated with City to identify opportune times for low flows expected from the hydraulic model.

G. The Contractor is to maximize visual inspection to as great a degree as possible. For pipes of height of 35" or less, regardless of the number and type of cleaning passes performed, the final pass of cleaning shall be undertaken in conjunction with the CCTV camera inspection that is to be provided as the final inspection deliverable. During the final cleaning pass, the CCTV inspection camera shall be mobilized to inspect the sewer segment while the jet nozzle pulls water away from the camera, drawing any water level down to maximize the exposure of the sewer pipe circumference.

H. The Contractor is to maximize visual inspection to as great a degree as possible. For pipes of height of 35" or less where the flow is greater than 50% after the Contractor has attempted to lower the water level by means of hydraulic equipment, the Contractor is to inform the Engineer. The Engineer may direct the Contractor to not clean the pipe and the inspection would be done by CCTV and SONAR.

I. No flow control shall be undertaken solely for the purpose of inspection for sewer pipe heights 36" and larger.

3.3 CCTV INSPECTION

A. All open access structures or manholes will be attended at all times, and all access structures or manholes that were sealed or bolted to control odors or entry of extraneous water or for security reasons will be resealed or re-bolted after entry. The Contractor shall liaise with the Engineer to ensure that sealed or bolted chambers have been adequately sealed or bolted, post inspection.

B. The Contractor understands that DWSD shall incur significant and substantial penalties from the state of Michigan in the event that sewage is discharged onto the ground or into any streams as related to the Work in this Contract. In the event that sewage is released into the environment as a result of the Contractor's work, the Contractor shall immediately rectify the situation and notify the Engineer.

C. At the commencement of each CCTV inspection, temporarily insert a survey rod or steel tape from the manhole surface to the invert of the pipe that is to be surveyed so that the rod or tape vertically crosses the 12 to 6 o'clock positions. The gradations shall be clearly visible in the resultant video footage so the pipe height can be verified by viewing the footage.

D. Ensure camera speed does not exceed 30 feet / minute during sewer and manhole inspections.

E. Inspect sewer pipelines and manholes with pan and tilt conventional television imagery so as to record relevant features and defects of the pipeline under inspection. Inspection of pipelines shall be carried out in accordance with NASSCO PACP standards in conjunction with cleaning operations in accordance with the requirements of the Contract Documents. A skilled and NASSCO PACP certified technician or supervisor who shall be located at the control panel in the mobile television studio shall control the operation of the television equipment.

F. If television inspection of an entire Section cannot be successfully performed from one manhole, perform a reverse setup to obtain a complete television inspection.

1. Perform a reverse set-up inspection when a blockage in the sewer prevents completion of the inspection from one manhole. Move the equipment to the other manhole at the opposite end of the sewer segment and attempt to complete the inspection of the entire sewer to the original manhole.

2. Immediately advise the Engineer when a complete sewer inspection cannot be completed.

3. In the event the Contractor is unable to completely perform CCTV inspection or cleaning from both directions (with the exception of a cross-bore or collapse), the Contractor must have the obstructions removed using specialty cleaning equipment capable of removing the obstruction and simultaneously viewing the cleaning activity from the same vantage point in order to view the cleaning operation and not cause any damage to the host pipe. The Contractor will then televise the pipe segment in its entirety.

4. If the Contractor cannot complete the inspection after attempting to use specialty cleaning equipment, the Contractor and Engineer shall jointly decide if the Contractor shall re-perform the inspection subsequent to completion of external or emergency repair.

G. Note in a log the Asset ID and Manhole ID's, surface distance or calibrated footage counter measurement, upstream and downstream length from associated manhole, length of missing video and the reason the inspection could not be completed and review with the Engineer for approval on a weekly basis.

H. Whenever prevailing conditions allow, position the camera head to reduce the risk of picture distortion. In circular sewers, position the camera lens centrally (i.e., in prime position) within the sewer. In noncircular sewers, picture orientation shall be taken at mid-height, unless otherwise agreed, and centered horizontally. Direct the camera lens along the longitudinal axis of the sewer when in prime position. A positioning tolerance of +/- 10 percent of the vertical sewer dimension shall be allowed when the camera is in prime position.

I. Indicate on the monitor screen accurate automatic distance measurement that begins to move immediately as the camera moves. Ensure measurement is accurate from the cable calibration point to the pipe to finish manhole interface.

J. Above Ground Measure (AGM) is required in order to check the horizontal footage of the inspected sewer at the surface as compared to the footage listed in the CCTV video. If a difference in the recorded footage exceeds a tolerance of 2 feet, calibration of CCTV equipment may be needed.

1. Measure the distance between the center of the start and finish manholes on the ground surface above the sewer to the nearest half an inch using a survey grade ISO 16331-1:2012(E) approved outdoor LASER distance measurer capable of attaining 500 feet minimum surface distance, or alternative measuring methods approved by the Engineer, before beginning the sewer inspection. The center of the manhole will be based on the center of the manhole cover regardless of the manhole configuration. If bends are identified to exist within the sewer segment, the Contractor shall approximate the measurement on the ground surface using incremental distances to the approximate alignment of the sewer between the start and finish manholes, to the approval of the Engineer.

K. All defects and observations are to be circumferentially located based on the side periphery only.

L. Stop the camera and position to provide a steady 2 second perpendicular view of connections, junctions, major branches and major defects including deformed sewers, displaced bricks, holes, large displaced joints, missing bricks, missing mortar, obstructions, and large open joints.

M. Sewer lateral (tap) observation distances must occur at the center of the tap and the side periphery. To determine use and deficiencies of the tap, the camera must continue to travel, camera centered in the perspective view (to capture other observations), to stop perpendicular to the tap and pan so that the camera can view directly into the barrel of the lateral, to enable the inspector to apply modification and descriptor codes to the tap as per NASSCO PACP standards as necessary.

N. All taps shall be associated to a physical property address and this shall be recorded within the PACP inspection. Further to coding Taps, the Contractor shall conform to NASSCO requirements; however, where defective Taps are identified, the most significant observed defect seen within the lateral shall be communicated within the "Remarks" field as per PACP requirements including but not limited to appropriate dimensioning, percentage values and clock references relating to its defect, but also providing the associated property address of the Tap comma separated for data processing requirements (e.g., "RM,50%,03,09,456 Second Avenue"). Furthermore, the Contractor shall identify the affected property by completing a steel tape or calibrated footage counter measurement on the surface to confirm property number and note this within the "Remarks" field with an associated photograph taken of the offending defective tap.

O. Perform television inspections during low flow conditions. The Engineer will reject any television inspection that, because of high flow conditions or for any other reason, does not produce an effective survey of the sewer pipe. In addition, if it is determined that effective conventional television inspection cannot be performed, notify the Engineer in writing.

P. Observations that are critical to public safety or pose imminent threat to the public or environment shall be reported within 24-hours.

Q. Re-perform sewer inspections where the Engineer has determined the tolerance requirements for camera position and speed and internal distance measurement requirements as per this Specification have not been satisfied.

3.4 MULTI-SENSOR INSPECTION

A. For inspection of circular brick pipe where the pipe is 36 inches in height or greater and non-circular pipe for all materials where the pipe is 36 inches in height or greater, the LASER capability on multi-sensor inspection equipment shall be turned on and data shall be collected. Post-processing of the LASER data shall be performed at the direction of the Engineer after initial review of the processed PACP coded inspection data.

3.5 DIGITAL VISUAL RECORDING

A. Take continuous digital video recordings of the inspection view as it appears on the television monitor. The recording shall be used as a permanent record of defects. The video recording shall be in MPEG file format. The digital video encoding shall include video information that can be reproduced with a video image equal or very close to the quality of the original picture on the television monitor. The replay of the recorded video information when reviewed by the appropriate MPEG 2/4 viewing software, shall be free of electrical interference and shall produce a clear, stable image.

B. Create separate MPEG video files for each sewer line segment. In case of a reverse setup, store such inspection in a separate MPEG file. The MPEG video files shall be written to 2.5-inch portable HDD, or other digital media acceptable to the Engineer and delivered to the Engineer. Multiple digital videos may exist on each HDD. Each HDD folder shall be labeled, at a minimum, with the following information: Project Name, Date and time of inspection, pipe segment referenced Asset ID, Sewer Line Sections with manhole IDs, Direction of survey, Current distance along reach (counter footage), and TV Inspection Contractor's firm name.

C. For sewers, provide file names for each digital video file in accordance with the following.

1. Contract No_E<entity no>_F<from entity no>_T<to entity no>_StreetName_M <measured len>_I<inspected len>_DS or US<inspection dir>_<Letter designating inspection sequence>_<YYYYMMDD>.MPG
2. Eg. 910-2000_ES-MA0000001_FS-MH0000001_TS-MH0000002_BERRY_M100.0_ I39.2_US_B 20200325.MPG

    a. B (indicates that this is the second or "B" partial inspection of this entity, 39.2 ft long).

D. Digital video still frame captures shall be from 1080 High-Definition (HD) video in JPEG format for every observation. Photographs shall be clear and accurately show the observation. Photographs shall have the following annotation:

1. Upstream and downstream manhole ID, survey direction, footage, time and date, description. Name photos as follows: **[Pipe Asset ID]_[Upstream Manhole ID-Downstream Manhole ID]_[HHMM_YYYYMMDD]_[Code]_[Footage].**jpg.
2. When more than one (1) of the same point defect or construction feature is observed at the same distance but at different clock positions, name photos as follows: **[Pipe Asset ID]_[Upstream Manhole ID-Downstream Manhole ID]_[HHMM_YYYYMMDD]_ [Code]_[Footage]_[Clock Position].**jpg.

E. CCTV video header information will be recorded for each pipe segment video and will be displayed for a minimum of 30 seconds at the start of all inspections. Inspection of the sewer shall not proceed while the information screen is being displayed. The data must be presented in a format with white text on a black background. The following information will be provided in the video header.

1. Contract Number:
2. Date: Date inspection was completed. Format: MM-DD-YYYY.
3. Time: Time survey was initiated. Format: 24-hr military, HH:MM.
4. Surveyed By: Name of PACP certified inspection operator conducting the inspection.
5. Certificate Number: NASSCO certificate number of the operator conducting the inspection.
6. Company: Name of company completing the inspection.
7. Start MH ID: ID number of the MH where the inspection is initiated.
8. Finish MH ID: ID of the MH where the inspection is ended.
9. Pipeline Reference Asset ID: Asset ID of the pipe segment.
10. Street: Street in which a majority of the sewer being inspected is located. Enter "ROW, (Street Name)" if sewer is not in the road but is in close proximity to a readily identifiable street. Enter "ROW" if sewer is not in close proximity to a readily identifiable street.
11. Start Location: Physical address, intersection or nearest landmark that can be used to readily identify the location of the start MH.
12. Survey Direction: Direction of inspection in relation to flow in the sewer; Upstream or Downstream.
13. Material: Material composition of sewer being inspected. Format: NASSCO PACP code.
14. Height: Nominal sewer dimensions. Pipe diameter if circular, height if non-circular.
15. Width: Nominal sewer dimensions. Maximum width if non-circular.

F. The Engineer reserves the right to refuse a video file on the basis of poor image quality, excessive bit rates, inconsistent frame rates, or any other characteristics that may affect usability by the Engineer.

G. The Contractor shall supply digital video files containing all video inspections and coding data to the Engineer. The Contractor shall provide at least three (3), 2.5-inch portable HDD, complete with all associated drivers and software, power adaptors and USB cables, delivered on a bi-weekly rotation exchange that contains completed sewer inspection video with viewing software and sewer condition coding data to the Engineer. Sewer condition coding shall be submitted as a PACP.mdb files accordingly. Retained HDD's will be returned at an agreed frequency. Alternatively, data may be provided through the use of a cloud-based application with the approval of the Engineer. The final determination for data transfer shall be approved by the Engineer.

H. All HDD's shall be sized appropriately to accommodate all above mentioned files and have dual USB 3.0 (preferable) and (a minimum) USB 2.0 compatibility with a minimum data transfer rate of 480 MB/s.

I. The Contractor shall organize data accordingly within the following folder structure when providing PACP data submittals:

1. Database (folder).
2. Videos (folder).
3. Photos (folder).
4. Reports (folder).

5. CCTV Inspection Data Submittal Tracking Spreadsheet.

3.6 UNCHARTED ASSETS

A. If television inspection reveals new manholes, locate, mark by painting or flagging and name the manhole in accordance with the methodology for temporary or new asset ID for new manholes and sewers as specified by the Engineer.

B. All uncharted manholes will be inspected as per the Specification and also internally scanned during the pipe inspection (in case manhole inspection is not possible).

C. For manholes that are more than ten feet from the location shown in the mapping, outside of the ROW or easement shown on the mapping or for newly found manholes, the Contractor shall provide the Engineer with a legible sketch drawing that provides the location of the manholes, structures, or piping and GPS survey the manhole to submeter accuracy. These markups will be approved by the Engineer for mapping corrections by the Engineer.

D. Found manholes and uncharted pipes will be automatically assigned Asset IDs by the ArcGIS Collector application.

E. The split pipe segments resulting from found manholes will be assigned Asset IDs by the CCTV crew operator by adding sequential numeric suffix to the original pipe asset ID. Example: **WWGM0012345678-1** and **WWGM0012345678-2** where two new manholes are found.

F. Manhole inspections shall be conducted in accordance with NASSCO MACP version 7.0.0 (or newer) Level 2 standards but by utilizing non-man-entry techniques as noted in the Section 33 01 30.17 Manhole Panoramic Inspection Specification.

G. All open access structures or manholes will be attended at all times, and all access structures or manholes that were sealed to control odors or entry of extraneous water will be resealed after entry.

3.7 INSPECTION REPORTS

A. Prepare a television inspection report covering the television inspection work and the information acquired. Inspection forms shall be completed and submitted for all pipe sections requiring inspection, including those for which an actual inspection cannot be performed as described in this Specification.

B. Name the report files according to the following file specification: **[Pipe Asset ID]_[Start Manhole Number]_[End Manhole Number]_[YYMMDD]_[HH:MM – 24 hour format]**. Pdf.

C. Report sewer defects in accordance with the National Association of Sewer Service Companies (NASSCO) program known as Pipeline Assessment and Certification Program (PACP). The

Engineer reserves the right to refuse any inspection report that does not comply with the PACP program.

D. In addition to completing all mandatory PACP inspection required fields, the Contractor shall complete the following fields in the PACP Header Section:

Pipe Header Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
General Information	1	Surveyed By (*Operator / PACP User Name*)	Yes	Yes
	2	Certificate Number	Yes	Yes
	3	Reviewed By	No	No
	4	Reviewer Certificate Number	No	No
	5	Owner	No	Yes
	6	Customer	No	Yes
	7	P/O Number (*Contract No.*)	No	Yes
	8	Work Order	No	Yes
	9	Media Label	No	Yes
	10	Project	No	Yes
	11	Date	Yes	Yes
	12	Time	No	Yes
	13	Sheet Number	Yes	Yes
	14	Weather	No	Yes
	15	Pre-Cleaning	Yes	Yes
	16	Date Cleaned	No	Yes
	17	Flow Control	No	Yes
	18	Purpose of Survey	No	Yes
	19	Direction of Survey	Yes	Yes
	20	Inspection Technology Used	No	Yes
	21	Inspection Status	Yes	Yes
	22	Consequence of Failure	No	No
	23	Pressure Value	No	No

Pipe Header Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
Location	24	Drainage Area	No	Yes
	25	Pipe Segment Reference (*Asset ID*)	No	Yes
	26	Street (*Name and Number*)	Yes	Yes
	27	City	Yes	Yes
	28	Location Code	No	Yes
	29	Location Details	No	Yes
Pipe	30	Pipe Use	Yes	Yes
	31	Height (*Diameter*)	Yes	Yes
	32	Width	Yes	Yes
	33	Shape	Yes	Yes
	34	Material	Yes	Yes
	35	Lining Method	No	Yes
	36	Coating Method	No	No
	37	Pipe Joint Length	No	Yes
	38	Total Length (Surface Distance-AGM)	No	Yes
	39	Length Surveyed	No	Yes
	40	Year Constructed	No	No
	41	Year Renewed	No	No
Measurements	42	Upstream MH No.	Yes	Yes
	43	Upstream MH Rim to Invert	No	Yes
	44	Upstream MH Rim to Grade	No	No
	45	Upstream MH Grade to Invert	No	No
	46	Upstream MH Northing	No	No
	47	Upstream MH Easting	No	No

Pipe Header Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
Measurements	48	Upstream MH Elevation	No	No
	49	Downstream MH No.	Yes	Yes
	50	Downstream MH Rim to Invert	No	Yes
	51	Downstream MH Rim to Grade	No	No
	52	Downstream MH Grade to Invert	No	No
	53	Downstream MH Northing	No	No
	54	Downstream MH Easting	No	No
	55	Downstream MH Elevation	No	No
	56	MH Coordinate System	No	No
	57	MH Vertical Datum	No	No
	58	GPS Accuracy	No	No
	59	Additional Information	No	Yes*

Yes* - if required.

E. An "empty header" or "0-ft MSA" inspection shall be completed for sewer segment that cannot be inspected for reasons such high flow, depths or velocities, inaccessibility to the sewer due to inaccessible or unlocated access structures, heavy debris, Engineer direction, etc. The inspection form header and detail sections shall comply with NASSCO PACP guidelines populating all required header fields. The Contractor will abandon the survey at a distance of 0-ft inspected and provide a general comment that describes the reason that the inspection cannot be conducted in the Additional Information field. An "empty header" inspection shall also be created for reversal inspections that cannot be completed. Contractor shall record at least one photo documenting conditions preventing the inspection of the pipe segment. Empty header records, and image references for the photos, shall be included in the PACP database as submitted by the Contractor with adjoining segments.

F. Contractor shall provide a summary listing of all manholes or structures included in the original task order, listing the date of inspection or attempted inspection, and indicating if the manhole was inspected, or if not, the reason, e.g., not found (NF), no access (NA), not opened (NO), structure is a lamphole (LH) or cleanout (CO), or other reason.

G. The MSI Report shall include the following information:

1. LASER Scanning Inspection:

   a. Summaries of pipe corrosion and debris build-up, presented as unrolled color-coded full-circumference graphical illustrations of pipe condition, over the length of the sewer inspected. Where the presence of fluids in the pipe necessitates interpolation to complete the full circumference view, the method and calculations used to support these assumptions shall be presented.
   b. Cross-sectional scans, taken at regular intervals along the inspected sewer segment, showing measured pipe cross-section superimposed over as-built pipe cross-section, and color highlighted to identify all areas of apparent cross-section loss and gain, construction or defective pipe features in alignment with CCTV payout distances.
   c. All raw and post processed LASER data shall be submitted with associated and compiled reports that shall determine pipe geometry for features including but not limited to defects, construction features and pipe shape above fluid level.
   d. Summaries of pipe ovality and deflection, including:

      i. Vertical AND horizontal diameter plots of individual diameter measurements versus pipe length, for each section of sewer inspected.
      ii. Ovality plots depicting percent deviation from as-built records.
      iii. LASER data as VRML (Virtual Reality Modeling Language) 3D computer graphic representations, in WRL format, with software viewer that can be used to display and interpret the LASER data

2. SONAR Scanning Inspection:

   a. Graphical summaries of sediment thickness and cumulative sediment volumes in the trough of the pipe below the water line versus pipe location, and pipe capacity depicting actual versus original theoretical storage capacity.
   b. Statistical average, minimum, and maximum values of sediment accumulation along the sewer, where appropriate, as determined by calculating the portion of the pipe obstructed by sediment and presented as a percentage of the pipe area.
   c. Cross-sectional scans, taken at regular intervals along the inspected sewer segment, showing sediment and pipe shape to identify all apparent cross-section loss or gain in alignment with CCTV payout distances.
   d. Video file of SONAR data in AVI, MOV, MPEG-2 or MPEG-4 file formats.
   e. All raw and post processed SONAR data shall be submitted with associated and compiled reports that shall determine pipe geometry for features including but not limited to potential defects, debris and water levels and pipe shape below fluid level.

3.8 OBSERVED FAILURES DURING SEWER AND MANHOLE INSPECTIONS

A. Cross-bores are intersections of one (1) utility pipeline through another, such as when a gas pipeline is inadvertently installed through a sewer pipeline. Cross-bores generally occur when a third-party utility is installed using a trenchless method that prevents visibility of the underground sewer pipeline and are commonly a water or gas service.

1. Cutting devices are to be used in conjunction with CCTV equipment only.

2. Cutting devices are not to be used in the vicinity of cross-bores.

3. Capture photograph or digital images and notify the Engineer immediately where third-party cross-bores are observed during the sewer or manhole inspection. Provide the captured CCTV images and the distance from the start node of the inspection along the pipe to note the location of the cross-bore to the Engineer immediately after observation.

4. MISS DIG (811) should be contacted to provide locates prior to all cleaning operations located in the right of way to reduce impact with potential cross-bores.

5. A reverse set-up inspection shall be performed when a cross-bore prevents completion of the inspection from the initial access point. Move the equipment to a different access point and attempt to complete the inspection of the pipe up to the cross-bore location.

B. In addition to standard NASSCO inspection, the Contractor shall also be required to record and locate any sinkholes or cave-ins along the pipe alignment for up to twenty (20) feet on either side of the pipe that are greater than six (6) inches deep and two (2) feet wide within the public right of way or easement prior to performing the CCTV inspection. Upon approval by the Engineer, immediately following the initial condition assessment CCTV inspection, certain sinkholes shall be dye-tested to determine if the dye reaches the sewer and the location where the dye is observed shall be recorded as part of a Dye-Test CCTV inspection for verification purposes. The Contractor shall record the sinkhole information in the ArcGIS Collector application. The Contractor shall provide the two captured images of the sinkhole (image from above and location image), X and Y coordinates, location and dimensions of the sinkhole, if the sinkhole was dye-tested and the results of the dye-test including the Asset ID of the televised pipe or manhole where the dye was observed. This Work shall be paid under the line item, “Dye-testing for Sinkholes.”

C. Capture photographs or digital images and notify the Engineer immediately after observation where issues identified in the tables below are observed during the sewer or manhole inspection. Provide the captured images in addition to Asset ID’s, observed issue identified by defect code and description, and footage along the pipe to the Engineer immediately via e-mail after observation. The format of this communication is shown in the Appendix. The Engineer shall create the incident within the ArcGIS Collector application for review by Engineering.

1. Structural:

Defect	Grade	Description
X	5	Collapse
DR	5	Deformed Rigid
H	5	Hole
HSV	5	Hole Soil Visible
HVV	5	Hole Void Visible
X (Lateral)	5	Collapsed Lateral

2. Operational:

Defect	Grade	Description
OBI	5	Obstruction Intruding Through Wall
RBB	5	Roots Ball Barrel
IG	5	Infiltration Gusher
IR	4	Infiltration Runner

3. Miscellaneous:

Defect	Grade	Description
MWLS	5	Miscellaneous Water Level > 75%

D. Place barricades around the location above the sewer or manhole where a void is visible or suspected to be outside of the sewer pipe or manhole and immediately notify the Engineer. Detroit Water and Sewerage Department (DWSD) Emergency Services at telephone number 313-267-8000 after normal working hours if the Engineer cannot be reached. Caller should be prepared to share project specific information such as address, street intersections, and describe the emergency situation.

E. The Engineer will arrange for emergency sewer or manhole repairs to be performed if required as soon as possible if the inspection cannot be completed or the sewer or manhole condition poses an immediate operational or safety concern such as a complete collapse.

F. Emergency sewer or manhole repairs will be prioritized if more than one emergency repair arises at the same time.

G. Carry out inspection of other sewers not affected by the emergency repair and complete inspection of the sewer when notified by the Engineer that the emergency repair has been completed.

H. Perform repeat cleaning of the sewer in accordance with Section 33 01 30.19 - Sanitary Sewer Pipeline Cleaning if required.

3.9 REMOVAL OF EQUIPMENT THAT BECOMES STUCK IN A SEWER

A. No additional compensation will be provided to remove equipment or repair the sewer in the event the Contractor's equipment becomes stuck in the pipe or is otherwise damaged as a result of conducting Work in the sewer.

B. The Contractor shall advise the Engineer immediately if equipment becomes stuck in a sewer. The Contractor shall attempt to remove equipment that is stuck using whatever means are necessary for up to four (4) hours. The Contractor shall advise the Engineer if the equipment cannot be freed after four (4) hours and mark the position on the surface over the sewer where the equipment is stuck.

C. The Engineer will arrange to have an excavation made to the top of the sewer where the equipment is stuck within 48 hours of notification the equipment cannot be freed at the expense of the Owner.

D. The Contractor shall advise the Engineer if bypass pumping is required to ensure the normal sewer flow continues while the obstruction is present. All costs incurred due to the bypass pumping activity shall be at the cost of the Owner.

E. The Contractor and Engineer shall be present during the excavation and once the top of the sewer is exposed and the excavation is secured, the Contractor shall do one of the following:

1. Remove the top of the sewer pipe and retrieve the equipment stuck in the sewer or;

2. Defer removal of the top of the sewer and retrieval of the stuck equipment to the excavation contractor. Damages caused to the stuck equipment will not be the responsibility of the excavation contractor. No claim for equipment damages will be made against the excavation contractor.

F. The Engineer will arrange to have the sewer repaired after removal of the equipment that was stuck at the expense of the Owner.

G. The Contractor shall clean and remove backfill and debris that may have entered the sewer during removal of the equipment and subsequent repair of the sewer.

3.10 TRAFFIC CONTROL

A. Contractor shall provide traffic control as required and in compliance with the Local and State governing authorities and in accordance with Section 01 55 26 – Traffic Control.

B. Contractor shall coordinate traffic control with City of Detroit and other jurisdictional authorities.

C. The Work of Maintaining Traffic consists of furnishing all labor, equipment, and materials required for maintaining traffic throughout the project area in accordance with Sections 104.07.C, 104.11, 812, and 922 of the MDOT 2012 Standard Specifications for Construction and this Special Provision.

1. Notify the Engineer a minimum of 72 business hours prior to the implementation of any road closures, lane closures, or major traffic shifts. The Contractor will be required to contact all local and state police, fire, and emergency services that will have jurisdiction within 72 business hours prior to the implementation of any lane closure.

2. Construction Influence Area (CIA) – The CIA includes the right-of-way of the roadways within the project limits.

3. General Traffic Restrictions:

   a. Normal work hours are Monday thru Friday from 7:00 a.m. to 7:00 p.m., or as approved by the Engineer. Work outside the normal work hours will require prior approval from the Engineer.

   b. No Work or lane closures will be allowed during Independence Day, Memorial Day or Labor Day weekends. These holiday weekends are defined as beginning at 12:00 p.m. on Friday and ending at 6:00 a.m. on the following Tuesday, or as defined by the Engineer. No Work will be allowed during any standard holiday weekends, which will be defined by the Engineer.

   c. Maintain access to all residential and business drives at all times. Maintain access to drives in active work zones when possible as directed by the Engineer.

   d. All labor, equipment, and aggregate required to maintain street, intersections, and driveways for traffic will be included in the execution of the Work.

   e. Coordinate operations with the other Contractors performing Work on projects within or adjacent to the CIA. Maintenance crews and/or Contractor Maintenance Agencies may preform maintenance work within or adjacent to the CIA. The Maintenance Division of MDOT and/or Contract Maintenance Agency will coordinate their operations with the Engineer to minimize interference to the Contractor. No additional payment will be made to the Contractor for joint use of the traffic control items.

   f. Maintain access for emergency vehicles at all times through the Work area.

   g. Provide fencing to protect open trenches and pits during working and non-working hours.

4. Project General: During work hours, equipment material, and company vehicles may be parked or stored within the right-of-way as directed by the Engineer. The Contractor is responsible for restoring to its original condition any area damaged by their equipment, material, or company vehicles. Restoration of damaged areas will be in accordance with the plans and 2012 MDOT Standard Specifications for Construction and this Special Provision.

3.11 ACCEPTANCE OF WORK

A. The Contractor will submit required video, LASER or SONAR inspections of each sewer segment to the Engineer for review and determination if the Work performed is acceptable.

B. The sewer inspections shall also be used by the Engineer to determine acceptance of sewer and manhole cleaning, physically attached solid debris cutting, removal of excessive grease and roots and intruding sewer tap removal where undertaken. If physically attached solid debris cutting, removal of excessive grease and roots, and intruding sewer tap removal occurs, the Contractor shall submit the survey abandonment videos from the initial survey attempts in addition to the final completed survey to the Engineer for review and determination if the Work performed is acceptable.

C. The Engineer will review the inspection videos within fifteen (15) working days of submission.

D. The Contractor will re-perform sewer inspections where the Engineer has determined the requirements of the Specification have not been satisfied.

E. The Contractor will correct non-compliant inspection submissions and resubmit the corrected inspections to the Engineer within five (5) working days.

F. The Contractor will repeat the process until the inspection submissions are accepted by the Engineer. Work to perform remedial work will not be eligible for additional payment.

END OF SECTION 33 01 30.16

SECTION 33 01 30.17 – MANHOLE PANORAMIC INSPECTION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This Specification covers inspection of manholes using side scanning imaging and point cloud collection equipment to perform National Association of Sewer Service Company's (NASSCO) Manhole Assessment Certification Program (MACP) Level 2 inspections for the purposes of assessing thoroughness of cleaning, observing and recording structural and service defects, evaluating construction, operational performance and miscellaneous features of existing manhole assets and to verify rehabilitated or new manhole construction prior to acceptance.

B. The Contractor shall provide all equipment, tools, labor, materials, and incidental services necessary to perform all Work for Panoramic inspection of manholes as indicated and in compliance with the Contract Documents.

C. Type of cleaning to be performed shall be undertaken in accordance with Section 33 01 30.19 - Sanitary Sewer Pipeline Cleaning Specification in order to be able to conduct a NASSCO compliant inspection. This also provides specifications for Cleaning, Excessive Grease and Root Removal, Physically Attached Solid Debris Cutting, Removal of Intruding Taps, and Manhole Cleaning.

D. Inspections may be witnessed by the Engineer according to the Quality Assurance Section.

E. Related Requirements:

1. Section 33 01 30.16 - Sanitary Sewer Pipeline Inspection.
2. Section 33 01 30.18 – Security Clearances and Communications.
3. Section 33 01 30.19 - Sanitary Sewer Pipeline Cleaning.

1.2 REFERENCES

A. National Association of Sewer Service Companies (NASSCO):

1. Pipeline Assessment and Certification Program (PACP) Reference Manual.
2. Manhole Assessment and Certification Program (MACP) Reference Manual.

1.3 DEFINITIONS

A. Digital Panoramic Inspection: Operation necessary to complete a high-definition, true-color visual inspection for verification of existing internal manhole chamber conditions.

B. Closed-Caption Television (CCTV) Inspection: Operation necessary to complete a high-definition, true-color audio-visual inspection for verification of existing internal sewer line conditions.

C. Moving Pictures Expert Group (MPEG): A family of international standards fused for coding audio-visual information in a digital compressed format.

D. Portable Hard Disk Drive (HDD): For the purposes of this Specification, HDD shall be written in accordance with the ISO-9660 Level 2 Specifications

E. Engineer: The Engineer is defined as the Director of DWSD or their representative which may include a DWSD Engineer , a Field Inspector, or an Owner's third party Representative.

1.4 RELATED WORK

A. Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning Specification.

1.5 SUBMITTALS

A. Sample Inspection Report: The Contractor shall submit to the Engineer the following documentation to ensure quality and conformity requirements of this Contract:

1. Sample Report of each manhole inspection type, including digital data files of an actual manhole performed by each device to be used to perform the Work, for review at least one (1) month before beginning the inspection work. The Contractor shall:
    a. Submit two (2) copies of the data to the Engineer. Provide the appropriate viewing software, associated image and point cloud data and associated files to enable the interactive review of the inspection of the sample inspection for each device used as part of the submittal where viewing software shall be provided at no additional cost to the Engineer. The Engineer shall review the inspections for completeness and accuracy of content, to ensure that the required information is provided, and the image quality is acceptable. If the Engineer determines that the image data are defective or not of adequate quality, the Contractor shall re-perform the MACP inspection at the Contractor's expense.
    b. Submit one (1) MACP (version 7.0.0 or newer) compliant Microsoft Access, manhole inspection databases containing inspection and defect information. Sewer condition coding shall be submitted as a MACP.mdb file accordingly.
    c. Submit a PDF copy of the manhole inspection logs to the Engineer. Logs shall record defects according to NASSCO MACP standard.
    d. Submit sample observation photos in the sample submittal.
    e. Submit the submittal tracking spreadsheet in the sample submittal.

2. Provide a sample "empty header" or "0-feet MSA" inspection for a manhole that cannot be inspected.

3. Clearly identify the equipment make, model and serial number for the Sample Report and all submittals. Demonstrate the resolution of each camera using the recording resolution specified herein.
4. If the Engineer determines that the recording is defective or not of adequate quality, the Contractor shall correct deficiencies and re-perform manhole inspection at the Contractor's expense.
5. Use the Sample Report submission accepted by the Engineer as a benchmark for subsequent inspection report submissions.
6. No inspection work is to be performed until the Sample Report inspection report has been accepted by the Engineer.

B. Inspection reports shall be completed within two (2) weeks of the completion of a Work area or intermittent submittals as approved by the Engineer.

C. Submit copies of current NASSCO MACP certifications for all inspectors and reviewers who shall perform the Work.

D. Submit a written description of procedures to be used to the Engineer, including product literature for all digital video equipment including, but not limited to side scanning post processed and point cloud data and reader software.

E. For the bi-weekly data submittals, submit two (2) copies of the data to the Engineer. The Engineer shall review the inspections for completeness and accuracy of content, to ensure that the required information is provided, and the image quality is acceptable. If the Engineer determines that the image data are defective or not of adequate quality, the Contractor shall re-perform the MACP inspection at the Contractor's expense.

F. For the bi-weekly data submittals, submit one (1) MACP (version 7.0.0 or newer) compliant Microsoft Access, manhole inspection Database containing inspection and defect information. Sewer condition coding shall be submitted as a MACP.mdb file accordingly. Name the MACP database according to the following file Specification: **[Contractor Name]_[Contract Number]_MACP_Submittal ##**.mdb.

G. For the bi-weekly data submittals, submit a PDF copy of the manhole inspection logs to the Engineer. Logs shall record defects according to NASSCO MACP standard.

H. For the bi-weekly data submittals, submit a submittal tracking spreadsheet to the Engineer.

I. Prior to initiating cleaning or inspection efforts, the Contractor shall submit an Emergency Plan that outlines proposed methods for recovering their cleaning or inspection equipment that has become lodged, lost, or uncontrollable within the manhole or sewer, including confined space entry procedures.

J. Contractor is to provide a daily schedule to the Engineer with planned inspection assets and locations.

1.6 QUALITY ASSURANCE

A. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the Work.

B. The inspections shall be performed one manhole at a time as per NASSCO requirements.

C. Inspection shall be performed in accordance with most current NASSCO's Manhole Assessment and Certification Program (MACP).

D. Inspection shall be performed by certified operators and reviewers in accordance with NASSCO, with all staff having attained and retained their MACP certification. Contractor shall ensure each operator is fully trained and certified in all aspects of manhole inspection and capable of making accurate observations, as well as and coding and recording all conditions that may be encountered in the manholes.

E. Coding accuracy shall be a function of the number of defects or construction features not recorded or omitted as well as of the correctness of the coding and classifications recorded. Coding accuracy is to satisfy the following requirements:

1. MACP Header accuracy: 95%.
2. MACP Component Observation Section: 95%
3. Component defect coding accuracy: 85%.

Inspections failing to meet these criteria shall be rejected, re-inspected and recoded (if required), and resubmitted at no additional cost to the Owner.

F. Contractor shall implement a formal coding accuracy verification system before starting the Work.

1. Verify coding accuracy on a random basis on a minimum of 10% of the digital panoramic inspection reports. Submit coding accuracy checks with the corresponding digital panoramic data. The Contractor shall complete the Manhole Inspection Contractor Data Submittal and a Quality Assurance (QA) Review Report documenting the results of the coding accuracy verification, attached separately, and include it with each respective data submission. Where QA has been undertaken by the Contractor, MACP Section Header Fields 3 and 4 must be populated by the Contractor.
2. Re-code manhole inspections not satisfying the accuracy requirements and verify the accuracy of the manhole inspection immediately preceding and immediately following the non-compliant inspection. Repeat the process until the preceding and subsequent inspections meet the accuracy requirements.

G. The Contractor shall maintain an up to date Progress Log that tracks the progress of the Work and status of inspections. The Engineer should be provided with this information upon request. The log should document the following information at a minimum:

1. Asset ID.
2. Date of inspection.

3. Date of data submission.
4. Status of data acceptance / rejection.
5. Date of data acceptance / rejection.
6. Date of manhole re-inspection (as required).
7. Date of data resubmittal (as required).
8. Date of resubmitted data acceptance (as required).

H. In accordance with ISO 2859-1 and ANSI/ASQ Z1.4 Level I requirements, the Engineer shall randomly observe three (3) out of sixteen (16) inspections performed over one (1) or two (2) consecutive days to verify field results. The Engineer shall observe the performance of the Work. If one (1) or more tests significantly differ from those obtained by the Contractor for the Mandatory Field Data QC Items or items are found not to be recorded, all sixteen (16) inspections performed by the Contractor shall be rejected.

I. The Mandatory Field Data QC Items are as follows:

1. Asset ID.
2. Test Completed.
3. All Dimensions are Recorded.
4. External and Internal Images are Captured.
5. All Observations are Coded to NASSCO Standards.

G. The Engineer shall be entitled to an audit of the control system and be present when assessments of the sewer integrity are being determined. When requested by the Engineer in writing, the Contractor shall forward to the Engineer sufficient details and information for such audit assessment. Should any report fail to achieve a margin that the Engineer deems satisfactory, the Contractor, without any additional compensation, shall recode and resubmit any data or reports that the Engineer deems necessary.

J. All submittals shall be subjected to an independent Quality Control/Quality Assurance (QA/QC) audit by the Engineer. Where inconsistencies are noted, Contractor shall be responsible, where necessary and at no additional cost to the Engineer, for corrections including, re-inspection, recoding and entering additional information.

1.7 QUALIFICATIONS

A. The Contractor shall submit documentation for Engineer approval to demonstrate the following experience as a business engaged in the digital panoramic inspection of manhole entities per the Contract Documents:

1. The Contractor shall be in good standing under local contracting requirements or otherwise properly registered, licensed or permitted by law to carry on business within the State of Michigan, County of Wayne throughout the term of the Contract, and shall provide the Engineer with evidence thereof per the Contract Documents.
2. At any time during the term of the Contract, the Engineer may, at their sole discretion and acting reasonably, request updated evidence of good standing. A Contractor, who fails to provide satisfactory evidence, shall not be permitted to continue to perform any Work.

B. The Contractor and/or any proposed Subcontractor, for the portion of the Work proposed to be contracted to them, shall meet the minimum qualifications as listed in the bidding documents.

C. The Contractor shall provide the Engineer with a complete list of Subcontractors whom the Contractor proposes to use prior to the commencement of Work.

D. The Contractor shall be fully capable of performing the Work required in strict accordance with the terms and provisions of the Contract Documents.

E. The Contractor shall submit, for Engineer's approval, documentation to demonstrate the following experience of the staff proposed for this project:

1. Operator certification documentation of each CCTV operator and reviewer's NASSCO PACP certificates and, for manhole inspectors, MACP certificates. The PACP and MACP certificate for all staff performing Work shall be current on the day of the Contractor's submission and shall remain current throughout the performance of this Work.
2. Documentation of supervisors' and operators' training certifications, listing of completed projects, and a minimum of five (5) years of experience in the internal inspection of manholes.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish the panoramic inspection studio, camera, audio-visual digital encoding equipment/software, and other necessary equipment, materials, electricity, labor, technicians, as may be needed to perform the panoramic inspection.

2.2 EQUIPMENT

A. The Contractor shall submit a list describing all equipment to be used for review and approval by the Engineer.

B. Sewer and manhole inspection units are to consist of a self-contained vehicle with separate areas for viewing and storage complete with the following equipment as a minimum:

1. Cellular telephone and/or suitable communication systems linking all crew members.
2. Fans and blowers capable of removing fog that may be present in sewers at the time of the inspection.
3. Video cameras, lighting, cables and power source.
4. Video monitor, videocassette recorder and digital video recorder.
5. Computer system with video capture card or dedicated unit and other related equipment.
6. Temporary manhole covers to provide fall-in protection while performing Work.

C. Panoramic Digital Inspections:

1. Manhole inspections are to be performed using digital panoramic inspection system such as the IBAK PANORAMO SI, RST Helix or equivalent meeting the following criteria:

   a. The inspection camera system must be 100% digital. Any analog or NTSC video camera shall be deemed unacceptable.
   b. The inspection camera system must have minimum of two independently or simultaneously controlled digital cameras, one facing in the downward direction and one facing in the upward direction to encapsulate all observations and features within the chamber. Each camera must have a minimum of 185 degree field of view.
   c. The inspection camera system must provide sufficient illumination of the interior of the manhole to obtain proper exposure without introducing any motion blur. The light shall be positioned 360 degrees around the camera to distribute the light evenly onto the structure walls. The lighting must be able to illuminate manholes up 120 inches in diameter without the need of any auxiliary lighting. Auxiliary lighting may be required within larger special purpose chambers and shall be inclusive to the Contract.
   d. Distance 0.0 foot shall be set to the manhole rim level in alignment to and above the 6 o'clock outgoing pipe (or first encountered outgoing pipe rotating clockwise from due north, if more than one outgoing pipe is encountered as per MACP) where all measurements for all respective manhole component observation depths shall be recorded.
   e. The inspection system shall produce individual images or frames with no more than 0.001 inches of movement during image or frame exposure to produce crisp, clear images. Inspections showing evidence of blurred, corrupt, or erroneous imagery, scratched lenses, or protective glass plate or similar due to poor handling and application shall be rejected.
   f. The inspection camera must provide a minimum of 3,000 lines of vertical resolution in the side view and a minimum of 500 lines in the perspective view.
   g. Contractor is responsible for reviewing collected data, coding observations, however the Engineer must have the ability to view the digital film file in the way that the Contractor can view them, including full control of the virtual pan and tilt. Survey and coded metadata shall be preserved within the file deliverables for future reference by the Engineer or Owner.
   h. The digital film files shall be captured to a "High Quality" setting that must include an unfolded view of the manhole with a minimum of 3,000 lines of vertical resolution, providing all front, back and wrapped images that shall be, at a minimum height and width of 1040x1040 pixels, to a resolution of 96 dots per inch. Latest 4k technologies shall also be reviewed for acceptance. The unfolded view shall provide the user both a depth and clock visual reference (ruler, scale or similar) to any observation or feature seen within the chamber.
   i. Contractor to also provide file names within the executable software and the manholes are to be in alpha numeric order to ensure efficient reference.

j. The inspection system must descend to the lowest point within the manhole chamber to a depth that shall facilitate accurate perpendicular measurements using the software's measuring tools to occur.

k. Any inspection exhibiting an incomplete descent having a distance greater than three (3) feet above the invert or water level resulting to data interpolation, shall be rejected unless appurtenances or obstructions are present within the chamber and inspection is accepted by the Engineer.

l. The digital film files must include the capability to produce a three-dimensional representation of the manhole structure. This data shall be used to perform geometric measurements. This file shall be exportable to common CAD programs for further analysis.

m. The digital files must include a distortion-free virtual pan and tilt allowing the review of the manhole structure from any angle from any depth. The virtual pan and tilt must be able to view 360 degrees in any direction. The virtual pan and tilt must consist of views from the top and bottom camera, any virtual pan and tilts that artificially create this view from a single camera shall be deemed unacceptable due to distorted images on the direct side view.

n. The virtual pan and tilt and unfolded views must be able to be viewable by the Engineer with all the required software included at no additional cost.

o. Scratches identified on glass camera lens or protective covers that inhibit clear views shall be rejected with instruction to re-inspect using repaired or replaced equipment. Excessive glare caused by sunlight that inhibits clear views shall be rejected with instruction to re-inspect using appropriate shielding.

p. All chambers that exhibit weir wall or spill pipe weir levels as observed within the field or identified, but not limited to control structures or manholes identified by the Engineer, must be measured from manhole rim to weir crest where possible and detailed within the Inspection Comments field. Chambers exhibiting weir walls with no coded depth observations shall be rejected.

q. All sewer laterals (taps) shall be associated to a physical property address and this shall be recorded within the MACP inspection. Further to coding taps, the Contractor shall conform to NASSCO requirements; however, where defective taps are identified, the most significant observed defect seen within the lateral shall be communicated within the "Remarks" field as per MACP requirements including but not limited to appropriate dimensioning, percentage values and clock references relating to its defect, but also providing the associated property address of the tap comma separated for data processing requirements (e.g., "RM,50%,03,09,456 Second Avenue"). Furthermore, the Contractor shall identify the affected property by completing a steel tape or calibrated footage counter measurement on the surface to confirm property number and note this within the "Remarks" field with an associated photograph taken of the offending defective tap.

PART 3 - EXECUTION

3.1 PREPARATION

A. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

B. Working hours shall be in accordance with Section 01 14 00 – Work Restrictions.

C. Manholes and catch basins shall be cleaned of loose and settled debris, including sludge, dirt, sand, gravel, rocks, bricks, roots, grease. All other solid and semi-solid materials shall be removed from the sewer with the equipment detailed in this Specification.

D. It shall be the responsibility of the Contractor to locate manholes and catch basins by use of a CCTV camera and sonde locator and in conjunction with the use of a metal detector.

1. Should the Contractor be unable to find the manhole, they shall notify the Engineer immediately. The Engineer shall then direct the Contractor regarding whether they should continue to search for the manhole. Time spent searching for a manhole is incidental to the cost for cleaning and inspection of manholes and sewers. If the manhole cannot be located, the Contractor shall mark the inspection as not found (NF) providing adequate detail on efforts made to locate the asset and site observations and move on to the next asset for inspection. The Contractor shall notify the Engineer of the uninspected asset for further investigation The Engineer shall communicate to the Contractor to return if the Engineer locates the asset.
2. In the event that a manhole is buried in unpaved areas, the Contractor shall notify the Engineer of the buried manhole occurrence and, upon approval by the Engineer, uncover buried manholes to a maximum depth of two (2) feet. This Work shall be considered incidental to the sewer inspection. The Engineer may direct the Contractor to fill the hole back in on a case by case basis at no additional cost. Manholes that are deeper than two (2) feet shall be marked for follow up and the Engineer shall be notified. The Engineer shall communicate to the Contractor to return if the Engineer arranges for the raising to grade of the manhole.
3. In the event that a manhole is buried in paved areas, the Contractor shall notify the Engineer of the buried and marked (BM) manhole occurrence and, upon approval by the Engineer, move on to the next asset for inspection. The Engineer shall communicate to the Contractor to return if the Engineer arranges for the raising to grade of the manhole.
4. Furthermore, for additional work where efforts to open manholes that may be welded shut, have stripped bolts, broken locking devices, stuck or broken covers, or other conditions preventing the opening of the structure and requiring mechanical equipment and/or hand tools to open, the Contractor shall be compensated by time and materials using the allowance, “Provisional Allowance”. This item shall be used as directed by the Engineer, after one (1) hour of labor expended in the Contractor’s reasonable attempt to access and gaining entry to an individual manhole that has been located.

5. The Contractor shall edit the as-builts or provide the Engineer with a legible sketch drawing to identify the approximate location of any manholes, structures, pipes, or other assets that are not accurately depicted on the mapping (more than ten (10) feet from the location shown in the mapping, outside of the ROW or easement shown on the mapping), are determined to not exist or be abandoned, or is not shown on the mapping. The Contractor shall complete GPS survey of the newly found manholes or manholes not accurately depicted to submeter accuracy. Markups shall be confirmed with the Engineer and should be legibly recorded in the as-builts. The edited as-builts or sketches shall be provided to the Engineer with each bi-weekly inspection submittal or upon request.

    a. The Engineer shall communicate the methodology and application of temporary or new Asset ID for new manholes and sewers located during the Work that conforms to the Engineer's requirements.
    b. The Contractor shall notify the Engineer if a manhole is not accessible due to bury depth or other factors.

6. Once any phase of the Contract is started in an area, Work shall continue in a timely manner until all manholes and pipe sections are cleaned and inspected in that area. Completion of internal inspection of manholes shall be within one (1) week after cleaning assuming that the manhole is still clean upon initial inspection.

E. Sewers and manholes may be located in easements, public or private property, City-owned parklands, rights-of-way and restricted alleyways where no paved access may exist, or where paved access is obstructed to the extent that would inhibit equipment and materials mobilization. It shall be the Contractor's responsibility to identify these sewers and arrange for access using "Door Hanger" notifications as necessary and to restore any surface damage to private and City-owned property to the satisfaction of the Engineer.

F. Where access routes to various manhole locations must be cleared of heavy vegetation, the Contractor shall perform the clearing of pathways and alleyways to the extents necessary to facilitate mobilization of cleaning and internal sewer inspection equipment. The Contractor shall not remove vegetation on private property or outside of the sewer easement or right of way.

1. Any vegetation or other debris cleared by the Contractor shall be removed and disposed of properly by the Contractor, and the site restored by the Contractor as approved by the Engineer.
2. Trees larger than six (6) inches in diameter measured at a point 4.5 feet above grade (diameter at breast height) shall not be removed as part of the Work. The Contractor shall notify the Engineer of site conditions that impede the completion of the Work.
3. Trees smaller than six (6) inches in diameter measured at a point 4.5 feet above grade (diameter at breast height) shall be removed as part of the Work and shall be incidental to the Work.

G. The Contractor shall remove and clear restricted alleyways or easements to enable the mobilization of inspection and cleaning equipment. This Work shall be incidental to the manhole cleaning and inspection activities.

H. The Contractor shall schedule, maintain, and coordinate all activities and shall cooperate with the Engineer to ensure a minimum interruption to services. The Contractor shall not operate existing system valves, controls, or other appurtenances at any time, however, if operation of assets is necessary to facilitate and accommodate activities, shall request such operation from the Engineer. The Contractor shall provide the Engineer with 48-hour advance notice for such assistance.

I. The Contractor is hereby made aware no flow shall be discharged to waterbodies, wetlands, floodplains, or any other storm outlet during cleaning or inspection operations. Additionally, no sewage shall be permitted to surcharge to the point that it overflows to any of the above or back into private buildings through lateral connections. The Contractor must notify the Engineer immediately of any spill event. Any damage or fines resulting from such occurrences are the sole responsibility of the Contractor.

J. The Contractor shall notify the Engineer 96 hours prior to mobilizing for internal inspection or cleaning activities.

3.2 HIGH FLOW CONDITIONS

A. The Contractor shall attempt inspections at times that facilitate obtaining the maximum visible image above the flow surface which are typically at the diurnal low flow periods each day or, subject to public notification, at night. Work that cannot be completed due to excess water levels shall be coordinated with the Engineer. If work is deemed necessary, flow controls and diversion shall be submitted to the Engineer for approval.

B. If manhole chambers are observed to be surcharged the Contractor shall communicate the observation to the Engineer prior to inspection.

1. The Engineer and Contractor shall collaborate to determine if there is a hydraulic or operational restriction within the area.
2. If hydraulic overload is determined by the Engineer, inspection shall take place during a low diurnal period, such as nighttime to ensure a full inspection of the chamber is completed as instructed by the Engineer.
3. If an operational issue exists, the cleaning of associated sewers shall be completed to alleviate and reduce flow. Otherwise, the Engineer shall instruct whether an incomplete inspection be carried out of the surcharged manhole chamber.

3.3 MACP MANHOLE INSPECTION

A. Manhole inspections shall be conducted in accordance with NASSCO MACP version 7.0.0 (or newer) Level 2 standards but by utilizing non-man-entry techniques as noted herein.

B. If television inspection reveals new manholes, locate, mark by painting or flagging and name the manhole in accordance with the methodology for temporary or new Asset ID for new manholes and sewers as specified by the Engineer. If manhole is in an unpaved area, the Contractor shall unearth the manhole if the manhole cover is within two (2) feet of grade. This

Work shall be considered incidental to the sewer inspection. The Engineer may direct the Contractor to fill the hole back in on a case by case basis at no additional cost. Manholes that are deeper than two (2) feet or are in paved areas shall be marked for follow up and the Engineer shall be notified.

C. A NASSCO MACP certified technician or supervisor who shall be located at the control panel in the mobile data collection studio shall control the operation of the digital panoramic inspection equipment. The Contractor shall perform manhole inspections in accordance with the following:

1. From the top to the bottom of the manhole.
2. From the manhole frame to the center line elevation of the existing sewer.
3. Ensure the frame of the manhole is clearly visible at the start of the inspection.
4. Provide a chalk board placed adjacent to the manhole cover, within the inspection imagery, noting the manhole Asset ID, location details (i.e. address), date and physical measurement of manhole rim to invert dimension.
5. Spray paint a mark (with a color consistent for the duration of the project) indicating north using an arrow visible on the surface and within the manhole frame.
6. Spray paint a mark (with a color consistent for the duration of the project and a different color to the north mark) indicating the 6 o'clock position that is in reference to the first outgoing pipe (taken from north in a clockwise direction, as per NASSCO MACP requirements) visible on the surface and within the manhole frame.
7. Block ambient light during the inspection to minimize problems related to lens flare and poor contrast.
8. Inspect the manhole to the lowest depth that shall facilitate accurate perpendicular measurements using the software's measuring tools.
9. Complete all steel tape or calibrated footage counter measurements pertinent to mandatory MACP Level 2 measurements that are located at or around the cover and frame area. In accordance with NASSCO MACP standards, the Contractor shall measure the rim to invert using a steel tape or survey rod from the surface to validate the measurement available from the panoramic scan.
10. No confined space entry shall be completed.

D. The panoramic inspection device must descend to the lowest point within the chamber to minimize interpolated data beyond the scanning range or the inspection shall be rejected if insufficient evidence is reported to the Engineer. If the equipment cannot be lowered sufficiently due to permanent internally fitted appurtenances, the Contractor shall complete the inspection, reporting all observations and reasoning for survey abandonment for acceptance by the Engineer. Debris in manhole shall not be a reason for survey abandonment.

E. If temporary flow control equipment and monitoring devices are discovered within the chamber, the Contractor shall not proceed with the inspection and communicate to the Engineer of their discovery. This equipment is sensitive to movement and disturbance. The Engineer shall make reasonable efforts to have the equipment temporarily removed for re-inspection. Costs incurred for re-mobilization to the manhole shall be inclusive of the Contractor's unit price.

F. Contractor shall document manhole conditions in digital photographs and digital scan. Digital photographs shall be taken of the surface (showing the manhole cover and ground surface), manhole interior, and of all observed defects (using a zoom lens or scan as needed). Additionally, and separate from the panoramic scan, the Contractor shall take a digital photograph of the manhole cover with a black chalkboard documenting the manhole Asset ID, location details (i.e., address), date and physical measurement of manhole rim to invert dimension written in chalk and laid flat near the manhole cover, and one photograph of the outside of the manhole (capturing physical address, intersection or nearest landmark that can be used to readily identify the location of the manhole) and an interior photo looking down from the rim with the outgoing pipe at 6 o'clock.

G. Name the digital scan files according to the following file Specification: **[Manhole ID]_[YYYYMMDD]_[HH:MM – 24 hour format]**.ipf

H. Name the digital photograph files for observations according to the following file Specification: **[Manhole ID]_[YYYYMMDD]_[Code]_[Footage]**.jpg

I. Name the digital photograph files for pipe connections according to the following file Specification: **[Manhole ID]_[YYYYMMDD]_Connection_[pipe connections number]**.jpg

J. Name the digital interior photograph file according to the following file Specification: **[Manhole ID]_[YYYYMMDD]_[Interior]**.jpg

K. Name the digital exterior photograph file according to the following file Specification: **[Manhole ID]_[YYYYMMDD]_[Exterior Location]**.jpg

L. Name the digital exterior photograph file according to the following file Specification: **[Manhole ID]_[YYYYMMDD]_[Exterior Cover]**.jpg

M. All open access structures or manholes shall be attended at all times, and all access structures or manholes that were sealed or bolted to control odors or entry of extraneous water or for security reasons shall be resealed or re-bolted after entry. The Contractor shall liaise with the Engineer to ensure that sealed or bolted chambers have been adequately sealed or bolted, post inspection.

3.4 INSPECTION REPORTS

A. Prepare an Inspection Report covering the panoramic inspection work and the information acquired. The Contractor shall prepare inspection reports covering the panoramic inspection work and the information acquired to the Engineer for review and approval.

B. Contractor shall report manhole defects in accordance with the National Association of Sewer Service Companies (NASSCO) program known as Manhole Assessment and Certification Program (MACP). The Engineer reserves the right to refuse any inspection report that does not comply with the MACP Program.

C. Contractor shall provide a summary listing of all manholes or structures included in the original task order listing the date of inspection or attempted inspection, and indicating if the manhole was inspected, or if not, the reason, e.g., not found (NF), no access (NA), not opened (NO), structure is a lamphole (LH) or cleanout (CO), or other (OTHER) reason.

D. An "empty header" or "MSA" inspection shall be completed for manholes that cannot be inspected for reasons such as high flow, depths or velocities, inaccessibility or unlocated access structures, heavy debris, Engineer direction, etc. The inspection form header and detail sections shall comply with NASSCO MACP level 1 guidelines populating all required header fields. The Contractor shall abandon the survey at a distance of 0-ft inspected and provide a general comment that describes the reason that the inspection cannot be conducted in the Additional Information field. Contractor shall record at least one photo documenting conditions preventing the inspection of the manhole including inaccessible and survey abandoned conditions, and one photo documenting manhole location. Empty header records, and image references for the photos, shall be included in the MACP database as submitted by the Contractor with manholes on adjoining segments.

E. The following fields shall be used when completing the "Header" details in the manhole inspection header form.

1. Field 5 the "Owner" is DWSD.
2. Field 38 – 43 - data shall be collected using a hand-held GPS device to achieve Nearest (N) or sub-meter (M) accuracies dependent upon available satellite coverage.
3. Field 44 – Additional Information should be populated with the physical rim to invert measurement taken in the field.
4. Field 106 – Additional Component Information should be populated with the recorded height of evidence of surcharge (from manhole rim to surcharge level).

Manhole Header Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
General Information	1	Surveyed By (*Operator / MACP User Name*)	Yes	Yes
	2	Certificate Number	Yes	Yes
	3	Reviewed By	No	No
	4	Reviewer Certificate Number	No	No
	5	Owner	No	Yes
	6	Customer	No	Yes
	7	P/O Number (*Contract No.*)	No	Yes
	8	Work Order	No	Yes
	9	Media Label	No	Yes
	10	Project	No	Yes
	11	Date	Yes	Yes
	12	Time	No	Yes
	13	Sheet Number	Yes	Yes

Manhole Header Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
General Information	14	Weather	No	Yes
	15	Pre-Cleaning	Yes	Yes
	16	Date Cleaned	No	Yes
	17	Purpose of Survey	Yes	Yes
	18	Inspection Level	Yes	Yes
	19	Inspection Status	Yes	Yes
	20	Consequence of Failure	No	No
Location	21	Drainage Area	No	Yes
	22	Manhole/Access Point Number (*Asset ID*)	Yes	Yes
	23	Street (*Name and Number*)	Yes	Yes
	24	City	Yes	Yes
Location	25	Location Code	Yes	Yes
	26	Surface Type	Yes	Yes
	27	Inflow Potential from Runoff	No	No
	28	Location Details	No	Yes
Manhole	29	MH Use (*Use of Access Point/Structure*)	Yes	Yes
	30	Access Type	Yes	Yes
	31	Year Constructed	No	No
	32	Year Renewed	No	No
	33	Evidence of Surcharge	Yes	Yes
Measurements	34	Rim to Invert (Outgoing)	Yes	Yes
	35	Rim to Grade (Outgoing)	Yes	Yes
	36	Grade to Invert (Outgoing)	Yes	Yes
	37	Rim to Grade Exposed	No	No
	38	Northing (*Y Coordinate*)	No	Yes
	39	Easting (*X Coordinate*)	No	Yes
	40	Elevation (*Z Coordinate*)	No	Yes
	41	Coordinate System (*Nearest Meter*)	No	Yes
	42	Vertical Datum (*Elevation*)	No	Yes
	43	GPS Accuracy	No	Yes
	44	Additional Information	No	Yes*

The following fields shall be used when completing the "Manhole Component Observation Section" details in the manhole component observation form.

Manhole Component Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
Cover	45	Cover Type	Yes	Yes
	46	Cover Shape	Yes	Yes
	47	Cover Size	Yes	Yes
	48	Centre Cover Size	No	No
	49	Cover Size Width	Yes	Yes
	50	Cover Material	Yes	Yes
	51	Hole Diameter (Vent)	Yes	Yes
	52	Hole Number (Number of Vent Holes)	Yes	Yes
Cover	53	Cover Bearing Surface Diameter	Yes	Yes
	54	Cover Bearing Surface Width	Yes	Yes
	55	Cover/Frame Fit	Yes	Yes
	56	Cover Condition	Yes	Yes
Cover Insert	57	Insert Type	Yes	Yes
	58	Cover Insert Condition	Yes	Yes
Manhole Cover Adjustment Ring	59	Adjustment Ring Type	Yes	Yes
	60	Adjustment Ring Material	Yes	Yes
	61	Ring Condition (Adjustment Ring)	Yes	Yes
	62	Adjustment Ring Height	No	No
Frame	63	Frame Material	Yes	Yes
	64	Frame Bearing Surface Width	Yes	Yes
	65	Frame Bearing Surface Depth	Yes	Yes
	66	Frame Clear Opening Diameter	Yes	Yes
	67	Frame Clear Opening Width	Yes	Yes
	68	Frame Condition	Yes	Yes
	69	Seal Condition	Yes	Yes
	70	Frame Offset Distance	Yes	Yes
	71	Frame Seal Inflow	Yes	Yes
	72	Frame Depth	No	No

Manhole Component Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
Chimney	73	Chimney Present	Yes	Yes
	74	Chimney First Material	Yes	Yes
	75	Chimney Second Material	No	No
	76	Chimney I/I	No	No
	77	Chimney Clear Opening	No	No
	78	Chimney Depth	Yes	Yes
	79	Chimney Lining Interior (Coating)	No	No
	80	Chimney Lining Exterior (Coating)	No	No
	81	Chimney Condition	Yes	Yes
Cone	82	Cone Type	Yes	Yes
	83	Cone Material	Yes	Yes
	84	Cone Depth	Yes	Yes
	85	Cone Lining Interior	No	No
	86	Cone Lining Exterior	No	No
	87	Cone Condition	Yes	Yes
Wall	88	Wall Diameter (Length)	No	Yes
	89	Wall by Size (Width)	No	No
	90	Wall Material	Yes	Yes
	91	Wall Depth	Yes	Yes
	92	Wall Lining Interior (Coating)	No	No
	93	Wall Lining Exterior (Coating)	No	No
	94	Wall Condition	Yes	Yes
Bench	95	Bench Present	Yes	Yes
	96	Bench Material	Yes	Yes
	97	Bench Lining (Coating)	No	No
	98	Bench Condition	Yes	Yes
Channel	99	Channel Installed	Yes	Yes
	100	Channel Material	Yes	Yes
	101	Channel Type	Yes	Yes
	102	Channel Exposure	Yes	Yes
	103	Channel Condition	Yes	Yes

Manhole Component Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
Manhole Steps	104	Step Number	Yes	Yes
	105	Step Material	Yes	Yes
Additional Component Information	106	Additional Component Information	No	Yes*
Pipe Connections	107	Pipe Number	Yes	Yes
	108	Clock Position	Yes	Yes
	109	Rim to Invert	Yes	Yes
	110	Direction	Yes	Yes
	111	Material	Yes	Yes
	112	Shape	Yes	Yes
	113	Height (Diameter)	Yes	Yes
	114	Width	Yes	Yes
	115	Pipe Condition	Yes	Yes
	116	Pipe Seal Condition	Yes	Yes
	117	Pipe Type	Yes	Yes
	118	Structure ID (Pipe/Lateral Segment Reference)	No	Yes
	119	Pipe Comments	No	No

Yes* - when required.

3.5 OBSERVED FAILURES DURING MANHOLE INSPECTIONS

A. Cross-bores are intersections of one utility pipeline through another, such as when a gas pipeline is inadvertently installed through a manhole. Cross-bores generally occur when a third-party utility is installed using a trenchless method that prevents visibility of the underground sewer pipeline and are commonly water or gas services.

1. Capture images of the cross-bore and notify the Engineer immediately where third party cross-bores are observed during the manhole inspection. Provide the captured digital images of the cross bore with the Manhole ID to the Engineer immediately after observation.

B. Capture photographs or digital images and notify the Engineer immediately after observation where issues identified in the tables below are observed during the sewer or manhole inspection. Provide the captured images in addition to Asset IDs, observed issue identified by defect code and description, and footage along the pipe to the Engineer immediately via e-mail after observation. The format of this communication is shown in the Appendix. The Engineer shall

create the incident within the ArcGIS Collector or Cityworks application for review by Engineering.

C. Follow the Traffic and Safety protocols contained in this Specification. At a minimum, place barricades around the location above the manhole where a void is visible or suspected to be outside of the sewer pipe or manhole and immediately notify the Engineer. Call Detroit Water and Sewerage Department (DWSD) Emergency Services at telephone number 313-267-7401 after normal working hours.

D. The Engineer shall arrange for emergency manhole repairs to be performed if required as soon as possible if the inspection cannot be completed or the sewer or manhole condition poses an immediate operational or safety concern such as a complete collapse.

E. Emergency manhole repairs shall be prioritized if more than one emergency repair arises at the same time.

F. Carry out inspection of other manholes not affected by the emergency repair and complete inspection of the manhole when notified by the Engineer when the emergency repair has been completed.

G. Repeat cleaning of the manhole in accordance with Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning if required.

3.6 TRAFFIC CONTROL

A. Contractor shall provide traffic control as required and in compliance with the Local and State governing authorities and in accordance with Section 01 55 26 – Traffic Control.

B. Contractor shall coordinate traffic control with City of Detroit and other jurisdictional authorities.

C. The Work of Maintaining Traffic consists of furnishing all labor, equipment, and materials required for maintaining traffic throughout the project area in accordance with Sections 104.07.C, 104.11, 812, and 922 of the MDOT 2012 Standard Specifications for Construction and this Special Provision.

1. Notify the Engineer a minimum of 72 business hours prior to the implementation of any road closures, lane closures, or major traffic shifts. The Contractor shall be required to contact all local and state police, fire, and emergency services that shall have jurisdiction within 72 business hours prior to the implementation of any lane closure.
2. Construction Influence Area (CIA) – The CIA includes the right-of-way of the roadways within the project limits.
3. General Traffic Restrictions:
    a. Normal work hours are Monday thru Friday from 7:00 a.m. to 7:00 p.m., or as approved by the Engineer. Work outside the normal work hours shall require prior approval from the Engineer.

b. No work or lane closures shall be allowed during Memorial Day or Labor Day weekends. These holiday weekends are defined as beginning at 12:00 p.m. on Friday and ending at 6:00 a.m. on the following Tuesday, or as defined by the Engineer. No work shall be allowed during the 4th of July holiday weekend, which shall be defined by the Engineer.
c. Maintain access to all residential and business drives at all times. Maintain access to drives in active work zones when possible as directed by the Engineer.
d. All labor, equipment, and aggregate required to maintain street, intersections, and driveways for traffic shall be included in the execution of the Work.
e. Coordinate operations with the other Contractors preforming Work on projects within or adjacent to the CIA. Maintenance crews and/or Contractor Maintenance Agencies may preform maintenance work within or adjacent to the CIA. The Maintenance Division of MDOT and/or Contract Maintenance Agency shall coordinate their operations with the Engineer to minimize interference to the Contractor. No additional payment shall be made to the Contractor for joint use of the traffic control items.
f. Maintain access for emergency vehicles at all times through the Work area.
g. Provide fencing to protect open trenches and pits during working and non-working hours.

4. Project General: During work hours, equipment, material, and company vehicles may be parked or stored within the right-of-way as directed by the Engineer. The Contractor is responsible for restoring to its original condition any area damaged by their equipment, material, or company vehicles. Restoration of damaged areas shall be in accordance with the plans and 2012 MDOT Standard Specifications for Construction and this Special Provision.

3.7 PROJECT DELIVERABLES

A. The Contractor shall submit a formal Inspection Report, in digital formats, that summarizes all inspection activities and includes all inspection data in their raw format, along with any software required to view or utilize the raw data. Free viewer software, at no expense to the Engineer, must be provided by the Contractor to allow dimension verification and measurement and complete viewing of the data for Panoramic MACP scans including, but not limited to, the unfolded view and virtual pan and tilt.

B. In addition to the viewing software, raw data to include but not limited to pointcloud, contour and other .dat files (or similar) shall be provided in addition to scanned front, back and wrapped images and snapshots of any pertinent defects or features.

C. The Contractor shall provide at least three (3), 2.5-inch portable hard disk drives (HDD), complete with all associated drivers and software, power adaptors and USB cables, delivered on a bi-weekly rotation exchange that contains completed inspections and data with viewing software and sewer condition coding data to the Engineer. Manhole condition coding shall be submitted as MACP.mdb files accordingly. Retained HDD's shall be returned at an agreed frequency.

D. All HDD's shall be sized appropriately to accommodate all above mentioned files and have dual USB 3.0 (preferable) and (a minimum) USB 2.0 compatibility with a minimum data transfer rate of 480 MB/s.

E. Submit one MACP (version 7.0.3 or newer) compliant Microsoft Access, macp.mdb inspection database containing observed construction, structural, operational and miscellaneous observations for batches of manhole inspections that coincide with agreed submittal schedule to the Engineer for review. Name the MACP database according to the following file Specification: **[Contractor Name]_[Contract Number]_[MACP_Submittal]_[Number]** .mdb.

F. The Contractor shall organize data accordingly within the following folder structure when providing MACP data submittals:

1. Database (folder).
2. Panoramic Scans (folder).
3. Photos (folder).
4. Reports (folder).
5. MH Inspection Data Submittal Tracking Spreadsheet.

3.8 ACCEPTANCE OF WORK

A. The Contractor shall submit required inspections of each manhole to the Engineer for review and determination if the Work performed is acceptable.

B. The Engineer shall review all inspection reports within fifteen (15) working days of submission and determine if Work performed is acceptable.

C. The Contractor shall re-perform manhole inspections where the Engineer has determined the requirements of the Specification have not been satisfied.

D. The Contractor shall correct non-compliant inspection submissions and resubmit the corrected inspections to the Engineer within five (5) working days.

E. The Contractor shall repeat the process until the inspection submissions are accepted by the Engineer. Work to perform remedial work shall not be eligible for additional payment.

END OF SECTION 33 01 30.17

SECTION 33 01 30.18 – SECURITY CLEARANCES AND COMMUNICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Provide all equipment, tools, labor, materials and incidental services necessary to perform all security clearances and communications as indicated and in compliance with the Contract Documents.

1.2 OWNERSHIP OF INFORMATION, CONFIDENTIALITY AND NON-DISCLOSURE

A. The Contract, all deliverables produced or developed, and information provided to or acquired by the Contractor are the property of the City of Detroit and shall not be appropriated for the Contractors own use or for the use of any third party.

B. The Contractor shall not make any public announcements or press releases regarding the Contract without the prior written authorization of the Owner.

C. The following shall be confidential and shall not be disclosed by the Contractor to the media or any member of the public without the prior written authorization of the Owner:

1. Information provided to the Contractor by the City or acquired by the Contractor during the course of the Work.
2. The Contract and all deliverables produced or developed.
3. Any statement of fact or opinion regarding any aspect of the Contract.

1.3 SITE INVESTIGATION

A. The Bidder may visit the Site to verify site conditions without making an appointment.

B. The Bidder shall not be entitled to rely on any information or interpretation received regarding the Site unless that information or interpretation is the Bidder's direct observation or is provided by the Owner in writing.

1.4 SECURITY CLEARANCES

A. Section indicates requirements for each individual proposed to perform the following portions of the Work:

1. Any Work on, or requiring access to, private property.
2. Communicating with residents and homeowners in person or by telephone.

B. Prior to the award of Contract, and during the term of the Contract if additional or replacement individuals are proposed to perform Work, the Contractor shall supply the Owner with a background check obtained not earlier than one (1) year prior to the Submission Deadline, or a certified true copy thereof, for each individual proposed to perform such Work.

C. Any individual for whom a background check is not provided, or for whom a background check indicates any convictions or pending charges related to property offences or crimes against another person will not be permitted to perform any Work on the Contract.

D. Any background check obtained will be deemed valid for the duration of the Contract subject to a repeated records search as specified herein.

E. Notwithstanding the foregoing, at any time during the term of the Contract, the Owner may, at its sole discretion and acting reasonably, require an updated background check. Any individual who fails to provide a satisfactory background check as a result of a repeated background check will not be permitted to continue to perform any Work on the Contract.

1.5 PRIVATE PROPERTY DAMAGE

A. In the event of any private property damage incurred by the Contractor, the Contractor shall:

1. Notify the Engineer immediately when damage to property occurs.
2. The Contractor shall provide written reports to the Engineer for each property attended for investigation of damage. Reports shall include photographs of all damage, dates and times, verbal or written agreements with property owner, and all actions taken or proposed to rectify the damage. Reports shall be submitted to the Engineer within 24 hours of attending the property.

1.6 CONTRACTOR IDENTIFICATION

A. Identification Badges:

1. The Contractor shall be required to secure identification badges and each individual shall clearly display their identification while performing the Work in all neighborhoods.

2. Identification badges shall be produced by the Contractor and shall conform to the following:
   a. Measure 3.375” x 2.125” in size.
   b. Be waterproof, made of plastic and/or laminated to protect the information that is provided on the identification badge.
   c. Hole punched to facilitate a mylar strap or lanyard.
   d. Badges must feature the following:
      1) DWSD Logo.
      2) Individuals Name.
      3) Photograph of the Individual.

B. Signs for Vehicles:

1. Contractors and inspectors performing Work of the Contract must be in vehicles featuring magnetic signs and/or removable signs that include the DWSD logo referenced above.
2. 12” x 24” standard size magnetic signs will be affixed to each vehicle door.
3. The material is 30 MIL Magnet with digital printing.
4. The magnets are not reflective.
5. Owner will provide artwork for sign production.

1.7 COMMUNICATIONS

A. Preconstruction Meeting:

1. Comply with preconstruction meeting requirements in section 01 30 00 – Administrative Requirements.

B. Progress Meetings:

1. Comply with preconstruction meeting requirements in section 01 30 00 – Administrative Requirements.

C. Resident Notifications:

1. The Owner will provide the Contractor with print-ready door hanger files it has identified as necessary to properly inform the community of Work planned.

2. The Contractor will print the appropriate count of door hangers for distribution to residences and businesses within the Contract areas.

3. The Contractor will hand-deliver door hangers to residences and businesses in accordance with the Work schedule as approved by the Owner.

4. The Contractor will attend a customized outreach training to ensure protocols are met when distributing door hangers to the community.

5. The Contractor shall provide proof of notice for door hanger delivery. Time stamped photos will be collected depicting the address of recipient and door hangers in one image. Photos and files are organized in folders by date and neighborhood.

6. Door hangers will notify the community of the scheduled Work as well as inform the community what to expect during Work activities . This Work activity can include but will not be limited to water and sewer condition assessments and water and sewer upgrades and construction.

7. If the Contractor needs to access private property for condition assessment or construction activities, the protocol below shall be followed:

a. Homeowner is home and gives permission to access property:
   1) If the homeowner gives permission to access property, Work will proceed as scheduled.
   2) Once the Work is completed, the Contractor will notify the resident that Work has been completed by leaving a "Thank You" door hanger.

b. Homeowner is not home:
   1) If access can be gained, the Contractor will proceed with the Work and leave a "Thank You" door hanger when Work is completed.
   2) If access cannot be gained, the Contractor will leave a Notice to Access door hanger.
   3) The Notice to Access door hanger must be delivered at least 24 hours prior to returning to a home to access the property.

c. Homeowner does not give permission to access property:
   1) Contractor will not access property.
   2) Property address will be recorded by Contractor along with impediments to access.
   3) Owner will work with the Contractor to determine next steps.

8. Door hanger delivery for condition assessment activities:

   a. A General Notification door hanger will notify the public of the Work planned and will be delivered at least 48 hours prior to start of Work.

9. Door hanger delivery for construction activities:

   a. A General Notification door hanger will notify the public of the Work planned and will be delivered no more than ten (10) days and no less than five (5) days prior to the start of Work. The door hanger will require project and location specific information to be filled in and shall be completed by the Contractor and distributed. There are two types of General Notification door hangers for construction:
      1) Water main upgrade door hangers
      2) Sewer pipeline upgrade door hangers

   b. A Temporary Service Interruption door hanger will be distributed to each address that will be impacted by interruption as a result of construction or upgrades. This door hanger will be distributed no more than five (5) days and no less than three (3) days prior to water and sewer interruptions. There are two (2) types of Service Interruption door hangers for construction:
      1) Water main
      2) Sewer pipeline

   c. A Notice of Service Restoration door hanger will be distributed to all homes and businesses whose service was temporarily interrupted as a result of construction.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION – Not Used

END OF SECTION 33 01 30.18

SECTION 33 01 30.19 - SANITARY SEWER PIPELINE CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Description of Work:

1. Provide all equipment, tools, labor, materials and incidental services necessary to perform all gravity sewer line, manhole and catch basin cleaning work as indicated and in compliance with the Contract Documents.
2. The intent of sewer cleaning is to remove settled and loose foreign material such as bricks, rocks, dirt, grease, settled deposits (sand and grit), solids, fine roots, and other debris with a high-pressure water jetter.
3. The intent of manhole cleaning is to remove foreign material such as bricks, rocks, dirt, grease, settled deposits (sand and grit), solids, roots, and other debris using multiple passes using a cleaning wand associated with the high-pressure water jetter equipment and removal of debris from the bench and channel.
4. The intent of catch basin cleaning is to remove foreign material such as bricks, rocks, dirt, grease, settled deposits (sand and grit), solids, roots, and other debris using multiple passes using a cleaning wand associated with the high-pressure water jetter equipment, to clean the catch basin lead and to perform tracing to locate its connection to the sewer main.
5. The Contractor shall contact MISS DIG (811) to provide locates prior to all cleaning operations in all storm sewers and shallow sewers (less than six (6) feet deep, based on the available information from GIS or engineering records) located in the right of way to reduce impact with potential cross bores when cleaning.

B. Types of Cleaning are described below. Regardless of the number and type of cleaning passes performed, the final pass of cleaning shall be undertaken in conjunction with the CCTV camera inspection that is to be provided as the final inspection deliverable. The use of the cleaning equipment in conjunction with the CCTV camera inspection shall not be considered an additional pass but shall be incidental to the Contract:

1. Cleaning: Cleaning of the entire length of the sewer segment with a high-pressure water jetter using the step-cleaning method described in this Contract for the entire length of the pipe. The intent of cleaning is to remove settled and loose foreign material such as bricks, rocks, dirt, grease, settled deposits (sand and grit), solids, fine roots, and other debris with a high-pressure water jetter.
2. Excessive Grease and Root Removal: Excessive grease and root removal shall include the cutting and removal from the sewer of grease or roots that could not be removed with standard cleaning. This includes the use of remote controlled hydraulically or mechanically driven saw or blade cutters or grinders, remotely operated robots or other types of equipment capable of removing grease and roots. To be completed only as directed by the Engineer.

3. Physically Attached Solid Debris Cutting: Physically Attached Solid Debris Cutting shall include the cutting and removal from the sewer of physically attached solid debris including but not limited to concrete, asphalt or encrustation that is attached to the pipe surface and could not be removed with standard cleaning. This includes the use of remote controlled hydraulically or mechanically driven saw or blade cutters or grinders, remotely operated robots or other types of equipment capable of removing solid debris.
4. Removal of Intruding Taps: This Work shall include the cutting and removal of intruding taps from the sewer. This includes the use of remote controlled hydraulically or mechanically driven saw or blade cutters or grinders, remotely operated robots or other types of equipment capable of removing solid taps to be cut and ground and removed from the sewer.
5. Debris Removal: The extraction of and proper disposal of foreign material from the sewer that includes but is not limited to loose or settled debris of any size including sludge, dirt, sand, gravel, rocks, bricks, roots, grease, concrete, asphalt, encrustation, broken pipe and other solid and semi-solid materials.
6. Manhole Cleaning: Cleaning of the entire height of the manhole using a cleaning wand associated with the high-pressure water jetter equipment and removal of debris from the bench and channel.
7. Catch Basin Cleaning: Cleaning of the entire height of the catch basin using a cleaning wand associated with the high-pressure water jetter equipment, cleaning of the catch basin lead, tracing of the catch basin lead to locate its connection to the sewer main and removal of debris from the catch basin.

C. Related Requirements:

1. Section 33 01 30.16 - Sanitary Sewer Pipeline Inspection.
2. Section 33 01 30.17 – Manhole Panoramic Inspection
3. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.

1.2 DEFINITIONS

A. Closed-Circuit Television (CCTV) Inspection: Operation necessary to complete a high-definition, true-color audio-visual inspection for verification of existing internal sewer line conditions.

B. Engineer: The Engineer is defined as the Director of DWSD or their representative which may include a DWSD Engineer , a Field Inspector, or an Owner’s third party Representative.

1.3 STANDARDS

A. National Association of Sewer Service Companies (NASSCO):

1. Pipeline Assessment and Certification Program (PACP) Reference Manual.

2. Manhole Assessment and Certification Program (MACP) Reference Manual.

1.4 SUBMITTALS

A. Submit the submittals of this section in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit a written description of procedures to be used to the Engineer, including product literature for all high-pressure water jetter equipment per the equipment section of this specification including, but not limited to hosing, jetter nozzles, water tanks, auxiliary engines, pumps, hydraulically driven hose reels, wash down wands, vactor units and backflow prevention devices. The Contractor shall submit information on all equipment to be used for review and approval of the Engineer at least one (1) month before beginning the cleaning work.

C. Provide written procedure for method of dewatering and debris disposal to Engineer for approval.

D. Prior to initiating cleaning or inspection efforts, the Contractor shall submit an Emergency Plan that outlines proposed methods for recovering their cleaning or inspection equipment that has become lodged, lost or uncontrollable within the manhole or sewer, including confined space entry procedures.

E. Contractor is to provide a daily schedule to the Engineer with planned cleaning locations.

1.5 QUALITY ASSURANCE

A. Comply with the requirements of Section 01 40 00 – Quality Requirements and Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.

B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the Work.

C. No discharge of sewage resulting from the Contractor's operations shall be allowed. The Contractor will be responsible to pay all fines associated with sewage discharges resulting from the Contractor's activities.

D. The Contractor shall not discharge into the sewer system, any water containing silt, mud or any other concentrated settleable material.

1.6 QUALIFICATIONS

A. The Contractor shall submit documentation for Engineer approval to demonstrate the following experience as a business engaged in the cleaning of sewer lines per the Contract Documents:

1. The Contractor shall be in good standing under local contracting requirements or otherwise properly registered, licensed or permitted by law to carry on business within the State of Michigan, County of Wayne throughout the term of the Contract, and shall provide the Engineer with evidence thereof per the Contract Documents.

2. At any time during the term of the Contract, the Engineer may, at their sole discretion and acting reasonably, request updated evidence of good standing. A Contractor, who fails to provide satisfactory evidence, will not be permitted to continue to perform any Work.

B. The Contractor and/or any proposed Subcontractor, for the portion of the Work proposed to be contracted to them, shall meet the minimum qualifications as listed in the bidding documents.

C. The Contractor shall provide the Engineer with a complete list of Subcontractors whom the Contractor proposes to use prior to the commencement of Work.

D. The Contractor shall be fully capable of performing the Work required in strict accordance with the terms and provisions of the Contract Documents.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. The Contractor shall submit information on all equipment to be used for review and approval of the Engineer.

B. At a minimum, the Contractor shall provide documentation of availability of the following equipment (or equivalent) for this project:

1. High Flow Jetting Pump – Cleaning: Minimum requirement is 80 GPM at pressures up to 2,000 psi with Minimum Spool Capability of 600 feet jetter hose; Maximum is up to 230 GPM at pressures up to 2,900 psi with Minimum Spool Capability of 1,500 feet of dual fused Jetter hose.
2. 6,000 cfm at 15 inches hg; articulating boom; 50 feet of 6 inch to 10 inch vacuum pipe. Vactoring capability of not less than 40 feet vertical.
3. Mobile TV Studios in accordance with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
4. Water tank, generators, pumps, and air compressors.
5. Jetting nozzles and floor skids designed specifically for the size ranges specified in the Contract Documents. Demonstrate availability of appropriate heads for the various work requirements.
6. Water-tight debris boxes with decant system.
7. CCTV camera equipped with a locating sonde.
8. Approved backflow prevention device for filling water tank from a hydrant.
9. High Velocity Jetting Equipment:
    a. All high velocity sewer cleaning equipment shall be set up for ease and safety of operation.
    b. The equipment shall have a selection of two or more velocity nozzles. The nozzles shall be capable of producing a scouring action from 15 to 45 degrees in all size lines to be cleaned.
    c. Equipment shall also include a high velocity wand for washing and scouring

manhole walls and floor. The wand shall be capable of producing flows from a fine spray to a long-distance solid stream.

d. The equipment shall carry its own water tank, auxiliary engines, pumps and hydraulically driven hose reel.

e. All controls shall be located so the equipment can be operated above ground.

C. Debris Removal Equipment: Vacuum unit(s) used for removing sewer debris to include the following:

1. Positive displacement pumps or fans producing a minimum 1,500 cubic feet per minute of air movement.
2. Storage tank.
3. Minimum 6 inch diameter suction hoses attached to a hydraulic boom.
4. Configure the storage tank to allow the liquid portion of the debris to be returned to the sewer.

D. Physically Attached Solid Debris Cutting and Intruding Sewer Tap Removal and Excessive Grease and Root Cutting (Specialty Cleaning) Equipment:

1. Cutting equipment to consist of remote controlled hydraulically driven saw, grinders or blade cutters, remotely operated robots or other types of equipment capable of removing physically attached solid debris, excessive grease and roots.
2. Intruding sewer tap pipe removal equipment to consist of remote controlled hydraulically driven cutters and reamers and remotely operated robotic routers or grinders capable of cutting back intruding sewer service pipes.
3. Select the cutting equipment to be used considering debris type, pipe material, and sewer pipe condition.
4. The specialty cleaning equipment shall include a unit that has a cutting nozzle and camera on the same platform, capable of removing an obstruction while simultaneously viewing the cleaning activity from the same vantage point. This unit is to be used where blockages are encountered in both directions that prevent completion of the CCTV inspection for the entire length of the pipe or in cases where the pipe can only be accessed from one access point and a blockage prevents completion of the CCTV inspection.

E. Communication Equipment: Equipment cleaning crews shall have and utilize a suitable communication system, linking all crewmembers.

F. Flow Control and By-Pass pumping Equipment

1. Flow Control
   a. Undertake flow control measures such as off peak work, plugging or use of sewer cleaning equipment to lower downstream flow levels if sewer flows are hampering effective sewer cleaning.

2. By-Pass Pumping
   a. Comply with Section 01 57 15 – Temporary Bypass Pumping.

3. The Contractor shall select pumping/bypassing equipment that will not have excessive noise levels from pumping/bypassing equipment and shall be restricted to a maximum of ninety decibels (90 dB) at a distance of 50 feet, or as directed by the Engineer. If pumping is required on a 24-hour basis, engines shall be equipped in a manner to keep noise to a minimum and in accordance with the local requirements for noise control.

G. In areas where self-propelled track-mounted platforms are not practical given the conditions of the sewer during inspections, the inspections shall be performed using alternate methods including tethered float or skid systems, jetter assistance or by man-entry methods. The Contractor shall notify the Engineer prior to the use of alternate inspection platforms as means of establishing tethers for floatation or skid systems where consensus on the appropriate methods of platform conveyance must be agreed.

PART 3 - EXECUTION

3.1 PREPARATION

A. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

B. Working hours shall be in accordance with Section 01 14 00 – Work Restrictions.

C. Sewers and associated upstream or downstream manholes and/or catch basins shall be cleaned of loose and settled debris including sludge, dirt, sand, gravel, rocks, bricks, roots, grease, concrete, asphalt, encrustation, broken pipe and other solid and semi-solid materials and removed from the sewer with the equipment detailed in this specification.

D. It shall be the responsibility of the Contractor to locate manholes and/or catch basins by use of a CCTV camera and sonde locator and in conjunction with the use of a metal detector.

1. Should the Contractor be unable to find the manhole, they shall notify the Engineer immediately. The Engineer will then direct the Contractor regarding whether they should continue to search for the manhole. Time spent searching for a manhole is incidental to the cost for cleaning and inspection of manholes and sewers.
2. The Contractor will edit the as-builts or provide the Engineer with a legible sketch drawing to identify the approximate location of any manholes, structures, or piping that are not accurately depicted on the mapping (more than ten feet from the location shown in the mapping, outside of the ROW or easement shown on the mapping), does not exist, or is not shown on the mapping. The Contractor shall GPS survey the newly found manholes or manholes not accurately depicted to submeter accuracy. Markups will be confirmed with the Engineer and should be legibly recorded in the as-builts. The edited as-builts or sketches will be provided to the Engineer with each bi-weekly inspection submittal or upon request.

a. The Engineer will communicate the methodology and application of temporary or new Asset ID for new manholes and sewers located during the Work that conforms to the Engineer's requirements.
b. The Contractor shall notify the Engineer if a manhole is not accessible due to bury depth or other factors.

3. Determination of the cleaning technique proposed by the Contractor must meet the requirements of the Contract Documents. Contingent Work items require approval of the Engineer.
4. Clean line sections by the procedure proposed by the Contractor and approved by the Engineer. Properly dispose of all material, debris, etc. removed from the sections at an approved disposal site to include applicable disposal fees and provide a copy of the manifest to the Engineer.

E. During all cleaning operations, precautions shall be taken to protect sewer lines from damage. Any damage to the sewer caused by the use of cleaning equipment, regardless of the cleaning method, shall be repaired by the Contractor at no additional cost and to the satisfaction of the Engineer.

F. Sewers and manholes may be located in easements, through public or private property, City owned parklands and rights-of-way and restricted alleyways where no paved access may exist, or paved access is obstructed to the extent that would inhibit equipment and materials mobilization. It will be the Contractors responsibility to identify these sewers and arrange for access using "Door Hanger" notifications as necessary and to restore any surface damage to private and City owned property to the satisfaction of the Engineer.

G. Where access routes to various manhole locations must be cleared of heavy vegetation, the Contractor shall perform the clearing of pathways to the extents necessary to facilitate mobilization of cleaning and internal inspection equipment. The Contractor shall not remove vegetation on private property or outside of the sewer easement or right-of-way.

1. Any vegetation or other debris cleared by the Contractor shall be removed and disposed of properly by the Contractor, and the site restored by the Contractor as approved by the Engineer.
2. Trees larger than 6 inches in diameter measured at a point 4.5 feet above grade (diameter at breast height) will not be removed as part of the sewer cleaning. Notify the Engineer of site conditions that will impede the completion of the Work.
3. Trees smaller than 6 inches in diameter measured at a point 4.5 feet above grade (diameter at breast height) will be removed as part of the Work and shall be incidental to the Contract.

H. The Contractor shall schedule, maintain, and coordinate all activities and shall cooperate with the Engineer such that a minimum of interruption to the services results. The Contractor shall not operate existing system valves, controls, or other appurtenances at any time, but when the same is needed to facilitate and accommodate activities, shall request such operation from the Engineer. The Contractor shall provide the Engineer with 48-hour advance notice for such assistance.

I. The Contractor is hereby made aware no flow shall be discharged to the river, streams, banks, or any other storm outlet during cleaning or inspection operations. Additionally, no sewage shall be permitted to surcharge to the point that it overflows to any of the above or back into private buildings through lateral connections. The Contractor must notify the Engineer immediately of any spill event. Any damage or fines resulting from such occurrences are the sole responsibility of the Contractor.

J. The Contractor shall notify the Engineer 96 hours prior to mobilizing for internal inspection or cleaning activities.

3.2 FLOW CONTROL

A. Undertake flow control measures such as working during off-peak hours, the use of sewer cleaning equipment to lower downstream flow levels or blocking/plugging if sewer flows are hampering effective sewer cleaning.

B. Provide the Engineer with at least 48 hours' notice and proposed method of flow control before undertaking flow control measures for sewers larger than 18 inches in height.

C. Use sewer plugs to stop or reduce sewer flow that tether to and are removable from the ground surface.

D. Monitor flow levels upstream of a plugged sewer at all times to ensure flooding of public or private property does not occur.

E. The Contractor must, at a minimum, make reasonable effort to control the flow by using pipe-cleaning equipment to temporarily retain flow or to remove standing water.

3.3 PERFORMANCE

A. All open access structures or manholes will be attended at all times, and all access structures or manholes that were sealed or bolted to control odors or entry of extraneous water or for security reasons will be resealed or re-bolted after entry. The Contractor shall liaise with the Engineer to ensure that sealed or bolted chambers have been adequately sealed or bolted, post inspection.

B. The Contractor understands that DWSD shall incur significant and substantial penalties from the state of Michigan in the event that sewage is discharged onto the ground or into any streams as related to the Work in this Contract. In the event that sewage is released into the environment as a result of the Contractor's performing the Work, the Contractor shall immediately rectify the situation and notify the Engineer.

C. All cleaning shall commence with the most upstream sections of the sewer lines to be cleaned and end with the most downstream sections of the sewer lines to be cleaned regardless of the method chosen to clean the sections. The cleaning process shall be carried out using the step-cleaning method using the appropriate carrying capacity of each jetter nozzle for the respective

sewer pipe height and shape. All sediments and residual wastes shall be evacuated from each successive manhole as the cleaning progresses.

1. Suitable equipment will be temporarily installed as necessary in the downstream manholes to ensure that solids and debris are trapped and no silts, sand, gravel, debris, etc., shall be allowed to pass into the adjacent pipes.
2. Under no circumstances shall sewage or solids removed from the sewer be dumped onto streets, catch basins, storm drains, or receiving waters.
3. All materials removed shall be properly disposed at a landfill licensed to receive the applicable wastes.

D. Each designated sewer line section shall be cleaned using a high-pressure water jetter. The equipment selected for cleaning shall be capable of removing loose or settled debris including sludge, dirt, sand, gravel, rocks, bricks, roots, grease, concrete, asphalt, encrustation, broken pipe and other solid and semi-solid materials from the sewer lines and manholes.

1. If cleaning of an entire section cannot be successfully performed from one manhole, the equipment shall be set up on the other manhole at the opposite end of the sewer segment and a reversal clean again attempted, without additional compensation.
2. In the event the Contractor is unable to completely perform CCTV inspection or cleaning from both directions (with the exception of a cross bore or collapse), the Contractor must have the obstructions removed using specialty cleaning equipment capable of removing the obstruction and simultaneously viewing the cleaning activity from the same vantage point in order to view the cleaning operation and not cause any damage to the host pipe.
3. If the Contractor cannot complete the inspection after attempting to use specialty cleaning equipment, the Contractor and Engineer shall jointly decide if the Contractor shall re-perform the inspection subsequent to completion of external or emergency repair.
4. Sewer cleaning shall be considered the use of a step method to Work through the pipe in increments that removes debris in a segmented and controlled manner throughout the full length of the pipe to be cleaned. This means that the Contractor shall clean an initial portion of the pipe for a length appropriate to the carrying capacity of each jetter nozzle, sewer pipe height and shape and level of debris encountered, pulling back debris to the manhole. The Contractor shall then clean successive increments of pipe in the same way, each time pulling the displaced debris in solution back over increments of pipe previously cleaned. The Contractor will complete the cleaning using the step method approach through the entire segment of the pipeline with a high-pressure water jetter to ensure the sewer is adequately cleaned. During the final cleaning pass, the CCTV inspection camera shall be mobilized to inspect the sewer segment while the jet nozzle pulls water away from the camera, drawing any water level down to maximize the exposure of the sewer pipe circumference.
5. The Contractor shall evaluate if the line is adequately cleaned to justify televising inspection work after each cleaning pass. The Contractor is wholly responsible for determining if the line is adequately cleaned to complete televising inspection for approval of the cleaning work.
6. During all sewer cleaning operations, satisfactory precautions shall be taken to protect the sewer lines from damage that might be inflicted by the improper use of cleaning equipment. Whenever hydraulically propelled cleaning tools which depend upon water pressure to

provide their cleaning force or any tools which retard the flow of water in the sewer line are used, precautions shall be taken to ensure that the water pressure created does not cause any damage or flooding to public or private property being served by the sewer segment involved.

E. The catch basin cleaning and inspection shall include fully cleaning the catch basin sump/well and the vacuuming and removal of all dirt, debris, and sludge.

1. The Contractor shall transport and dispose of the debris/sludge at an approved landfill.
2. The Contractor shall be required to rod 30 linear feet of each catch basin lead, through the catch basin trap, to determine whether the catch basin is properly flowing after cleaning.
3. The Contractor shall take a location photo and interior photo of each cleaned catch basin and add them to the inspection in the ArcGIS Collector application.
4. The Contractor shall also be required to inspect and determine the type, size, condition, and location of connection to sewer of each catch basin and record the information from the condition assessment into the ArcGIS Collector application or delivered to the Engineer in the approved project record documentation in construction contracts.
    a. The location of the connection to the existing sewer shall be identified via flow or dye test and recorded with the manhole and pipes clearly identified where evidence of the dye or flow was observed.
    b. The approximate location of the catch basin lead from the catch basin to the sewer main shall be drawn in the ArcGIS Collector application.

F. Manhole cleaning shall comply with the cleaning section of Section 33 01 30.81 – Manhole Rehabilitation and the requirements within this specification.

G. The manholes shall be cleaned using a high pressure water jetter with jetter wash down wand to ensure the chamber is adequately cleaned. The equipment selected for cleaning shall be capable of removing loose or settled dirt, grease, rocks, sand, roots and other deleterious materials and obstructions from the sewer lines and manholes using the provided types of cleaning per these specifications.

H. Manhole cleaning shall be considered the removal of debris and the use of a rotation method to Work down the chamber through the components in increments that remove debris in a segmented and controlled manner throughout the full depth of the chamber to be cleaned. Cleaning shall include the trapping and removal of all sediments and residual wastes from the invert of the manhole including the bench and channel as the cleaning progresses. Any debris moved into the associated mainline sewers shall be subsequently cleaned.

1. Suitable equipment will be temporarily installed as necessary in the downstream manholes to ensure that solids and debris are trapped and no silts, sand, gravel, debris, etc., shall be allowed to pass into the adjacent pipes.
2. The cleaning and inspection submittal shall be rejected if the inspection observes debris within the interconnecting mainline sewers by the Engineer. The Contractor shall be instructed to revisit, re-clean and re-inspect the asset.
3. Under no circumstances shall sewage or solids removed from the sewer be dumped onto streets, catch basins, storm drains, or receiving waters.

4. All materials removed shall be properly disposed at a landfill licensed to receive the applicable wastes.

I. During all manhole cleaning operations, satisfactory precautions shall be taken to protect the manhole chamber from damage that might be inflicted by the improper use of cleaning equipment. Whenever hydraulically propelled or pressurized cleaning tools which depend upon water pressure to provide their cleaning force or any tools which retard the flow of water in the manhole chamber are used, precautions shall be taken to ensure that the water pressure created does not cause any damage or flooding to the manhole or to public or private property being served by the manhole or surrounding sewers involved.

3.4 CROSS-BORES

A. Cross-bores are intersections of one utility pipeline through another, such as when a gas pipeline is inadvertently installed through a sewer pipeline. Cross bores generally occur when a third-party utility is installed using a trenchless method that prevents visibility of the underground sewer pipeline and are commonly a water or gas service.

1. Cutting devices are to be used in conjunction with CCTV equipment only.
2. Cutting devices are not to be used in the vicinity of cross bores.
3. Capture photograph or digital images and notify the Engineer immediately where third-party cross-bores are observed during the sewer or manhole inspection. Provide the captured CCTV images and the distance from the start node of the inspection along the pipe to note the location of the cross-bore to the Engineer immediately after observation.
4. MISS DIG (811) should be contacted to provide locates prior to all cleaning operations in storm sewers and shallow sewers located in the right of way to reduce impact with potential cross bores.

3.5 TRAFFIC CONTROL

A. Contractor shall provide traffic control as required and in compliance with the Local and State governing authorities and in accordance with Section 01 55 26 – Traffic Control.

B. Contractor shall coordinate traffic control with City of Detroit and other jurisdictional authorities.

C. The Work of Maintaining Traffic consists of furnishing all labor, equipment, and materials required for maintaining traffic throughout the project area in accordance with Sections 104.07.C, 104.11, 812, and 922 of the MDOT 2012 Standard Specifications for Construction and this Special Provision.

1. Notify the Engineer a minimum of 72 business hours prior to the implementation of any road closures, lane closures, or major traffic shifts. The Contractor will be required to contact all local and state police, fire, and emergency services that will have jurisdiction within 72 business hours prior to the implementation of any lane closure.

2. Construction Influence Area (CIA) – The CIA includes the right-of-way of the roadways within the project limits.
3. General Traffic Restrictions:

    a. Normal work hours are Monday thru Friday from 7:00 a.m. to 7:00 p.m., or as approved by the Engineer. Work outside the normal work hours will require prior approval from the Engineer.
    b. No work or lane closures will be allowed during Memorial Day or Labor Day weekends. These holiday weekends are defined as beginning at 12:00 p.m. on Friday and ending at 6:00 a.m. on the following Tuesday, or as defined by the Engineer. No work will be allowed during the 4th of July holiday weekend, which will be defined by the Engineer.
    c. Maintain access to all residential and business drives at all times. Maintain access to drives in active work zones when possible as directed by the Engineer.
    d. All labor, equipment, and aggregate required to maintain street, intersections, and driveways for traffic will be included in the execution of the Work.
    e. Coordinate operations with the other Contractors performing Work on projects within or adjacent to the CIA. Maintenance crews and/or Contractor Maintenance Agencies may preform maintenance work within or adjacent to the CIA. The Maintenance Division of MDOT and/or Contract Maintenance Agency will coordinate their operations with the Engineer to minimize interference to the Contractor. No additional payment will be made to the Contractor for joint use of the traffic control items.
    f. Maintain access for emergency vehicles at all times through the Work area.
    g. Provide fencing to protect open trenches and pits during working and non-working hours.

4. Project General: During work hours, equipment, material, and company vehicles may be parked or stored within the right-of-way as directed by the Engineer. The Contractor is responsible for restoring to its original condition any area damaged by their equipment, material, or company vehicles. Restoration of damaged areas will be in accordance with the plans and 2012 MDOT Standard Specifications for Construction and this Special Provision.

3.6 REMOVAL OF EQUIPMENT THAT BECOMES STUCK IN A SEWER

A. No additional compensation will be provided to remove equipment or repair the sewer in the event the Contractor's equipment becomes stuck in the pipe or is otherwise damaged as a result of conducting Work in the sewer.

B. The Contractor shall advise the Engineer immediately if equipment becomes stuck in a sewer. The Contractor shall attempt to remove equipment that is stuck using whatever means are necessary for up to 4 hours. The Contractor shall advise the Engineer if the equipment cannot be freed after 4 hours and mark the position on the surface over the sewer where the equipment is stuck.

C. The Engineer will arrange to have an excavation made to the top of the sewer where the equipment is stuck within 48 hours of notification the equipment cannot be freed at the expense of the Owner.

D. The Contractor shall advise the Engineer if bypass pumping is required to ensure the normal sewer flow continues while the obstruction is present. All costs incurred due to the bypass pumping activity shall be at the cost of the Owner.

E. The Contractor and Engineer shall be present during the excavation and once the top of the sewer is exposed and the excavation is secured, the Contractor shall do one of the following:

1. Remove the top of the sewer pipe and retrieve the equipment stuck in the sewer or;

2. Defer removal of the top of the sewer and retrieval of the stuck equipment to the excavation contractor. Damages caused to the stuck equipment will not be the responsibility of the excavation contractor. No claim for equipment damages will be made against the excavation contractor.

F. The Engineer will arrange to have the sewer repaired after removal of the equipment that was stuck at the expense of the Engineer.

G. The Contractor shall clean and remove backfill and debris that may have entered the sewer during removal of the equipment and subsequent repair of the sewer.

3.7 DAMAGE TO OWNER AND PRIVATE PROPERTY

A. In the event of damage to Owner's assets and private property the Contractor shall immediately notify the Engineer.

1. The Contractor shall provide written reports to the Engineer for each property attended for investigation of damage. Reports shall include photographs of all damage, dates and times, written agreements with property owner and all actions taken or proposed to rectify the damage. Reports shall be submitted to the Engineer within 24 hours of attending the property.
2. Sewers and manholes may be located in easements, through public or private property, City owned parklands and rights-of-way and restricted alleyways where no paved access may exist, or paved access is obstructed to the extent that would inhibit equipment and materials mobilization. It will be the Contractors responsibility to identify these sewers and arrange for access using notifications as identified in the specifications and to restore any surface damage to private and City owned property to the satisfaction of the Engineer.
3. Sewer backup or "blow-back" on private property resulting from cleaning or inspection activities is not acceptable and shall be avoided at all costs. It is expected that where this possibility exists the Contractor shall take appropriate measures such as making modifications to cleaning equipment and/or taking additional time to clean such sewers.
    a. Clean-up of affected residences shall be done by cleaning professionals. Under no circumstances are cleaning equipment operators to enter residences unless they are neat and presentable, and the Engineer has received a Background Check for that

individual in accordance with Section 33 01 30.18 – Security Clearances and Communications.

b. Where actual sewage or "grey water" has flooded private property, the Contractor shall immediately clean and disinfect all affected areas. The Contractor shall immediately hire an independent certified water damage or flood restoration Contractor to assess any damage to contaminated building materials such as drywall, insulation, carpets or sub-floors, and immediately make any required repairs at the sole cost of the Contractor.

c. If a residence is uninhabitable as a result of a sewer back-up the Contractor shall pay for reasonable hotel accommodations and meals for all affected residents at the sole cost of the Contractor.

4. The Contractor shall provide the Engineer with a 24-hour contact number to arrange for immediate clean-up and repair of private property.

3.8 REMOVAL OF EXCESSIVE GREASE AND/OR ROOTS

A. Excessive grease and/or roots shall be reported to the Engineer.

B. Excessive grease and/or roots shall be removed, as approved by the Engineer or as indicated in the Drawings. Special precautions should be exercised during the cleaning operation to assure virtually complete removal of visible roots from the joint area.

1. Contractor shall cut and remove grease and/or roots that cannot be removed through standard cleaning efforts.
2. Contractor may use mechanical devices such as expanding root cutters and hydraulic procedures such as high-pressure jet cleaners.
3. Contractor may use hydraulically driven saw, grinder or blade cutters to remove grease and/or roots.
4. Contractor must remove grease and or roots to within one-half (1/2) inch to flush with the inside surface of the sewer.
5. Contractor shall monitor the entire removal operation and while the removal equipment is travelling within the pipe to reach the Work area by CCTV.
6. Flushing the sewer or the use of "spin nozzles" to remove grease will not be permitted.

3.9 REMOVAL OF INTRUDING SEWER TAPS

A. Intruding sewer taps shall be removed, as approved by the Engineer or as indicated in the Drawings. Special precautions should be exercised during the grinding operation to assure unnecessary damage does not occur to the tap given the conditions of the sewer main and tap. Contractor shall complete the Work as follows:

1. Contractor shall cut and remove intruding sewer taps from the sewer at the locations identified by the Engineer or the Drawings.

2. Contractor shall select the cutting equipment to be used considering tap material and sewer pipe condition.
3. Contractor shall leave intruding sewer taps finished smooth and within one-half (1/2) inch to flush with the inside surface of the sewer.
4. Contractor shall monitor the entire intruding sewer tap removal process while the cutting equipment is travelling within the pipe to reach the Work area by CCTV.

3.10 PHYSICALLY ATTACHED SOLID DEBRIS CUTTING

A. Removal of physically attached solid debris that cannot be removed using standard cleaning methods shall be undertaken, as approved by the Engineer or as indicated on the Drawings. The Work shall be done by the use of solid debris cutting equipment that will consist of remote controlled hydraulically driven saw, grinders or blade cutters, remotely operated robots or other types of equipment capable of removing solid debris such as concrete, asphalt, and encrustation.

1. Contractor shall complete the Work and remove solid debris from the sewers for the limits identified by the Engineer or as indicated on the Drawings.
2. Solid debris removal equipment to consist of remote controlled hydraulically driven cutters and reamers capable of cutting back the solid debris.
3. Contractor shall select the cutting equipment to be used considering debris type and sewer pipe condition. Remove solid debris to within one-half (1/2) inch to flush with the inside surface of the sewer.
4. Contractor shall monitor the entire cutting operation and while the cutting equipment is travelling within the pipe to reach the Work area by CCTV.

3.11 DEBRIS REMOVAL

A. All loose or settled debris of any kind including sludge, dirt, sand, gravel, rocks, bricks, roots, grease, concrete, asphalt, encrustation, broken pipe and other solid and semi-solid residue, debris, and material resulting from all cleaning operations shall be removed at the downstream manhole of the section of sewer being cleaned. Passing material from manhole section to manhole section which could cause line stoppages, accumulations of sand in wet wells, or damage to pumping equipment, shall not be permitted.

B. Contractor shall be responsible for daily hauling and removal of the removed material from the work site and the proper disposal of the removed material at an approved disposal site. Material will not be accepted by the Engineer for disposal.

C. All debris, residue and other materials resulting from cleaning operations shall be removed from the site no less often than at the end of each workday and shall be disposed of in an approved manner. Under no circumstances will the accumulation of debris, residue, etc., be left at the Work site overnight, unless prior written authorization is given for storage in totally enclosed containers.

D. Decant or dewater debris removed from sewers and catch basins and legally dispose of solid and semi-solid debris. Return decanted or dewatered liquid to the sewer of origin as soon as possible, but not within three (3) sewer sections upstream of a lift station. If decanting is required, it shall be done immediately downstream of the lift station. Any spillage from the container system is not allowed. Any off-site decanting methods shall be approved by the Engineer.

E. Store debris in totally sealed containers at all times and remove from the Site at the end of each day. Vehicles used to transport sewage within the Owner's limits must conform to City of Detroit laws, licensing and permits as necessary.

F. Off-site debris dewatering facilities must meet State environmental regulations and requirements. Obtain approval from Owners Waste Control Branch and provide copies of required licenses, permits and relevant documentation required for dewatering facility to the Engineer before starting the Work.

G. Landfill reports and/or weigh tickets must be submitted. Keep a log containing the following information for each debris disposal unit.

1. Contract Name and Bid Opportunity Number.
2. Vehicle ID – License Number.
3. Date of Disposal.
4. Time of Disposal.
5. Origin of Debris.
6. Net Weight of Load.

H. The Contractor is responsible for monitoring weather conditions continuously during the cleaning operations. If the combined storm and sanitary sewer flows, including increased flows due to storm or snow melt runoff, disrupt the cleaning operation at any time during the Work, the Contractor must be prepared to remove their equipment and restore the sewer system to normal operation. Any Contractor costs that are a result of high flows or unsuitable weather conditions will not be reimbursed by the Engineer.

I. Immediately upon completion of Work, the Contractor shall ensure that the entire area is cleaned of all debris, and that all debris is disposed of properly.

3.12 WATER SUPPLY FOR SEWER CLEANING

A. Obtain permit(s) for hydrant use for water supply for sewer cleaning in accordance with DWSD requirements as necessary.

B. Water supply for the Work may be taken from DWSD hydrants in accordance with the following:

1. Water shall be taken from approved hydrants only.
2. Submit a list of proposed hydrant location(s) to the Engineer for approval. If a proposed hydrant location is not approved, the Contractor shall submit an alternate hydrant location for approval.

3. The Contractor shall supply and use a Backflow Protection Arrangement when taking water from Owner's hydrants. Alternatively, the Contractor may rent the Backflow Protection Arrangement from the Engineer if available. All costs associated with the supply of the Backflow Protection Arrangement or rental of same from the Engineer will be included in the cost of sewer and manhole cleaning. The Engineer will supply a meter and locks for the Backflow Protection Arrangement.
4. The Contractor is permitted to turn approved hydrants on and off provided the Contractor has received training by the Engineer and the turn-ons and turn-offs are done in the presence of the Engineer.
5. Hydrants approved for use shall be considered to be "in the Contractor's control" from the time the Engineer has turned the hydrant on until the Contractor has notified the Engineer the hydrant is no longer being used and the flow meter has been removed.
6. Between November 1 and April 30 of any year the Contractor shall take all necessary precautions to prevent freezing of hydrants and related appurtenances for hydrants in their control and shall be responsible to pump out hydrants turned off by Emergency Services. Heating and protecting of hydrants will be required by the Contractor. All costs associated with heating and protecting shall be included in the price of cleaning items.
7. If a hydrant or appurtenance is damaged due to freezing or improper turn-on or turn-off procedures while in the Contractor's control, E will assess the damage and determine if the Engineer will repair the damage or if the Contractor will be responsible to repair the damage. Costs for repairs completed by the Engineer will be deducted from payments owing the Contractor. Repairs completed by the Contractor will be at the Contractor's expense.
8. Erect and maintain appropriate signage warning oncoming traffic of hose crossings to the satisfaction of the Engineer. Construction ramps shall be employed during the Contract to maintain access to all residences and businesses.
9. Direct hook-up of sewer flushing equipment to a hydrant is not permitted unless approved by the Engineer.
10. No fire hydrant shall be obstructed so as to prevent its use in case of a fire in the area served by the hydrant, nor shall a hydrant be used for the purpose described unless a vacuum break is provided.
11. The Engineer may instruct the Contractor to make other arrangements such as hydrant valve closure for hydrant turn-ons and turn-offs in the event that the hydrant doesn't close properly.

3.13 ACCEPTANCE OF WORK

A. The Contractor shall submit required video inspections of the cleaned sewer to the Engineer for review and determination if the Work performed is acceptable.

B. If physically attached solid debris cutting, removal of excessive grease and roots, and intruding sewer tap removal occurs, the Contractor shall submit the survey abandonment videos, if available, from the initial survey attempts in addition to the final completed survey to the Engineer for review and determination if the Work performed is acceptable.

C. The Contractor shall submit required panoramic inspections of the manhole to the Engineer for review and determination if the cleaning Work performed is acceptable.

D. The Engineer will visually inspect catch basins in the field to determine if the cleaning Work performed is acceptable.

E. Additionally, the Contractor shall submit required interior photographs of the catch basins to the Engineer for review and confirmation that the cleaning Work performed is acceptable.

F. The Contractor shall submit required weigh tickets to the Engineer for review and determination if the debris disposal Work performed is acceptable.

G. The Engineer will review the pipe inspection videos and manhole scans within fifteen (15) working days of submission.

H. The Contractor shall perform remedial Work for sewer, manhole and catch basin cleaning, cutting of physically attached solid debris, removal of excessive grease and roots, and removal of intruding sewer taps and a re-inspection for the locations where the Work was determined by the Engineer as not being acceptable. Work to perform remedial work will not be eligible for additional payment.

END OF SECTION 33 01 30.19

SECTION 33 01 30.23 – SEWER PIPE BURSTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements to replace existing sanitary sewers using a pipe bursting system.
2. Removal and replacement of service lateral connections.
3. Connections to manholes.
4. Construction of drop manholes.
5. Placing replacement pipelines into service.

B. Related Requirements:

1. Section 01 57 15 - Temporary Bypass Pumping.
2. Section 02 01 20 - Protecting Existing Underground Utilities.
3. Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
4. Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning.
5. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.

1.2 STANDARDS

Comply with the latest version of the following standards, except as amended herein.

A. ASTM International:

1. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM C1173 - Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
3. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
4. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
5. ASTM D3262 - Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
6. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
7. ASTM D4161 - Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
8. ASTM D6783 - Standard Specification for Polymer Concrete Pipe.
9. ASTM F412 - Standard Terminology Relating to Plastic Piping Systems.
10. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.3 DEFINITIONS

A. Pipe Bursting: The process of splitting or fracturing the host sewer main and forcing the fragments into the surrounding soil to insert a new pipe of equal or larger diameter.

1. Pipe Bursting shall be accomplished by use of pneumatic, static or hydraulic bursting head, with pipe splitters as cutting wheels.
2. The mole or bursting head shall be directionally guided by the host sewer main and towed under tension by a winch, chain or rod assembly.
3. New pipe shall be towed or jacked in immediately behind mole or bursting head.

B. Host Sewer Main: The existing pipeline subject to the pipe bursting system, made of vitrified clay, asbestos cement, polyvinyl chloride (PVC), cast iron, concrete, steel or lined pipe, as shown on the Drawings.

C. Replacement Pipe: Pipe inserted into host sewer main by pipe bursting system.

D. Continuous Pipe: High-Density Polyethylene (HDPE) plain-end pipe, with fused joints, assembled and inserted to form continuous section between access pits.

E. Sectional Pipe: HDPE gasketed pipe, polymer pipe, or PVC pipe assembled using leak proof joints and inserted into host sewer main in sections.

F. Renew Lateral: Replace service lateral in public space or easement by pipe bursting, or if necessary, by excavation and replacement.

1.4 COORDINATION

A. Coordinate Work of this Section with users connected to system. Notify homeowners and businesses of expected disruption of sanitary service as described in Section 33 01 30.18 – Security Clearances and Communications.

B. Provide and maintain temporary facilities, including piping and pumps, to meet requirements.

1.5 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Convene pre-installation meeting a minimum of one week prior to commencing Work of this Section.

1.6 QUALITY ASSURANCE

A. The pipe bursting system shall be commercially proven to have successfully completed a minimum of 5,000 linear feet sewer main line.

B. Personnel performing pipe bursting:
   1. The Contractor shall be certified by the particular pipe bursting system Manufacturer that they are a fully trained user of the pipe bursting system. Including training in:
      a. Operating bursting head.
      b. Installing proposed replacement pipe.
      c. Operation and maintenance of all equipment to be used.

C. Personnel performing fusing of HDPE pipe and fittings:

   1. The Contractor shall be certified by the manufacturer of the fusing equipment and shall have successfully completed training in:
      a. Handling replacement pipe materials.
      b. Butt fusion of pipe joints, saddle fusion of fittings for service laterals.
      c. Operation and maintenance of all equipment to be used.

   2. The supervisory personnel performing pipe bursting shall have a minimum three (3) years' experience in the Work specified.

D. Pre-Inspection:

   1. Inspect the existing sewer pipe, per the Execution section herein, immediately before the pipe bursting operation to assure that the existing sewer pipe conditions are acceptable for the installation.
   2. Create a log with exact measurements of each service connection in the sewer pipe in order to re-connect the service connections after the installation. The service log shall at least state the distance from the manhole wall to the middle of each service connection, the manhole number from where the measurement has been taken, and the location of the service connection.

1.7 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures:

   1. Pipe bursting plan including at minimum:
      a. Technical data for equipment, method of installation, and proposed sequence of construction.
      b. Anticipated rig capacity, the proposed equipment and the method for advancing the pipe bursting operation through expected soil conditions, depth and exact location of the entrance and exit pits, and the contingency equipment and plans for dealing with soil conditions that a soil engineer could reasonably expect to be encountered at the proposed pipe bursting installation site.
      c. Contingency plan for the stopping of pipe bursting operation due to obstructions, max pull load exceeded, or any other disruption in advancement of pipe burst.
      d. Information pertaining to dewatering, method of excavated material removal, equipment size and capacity, equipment capabilities, pipe bursting method and associated equipment, method of monitoring line and grade and detection of surface movement, name plate data for bursting equipment, and mobile spoils removal unit.

e. Anticipated hours of operation during the pipe bursting and installation process, the minimum number of personnel, and their responsibilities on-duty and on-site during all pipe bursting operations.
f. Replacement pipe and fitting selection and composition.
g. Recommended manufacturer's installation procedures.
h. References to applicable ASTM standards.
i. Layout, storage and pipe handling area requirements for maintenance of pedestrian and vehicle traffic for each project site.

2. Plan for locating, exposing and re-connecting service laterals and restoring manhole connections. The manhole connection shall include waterstop and pipe restraint.
3. Proposed point repair method to remove sags, offset joints and constrictions or obstructions prior to bursting.
4. Bypass pumping plan.
5. Emergency plan. Maintain a copy of emergency plan on site for duration of project.
6. Certification that backup equipment is available and can be delivered to project sites within 24 hours.
7. Certificates of Compliance for raw materials, pipe, joints, fittings, and service connections.
8. Certificates of Training for processes to be used, including joint fusion, if applicable. Include installer's name, date of issuance, and process for which certified.
9. Design calculations resulting in wall thickness for appropriate sized DR for each trenchless technology installation.
   a. Use soil depth at deepest manhole in installation.
   b. Assume ground water table height of four feet below grade unless ground water monitoring data indicate a different height.
   c. List values of key parameters used in calculations, including but not limited to; density of soil, depth of burial, live loads, safety factors, pipe modulus of elasticity, soil modulus and total calculated pressure on the pipe.
   d. Documentation of source of equations and methodologies used in calculations.
   e. Allowable tensile stress during pulling of pipe.
   f. Calculated pipe deflection versus allowable pipe deflection for selected pipe.
   g. Critical buckling pressure.
   h. Slip trench or entry pit dimensions for pipe insertion (as applicable).

10. Pre-bursting and post-bursting television inspection reports. Complete post-bursting inspection after bursting process, reconnection of laterals and renewals are completed.
11. Pulling log to include Allowable Tensile Load (ATL) and duration of pull of the replacement pipe.
12. Field testing results.

B. Packing list, invoice, or delivery ticket with every shipment, to contain Contract number, type and class of pipe, length, and other pertinent information.

C. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

1.8 DELIVERY AND STORAGE

A. Transport, handle, and store pipes and fittings as recommended by manufacturer.

B. Replace pipe or fittings damaged before or during installation at no additional cost to the Owner.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to submittal and fabrication including size, length and depth of sewer reaches to be lined.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Provide a one (1) year warranty period for all materials and workmanship. Warranty period will commence on the date of substantial completion of the Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. Minimum design life span: 50 years.
2. Chemically unaffected by internal exposure to sewage containing hydrogen sulfide, carbon dioxide, methane, mercaptans, kerosene, moisture, and diluted sulfuric acid.
3. Chemically and physically unaffected by external exposure of soil, bacteria, moisture, roots, and chemical attack due to material in surrounding ground.
4. Metal in saddles, clamps and appurtenances: 304 stainless steel following ASTM A240.
5. Elastomeric materials, gaskets, clamps, connectors: Oil resistant and manufactured following ASTM F477.
6. Select appropriate type pipe to maintain nominal inside diameter specified for each pipe segment.
7. Pipe and joints specifically designed for selected pipe bursting application:
    a. Threaded or solvent-cement joints and connections: Not permitted.
    b. Sectional pipe: Joint following manufacturer's recommendations and approved submittals for leak-proof stab joint method, using EPDM O-ring synthetic elastomeric gaskets.

8. Fittings:

a. Pressure rated and classified same as adjoining pipe.
b. Inside diameter to match inside diameter of adjoining pipe.
c. Designed for pipe bursting or pipe jacking applications.

B. HDPE pipe, joints, and fittings:

1. Polyethylene: Minimum cell classification of PE 345464C for black unless otherwise specified in these documents.
2. Material designation: PE 3408 complying with ASTM F412.
3. Pipe:
   a. Manufactured, and sized complying with ASTM F714.
   b. Minimum wall thickness: SDR 17.
   c. Measure length to provide continuous, homogeneous pipe from manhole to manhole with enough extra length to allow relaxing and finishing off at manholes.
   d. Pipe Markings:
      1) Mark complying with ASTM F714.
      2) Legibly marked in green to identify as sewer pipe.

4. Molded fittings: Manufactured, sized and marked following ASTM D3261.
5. Field fabricated fittings: Stock manufactured, sized and marked following ASTM F714.
6. Joint connection minimum requirements:
   a. Continuous pipe:
      1) Assemble pipe lengths in field with butt-fused joints following ASTM D2657 and approved submittals or with electrofused joints following approved submittals.
      2) In case of conflicts between ASTM D2657 and approved submittals or if the ASTM reference is nonspecific, follow approved submittals.
      3) Joint strength: Equal to or greater than pipe strength.

   b. Excavations for pipe bursting insertion or depression removal made between manholes:
      1) Joint pipe ends using butt-fused joints or electrofusion coupling.
      2) With Engineer's approval, use full circle seal clamps specified herein or seal and restraint type mechanical couplings.
7. Internal Pipe Stiffeners:
   a. JCM Stainless Steel Stiffener.
   b. Or Approved Equal.

C. Manhole Connection Materials:

1. Concrete:
   a. High strength, non-shrink, chemical resistant.
   b. Cures in presence of water.

D. Lateral Reconnections: As shown on the Drawings.

1. Heat fusion or electrofusion saddles:
   a. Nominal inside diameter of existing service.

b. Made of polyethylene pipe compound following ASTM D3350 and suitable for fusion welding to polyethylene pipe.
c. Branch saddle style or approved equal.

2. Mechanical saddles: As approved by the Engineer.

3. Insertion connections: Nominal inside diameter of existing service.

E. Connection Appurtenances:

1. Use Full Circle Elastomeric Seal Clamps for joining plain ends of pipe.
   a. Rubber sleeve coupling with stainless steel shear ring.
   b. Comply with ASTM C1173.

2. Joint lubricants:
   a. Follow manufacturer recommendations.
   b. Approved methods of application:
      1) By brush.
      2) By hand.

2.2 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

C. Certificate of Compliance: Submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

PART 3 - EXECUTION

3.1 MAINLINE PREPARATION

A. Respond to project site within 2 hours of Engineer’s notification of problem on site. Cost incurred by the Owner due to failure to respond within time frame specified may be deducted from the Contract.

B. Bypass pumping: Comply with Section 01 57 15 - Temporary Sewer Bypass Pumping.

C. Pre-bursting inspections:

1. Perform internal inspections.

2. Confirm, locate, and identify by building address, existing lateral connections and services attached to host sewer main. Furnish log to Engineer.
3. Confirm host pipe is ready for bursting.
    a. Demonstrate on CCTV recording:
        1) Realigned major sags.
        2) Removed obstructions, offset joints, missing or collapsed pipe that could interfere with bursting process.

4. Notify Engineer if bursting is not viable with pre-inspection CCTV recording to support assertion.

D. Locate and protect existing utilities following Section 02 01 20 - Protecting Existing Underground Utilities.

E. External point repairs prior to bursting: Before bursting, perform external point repair to remove sags, offset joints and bursting constrictions or obstructions as shown on the Drawings that cannot be removed internally, and may impede process or prevent successful completion.

F. Maintaining invert and slope: Ascertain elevations of upstream and downstream manhole invert of host sewer main to be burst as well as intermediate point on mainline for verification that line and grade is maintained.

G. Vibration monitoring equipment: Placed where necessary when directed by Engineer.

3.2 MANHOLE PREPARATION

A. Enlarge manhole pipe openings to size sufficient to allow bursting head to pass without damaging manhole.

B. Remove manhole drop connections that interfere with bursting process.

3.3 BURSTING AND PIPE INSTALLATION

A. Disconnect laterals from host sewer main following approved submittals.

B. Construct access pits as necessary to facilitate pipe bursting insertion process.

1. Locate pits where interference to vehicular traffic and inconvenience to public is minimized.
2. Where practical, use sewer lateral connection locations, changes in sewer line and grade, and sags as access pit locations, and provide access to sewer from both directions.
3. Prevent damage to adjacent areas during bursting process.

C. Do not exceed approved submittal insertion rate or force at any time. Maintain logs verifying that rate and force did not exceed submitted calculations.

D. Use approved lubricant to ease installation friction. Match lubricants to soil and insertion conditions.

E. Remove irregular internal bead projections that are not uniform and rolled-back from butt-fused joints.

F. Remove and replace improperly burst sewer mains at no additional cost to the Owner.

G. Replace inaccurately located or misidentified live/active sewer lateral connections. Re-connect missed or active taps and abandon erroneously opened connections at no additional cost to the Owner.

H. If the ambient air temperature is under 40 degrees F, performing fusion of HDPE pipe must be approved by the Engineer. Additional precautions such as supplying heated enclosures may be requested and are subject to approval by the Engineer.

3.4 RELAX PERIOD

A. Allow inserted HDPE pipes to rest for a period of at least 12 hours before cutting and trimming replacement pipe or making any manhole connections.

B. If replacement pipe exhibits retraction at end of relax period and after flexible manhole connectors' grout has set, anchor HDPE pipe at manholes following submittal and approval of HDPE wall anchor fitting Shop Drawings in accordance with the Submittals section herein and with Section 01 33 00 – Submittal Procedures.

C. After relaxation period, cut and trim replacement pipe 3 inches inside upstream and downstream manholes.

3.5 MANHOLE RECONNECTION

A. Comply with Section 33 05 61 – Concrete Manholes.

3.6 SERVICE RECONNECTIONS

A. Service connections to the pipe shall be made with materials submitted and approved in accordance with Section 01 33 00 – Submittal Procedures.

B. Services shall be reconnected to minimize disruption of service to the resident.

C. After the new pipe has been installed and tested, reconnect existing sewer services. All service lines shall be the size and material indicated in the specifications.

3.7 FIELD TESTING

A. Prior to final inspection and acceptance of the new pipe, flush and clean the system according to Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning, removing all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the pipe.

B. After completion of the pipe, service reconnecting, work at manholes, and final cleaning, televise the sewer according to Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection. The final video shall be submitted to the Engineer for approval and acceptance.

END OF SECTION 33 01 30.23

SECTION 33 01 30.24 – WATER MAIN PIPE BURSTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements to replace existing water main using a pipe bursting system.

B. Related Requirements:

1. Section 01 51 36 – Temporary Water Service.
2. Section 02 01 20 – Protecting Existing Underground Utilities.
3. Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
4. Section 33 14 13 – Public Water Utility Distribution Piping
5. Section 33 14 17 – Water Services.
6. Section 33 14 17.81 – Lead Service Line Replacement.

1.2 STANDARDS

Comply with the latest version of the following standards, except as amended herein.

A. ASTM International:

1. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM C1173 - Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
3. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
4. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
5. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
6. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
7. ASTM F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

B. American Water Works Association (AWWA):

1. AWWA M55 – PE Pipe Design and Installation
2. AWWA C906 – Polyethylene Pressure Pipe and Fittings, four (4) inch through 63 inch for water.

C. International Pipe Bursting Association (IPBA) – Division of NASSCO:

1. Guideline for Pipe Bursting.

D. Plastic Pipe Institute (PPI):

1. PPI Handbook of Polyethylene Pipe – 2009 2nd Edition.

1.3 DEFINITIONS

A. Pipe Bursting: The process of splitting or fracturing the host water main and forcing the fragments into the surrounding soil to insert a new pipe of equal or larger diameter.

1. Pipe Bursting shall be accomplished by use of pneumatic, static or hydraulic bursting head, with pipe splitters and cutting wheels.
2. The mole or bursting head shall be directionally guided by the host water main and towed under tension by a winch, chain or rod assembly.
3. New pipe shall be towed or jacked in immediately behind mole or bursting head.

B. Host Water Main: The existing pipeline subject to the pipe bursting system, made of vitrified clay, asbestos cement, polyvinyl chloride (PVC), cast iron, ductile iron, concrete, steel or lined pipe, as shown on the Drawings.

C. Replacement Pipe: Pipe inserted into host water main by pipe bursting system.

D. Continuous Pipe: High-Density Polyethylene (HDPE) plain-end pipe, with fused joints, assembled and inserted to form continuous section between access pits.

E. The Dimension Ratio (DR): DR is the ratio of wall thickness to the outside diameter of the pipe.

F. Pre-Chlorinated Pipe Bursting: Method of pipe bursting where new water main pipe is assembled, pressure tested and disinfected above ground prior to installation. Pre-Chlorinated pipe is then installed replacing the host pipe via pipe bursting.

1.4 COORDINATION

A. Coordinate Work of this Section with users connected to system per the included Resident Notifications submittals.

B. Provide and maintain temporary facilities, including piping and service connections, to meet requirements.

1.5 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Convene pre-installation meeting a minimum of one (1) week prior to commencing Work of this Section.

1.6 QUALITY ASSURANCE

A. The pipe bursting system shall be commercially proven to have successfully completed a minimum of 30,000 lineal feet water main line of similar size, material and complexity.

B. The company performing Work of this Section shall have a minimum five (5) years and at least 30,000 lineal feet documented experience in pipe bursting of 6-inch to 24-inch diameter water main and sewer pipe.

C. Personnel performing pipe bursting:

1. The Contractor shall be certified by the particular pipe bursting system manufacturer that they are a fully trained user of the pipe bursting system. Including training in:
   a. Operating bursting head.
   b. Installing proposed replacement pipe.
   c. Operation and maintenance of all equipment to be used.

2. The supervisory personnel performing pipe bursting shall have a minimum three (3) years' experience in the Work specified.

D. Personnel performing fusion of HDPE pipe and fittings:

1. The Contractor shall be certified by the manufacturer of the fusing equipment and shall have successfully completed training in:
   a. Handling replacement pipe materials.
   b. Butt fusion and electrofusion of pipe joints.
   c. Operation and maintenance of all equipment to be used.

2. The supervisory personnel performing fusing of HDPE pipe and fittings shall have a minimum three (3) years' experience in the Work specified.

1.7 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

C. Shop Drawings:

1. Documentation providing proof of Contractor and personnel experience as required by these Specifications.
2. Pipe bursting Installation Plan including at minimum:

a. Technical data for equipment, method of installation, and proposed sequence of construction.
b. Anticipated rig capacity, the proposed equipment and the method for advancing the pipe bursting operation through expected soil conditions, depth and exact location of the entrance and exit pits, and the contingency equipment and plans for dealing with soil conditions that a soil engineer could reasonably expect to be encountered at the proposed pipe bursting installation site.
c. Contingency plan for the stopping of pipe bursting operation due to obstructions, max pull load exceeded, or any other disruption in advancement of pipe burst.
d. Information pertaining to dewatering, method of excavated material removal, equipment size and capacity, equipment capabilities, pipe bursting method and associated equipment, method of monitoring line and grade and detection of surface movement, name plate data for bursting equipment, and mobile spoils removal unit.
e. Anticipated hours of operation during the pipe bursting and installation process, the minimum number of personnel, and their responsibilities on-duty and on-site during all pipe bursting operations.
f. Replacement pipe and fitting selection and composition.
g. Recommended manufacturer's installation procedures.
h. References to applicable ASTM standards.
i. Layout, storage and pipe handling area requirements for maintenance of pedestrian and vehicle traffic for each project site.

3. Plan for locating, exposing and re-connecting water services.
4. Temporary Water Service plan, if applicable.
5. Emergency plan. Maintain a copy of emergency plan on-site for duration of project.
   a. Emergency plan is to include, but is not limited to, plans and procedures for providing temporary water service to residents and a Fire Protection Plan to provide adequate fire flows in case of emergency.

6. Certification that backup equipment is available and can be delivered to project sites within 24 hours.
7. Certificates of Compliance for raw materials, pipe, joints, fittings, and service connections.
8. Certificates of Training for processes to be used, including joint fusion, if applicable. Include installer's name, date of issuance, and process for which certified.
9. Design calculations resulting in wall thickness for appropriately sized DR for each trenchless technology installation. Design calculations to be signed by Michigan PE Licensed Professional.
   a. Use soil depth at deepest location in installation.
   b. Assume ground water table height of four feet below grade unless Drawings or geotechnical data indicate a different height.
   c. List values of key parameters used in calculations, including but not limited to; density of soil, depth of burial, live loads, safety factors, pipe modulus of elasticity, soil modulus and total calculated pressure on the pipe.
   d. Documentation of source of equations and methodologies used in calculations.
   e. Allowable tensile stress during pulling of pipe.

f. Calculated pipe deflection versus allowable pipe deflection for selected pipe.
g. Critical buckling pressure.
h. Slip trench or entry pit dimensions for pipe insertion (as applicable).

10. Video Report of post installation conditions for any sewer crossed as part of bursting operation in conformance with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspections.
11. Field testing results.

D. Packing list, invoice, or delivery ticket with every shipment, to contain Contract number, type of pipe, length, and other pertinent information.

1.8 DELIVERY AND STORAGE

A. Transport, handle, and store pipes and fittings as recommended by manufacturer.

B. Replace pipe or fittings damaged before or during installation at no additional cost to the Owner.

1.9 WARRANTY

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Provide a one (1) year warranty period for all materials and workmanship. Warranty period will commence on the date of substantial completion of the Work.

2.1 MATERIALS

A. General:

1. Minimum design life span: 50 years.
2. Chemically and physically unaffected by external exposure of soil, bacteria, moisture, roots, and chemical attack due to material in surrounding ground.
3. Select appropriate type pipe to maintain nominal inside diameter specified for each pipe segment.

B. HDPE pipe, joints, and fittings:

1. Polyethylene (PE) Pipe:
   a. Comply with Section 33 14 13 – Public Water Utility Distribution Piping.
   b. Fittings: Comply with Section 33 14 13 – Public Water Utility Distribution Piping.

2. Joint connection minimum requirements:
   a. Continuous pipe:

1) Assemble pipe lengths in field with butt-fused joints following ASTM D2657 and approved submittals or with electro fused joints following approved submittals.
2) In case of conflicts between ASTM D2657 and approved submittals or if the ASTM reference is nonspecific, follow approved submittals.
3) Joint strength: Equal to or greater than pipe strength.

3. Tracer Wire:
   a. HDPE coated ten (10) gauge or thicker solid copper wire suitable for direct bury applications.

4. Internal Pipe Stiffeners:
   a. JCM Stainless Steel Stiffener.
   b. Or Approved Equal.

2.2 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

C. Certificate of Compliance: Submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

PART 3 - EXECUTION

3.1 MAINLINE PREPARATION

A. Respond to project site within 2 hours of Engineer’s notification of problem on site. Cost incurred by the Owner due to failure to respond within time frame specified may be deducted from the Contract.

B. The size, location, and number of pits shall be determined by the Contractor and submitted for review with adequate consideration taken for disruptions to traffic and local residents.

C. Locate, expose, and protect existing utilities following Section 02 01 20 - Protecting Existing Underground Utilities.

1. It is the responsibility of the Contractor to ensure that no damage occurs to existing utilities or infrastructure within the pipe bursting affected area.
2. The Contractor shall coordinate with utilities and local agencies to repair or replace damaged underground utilities and infrastructure.

3. Contractor is responsible for all damages resulting from failure to verify the location and protect existing utilities before performing pipe bursting.

D. Vibration monitoring equipment: Placed where necessary when directed by Engineer.

3.2 BURSTING AND PIPE INSTALLATION

A. Construct access pits as necessary to facilitate pipe bursting insertion process.

1. Locate pits where interference to vehicular traffic and inconvenience to public is minimized.
2. Where practical, use water valve locations as access pit locations.
3. Prevent damage to adjacent areas during bursting process.

B. If the pipe bursting operation and reinstatement of all water services cannot be completed within the same day and within a timeframe not to exceed 10 hours, the Contractor shall provide temporary water supply to all properties affected by the pipe bursting operations in accordance the submitted Emergency Plan and with Section 01 51 36 – Temporary Water Service.

C. Contractor shall at all times have equipment and procedures in place for emergency water supply for all water customers affected by the pipe bursting operation and shall be included in the Emergency Plan submittal.

D. Existing water main may contain existing valves, fittings, tees, and point repairs. Contractor shall account for differing pipe material in bursting plan and supply proper equipment to burst through all existing conditions.

E. Do not exceed approved submittal insertion rate or force at any time. Maintain logs verifying that rate and force did not exceed submitted calculations.

F. Use approved lubricant to ease installation friction. Match lubricants to soil and insertion conditions.

G. Remove irregular internal bead projections that are not uniform and rolled-back from butt-fused joints.

H. Remove and replace improperly burst water mains at no additional cost to the Owner.

I. Replace inaccurately located or misidentified water service connections.

J. Pipes with gashes, nicks, abrasions or any such physical damage which may have occurred during storage and handling which are wider or deeper than 10% of the pipe wall thickness shall not be used and must be cut out and removed from the Site.

K. Fused segments of pipe shall be handled so as to avoid damage to the pipe. Chains or cable type chokers must not be used when lifting fused sections of pipe.

L. If the ambient air temperature is under 40 degrees F, performing fusion of HDPE pipe must be approved by the Engineer. Additional precautions such as supplying heated enclosures may be requested and are subject to approval by the Engineer.

M. Install tracer wire so that wire is continuously pulled in place with new water main pipe. Perform a continuity check on tracer wire and repair if any drop is found.

1. Install trace wire continuous with each installation for non-conductive piping material. Splice trace wire only at intermediate bore pits. Tape or insulate trace wire to prevent corrosion and maintain integrity of pipe detection.
   a. Terminate trace wire for each pipe run at structures along pipe system.
   b. Provide extra length of trace wire at each structure so trace wire can be pulled 6-feet out top of structure for connection to detection equipment.
   c. Test trace wire for continuity for each bore before acceptance.

3.3 RELAX PERIOD

A. Allow inserted HDPE pipes to rest for a period of at least 12 hours before cutting and trimming replacement pipe or making any end connections.

B. Anchor HDPE pipe with concrete anchor block and flex restraint as shown in the drawings after the minimum relaxation period.

3.4 SERVICE RECONNECTIONS

A. Service connections to the pipe shall be made with materials submitted and approved in accordance with Section 01 33 00 – Submittal Procedures and Section 33 14 17 – Water Services.

B. Lead service lines shall not be reconnected to the new water main. Replacement of lead service lines shall be performed in accordance with Section 33 14 17.81 – Lead Service Line Replacement and the referenced attachments within.

C. Water services shall be reconnected to minimize disruption of service to residents. All water services are to be reinstated within the same day and under no circumstances shall the water customer be without service overnight or for a period longer than 10 hours.

D. After the new pipe has been installed and tested, reconnect existing water services as shown in the Drawings. All service lines shall be the size and material indicated in the Drawings and Section 33 14 17 – Water Services.

3.5 PRE-CHLORINATED WATER MAIN

A. Disinfect all equipment, tools, end caps, pipe fittings or product that may contact pipe.

B. Disinfection shall be carried out by immersing or rinsing items in a sodium hypchlorite solution containing one (1) to five (5) percent chlorine.

C. Product pipe shall be fused into a string of sufficient length to complete the designated section or be coiled in a manner suitable for delivery on a pipe reel. Maximum allowable length is 800 feet.

D. The surface upon which the product pipe rests during chlorination shall be relatively impervious, such as asphalt, concrete or stone, and free from visible contamination.

E. Swabbing, chlorination and testing of the inside diameter of the pipe shall be accomplished by:
   1. Swab being inserted at the lowest end of the pipe
   2. Calcium hypochlorite tablets or granules as described in Section 33 01 10.58 – Disinfection of Water Utility Piping Systems shall be placed behind the swab.
   3. A pressure tight end cap shall be mounted to the low end of the pipe either by fusing or mechanically assembled to the pipe.
   4. Potable water shall be introduced through this end cap at a controlled rate such that the swab is propelled at a velocity less than or equal to one foot per second. All air is to be dispelled from the pipe.
   5. Upon discharge of the swab from the elevated end of the pipe, the elevated end shall be capped with a pressure tight seal. This seal having a tapped access hole at least 1.25 inches, in accordance with the American National Taper Thread (NPT) Standard or incorporating the ability to leak (purge) air or water at will by adjustment of clamping bolts. Additional potable water should be added after capping to ensure that no air remains between the caps.
   6. Pressure testing of the pipe section should be performed per details in Section 33 14 13 – Public Water Utility Distribution Piping upon replacement of the second end cap.
   7. Chlorinated solution should be maintained in the pipe for a minimum of 24 hours prior to flushing when water temperature is above 41º F (5º C), 48 hours when water temperature is 41ºF (5ºC) or less. Time for retention of the chlorinated solution shall not be significantly over designated holding time to prevent damage to the pipe or end caps.
   8. After designated holding time, the pipe shall be drained, flushed and filled with potable water to expel the highly chlorinated solution. The spent chlorinated solution shall not be allowed to enter any watershed, a sanitary sewer or any other area where environmental damage may occur without neutralizing it in accordance with local ordinances. Flushing water shall be from a known drinking water source.
   9. Test samples shall be taken from each end of the pipe on consecutive days, 24 hours apart. Samples shall be tested by a state-certified lab within 30 hours of being taken.
   10. Failure of any sample to pass a bacteriological test should result in the related section of pipe being re-flushed and retested. Should any sample again fail, the section must be chlorinated before retest.
   11. Time before re-connection of a passing pipe section shall be limited to 14 days from the last sampling. After this time the pipe must be retested to be acceptable for use.
   12. Drain the section of pipe prior to pipe bursting. The pipe shall be drained on the day of the pipe bursting and sealed after draining and for the pipe bursting process.

13. After pipe installation, the pipe shall be rechlorinated using the slug method and another bacteriological sample collected, and results reported to be negative before connecting the water main to existing mains or reconnecting services.
14. Swabs should be designated by the manufacturer as suitable for potable water system use.

3.6 FIELD TESTING

A. HDPE water main is to be pressure tested in accordance with Section 33 14 13 – Public Water Utility Distribution Piping.

END OF SECTION 33 01 30.24

SECTION 33 01 30.25 - SLIPLINING OF EXISTING SEWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cleaning and flushing of existing sanitary sewers as preparation for Sliplining.
2. Performing video inspection of existing sewers to confirm their condition and location of service connections.
3. Installing sewer Liner Pipe by method of Sliplining.
4. Reestablishing service connections.

B. Related Requirements:

1. Section 01 57 15 - Temporary Sewer Bypass Pumping.
2. Section 03 60 00 – Grouting.
3. Section 31 23 33 - Trenching and Backfill.
4. Section 31 50 00 - Excavation Support Systems.
5. Section 33 01 30.16 - Sanitary Sewer Pipeline Inspection.
6. Section 33 01 30.19 - Sanitary Sewer Pipeline Cleaning.
7. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.

C. Description:

1. This specification includes the reconstruction of gravity sewers by the installation of Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe (CCFPMP) or Fiberglass Reinforced Polymer Mortar Pipe (FRPMP) Liner Pipe. The pipes are sliplined within the existing sewer and grouted in place forming a continuous and tight-fitting reconstruction product.
2. Liner Pipe shall be as Specified in Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.
3. The liner products installed for this project shall be a rigid, single piece lining that, once assembled, the liner alone will withstand grouting forces without internal support and without deformation. External support blocking between the liner and the host pipe will be allowed to position the liner in the host sewer. In addition, the liner shall be capable of accommodating annulus grouting around the entire liner circumference in a maximum of three grouting lifts, independent of pipe size. In the long term, the lining shall be able to withstand the long-term ground and traffic loadings as well as hydrostatic pressure with passive support from the annular space grout.
4. Lining products that rely on the strength of the annulus grout to withstand hydrostatic forces or methods such as shotcrete that do not include a liner designed to meet the requirements included in this specification will not be considered.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. ASTM International:

1. ASTM C 150 - Portland Cement.
2. ASTM C 3l - Standard Method of Making and Curing Concrete Test Specimens in the Field.
3. ASTM C 39 - Standard Test for Compressive Strength of Cylinder Concrete Specimens.
4. ASTM C 172 - Sampling Fresh Concrete.
5. ASTM C 531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts, and Monolithic Surfacings.
6. ASTM F 1803 - Standard Specification for Poly (Vinyl Chloride) (PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter.
7. ASTM D 2412 - External Loading Characteristics of Plastic Pipe by Parallel Plate Loading.
8. ASTM D 2444 - Test Method for Impact Resistance of Thermoplastic Pipe and fittings by Means of a Tup (Falling Weight).
9. ASTM D 3262 - Fiberglass Sewer Pipe.
10. ASTM D 4161 - Fiberglass Pipe Joints using Flexible Elastomeric Seals.
11. ASTM F 477 - Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.3 QUALITY ASSURANCE

A. Testing: The Owner shall be notified of the place and time of testing one (1) week prior to the commencement of testing. Testing shall be completed and certified results provided prior to shipping materials.

B. Factory Testing: Testing specified shall be completed and certified results provided prior to shipping materials.

C. Manufacturer’s Experience: The manufacturer of the Sliplining product shall have demonstrated a minimum 10,000 linear feet of liner product the same as that proposed to be furnished for this project installed in the U.S or Canada.

D. Contractor Experience:

1. Contractor and any subcontractor who will perform the actual liner work shall have demonstrated previous successful experience in installation of the approved Lining in sewers owned by public agencies or municipalities. The required experience shall include the following:

a. The Contractor shall have experience installing the approved Sliplining product in sewers at least 36 inches in diameter and equivalent sized non-circular sewers. Submit a list of three (3) qualifying projects totaling a minimum of 5,000 feet of

the approved liner installed in sewers in the last ten (10) years. The list shall include diameter of pipe, length of installation, size of bypass pumping required to perform the Work, name and telephone number of pipe Owner and date of installation. The stated experience requirements for the Contractor or installation Subcontractor must be projects which used the approved liner products. All referenced experience shall be for the projects completed within the United States or Canada.

b. Submit the name(s) and qualifications for each scheduled superintendent for the project. The superintendents named shall be the superintendents assigned to the project. At least one qualified superintendent shall remain on the job during all construction activities. The qualified superintendent must have a minimum of three (3) years Sliplining supervisory field experience on at least three (3) successfully completed projects totaling a minimum of 5,000 LF of 36-inch and larger diameter Sliplining. All referenced experience shall be for projects completed within the United States or Canada. References will be checked.

2. The Contractor's bid will be deemed non-responsive if the required information is not submitted within two (2) weeks of bid opening.

1.4 SUBMITTALS

A. Provide following submittals consistent with Section 01 33 00 – Submittal Procedures:

1. Documentation demonstrating the Contractor's compliance with the qualification and experience requirements listed in Section 1.3, including a copy of the manufacturer's licensee certificate.
2. Manufacturers Certificate of Compliance for each size and type of pipe and fittings used.
3. Certified test reports on materials manufactured for this project.

B. Shop drawings which include a detailed pipe laying plan and complete materials list showing liner and fittings dimensions and construction details. Shop drawings shall also include for each liner installation all excavation locations, interfering utilities, excavation dimensions, flow bypass and traffic control schematics.

C. A pipe blocking plan or a plan to use water to fill the pipe to confirm that the liner pipe will not float and will counter buoyancy forces experienced during annular space grouting.

D. Intended method and results of the sewer proofing/verification test performed within the sewer to confirm proper fit of the liner pipe within the host pipe.

E. Method of installation of liner pipe into host sewer. If pipe jacking is selected, all related calculations shall be submitted.

F. At least two (2) weeks prior to the start of Work, submit sliplining schedule identifying daily work hours and working dates for each installation. The noise level, measured in accordance with local noise ordinances, for all equipment to be used, shall be submitted.

G. Submit Installation methods and procedures that follow the liner manufacturer's recommendations.

H. Prior to commencement of grouting, submit grouting plan and method to the Owner for review and approval. The grouting plan and method shall consist of: grout mix specification; grout installation method (pumped, gravity flow, other); volume of grout to be used; grout density, annular space bulkheads, placement of grouting ports, overflow ports, vent ports and monitoring ports; method of dealing with service connections; method for determining adequate fill of space; grout set up time; and method for securing liner and grout at the liner termination points. If grout holes are proposed in the liner to install the grout, these holes shall be seated flush to the liner per manufacturer's recommendations.

I. Reinstatement procedure for Lateral or Side Sewer Connections. This submission shall provide a description of the method and materials for reinstating existing service connections into the liner. A detailed drawing/sketch is to be included illustrating the method.

J. Design Calculations to comply with Specification Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.

K. Flow control and/or bypass pumping plan to comply with Section 01 57 15 – Temporary Sewer Bypass Pumping.

L. Grout mix design including grout additives to improve its flow properties.

M. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Exercise adequate care during transportation, handling and installation to ensure liner material is not torn, cut, or otherwise damaged. Repair or replace any part or parts of the liner material that becomes torn, cut or otherwise damaged before or during insertion, before proceeding further.

B. Install liner at acceptable temperatures per the manufactures so to ensure no reaction to the liner during installation. Any damage to the liner shall be at no additional cost to the Owner.

1.6 EXISTING CONDITIONS

A. Photographic documentation of pre-existing conditions on the surface is required and shall comply with Section 02 22 30 – Pre-Construction Video and Photographic Record.

PART 2 – PRODUCTS

2.1 LINER PIPE

A. Comply with Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.

2.2 GROUT MATERIALS

A. Cement: ASTM C 150, Type II.

B. Fly Ash: ASTM C618, Class F, except loss on ignition shall not exceed three (3) percent.

C. Water:

1. Clean and free from deleterious substances and meeting requirements of ASTM C94.
2. Maximum water-soluble chloride ion in the water shall not exceed 0.10 percent by weight.

D. Foaming Agent: ASTM C869, Mearlcrete Foam Liquid Concentrate or Cellufoam Concrete Systems Foam Liquid Concentrate.

E. Admixtures:

1. Retarder: ASTM C494, Type D.
2. Plasticizer: ASTM C474, Type A.
3. Air-Entraining Agent: ASTM C260.

F. Fine Aggregate: ASTM C33.

G. Coarse Aggregate: ASTM C33.

H. Submit grout design mix with a minimum of 300 psi, 28-day compressive strength and 100 psi, 24-hour compressive strength.

I. Testing requirements shall be in accordance with ASTM C531.

J. Incorporate grout additives to improve its flow properties, provided that the minimum compressive strength requirements are met.

K. Grout design mixes with their test results shall be submitted prior to the grouting.

PART 3 – EXECUTION

3.1 GENERAL

A. Sewer Bypassing and Dewatering:

1. Bypass sewer flow around the Work and dewater sewer lines in accordance with the requirements of Section 01 57 15 – Temporary Sewer Bypass Pumping.
2. Maintain all connections to project sewers at all times.

B. Sewer Proofing and Verification:

1. Prior to Sliplining, clean and TV inspect the sewer line in accordance with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection and Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning, respectively. If TV inspection shows a major obstruction that may prohibit or otherwise damage the liner during installation and cannot be removed by standard cleaning methods in Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning, notify the Owner.
2. Following TV inspection, verify that the sewer is free of obstructions (proof the line) and that the intended liner will fit through the host pipe, including through bends angles and grade changes, by pulling a section of liner pipe or simulated liner pipe through the existing sewer line. The proofing section shall have the same diameter dimensions and length as the intended slipline pipe. The method of installing the proofing section, such as mechanically pulling or manually pushing, shall be determined by the Contractor as approved by the Engineer.
3. No Sliplining shall be performed until the sewer has been successfully proofed. Where the sewer is unacceptable for sliplining, review the TV inspection report and determine the location(s) where spot repair(s) or additional cleaning is required. Spot repairs shall be completed when authorized by the Owner.
4. Where bends or changes in grade are shown on drawings or noted on inspection reports, make detailed measurements and survey for pipe layout prior to ordering materials.

3.2 ACCESS PIT

A. Excavation shall be in accordance with Section 31 23 33 – Trenching and Backfill.

B. Access pit excavations shall be performed at all points where the liner pipe will be inserted into the existing sewer. When possible, access pit excavations shall coincide with side sewer connections or changes in the sewer line or grade.

C. At the access pit, the top of the existing sewer shall be removed down to the spring line. The edge of the existing pipe shall be smoothed to eliminate sharp edges that could damage the liner pipe.

D. Upon successful completion of the grouting of the annular as confirmed by the Owner, the access pit shall be backfilled in accordance with Section 31 23 33 – Trenching and Backfill.

E. Sheeting, sorting and bracing shall be in accordance with Section 31 50 00 – Excavation Support Systems. Access pit sheeting, shoring and bracing systems shall remain completely separated from the pipe support system.

3.3 INSTALLATION

A. Liner Pipe Insertion:

1. Maintain continuous operation of the sewer system, utilizing special construction techniques in the wet, or bypass pumping, or other means of handling the flows. A flow control plan shall be submitted to the Owner for approval prior to the start of Work.
2. Clear all debris and dirt from inside the sewer before installing and keep it clean until accepted.
3. The installation of pipe and fittings shall be in accordance with the project plans and specifications and the manufacturer's requirements and as approved by the Owner.
4. Insert liner pipe with spigot end first with bell end trailing.
5. Protect leading pipe spigot end with a nose piece designed to ride up and over offset joints and other minor inconsistencies in the invert.
6. Pushing forces shall be applied only to the wall end inside of the bell.
7. Lay accurately to lines and grades indicated on the Drawings or specified. Provide accurate alignment, both horizontally and vertically.
8. Install sliplining true to line and grade.
9. No open cut within the sliplining limits shown on the plans will be permitted without specific written authorization of the Owner.
10. Liner ends shall be closed as detailed on the Drawings.

3.4 REINSTATEMENT OF SERVICE CONNECTIONS

A. General:

1. The exact location and number of service connections and side sewers shall be determined during the initial television inspection. Accurately field locate all existing service connections or side sewers. Reconnect all service reconnections or side sewers to the liner pipe as indicated in accordance with the Contract Documents.
2. Restore or correct without any delay, all missed or faulty reconnections, and repair any damage caused to property owner.
3. Any lateral not initially reinstated that proves to be active shall be reinstated at no additional cost and any resulting property damage shall be restored to original condition at no cost to the Owner.
4. Service connections and side sewers shall be maintained during lining or grouting operations. Locations of side sewers indicated on drawings do not relieve Contractor from locating all service laterals and cleanouts. The connections shall be made from within the liner sewer or by open cut as detailed on the construction drawings. Service laterals shall be connected to the liner pipe as shown on the drawings and as recommended by the pipe manufacturer.

5. Provision shall be made to prevent any grout or other material from entering the existing service connection or the side sewer. Remove at no additional cost to the Owner any grout or other material that has entered the service connection.
6. All service connections and side sewers to be reconnected to the main sewer shall be cleaned to a length of three feet from the inside face of the existing wall of the main pipe. (one foot for mainline pipes smaller than 24 inches in diameter). All deposits within the first three feet of the service connection or side sewer (one foot for mainline pipes smaller than 24 inches in diameter) shall be removed, and laterals reinstated as shown in the Contract Drawings.

3.5 GROUTING OF ANNULAR SPACE

A. Installation methods and procedures shall follow the pipe liner and grout manufacturer's recommendations.

B. The annular space between the outside of the liner and the inside of the existing sewer shall be grouted.

C. Furnish and install grout with a minimum of 300 psi, 28-day compressive strength.

D. Grouting of the annular space shall be done in such a manner as to prevent damage or collapse of the liner. Grout shall be pumped into the annular space at the manholes and wherever the liner is exposed. If the distance between grout points exceeds the Contractor's pumping capability, as previously demonstrated, excavate additional grouting points at no cost to the Owner.

E. At manholes, trowel the grout to form a smooth transition between the manhole base and the liner. Do not damage the manholes during grouting.

F. Monitor joints and all side sewers or laterals during grouting annular space to assure that no grout enters these sewers. If any grout is discovered in these sewers after or during grouting, the excess grout shall be removed at no additional cost to the Owner.

G. Prevent the liner from floating or collapsing during grouting by blocking or filling the liner with water or some other positive method, as approved by the Engineer.

3.6 TV INSPECTION

A. After the installation of the liner and after annular space has been grouted, the liner shall be TV inspected in accordance with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection and submitted to the Owner. Where the TV inspection indicates the liner wall is damaged or forced out of round through grouting, the affected portion(s) of the liner shall be replaced at no additional cost to the Owner.

3.7 FIELD TESTING AND ACCEPTANCE

A. Field acceptance of the liner shall be based on the Owner's evaluation of the installation including a review of CCTV videos.

B. There shall be no infiltration through the liner.

C. After the annular space has been grouted, verify that all the annular space has been filled. Method shall be per the liner manufacturer and as approved by the Owner. Where the annular space indicates that the grout did not fully fill the area, the affected portion(s) of the liner shall be grouted at no additional cost to the Owner.

D. All service connections shall be open and clear. All service and manhole connections shall be watertight.

E. There shall be no evidence of splits, cracks, breaks, deformed or separated joints, or crazing in the liner.

F. If any detective liner is discovered after it has been installed, it shall be repaired per the manufacturer's recommendations at no additional cost to the Owner. Submit to the Owner the written manufacturer's approved process one week prior to repair.

G. Test for complete filling of the annular space with grout. This test shall be performed by sounding the entire circumference of the pipe at regular intervals.

3.8 CLEANUP

A. After the Work has been completed, clean up the entire project area. All excess material and debris not incorporated into the permanent installation shall be disposed of off-site in a lawful manner.

END OF SECTION 33 01 30.25

SECTION 33 01 30.60 – SPOT REPAIR OF EXISTING SEWERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies sewer rehabilitation by spot repair of existing sewers as shown on the contract documents for the selected liner method, or as authorized by the Engineer.

B. Man-entry repairs shall be defined as repairs in pipes 42-inches and larger in height or diameter. Non-man-entry repairs shall be defined as repairs in pipes less than 42-inches in height or diameter.

C. Rehabilitate sewers to their original function as specified herein and in accordance with the Contract Documents, or as otherwise authorized by the Engineer. Furnish all labor, materials, utilities, operation, equipment and incidentals necessary to complete the spot repairs in entirety and provide rehabilitated sewers ready for operation.

D. Related Requirements:

1. Section 01 55 26 – Traffic Control.
2. Section 01 57 15 – Temporary Sewer Bypass Pumping.
3. Section 03 20 00 – Concrete Reinforcing.
4. Section 03 60 00 – Grouting.
5. Section 31 23 33 – Trenching and Backfill.
6. Section 31 50 00 – Excavation Support Systems.
7. Section 33 01 30.61 – Packer Injection Grouting.
8. Section 33 01 30.72 – Cured-In-Place Sewer Lining.
9. Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. International Concrete Repair Institute (ICRI):

1. ICRI 03732 – Guidelines for Surface Preparation of Concrete.

B. American Concrete Institute (ACI):

1. ACI 439.5R-18 – Comprehensive Guide for the Specification, Manufacture and Construction Use of Welded Wire Reinforcement.

C. ASTM International:

1. ASTM C32 – Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale).
2. ASTM C67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
3. ASTM C91 – Standard Specification for Masonry Cement.
4. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
5. ASTM C144 – Standard Specification for Aggregate for Masonry Mortar.
6. ASTM C150 – Standard Specification for Portland Cement.
7. ASTM C191 - Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
8. ASTM C1173 – Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
9. ASTM F2599 - The Sectional Repair of Damaged Pipe By Means of An Inverted Cured-In-Place Liner.

D. Occupational Safety and Health Administration (OSHA):

1. OSHA 29 CFR 1926 – U.S. Occupational Safety and Health Standards, Current Edition.

1.3 QUALITY ASSURANCE

A. Comply with Section 01 40 00 – Quality Requirements.

B. Contractor's Qualifications: The Sewer Rehabilitation Contractor shall have a minimum of five (5) years continuous successful experience in the repair of sewers similar to that required under this Contract.

C. Work Schedule: Coordinate with applicable authorities, agencies, and Engineer in preparing Contractor's work schedule.

1.4 PRODUCT SHIPPING, STORAGE AND HANDLING

A. Protect all materials and prevent damage during shipping, handling, and storage.

B. Comply with manufacturer-recommended practices for shipping, storage, handling, and installation of materials.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Submit documented experience of completion of at least three (3) projects of similar scope. Submit in accordance with Section 01 33 00 – Submittal Procedures, documentation for each project the name of project, location (city and state), value of the sewer repair work performed under the contract, the name of the Owner or Owner's representative, and contact information.

C. Submit shop drawings that include a complete list showing materials, fittings, special joints and assembly thereof, dimensions, and construction details. When required for spot repair, shop drawings shall also include for each installation all excavation locations, interfering utilities, excavation dimensions, flow control schematics, and traffic control schematics.

D. At least two (2) weeks prior to the start of Work, submit a spot repair schedule identifying the Contractors sequence of work, locations, daily work hours, and working dates for each installation.

E. Submit the manufacturer's recommended cure schedule.

F. Submit a Flow Control Plan to the Engineer for approval prior to the start of Work.

G. After Work is completed, submit a video documenting the repair to the Engineer.

H. Submittal information required by the referenced Specification Sections.

1.6 GUARANTEE

A. Submit written guarantee of all Work as specified in General Terms and Conditions Article 8.

PART 2 - PRODUCTS

2.1 GENERAL

A. Products for spot repairs are specified or referenced under each rehabilitation type described herein. Each material shall be manufactured specifically for the particular type of spot repair for which the material is applied.

B. The repair materials shall be compatible with the substrate to which the material is applied.

2.2 WATER

A. Water shall be potable. Furnish all water required for the Work.

B. Obtain the necessary permits and meet all other requirements of the Engineer or other local agencies if obtaining water from fire hydrants or other public or private water suppliers. Make arrangements with such agencies for metering water use.

2.3 PIPE REHABILITATION: MAN-ENTRY SEWER REPAIRS

A. Missing and Displaced Bricks and Clay Tiles Repair: Repair material for brick replacement repair at locations that are below 45 degrees from the crown of the sewer in each direction for missing and displaced brick repairs may be either Sewer Brick and Cement Mortar or Repair Mortar. Repair material must be Repair Mortar for repair locations that are at are 45 degrees from the crown of the sewer and above. These limits also apply to equivalent perimeter for pipes that are non-circular. Repair material for missing and displaced Clay Tile repairs must be Repair Mortar.

1. Sewer Brick shall conform to ASTM C32, Grade SS for sewers. Average dimensions of brick shall be those to match existing for repair and replacement work.
2. Cement Mortar
    a. Masonry cement shall conform to ASTM C91. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar.
    b. Aggregate for mortar shall be sand conforming to ASTM C144.
    c. Water shall be clean, potable, and free from substances, which could adversely affect the mortar.
    d. Mortar shall contain an admixture of Master Builders Rheomix 235, Sonneborn Hydrocide Powder, or approved equal.
    e. Mortar shall be ASTM C270, Type M for sewer walls and other load-bearing or shear-wall masonry with exception to re-pointing materials. Waterproofing compound shall be added in accordance with manufacturer's recommendations. Air content shall not be less than 11 percent. Dye colored mortar shall not be used.
    f. Premixed mortar shall be ASTM C270, Type M for use as specified herein. Water proofing compound shall be added in accordance with manufacturer's recommendation. Air content shall not be less than 11 percent. Die colored mortar shall not be used.
    g. Admixtures shall be used in cement mortar to accelerate curing. The accelerator shall provide for workability, shall not adversely affect bonding or compressive strength, and shall provide for a final set time of 3 to 5 hours. The cement mortar accelerator shall be non-chloride. Accelerator shall be Trimix-NCA as manufactured by Sonneborm, Accelguard 80 as manufactured by Euclid Chemical Company, or approved equal.

3. Repair Mortar:
    a. Repair mortar shall be a one-component system consisting of processed cement, graded aggregate, and microsilica and polypropylene fibers. The repair mortar shall be specifically designed for sewer pipe repair, shall be resistant to hydrogen sulfide attack in environments with pH greater than or equal to 2, capable of installation on damp surfaces and non-shrinking, and impermeable to infiltration.
    b. The mortar consistency prior to application shall be a paste form capable of being troweled or sprayed on without sagging when applied in horizontal or overhead configurations with up to 1-1/2-inches of mortar depth on one (1) pass. The repair mortar shall have a maximum initial set of 2 to 3 hours and a maximum final set time of 3 to 4 hours. The repair mortar shall have the following properties as determined by independent testing laboratory:

Flexural Strength, ASTM C78-84	Minimum 1,300 psi @ 28 days
Compressive Strength, ASTM C109	Minimum 9,000 psi @ 28 days
Splitting Tensile Strength, ASTM C496	Minimum 900 psi @ 28 days
Slant Shear Bond Strength, ASTM C882 (Modified)	Minimum 3,000 psi @ 28 days

c. Repair mortar shall be ThoRoc SP-15 as manufactured by Thoroc, EMACO S88 CI as manufactured by BASF, Sika Repair 224 as manufactured by Sika Corporation, or approved equal.

4. Rapid-Set Repair Mortar:
   a. Rapid-set repair mortar shall be a rapid setting mortar consisting of a blend of cements, chemical additives, and graded aggregate and free of chloride admixtures. The mortar shall be designed for high early strength to minimize downtime of the sewers. The repair mortar shall be specifically designed for sewer pipe repair, shall be resistant to hydrogen sulfide attack, capable of installation on damp surfaces and non-shrinking, and impermeable to infiltration.
   b. The mortar consistency prior to application shall be trowelable or pourable to suit the application. The repair mortar shall have a maximum initial set of 20-minutes and a maximum final set time of 30-minutes. The repair mortar shall comply with ASTM C928 and have the following properties as determined by independent laboratory testing:

Flexural Strength, ASTM C78-84	Minimum 1,100 psi @ 28 days
Compressive Strength, ASTM C109	Minimum 9,000 psi @ 28 days
Splitting Tensile Strength, ASTM C496	Minimum 1,300 psi @ 28 days
Slant Shear Bond Strength, ASTM C882 (Modified)	Minimum 3,100 psi @ 28 days.

   c. Rapid-set mortar shall be ThoRoc 1060 Rapid Mortar as manufactured by Thoroc, EMACO T415 as manufactured by BASF, Sika Repair 223 as manufactured by the Sika Corporation, or approved equal.

5. Cementitious Hydraulic Repair Mortar:
   a. Shall be a one-(1) component, cementitious, very fast-setting restoration/repair mortar and water/sewer plug and shall have the following properties as determined by laboratory testing:

1)	Compressive Strength, ASTM C109	3,000 psi @ 1 day 6,500 psi @ 28 days
2)	Set Time, ASTM C191	Initial: 3-5 minutes Final: 6-8 minutes

B. Missing Mortar Repair: Repair material for missing mortar brick re-pointing repair shall be Pre-Mix Hydraulic Cement:

1. Pre-Mix hydraulic cement shall be a premixed Portland cement based hydraulic cement consisting of Portland cement, graded silica aggregates, and plasticizing and accelerating agents. It shall not contain chlorides, gypsum, plasters, iron particles or gas forming agents, or promote the corrosion of steel it may come in contact with. The pre-mix hydraulic cement shall have an initial set time not greater than 30-minutes, designed to be troweled or knead applied and shall provide a watertight seal when cured. The cured product shall have the following physical properties:

Property	Result
Set Time (ASTM C-191-92)	Maximum 30-minutes
Compressive Strength (ASTM C-109-91)	
1 Hour	600 psi (4.2 MPa)
1 Day	2,200 psi (15.2 MPa)
8 Days	5,000 psi (34.6 MPa)

2. The pre-mix hydraulic cement shall be ThoRoc Patch as manufactured by ThoRoc, Sika Set Mortar, as manufactured by Sika Corporation, or approved equal.

C. Fracture/Crack Repair:

1. Repair material for fracture repair shall be repair mortar as specified herein, unless specified otherwise.
2. Where crack repair in brick sewer crowns is approved by the Engineer, make repairs with:
   a. Sika Sikadur 31 Hi-Mod gel LPL
   b. Sidakur Anchor Fix-3 or Sikadur Anchor Fix-4,
   c. Or approved equal.

D. Hole Repairs (Brick or Concrete Sewer):

1. Repair material for hole repair shall be repair mortar as specified herein. The Contractor has the option of using Rapid-Set Repair Mortar when performing hole repairs below the spring line of the pipe. Rapid-Set Repair Mortar shall be as specified herein.
2. Pipe Deterioration Repair: Repair material for pipe deterioration repair and additional pipe deterioration repair shall be Repair Mortar as specified herein.

E. Sewer Repair Reinforcement: Repair material for sewer repair reinforcement shall be in accordance with Section 03 20 00 – Concrete Reinforcing. If the Contract Drawings do not indicate a concrete reinforcement detail, concrete reinforcement for sewer repair shall be designed by the Contractor and submitted to the Engineer for approval. All sewer repair reinforcement materials shall be coated with one (1) of the following epoxy primers:

1. ThoRoc Rebar Primer as manufactured by ThoRoc.
2. EMACO P-22 as manufactured by Master Builders.
3. Or approved equal.

F. Service Repair by Grout: Repair material for service repairs shall be repair mortar as specified herein and PVC pipe as specified in Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.

G. Abandon Service: Repair material for capping non-active services shall be non-shrink grout as specified in Section 03 60 00 – Grouting.

H. Joint Repair, Concrete Pipe: Repair material for Joint Repair, Concrete Pipe shall be Repair Mortar as specified herein.

I. External Grout for Sewers/Manholes (Cementitious): Repair material for external grout for sewers (cementitious) shall be cement grout as specified in Section 03 60 00 – Grouting.

J. Elimination of Inflow/Infiltration: Repair material to seal inflow/infiltration shall be hydraulic cement and, if approved, Chemical Grout.

K. Hydraulic Cement:

1. The hydraulic cement shall be a rapid-set hand-mixed cementitious compound specifically formulated for use in stopping infiltration water entering the pipe through the pipe wall. The repair material shall be specifically designed for direct application to active infiltration, shall have a minimum set time of 5 minutes, and shall be resistant to hydrogen sulfide attack and non-shrinking.
2. The mortar consistency prior to application shall be trowelable or pourable to suit the application. The hydraulic cement material shall have the following properties as determined by independent laboratory testing:

Compressive Strength, ASTM C109	Minimum 2,000 psi @ 24 hrs.
Bond Strength, ASTM C900/D4541	Minimum 150 psi @ 24 hrs.

3. Rapid-set hydraulic cement shall be ThoRoc Plug as manufactured by Thoroc, EMACO 503 as manufactured by BASF, Sika Set Plug as manufactured by the Sika Corporation, or approved equal.

L. Chemical Grout:

1. The Contractor has the option to select either an acrylate based, or methane based, gel grout. Acrylamide grouts are prohibited. Acceptable grouts are as follows:

Chemical Grout	Type of Grout	Manufacturer
AV-254	Urethane	Avanti International
5610	Urethane	3M Company
FLEXGEL	Urethane	DeNeef America, Inc.

2. Chemical Grout Additives:
   a. Unless otherwise specified, incorporate into the grout mixture; chemical additives for shrink control, root control and strength in accordance with the manufacturer's written instructions. Diatomaceous earth, such as Celite 292 as manufactured by Johns Manville, shall be added for strength at a ratio of 50 pounds per 50 gallons

of grout catalyst (water). Dichlobenil shall be added to the grout catalyst for root control to achieve a minimum concentration of 200 ppm. Add a shrink control additive to the grout catalyst at a ratio of 10 to 15 percent of the volume of catalyst.

b. The applied grout mixture shall consist of eight parts catalyst to one-(1) part urethane. Follow the manufacturers written instructions regarding chemical handling, storage, application and disposal.

2.4 PIPE REHABILITATION: NON-MAN-ENTRY REPAIRS

A. Open Cut Point Repair: Repair material for mainline replacement by open cut repair shall be pipe and fittings as specified in Section 33 31 11 – Public Sanitary Sewerage Piping. All flexible couplings shall conform to ASTM C1173, match the pipe size to which the coupling is applied, and be specifically designed for the connections to the pipe materials. Flexible couplings shall be Fernco 1000 RC Series or approved equal. Coupling fasteners and bands shall be stainless steel.

B. Sewer Service repair by Open Cut: Repair material for service repair by open cut shall be pipe and fittings as specified in Section 33 31 11 – Public Sanitary Sewerage Piping. All flexible couplings shall conform to ASTM C1173, shall match the pipe size to which the coupling is applied, and shall be specifically designed for the connections to the pipe materials. Flexible couplings shall be Fernco 1000 RC Series or approved equal. Coupling fasteners and bands shall be stainless steel. The annulus space between the service and connecting mainline pipe shall be filled with 2,000 psi concrete as specified in Section 03 30 00 – Cast-in-Place Concrete and in the DWSD Sewer Standard Detail for Wye, Connection and Extension.

C. Sewer Trenchless Point Repair and Lateral Tee Liner by CIPP Liner:

1. General:
   a. Trenchless Point Repairs shall be the installation of a segmented CIPP liner to be installed on a section of existing sewer that will not reach manhole to manhole. Lateral tee liner is the installation of a CIPP liner in a sewer service (lateral) from the sewer main to improve the sewer service connection to the main.
   b. Trenchless Point repairs and lateral tee liners shall generally conform to ASTM F2599 - The Sectional Repair of Damaged Pipe by Means of An Inverted Cured-In-Place Liner and F2561-11 - Standard Practice for Rehabilitation of a Sewer Service Lateral and Its Connection to the Main Using a One-Piece Main and Lateral Cured-in-Place Liner.

2. Material:
   a. The liner assembly shall be continuous in length and consist of one (1) or more layers of absorbent textile material (i.e., needle punched felt or circular knit) that meet the requirements of ASTM F1216 and ASTM D5813 Sections 6 and 8. The textile tube and sheet shall be constructed to withstand installation pressure, have sufficient strength to bridge missing pipe segments, and flexibility to fit irregular pipe sections. The wet-out textile tube and sheet shall meet ASTM F1216, and shall have a uniform thickness and 5% to 10% excess resin distribution that when compressed at installation pressures will meet or exceed the design thickness after cure.

b. The outside layer of the textile tube (before inversion) and interior of the textile sheet shall be coated with an impermeable, translucent flexible membrane. The textile sheet before insertion shall be permanently marked as a "Service Identification" correlating to the address of the building or footage and the service pipe services. The sheet and tube shall be surrounded by a second impermeable, flexible translucent membrane (translucent bladder) that will contain the resin and facilitate vacuum impregnation while monitoring of the resin saturation during the resin impregnation (wet-out) procedure.

2. Resin System:
   a. The resin/liner system shall conform the ASTM D5813 Section 8.2.2 – 10,000-hour test.
   b. The resin shall be a corrosion resistant polyester, vinylester, epoxy or silicate resin and catalyst system that when properly cured within the composite liner assembly, meets the requirements of ASTM F1216, the physical properties herein, and those which are to be utilized in the design of the CIPP, for this project.
   c. The resin shall produce CIPP which will comply with the structural and chemical resistance requirements of ASTM F1216.

Table 33 01 30.60-1: CIPP Initial Structural Properties

Property	ASTM Test	Minimum Value
Flexural Strength	D 790	4,500 psi
Flexural Modulus	D 790	250,000 psi

3. Design Considerations:
   a. The CIPP shall be designed per ASTM F1216, Appendix X1 as a gravity pipe in a fully deteriorated pipe condition.
   b. The liner shall be sized in accordance with the design objectives to provide a close-fit with the host pipe with no annulus with the exception of the maximum allowable diametric shrinkage due to curing permitted in ASTM D5813.
   c. A design check shall be performed to confirm that the rehabilitated section of pipe will have a hydraulic capacity equal to or greater than the existing pipeline. This design check shall be based on full flow capacity and the use of Manning's formula. The assumed long-term Manning's 'n' for the CIPP Section shall be 0.012. The roughness of the existing section shall be estimated based on the observed condition of the pipeline from the CCTV inspection.
   d. The design features of the point repair and lateral tee liner system shall also include:
      1) Tapered end section to promote a smooth transition from point repair to host pipe.
      2) A means to facilitate flow through by-pass of existing wastewater during the course of the repair with the exception of sewer laterals which can be blocked but must not cause any resident backups at any time.

D. Sewer Trenchless Point Repair by Packer Injection Grouting: Repair material for mainline or service repair in locations as approved by the Engineer shall be as specified in Section 33 01 30.61 – Packer Injection Grouting.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor is responsible for inspection of existing pipe in order to determine accurate location and extent of the repair. Conditions may have changed from previous condition assessment or inspections provided to the Contractor. Television inspection shall be in accordance with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection and performed with appropriate flow control. Inspection for the purpose of locating and determining extent of repair will not require PACP coding.

B. Where a specific method of applying the repair materials is not specified herein, select and submit to the Engineer for review a proposed mechanical method of applying the repair materials that is suited for the Contractor's execution of the Work. Options include troweling, forming and low-pressure pumping, forming and pouring, and low-pressure spray application. Do not proceed to use the application method prior to review and acceptance by the Engineer. Regardless of type of mechanical application approved by the Engineer, apply all materials in strict accordance to manufacturer's requirements and meet the intent of the specifications herein.

C. Review and be familiar with the specified repair products to ensure that surfaces are adequately prepared, proper mixing ratios are met, and that the Contractor's Work Plan considers the applicable material set times to avoid wasting materials.

3.2 FLOW CONTROL

A. Maintain continuous operation of the sewer system utilizing special construction techniques in the wet, bypass pumping, or other means of handling flows. Divert flow around the Contractor's Work in accordance with the requirements of Section 01 57 15 – Temporary Sewer Bypass Pumping.

B. Control all flow around Contractor's Work until the sewer repairs are complete and approved by the Engineer.

3.3 SURFACE PREPARATION OF SEWERS FOR SPOT REPAIRS

A. Clean and prepare all the surfaces and substrates to be repaired. Prior to beginning Work on each spot repair, verify the size of the existing pipe, ovality, alignment and other dimensional constraints. Physical conditions that do not provide for suitable installation of the specified sewer rehabilitation type shall be immediately brought to the attention of the Engineer. The Engineer will review the site conditions and determine the appropriate action to be taken for execution of

the repair. The Engineer shall be the final authority for deciding whether or not the specified sewer rehabilitation type is suitable for the site conditions.

B. Surface preparation of the pipe shall be performed at each spot repair location and shall be specific to each spot repair depending on the condition of the pipe.

1. All pipe surfaces to be repaired shall be contaminate-free and shall have no dirt, dust, oil, grease, efflorescence, rust, previous costings of any kind, encrustations, spalled masonry (including mortar, concrete, and brick), projections and loosely adhering materials.
2. Exposed pipe reinforcement shall be clean and be free of scale and rust.
3. The finished surfaces shall consist of sound pipe materials, shall be dry and have a pH between 7 and 9 before applying any material.
4. Water blasting utilizing appropriate nozzles and application pressures shall be the primary method of cleaning; however, other methods such as wet or dry sandblasting, citric acid wash, concrete cleaners, degreasers, wire brushing and scraping, or other mechanical means may be required to properly clean the surface.
5. No acids, cleaners or degreasers shall be hazardous, nor have a deleterious effect on waste water plant operations. Proposed chemicals shall be approved by the Engineer before use.

C. If the Engineer determines that the pipe does not appear sufficiently clean for the spot repair methods, re-clean the spot repair area until acceptable to the Engineer and at no additional cost to the Owner.

D. Take precautions to preserve the condition of pipe material surrounding the spot repair area so that intact and sound materials are not damaged. Prior to utilizing hydraulic, chemical or mechanical cleaning equipment and methods on sewer pipes, demonstrate to the Engineer that the proposed cleaning equipment and methods will not damage intact and sound pipe material. The Contractor's demonstration shall consist of the Contractor field-testing the proposed cleaning method in the presence of the Engineer at one (1) spot repair for each type of pipe material, and in the case of clay tile and brick pipes, in each pipe reach designed for spot repairs. Provide live CCTV video of the demonstration for the Engineer's viewing. Determine the maximum allowable application pressure use to during cleaning procedures to meet the specifications herein. Adjust application pressures after Engineer-witnessing the field demonstrations to optimize surface preparation while preserving the condition of pipe material.

E. For man-entry spot repairs, within five (5) feet in any direction beyond extents of the spot repair, the pipe walls shall be visually examined and physically sounded or probed by use of a hammer or similar equipment for detection of unsound materials and void areas outside of the pipe. Care shall be taken to avoid damaging sound pipe materials. Unsound materials shall be removed, and the pipe and soil voids repaired with the specified materials. Existing voids found to exist behind walls and external to the pipe shall be repaired after the pipe wall defect is repaired. Payment for repairs outside of the limits listed on the plans will be paid for under the appropriate Additional Payment Item.

3.4 ELIMINATION OF SEWER INFLOW/INFLITRATION

A. General:

1. Inflow/Infiltration is defined as water that penetrates the inside of a pipe from outside of the pipe. Active inflow/infiltration quantity may occur over a wide flow range and evidence of infiltration will vary from a damp pipe surface to dripping water to a steady stream of flow. Additionally, inflow/infiltration may occur in a small specific area such as a pipe joint over a large surface area of pipe. Identify, isolate, and eliminate inflow/infiltration in repair areas indicated on the Drawings and elsewhere as directed by the Engineer under all inflow/infiltration conditions encountered in the pipe. Unless otherwise specified or authorized by the Engineer, repair inflow/infiltration with hydraulic cement as specified herein.
2. All inflow/infiltration repairs shall be made during dry weather periods defined as at least 48 hours of no recorded precipitation prior to commencement of the repair.
3. If the quantity of inflow/infiltration through the pipe wall is large enough where troweling or pressure injection installation of a sewer plug from inside the pipe cannot eliminate the inflow/infiltration, up to four holes may be drilled around the base of the pipe to act as relief ports and allow the water to seep into the pipe flow channel. The diameter of the holes shall be such that grouting the holes with sewer plug will stop inflow/infiltration through the relief holes. If four relief holes do not provide sufficient relief of inflow/infiltration, drill up to four additional relief holes until sufficient relief of inflow/infiltration is achieved. Relief holes shall be grouted after all other inflow/infiltration has been eliminated. The cost of drilling and grouting relief holes shall be included in the cost of the repair type and at no additional cost to the Engineer.
4. When inflow/infiltration conditions exist, which preclude the use of hydraulic cement, submit to the Engineer a request to proceed with a chemical grout repair. The Engineer will review the site conditions and make the final determination on which repair material should be used. Unless otherwise specified, do not proceed with chemical grout repairs without written approval from the Engineer. Chemical grout repairs shall be performed as specified herein. Chemical grouting shall be paid for under the appropriate Additional Payment Item.

B. Application of Hydraulic Cement :

1. Prior to application of the sewer plug, the substrate shall be prepared in accordance with manufacturer's requirements and as specified herein. The material shall be constructed by applying wet on wet layers without allowing previous layers to dry out. Protect against material sags and slumps. If the repair material sags and slumps, it shall be removed and replaced with new material at a layer thickness and interval that does not allow sag or slump. All excess material shall be removed, and the final layer shall be struck flush with the surface of the substrate.
2. Cure the material in accordance with the manufacturer's requirements and protect against freezing temperatures and washout throughout the curing period.

C. Application of Chemical Grout:

1. The grouting equipment shall be compatible with the requirements of mixing, pumping and placing the specified chemical grouting materials. The materials shall have the ability to accept suspended additives for increased strength and shall be mixed in strict conformance with manufacturer's requirements. Chemical grouts and admixtures shall be continuously agitated to keep the admixtures in suspension. All mixing and agitation equipment shall be power operated with variable speed controls. The applied chemical grout shall have the following properties:
   a. A controllable reaction time, from ten seconds to one (1) hour at temperatures from ambient to freezing.
   b. It shall be a true viscous solution that remains constant until gelatinization occurs.
   c. The ability to tolerate ground water dilution and react in moving water.
   d. The final reaction shall produce a continuous irreversible impermeable stiff gel, which is not rigid or brittle.
   e. The base solution can be varied by an addition of suspended solids, such as diatomaceous earth or other inactive solids. The effect of additives not specifically mentioned herein must be submitted and approved by the Engineer prior to use in the field.

3.5 SURFACE RESTORATION

A. Surface conditions that are altered through the Contractor's Work shall be restored to match existing conditions.

B. Replacement of roadways, driveways, walks, curbs, and other surface materials shall be in accordance with these Specifications.

3.6 TRAFFIC CONTROL

A. Furnish traffic control as required by the local agency having jurisdiction.

B. Comply with the requirements of Section 01 55 26 – Traffic Control.

3.7 CLEANUP

A. During the progress of the Work, maintain all job sites in a clean and orderly condition.

B. Restore facilities and site areas damaged by construction operations to existing condition before spot repair.

3.8 PIPE REHABILITATION – MAN-ENTRY SEWER REPAIRS

A. Abandon Service:

1. Only as directed by the Engineer, inactive services shall be abandoned in place.
2. Fill the inactive services with grout to a minimum of 6-inch depth from the face of the service at the connecting mainline pipe into the service pipe.
3. Protect from grout entering the service beyond 12-inches from the face of the service at the connecting mainline pipe into the service pipe.
4. The grout shall be struck flush with the face of the service at the adjoining mainline pipe.

B. Cut Protruding Service/Tap Repair: Services protruding into the adjoining mainline pipe that inhibit liner insertion or other rehabilitation methods Engineer shall be trimmed flush with the interior surface of the connecting mainline pipe. Services intruding into the pipe twenty percent (20%) or greater of the diameter of the pipe may be called out to be cut even if a subsequent lining or rehabilitation is not requested.

C. Chemical Grout: As indicated on the Drawings or where directed by the Engineer, and where hydraulic cement does not stop active inflow/infiltration, inflow/infiltration shall be stopped using chemical grout as specified herein.

D. Concrete Deterioration, Fracture/Crack, and Hole Repair for Concrete Pipe and Brick/Clay Tile Sewers:

1. Hole defects in concrete pipe, and brick sewers (where all courses are missing, and soil is exposed) shall be prepared in accordance with manufacturer's requirements and as specified herein.
2. Remove all loose and unsound pipe materials.
3. For concrete deterioration repairs, cut or chisel the edges of the areas to be repaired to a depth of at least 2 inches and then roughen the smooth cut edges to create a profiled edge for material bonding. Feathered edges are prohibited. For superficial repairs where saw-cutting the defect edges is not applicable, mechanical means or abrasive blasting shall be used to roughen the substrate to create a profiled surface for material bonding.
4. For hole repairs, cut or chisel the edges of the areas to be repaired to a depth of at least ½-inches, and then roughen the smooth cut edges to create a profiled edge for material bonding. Feathered edges are prohibited. Mechanical means or abrasive blasting shall be used to roughen the substrate to create a profiled surface for material bonding.
5. For fracture repairs, pre-clean crack/fracture with hand tools and pressure wash to remove any loose debris and pressure wash crack. Cut or chisel the edges of the areas to be repaired to a width of at least ¼-inches and a depth of at least ¼-inches. Existing fractures having width and depth exceeding ¼-inches do not require enlargement; however, the facing surfaces on the sides of the fractures shall be cut or chiseled square. Once the fracture has been cut square, all surfaces shall be roughened to create a profiled edge for material bonding. Feathered edges are prohibited.
6. For large holes, after surface preparation of the defect area, reinforcement shall be placed as specified herein and as shown on the Drawings.

7. For concrete deterioration repairs, existing reinforcing shall be completely exposed with a 3/4-inch minimum clearance at all sides. Thoroughly clean reinforcing and completely encapsulate the existing reinforcing steel with repair material. If the existing steel reinforcing is deteriorated, completely expose and remove all deteriorated steel and replace with new reinforcing steel. The Engineer will review and approve all areas prior to removal of concrete. Any replacement steel shall provide a minimum area of steel equal with that which has been removed or deteriorated. All new reinforcing shall be anchored into the existing concrete sufficiently to develop the strength of the reinforcing bars and should provide a minimum of two (2) inches of concrete cover.
8. Thoroughly soak the substrate with water and then remove excess water to provide a saturated surface dry condition immediately prior to application of the repair material. Once the defect is fully prepared to receive the repair material, install the repair material in accordance with the manufacturer's requirements, Section 03 60 00 – Grouting, and as specified herein.
9. For concrete deterioration, brick/clay tile sewer, and fracture repair, the repair material shall be applied in layers not less than ½-inches thick but not more than the manufacturer's recommendations. The required material thickness for concrete deterioration repair shall be equal to the depth of the defect or, when preparation of the defect results in a hole completely through the pipe wall, the total material thickness shall be equal to the total pipe wall thickness. The required material thickness to complete the brick repair shall be equal to the total pipe wall thickness surface. The required material thickness to complete the fracture repair shall be equal to the depth of the of the prepared mortar joint void.
10. The repair material shall be constructed by applying wet-on-wet layers without allowing previous layers to dry out. Protect against material sags and slumps. Use guide wires, rodding and forming for final shaping and elevations of the repair material. If the repair material sags or slumps, it shall be removed and replaced with new material at a layer thickness and interval that does not allow sag or slump. All excess material shall be removed, and the final layer shall be struck flush with the surface of the substrate.
11. Cure the material in accordance with the manufacturer's requirements and protect against freezing temperatures and washout throughout the curing period.
12. Where specifically approved by the Engineer, fractures may be repaired by filling with epoxy gel. The fracture shall be cleaned of any loose debris and pressure washed using low pressure. The surface shall be allowed to dry to prevent any standing water prior to injecting gel. Fill fracture in crown of pipe with approved epoxy gel. Install with a bulk caulk gun full depth of crack. Strike off surface with a trowel following installation of gel.

E. Missing Mortar and Missing/Displaced Bricks/Clay Tiles Repair:

1. Pipe brick and mortar defects under this repair type shall be prepared in accordance with the manufacturer's requirements and as specified herein. Remove all loose and unsound pipe materials. For brick repointing, cut or chisel the areas to be repointed to a uniform depth of 3/4-inches, or deeper as required to reach sound mortar; once the unsound materials are removed, all surfaces shall be roughened to create a profiled edge for material bonding. For missing/displaced brick repair, use mechanical means or abrasive blasting to roughen the edges of the area to be repaired to create a profiled edge for material bonding. Feathered edges are prohibited.

2. After surface preparation of the defect area, thoroughly soak the substrate with water and then remove excess water to provide a saturated surface dry condition immediately prior to application of the repair material. Once the defect is fully prepared to receive the repair material, install the repair material in accordance with the manufacturer's requirements and as specified herein.
3. The repair material shall be applied in layers not less than 1/2-inches thick, but not more than the manufacturer's recommendations. For brick repointing, the required material thickness to complete the repair shall be equal to the depth of the prepared mortar joint void. For missing/displaced brick/clay tiles repair, the required material thickness to complete the repair shall be equal to the total pipe wall thickness.
4. The material shall be constructed by applying wet-on-wet layers without allowing previous layers to dry out. Protect against material sags and slumps. Use guide wires, rodding and forming as required for final shaping and elevations of the repair material. If the repair material sags or slumps, it shall be removed and replaced with new material at a layer thickness and interval that does not allow sag or slump. All excess material shall be removed, and the final layer shall be struck flush with the surface of the substrate.
5. Cure the material in accordance with the manufacturer's requirements and protect against freezing temperatures and washout throughout the curing period.
6. Missing/displaced bricks/clay tiles repaired using brick and mortar shall be prepared as specified herein.

F. Sewer Repair Reinforcement:

1. Sewer repair reinforcement shall be placed as specified herein and on the Contract Drawings and as otherwise required by standards identified in the referenced reinforcement material specifications.
2. Expose the full circumference of corroded steel in areas to be repaired and remove loose scale and corrosion deposits. Pay particular attention to the back of exposed steel. Reinforcing which has lost 25% of its section area due to corrosion or erosion shall be cut out and replaced with new reinforcing equal to original size and grade of that removed. Additional reinforcing shall be installed as shown on the Contract Drawings. Welded wire fabric or reinforcing steel shall be added as required by ACI 439.5R-18. Reinforcing shall be mechanically fastened to existing reinforcing or to the substrate when existing reinforcing does not exist, and to be secured against movement during application of repair materials.
3. Corrosion deposits shall be removed from pits and imperfections in the existing reinforcement surface. Reinforcement shall be primed promptly after cleaning and or installation. The reinforcement primer shall be applied in accordance with the primer manufacturer's instructions and allowed to cure before application of the overlaying repair materials.

G. Joint Repair, Concrete Pipe:

1. Joint Repairs are defined as pipe deterioration repairs occurring at pipe joints. Joint repairs will require additional forming for both the interior face and the joint edge. After surface preparation of the defect area, reinforcement shall be placed as specified herein. Thoroughly soak the substrate with water and then remove excess water to provide a saturated surface dry condition immediately prior to application of the repair material.

Once the defect is fully prepared to receive the repair material, install the repair material in accordance with the manufacturer's requirements and as specified herein.

2. Set forms over the area to be repaired to conform to the interior face of the surrounding pipe and to form the pipe edge. The joint space consistent with the remainder of the joint shall be maintained. Multiple forms may be utilized to cover an odd shape or large repair areas. The repair material shall be thoroughly packed into the form filling the area completely, without any gaps or air pockets. After repair material is cured, the forming shall be removed. The repair thickness shall restore the pipe to the total pipe wall thickness.
3. If the repair is specified to be constructed of multiple layers of material, it shall apply wet on wet layers without allowing previous layers to dry out. Protect against material sags and slumps. Use guide wires, rodding and forming as required for final shaping and elevations of the repair material. If the repair material sags or slumps, it shall be removed and replaced with new material at a layer thickness and interval that does not allow sag or slump. All excess material shall be removed, and the final layer shall be struck flush with the surface of the substrate.
4. Cure the material in accordance with the manufacturer's requirements and protect against freezing temperatures and washout throughout the curing period.

H. External Grout for Sewers/Manholes (Cementitious)

1. Voids outside of the sewer pipe shall be repaired by pressure grouting as specified herein. The Engineer may direct the Contractor to perform external grout repair to be performed along with, or independent of other rehabilitation types. The Engineer may also direct the Contractor to modify the Contractor's grouting methods to suit the site conditions and intent of the external grout repair.

2. Placement of Grout:
   a. The Contractor shall ensure that the pipe surface to receive grouting materials is prepared in accordance with manufacture requirements, that the grouting material is applied in accordance with the manufacturers recommendations for application, that the grouting period is consistent with the grout setup time, and when pressure grouting, that the void pressure is sufficient to cause the grout to penetrate and seal the defect without causing damage to the sewer.
   b. Care shall be taken so that grout does not escape from the local void and be forced into nearby basements, manholes, or adjacent sewers, or cause damage to adjacent utilities. Formwork and formwork sealing required to maintain grout in the applied position prior to set shall be that specified for cast-in-place concrete and in accordance with these specifications. Reinforcement for grout shall be that specified for cast-in—place concrete in accordance with these specifications.
   c. Pressure Grouting for Man-Entry Sewers:
      1) Where shown on the drawings or directed by the Engineer, the Contractor shall perform external cementitious grouting to stabilize the soil conditions outside the pipe/manhole wall. In general, external grouting shall be performed from inside the existing pipes as described herein. Grouting shall be done using remote equipment or from the ground surface on pipes requiring external grouting that are not suitable for personnel entry.

2) After the pipe has been properly prepared, injection ports shall be drilled into the pipe wall where grout is to be applied. Injection ports shall be drilled at an angle from areas of sound pipe material to the void area or, when formwork is used, injection ports may be constructed integral to the formwork. The grout is to be injected by drilling minimum l-inch and maximum 3-inch diameter holes along both sides of the pipe below the springline at a longitudinal interval of 6 feet. At any given, time the Contractor will have at least two (2) holes drilled on each side of the pipe. Grout shall be pumped through two (2) drilled holes on either side of the pipe simultaneously, with equal flow volume and pressure. Once drilled or constructed, injection ports shall allow a visual placement and travel route of the grout for the applicator.

3) Once commenced, grouting shall be completed without stoppage. In case of breakdown of equipment, the Contractor shall wash out the grouting system sufficiently to ensure fresh grout and adequate bond and penetration will occur upon restarting the grouting operation. Grout pressure shall be maintained until grout has set.

4) A lateral camera shall be used to continually inspect laterals within 25 feet of the location of grout application during grouting operations. If grouting is to be performed prior to liner installation the Contractor shall internally brace the pipe to prevent damage or collapse of the existing pipe. Grout that enters a lateral shall be removed immediately by the Contractor.

d. Limits of Grout Placement:

1) The Contractor shall continuously monitor pressure and volume of grout placed. Grout placement shall be limited as follows. Limitation of volume of grout placed shall take precedence over limitations by grout pressure.

e. Limits of Grout Pressure:

1) For pipes that are above the ground water elevation the Contractor shall inject grout simultaneously through two (2) corresponding holes drilled through the pipe walls until a pressure of 5 psi is achieved. If grout begins to flow out of the adjacent hole preventing the desired pressure, the grout operation shall be moved to the adjacent holes.

2) For pipes that are below ground water the Contractor shall inject grout to achieve a maximum pressure of 5 psi. If when 5 psi is reached, the grouting pressure is not sufficient to overcome hydrostatic pressure of the groundwater, the Contractor shall gradually increase the pressure at increments of 0.5 psi until such time that grout begins to flow. Grouting shall then continue until such time that the measured grout pressure is 1.0 psi over the pressure required for the grout to flow. In no instance shall the grout pressures exceed 8 psi. Grout pressure shall be measured a close as practically possible to the injection point.

f. Limitation by Grout Volume:

1) The quantity of cementitious grout to be placed shall be limited to a maximum of 0.5 cubic yard per foot of length of the associated defect repaired whether or not the desired pressure is achieved. The quantity of the grout may only be adjusted as directed by the Engineer.

2) The equipment to be employed and method to be used for injecting grout is to be determined by the Contractor.

3) During grouting the inside of the pipe and all sewer laterals in the area shall be continuously monitored. If grout is observed entering through any lateral joints, pipe joints or pipe walls, or if any deflection of the pipe walls is observed, grouting shall be ceased immediately

g. Chemical Grouting:

1) Chemical grout is intended to stop infiltration and shall be used as such. The quantity shall be measured and placed increments of 1/4 gallons in the presence of the Engineer. Chemical grouting shall cease when the active infiltration being addressed stops or as directed by the Engineer. Chemical grout shall be installed through holes less than l -inch in diameter.

3. Grouting Reports:

a. The Contractor shall maintain daily grouting reports. The reports shall document repairs made and shall include:

1) Type of defect repaired.

2) Date repaired.

3) Location repaired indicating the sewer reach's upstream manhole and downstream manhole.

4) Footage from upstream of downstream manhole and clock position(s) of the repair and.

5) Unit quantity of the repair using the units indicated on the summary tables included on the plan sheets.

b. The Reports shall be provided to the Engineer's site representative no later than close of business the following workday.

I. Cutting of CIPP lining of tee (blind taps): CIPP liners to be installed with one (1) end concluding in a tee and connecting to a man-entry sewer shall be cut and sealed via access to the man-entry sewer. All CIPP requirements within this specification for CIPP liner shall apply to the CIPP lining, cutting of the liner and application of the end seal.

3.9 NON-MAN-ENTRY REPAIRS

A. Cut Protruding Services/ Taps: See Paragraph 3.8.B.

B. Open Cut Point Repair: and Open Cut Service Repair:

1. The Contractor is responsible for inspection of existing pipe in order to determine accurate location and extent of the repair. Conditions may have changed from previous condition assessment or inspections provided to the Contractor.
2. Mainline replacement by open cut and service repair by open cut shall be performed where specified or otherwise designated by the Engineer.
    a. Excavation, bedding, and backfill shall be in accordance with Section 31 23 33 – Trenching and Backfill.
    b. Pipe trench construction details shall be in accordance with the Contract Drawings.
    c. Sheeting, shoring and bracing requirements shall be in accordance with 29 CFR 1926 Subpart P - Excavations and other applicable OSHA requirements.
    d. Mainline pipes shall be excavated to the extents of the designated spot repairs. The Contractor may, for Contractor's convenience, over excavate to remove damaged pipe to the nearest joint but shall do so at no additional cost to the Owner.

3. Unless additional excavation is requested in writing by the Engineer, any and all cost for additional excavation length to that specified or shown will not be paid as extra Work and such costs shall be borne by the Contractor.

4. Pipe Installation:
    a. After the spot repair is located and the pipe exposed, unless otherwise specified, fix defective joints, wyes, tees, taps and sections of damaged pipe by removal and replacement of defective materials. Replacement pipe, fittings and couplings shall be as specified. Remove defective pipe either at exposed joints or by cutting the pipe perpendicular to the pipe axis at extents of section to be repaired. If required, connections to existing pipe shall be made with flexible couplings. Service connections shall be made using factory wyes or tees. The replacement pipe ends shall mate square with the existing pipe, with flowlines matching. Coupling sizes shall be as recommended by the manufacturer and shall be long enough to overlap pipe ends by a minimum of 6 inches; flexible couplings shall be installed on clean pipe and shall be watertight.
    b. For egg shaped sewers, a circular pipe shall be selected that best matches the dimensions of the egg-shaped sewer. Use manhole brick and mortar as specified herein to build a brick collar or a poured-in-place concrete collar to seal the space between the egg-shaped sewer and circular replacement sewer. Flow lines shall be matched.
    c. Inspect all pipe and fittings prior to lowering into trench to ensure no cracked, broken, or otherwise defective materials are used. Existing and replacement pipe ends and interiors shall be cleaned thoroughly and kept clean during laying and connection. Lower pipe into the trench in a manner to avoid any physical damage. All defective or damaged pipes shall be immediately removed from the job site.

d. After replacement pipe and fittings have been fully coupled to the existing sewer, all services shall be reinstated. Pipe testing shall be as specified in the individual pipe material specifications.

5. Cleaning and Acceptance:
   a. Following the repair, the Contractor shall clean the full pipe segment from manhole to manhole per Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning.
   b. The Contractor shall submit required CCTV video inspection of the full manhole to manhole repaired and cleaned sewer segment per Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection. The Engineer shall review and determine if the Work performed is acceptable.

C. Repairs by Grouting: See Section 33 01 30.61 Packer Injection Grouting.

D. Sewer Repair by Segmented CIPP Liner

1. Sewer Cleaning and Preparation:
   a. The Contractor shall remove all loose and solid debris and intruding connections, in accordance with this specification, to adequately prepare the sewer for internal point repairs.

2. Installation:
   a. Flow control shall be per Section 33 31 11 – Public Sanitary Sewerage Gravity Piping and Section 01 57 15 – Temporary Sewer Bypass Pumping. The upstream manhole shall be monitored at all times and an emergency deflating system shall be incorporated so that the plugs may be removed at any time without requiring confined space entry.
   b. The interior of the pipeline shall be carefully inspected to determine the location of any condition that may prevent proper installation, such as roots, and collapsed or crushed pipe sections. All existing service services shall be cleared of obstructions that may prevent the proper insertion and expansion of the lining system. Changes in pipe size shall be accommodated. Obstructions may include dropped or offset joints of no more than 20% of inside pipe diameter.
   c. The liner shall be encapsulated within the translucent bladder (liner/bladder assembly) and shall be vacuum-impregnated with resin (wet-out) under controlled conditions. The volume of resin used shall be sufficient to fill all voids in the textile lining material at nominal thickness and diameter. The volume shall be adjusted by adding 5% to 10% excess resin for the change in resin volume due to polymerization and to allow for any migration of resin into the cracks and joints in the original pipe. No dry or unsaturated area in the mainline sheet or service tube will be acceptable upon visual inspection.
   d. After liner placement is complete, pressure shall be maintained by pressing the liner firmly against the inner pipe wall. The liner shall be chemically cured at ambient temperatures or by a suitable heat source. The curing of the CIPP shall account for the existing pipe material, resin system, and ground conditions (temperature, moisture level, and thermal conductivity of the soil). The heat source temperatures shall be monitored and logged during the cure and cool down cycles.

e. Curing shall be done without pressure interruption with air or a mixture of air and steam for the proper duration of time per the resin manufacturer's recommendations.

3. Finish: The finished CIPP shall be continuous over the entire segment slated for repair. The CIPP shall smooth with minimal wrinkling and increase flow rate. The CIPP shall be free of dry spots, lifts, and delaminated portions. The CIPP shall taper at each end providing a smooth transition for accommodating video equipment and maintaining proper flow in the mainline. After the Work is completed, provide the Engineer with video documenting the repair.

4. Inspection and Testing Practices:
   a. Sampling: Samples shall be prepared by securing a flat plate mold using the textile tube material and resin system as used for the rehabilitated pipe.
   b. Pressure: The pressure applied on the plate sample shall be equal to the highest pressure exerted on the service tube during the inversion process.
   c. Length: The minimum length of the sample must be able to produce at least five specimens for testing in accordance with the current version of ASTM D790.
   d. Conditioning: Condition the test specimens at 73.4 $\pm$ 3.6°F and 50 $\pm$ 5% relative humidity for not less than 40 hours prior to test in accordance with Practice ASTM D618, for those tests where conditioning is required.
   e. Short-Term Flexural (Bending) Properties: The initial tangent flexural modulus of elasticity and flexural stress shall be measured for gravity and pressure pipe applications in accordance with Test Method D790 and shall meet the minimum requirements of Table 33 01 30.60-1.

END OF SECTION 33 01 30.60

SECTION 33 01 30.61 - PACKER INJECTION GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe Cleaning and Flushing.
2. Manhole Interior Cleaning.
3. Gravity Sewer Joint and Manhole Sealing.
4. Plugging.
5. Bypassing Sewage.
6. Joint Inspection and Testing.

B. Related Requirements:

1. Section 33 01 30.16 - Sanitary Sewer Pipeline Inspection.
2. Section 33 01 30.81 - Manhole Rehabilitation.
3. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.

C. Description:

1. Includes requirements for rehabilitation of defective mainline joints, circumferential mainline cracks/fractures, small mainline defects, and defective lateral-mainline interfaces by application of chemical grout material.

1.2 STANDARDS

Except as modified herein, comply with the following standards:

A. ASTM International:

1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM C150 - Standard Specification for Portland Cement.
3. ASTM F2304 - Standard Practice for Rehabilitation of Sewers using Chemical Grouting.
4. ASTM F2454 - Standard Practice for Sealing Lateral Connections and lines from the Mainline Sewer Systems by Lateral Packer Method, Using Chemical Grouting.

1.3 SCHEDULING

A. Schedule Work of this Section to coincide with existing sewer rehabilitation and new sewer installation.

B. Furnish Work schedule for periods of time when sewer piping section and manholes are out of service for joint sealing.

1.4 SEQUENCING

A. Sequence Work in the following order:

1. Locate joint, crack, or lateral connection.
2. Inflate packer at joint, crack, or lateral connection.
3. Inject chemical grout into soil.
4. Cure grout, air test, and deflate.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer information regarding grout, sealant, and root growth inhibitor.

B. Catalog data showing manufacturer's clarifications and updates, ASTM references, material composition, specifications, and physical and chemical properties of grout.

C. Submit work schedule for periods of time when sewer piping section and manholes are out of service for joint sealing.

D. Reports:

1. Submit bi-weekly report with daily entries showing the following:
   a. Location of joints sealed and successfully tested.
   b. Results of air or liquid joint tests before and after sealing joints.
   c. Volume of joint sealant or joint sealant/root treatment additive pumped.
   d. Pounds of acrylamide and N,N'-methylenebisacrylamide mixture used.
   e. Pounds of ammonium persulfate used.
   f. Gallons of root treatment additive material used each day, including gallons of triethanolamine.
   g. Elevation or depth of ground water.
   h. Location of pipe fractures and misalignment.
   i. Location of leaking joints, including non-leaking joints failing air test.
   j. Location of connections discharging continuous flow or incorrectly connected to sewer main.

2. Submit bi-weekly reports on form approved by Engineer prior to start of testing and sealing.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Prior to starting Work, submit certifications attesting to following:

1. Composition and manufacturer of joint sealing material and root treatment additive.
2. Chemical compatibility of sealant material and root treatment additive material.
3. Calibration of meters used to measure joint sealant and root treatment additive and pressure gages has been performed.

G. Field Quality-Control Submittals: Submit results of Contractor-furnished tests and inspections.

H. Submit Pre-Rehabilitation Closed-Circuit Television (CCTV) videos and inspection reports if not previously completed.

I. Submit Flow Control Plan.

J. Qualifications Statement:

1. Submit qualifications for manufacturer and applicator.
2. Submit manufacturer's approval of applicator.

K. Submit Emergency Plan detailing procedures to be followed in event of health and safety emergency, pump failures, sewer overflows, and service backups.

1.6 CLOSEOUT SUBMITTALS

A. Submit Project Record Documents: Record actual locations, type of pipe material, diameter and depth of pipe of repaired joints.

1.7 QUALITY ASSURANCE

A. Perform Work including all documentation and coding standards according to National Association of Sewer Service Companies (NASSCO) prepared Pipeline Assessment and Certification Program (PACP) standards.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years' experience.

B. Applicator: Company specializing in performing Work of this Section with minimum three (3) years' experience and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 GROUT SEALANT

A. Chemical Grout:

1. Description:
   a. Mixture of dry acrylamide and dry N,N'-methylenebisacrylamide in proportions capable of diluting aqueous solutions and, when properly catalyzed, forming stiff gels.
   b. Capable of tolerating ground water dilution and reacting in moving water.
   c. Reaction: Produce continuous, chemically stable, non-biodegradable, firm, flexible and irreversible gel.
   d. Cured grout shall be chemically stable and resistant to organics found in sewage.

2. Viscosity:
   a. Maximum: 0.0000418 lbf-s/sq. ft..
   b. Variation: Remaining constant until gelation concurs.

3. Reaction Time: Controllable from 10 seconds to 1 hour.
4. Reaction produces continuous and irreversible gel at chemical concentrations as low as 0.4 lb./gal. of water.

B. Catalyst:

1. Material: Ammonium persulfate.
2. Use in combination with activator.
3. Catalyst containing (dimethylamino) propionitrile is prohibited.
4. Activator: Triethanolamine or other compounds of equivalent properties.
5. Inhibitor: Potassium ferricyanide.

C. Root Growth Inhibitor:

1. Material:
   a. Dichlorobenzonitrile.
   b. Properties: Meet recommendations of grout manufacturer.

2. Root Treatment Additive:
    a. Capable of remaining active for minimum of two (2) years.
    b. Active Ingredient: Sodium methyldithiocarbamate.
    c. Root Cell Inhibiting Agent: 2,6-dichlorobenzonitrile (dichlobenil).
    d. For each application, disperse root control agent into clear, cool water free of acid, alkali, oxidizing agents, or large amounts of oil or other organic compounds or materials.
    e. Use tanks for transportation or storage of makeup water.

D. Portland Cement: Comply with ASTM C150, Type II.

E. Fine Aggregate Gradation: Comply with ASTM C33.

F. Packer for Joint Sealing:

1. Bladder:
    a. Furnish air-impervious, pneumatically inflatable bladder on each end of mounting cylinder.
    b. Seal ends of each bladder to cylinder by broad, confining bands.

2. Connect at each end by winch-powered cables.
3. Form positive seal between inflated bladders and interior periphery of sewer pipe and form annular void between inflated end bladders.
4. Design to allow restricted quantity of sewage flow through packer at designated times.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect joints to be sealed internally via CCTV prior to grouting, during grouting and post grouting.

B. Verify the locations of joints to be sealed as shown on the Drawings.

3.2 PREPARATION

A. Pipe Cleaning and Flushing:

1. Perform cleaning of pipe interior to extent necessary to pass equipment and materials required for joint sealing.
2. Flush foreign material cleaned from interior of sewer pipe, intercept, remove, and properly dispose.
3. Dumping of raw sewage on private property, in city streets, or into surface or groundwater is not permitted.

B. Roots, Loose Debris and Protruding Lateral Connections:

1. Remove all obstructions and protruding lateral connections which will prevent use of grouting equipment.
2. Remove all roots and loose debris from connections and mainline.

C. TV Inspection of Piping: Inspect as specified in Section 33 01 30.16 - Sanitary Sewer Pipeline Inspection.

D. Flow Control:

1. Exposing complete inside periphery of sewer pipe is required to conduct inspection, sealing, or testing.
2. Contractor to select and submit method of flow control such as flow-through plug, bypass pumping, or plugging sewer.

3.3 FIELD QUALITY CONTROL

A. Pre-Sealing Joint Test:

1. Air test each joint between manholes at locations identified on the Drawings as follows:
   a. Conduct pre-sealing test as specified for post-sealing test.
   b. Record failure of pre-sealing test in weekly report.
   c. Notify Engineer when pre-sealing test passes.
   d. Record passing tests in weekly report and discontinue joint sealing and post-sealing test sequence for passed joint.

B. Post-Sealing Joint Test:

1. Perform visual inspection of joint.
2. Apply positive air pressure in void area until the test pressure cannot be built in the void or and allow to stabilize due to temperature effect.
3. Complete air pressure stabilization.
4. Test Pressure: Not less than maximum ground water pressure or more than 7.5 psi above maximum ground water pressure at initiation of test procedure.
5. Record initial test pressure, stabilized test pressure, and period of time required to have 1.0-psi pressure drop from stabilized test pressure.
6. Minimum Test Duration:
   a. Pipe Diameter 8 inches: Zero minutes, 18 seconds.
   b. Pipe Diameter 10 inches: Zero minutes, 28 seconds.
   c. Pipe Diameter 12 inches: Zero minutes, 40 seconds.
   d. Pipe Diameter 15 inches: 1 minute, 3 seconds.
   e. Pipe Diameter 18 inches: 1 minute, 31 seconds.
   f. Pipe Diameter 21 inches: 2 minutes, 4 seconds.
   g. Pipe Diameter 24 inches: 2 minutes, 16 seconds.
   h. Pipe Diameter 27 inches: 2 minutes, 42 seconds.

7. Failure: Joint will be deemed to have failed if pressure drop exceeds 1.0 psi from the stabilized test pressure during minimum time specified above.
8. Passage:
    a. Discontinue test if the minimum time has been completed and 1.0-psi pressure drop has not occurred from the stabilized test pressure.
    b. In this circumstance, the joint has satisfactorily passed the test.

9. The following procedures shall be followed for sealed joints failing the air test:
    a. Visually inspect.
    b. Re-seal.
    c. Visually inspect.
    d. Retest until successful test is obtained or sealant limit is attained.

C. Manhole Rehabilitation: Comply with Section 33 01 30.81 – Manhole Rehabilitation.

3.4 APPLICATION

A. Root Control:

1. Apply chemical root control agent by foaming or soaking according to conditions in piping under treatment.
2. Foaming:
    a. Agent: Foaming Root Control Herbicide by Vaporooter or approved equal.
    b. Surfactant: Capable of producing foam and able to transmit at pressure of 30 psig.
    c. Concentration: Deliver foam to pipe to yield approximately 20 gal. of foam for each gallon of five (5) percent solution.

3. Soaking:
    a. Fill entire pipe with freshly prepared and well-mixed solution containing not less than one percent by volume of specified root growth inhibitor.
    b. Fully charge for soaking period of one hour and replenish solution to maintain its level above upper end of section under treatment at specified concentration.

B. Joint Sealing:

1. Seal joints that fail pre-sealing test as identified on the Drawings specified herein.
2. Monitor and record actual maintenance pressures when grouting and testing joints.
3. Pass sealing materials from dual independent pumping system through instantaneously controlled system and read flow meter to annular void in packer through dual hose systems.
4. Maximum Sealant:
    a. If sealant material injected into joint exceeds 15 gal. in 8-inch pipe, stop injection.
    b. Do not resume sealing of joint until other joints in manhole run are sealed.

5. Re-clean and repeat sealing process until positive seal is achieved.
6. Clean joint after sealant material has set.

7. Examine joint repair for visible defects using television camera and fix defects prior to testing of post-joint seal.

END OF SECTION 33 01 30.61

SECTION 33 01 30.71 – SPRAY-IN-PLACE SEWER AND MANHOLE LINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cleaning and flushing of existing sanitary sewers as preparation for lining.
2. Taking video of existing sewers to confirm their condition.
3. Field verification of size, length, and depth of sewer reaches to be lined.
4. Flow control.
5. Installing geopolymer liner and sealant.
6. Reestablishing service connections.

B. Related Requirements:

1. Section 01 57 15 – Temporary Sewer Bypass Pumping.
2. Section 02 22 30 – Pre-construction Video and Photographic Record.
3. Section 31 23 33 – Trenching and Backfill.
4. Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
5. Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning.
6. Section 33 01 30.61 – Packer Injection Grouting.

1.2 STANDARDS

Except as modified herein, comply with the following standards:

A. ASTM International:

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).
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 Surfacings 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.
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.

C. National Association of Sewer Service Companies (NASSCO):

1. NASSCO Pipeline Assessment & Certification Program (PACP).

D. Occupational Safety and Health Administration (OSHA):

1. Regulations Standard – 29 CFR.

1.3 COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Coordinate Work of this Section with users connected to system. Notify Engineer, homeowners and businesses at least 48 hours in advance of expected disruption of sanitary service.

C. Provide and maintain temporary facilities, including piping and pumps, to meet these requirements.

1.4 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 – Administrative Requirements.

B. Convene pre-installation meeting a minimum two weeks prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

C. Contractor's Qualifications:

1. Submit a copy of the Manufacturer's licensee certificate with the Bid.
2. Submit list of five (5) similar regional jobs in the states of Michigan, Ohio, Indiana, Illinois or Wisconsin within the past ten (10) years and include project information such as length of project, pipe diameter, date complete, and project cost.
3. Submit a certified statement from the Manufacturer that they are a certified installer of the liner.

D. Product Data: Submit manufacturer product data and installation instructions. Include required substrate preparation, on-site quality assurance recommendations, and a list of all materials to be used.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Shop Drawings:

1. Indicate liner dimensions for each pipe size to be relined.
2. Submit liner thickness calculations for each manhole-to-manhole section and furnish them to the Engineer with supporting assumptions. Calculations shall be done after cleaning, televising, and other field inspections have been accomplished. Design parameters given in this specification shall be used in calculations.
3. Submit plans showing points of insertion and methodologies.

H. Pre-lining video and logs: Submit a digital copy of the pre-lining video and two (2) copies of the logs to the Engineer that document existing conditions after the Contractor has cleaned the line.

I. Liner Thickness Calculations: Submit liner thickness calculations for each manhole-to-manhole section with supporting assumptions. Calculations shall be submitted after cleaning, televising, and other field inspections have been accomplished. Design parameters specified herein shall be used in calculations.

J. Post-lining tapes and logs: Submit two (2) copies of the cure logs for each manhole-to-manhole installation. Each cure log shall clearly indicate the project name, project number, and the manhole section that was lined.

K. Digital video media: Submit a copy of the final television inspection that shows the rehabilitated sewer along with reinstated service connections.

1. Submit video recordings of piping sections as follows:
    a. Show condition of existing pipe and pipe joints and location of existing service connections after cleaning and prior to relining.
    b. Show cured liner and reestablished service connections after relining Work has been completed.

L. Source Quality-Control Submittals: Submit results of shop tests and inspections.

M. A flow control/bypass pump plan for the mainline sewer, side sewers, and laterals in accordance with Section 01 57 15 – Temporary Sewer Bypass Pumping.

N. Work plan showing how the work shall be scheduled and coordinated.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of each service connection.

1.7 QUALITY CONTROL AND ASSURANCE

A. Daily Logs:

1. A daily activity log shall 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. Record important spray data including 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 shall all be recorded on the daily activity report.
3. Maintain a record of operating conditions. 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 shall be noted in the daily log.
4. Amount of material used and work completed shall be summarized on the log.
5. A copy of the daily log for all days of work on the project shall be provided in the final quality assurance documentation provided to the Engineer.

B. Equipment Calibration Reports: All applicable equipment calibrations shall be maintained on-site and shall be available for inspection upon request of the Engineer.

C. Inspections: Inspections of the lining products and materials may also be made by the Engineer 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.

D. Testing and Acceptance:

1. The completed liner shall be smooth and free from honeycomb and areas of segregation.
2. 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 testing shall include compressive strength (ASTM C39 or C-109). Minimum strength shall be 8,000 psi at 28 days tests. Additional samples may be held for retesting at 56 days if 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.
    b. The more frequent of once every other day of application or once for every 40,000 pounds of dry geopolymer material applied for sewer applications.
5. Thickness verification shall be done with mass balance calculations to determine the amount of material that went in over the surface area to get an average depth.
6. Small plastic indicator tabs shall be attached on the structure to verify that proper thickness is achieved. These shall be positioned to be just below the specified thickness and shall be left in place when sprayed over.
7. Thickness shall be recorded and logged before and after each spray application.
8. Remove a test core from the installed liner at each manhole. Mark the core samples with the date that the liner was installed and the date that the core was removed and the location taken. Core the liner at three different clock positions and measure the actual thickness of the liner. If a sample is not within 90% of the specified minimum thickness or 90% of the 28-day compressive strength, the liner is unacceptable. Submit a proposed method of repair or replacement as recommended by the Manufacturer to the Engineer. Work required to remedy nonconforming work shall be at no additional cost to the Owner.
9. If final inspection reveals that the geopolymer liner material did not match the submitted Manufacturer's claims, the product is unacceptable and non-conforming. Submit proof that the geopolymer liner meets the requirements of the specification using samples analyzed or retained at the manufacturing facility or submit a method for replacement of the sewer segment liner to the Engineer. Work required to remedy non-conforming work shall be at no additional cost to the Engineer.
10. For all instances where the geopolymer liner is unacceptable, as described in this specification section, submit a proposed method of repair or replacement as recommended by the Manufacturer to the Engineer. Work required to remedy non-conforming work shall be at no additional cost to the Owner.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three (3) years documented experience in installation of liner materials and shall be an approved installer of the geopolymer lining system as certified and licensed by the Manufacturer.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

D. Pipeline Assessor:

1. Person specializing in assessing condition of sewer pipelines prior to and following relining.
2. Currently certified in Pipeline Assessment and Certification Program (PACP) of the National Association of Sewer Service Companies (NASSCO).

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Materials shall be delivered to the job site in a covered truck to prevent exposure to sunlight.
2. Materials shall be delivered while maintaining temperatures within the Manufacturer's recommendations.
3. Delivery of material shall be coordinated with other trades to avoid delays.
4. Pipe preparations and field inspections shall be completed prior to delivery to site.

B. Storage of Materials:

1. Materials shall be kept dry, protected from weather and dust, and stored under cover at temperatures between 50°F and 90°F. Do not store near flame, heat, or strong oxidants.
2. No material shall be stored in the open or in contact with the ground.

C. Handling:

1. Handle all products with care. Only sound, undamaged products will be accepted.
2. Protective coating materials shall be handled according to their material safety data sheets.

1.10 EXISTING CONDITIONS

A. Verify field measurements prior to fabrication including size, shape, length, and depth of sewer reaches to be lined.

B. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PRODUCTS & MANUFACTURER

A. GeoSpray & GeoSpray AMS; Milliken Infrastructure Solutions, LLC, 920 Milliken Road, M-153, Spartanburg, SC 29303; Telephone (855) 655-6750; www.infrastructure.milliken.com.

B. Engineer approved equal.

2.2 MATERIAL SPECIFICATIONS

A. Geopolymer Pipe Lining Mortar:

1. The Spun-Cast GeoPolymer (SCGP) lining shall be GeoSpray as manufactured by Milliken Infrastructure Solutions, LLC., or Engineer approved equal, and conform to the properties in Table 33 01 30.71 under laboratory conditions.

Table 33 01 30.71-1: Liner Properties

Item	Standard	Time	Value
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	1,300 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 120 Min

2. The SCGP lining geopolymer mortar shall be composed of at minimum 70% Pozzolanic material selected from the list of: SiO_2, MgO, Al_2O_3, Fe_2O_3 and be verified by third party certified X-ray Fluorescence (XRF) testing.
3. Particle size of maximum aggregate of 2.38 mm based on 100% of material (except fibers) passing the No.8 Sieve.
4. The lining shall be compatible with the thermal and chemical conditions of the existing sewer structures. Surface temperatures will range from 20ºF to 100ºF and pH may range as low as 1.0.

B. Acid Mitigation System (AMS):

1. A liquid sealant must be applied to the geopolymer lining mortar after the final thickness has been spin cast. The sealant 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.
2. The liquid sealant shall be GeoSpray AMS Post-Coat manufactured by Milliken Infrastructure Solutions, LLC, or an Engineer approved equal.

C. Infiltration:

1. Chemical grouts and hydraulic cements shall be used to stop infiltration and create a surface for the geopolymer lining to be applied.
2. Specific materials shall be compatible with the geopolymer lining and the Engineer reserves the right to require preapproval of such materials.

2.3 DESIGN CRITERIA

A. Geopolymer Liner Thickness:

1. Submit liner design calculations to the Engineer for review.
2. Calculations shall be prepared by a professional engineer registered in Michigan.
3. The structural geopolymer lining rehabilitation systems shall be designed in accordance with a fully deteriorated pipe condition for structural linings conditions.
4. The minimum liner thickness, independent of design, shall be 1.0 inch for all pipes with an internal diameter of less than 54 inches for structural applications.
5. The minimum liner thickness, independent of design, shall be 1.5 inches for all pipes with an internal diameter of 54 inches or greater for structural applications.
6. Additional load calculations shall be determined for sewers with severe defects in existing deteriorating concrete or brick tunnels. Include epoxy coated reinforced steel or galvanized steel lattice girders to address distress and deficiencies after loading has been established by Engineer.
7. Protective non-structural coatings shall be designed in accordance with partially deteriorated conditions.
8. The minimum liner thickness, independent of design, shall be 0.5 inches for all non-structural pipeline applications.
9. The minimum liner thickness, independent of design, shall be 0.5 inches for all manholes.

10. Structural design shall be based on physical properties of materials and shall use the ASTM C78 values for Flexural Strength. Values obtained from ASTM C293 will not be acceptable.

PART 3 - EXECUTION

3.1 SAFETY EQUIPMENT AND PROCEDURES

A. Treat storm and sanitary sewers as confined spaces in accordance with OSHA, CFR 29, Part 1910.146. Personnel shall have been provided adequate training as either a confined space entrant or attendant.

B. Personnel records showing the date, location and test results of confined space training shall be submitted to the Engineer for review.

C. When working in Permit Required Confined Spaces (PRCS), the permit shall be fully and properly filled out before any operations begin.

3.2 PIPE CLEANING

A. Cleaning and surface preparation of the sewers and manholes shall be performed as recommended by the Lining Manufacturer. Procedures and equipment proposed shall be submitted to the Engineer.

B. All internal debris shall be removed from the original pipeline. Gravity pipes shall be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment.

C. If pipe diameters allow for manned entry, the use of high-pressure washers may be utilized.

D. The surface of the pipe to be lined shall be capable of directly receiving the lining material.

E. When grease and oil are present within the pipe, water shall 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.

F. All materials resulting from the cleaning of the pipe shall be removed prior to application of the geopolymer lining material.

G. All loose or defective concrete, brick, or grout shall be removed and replaced or repaired to provide an even surface prior to application of the geopolymer lining material.

3.3 PRE-INSPECTION

A. Perform a pre-installation television inspection that meets NASSCO PACP requirements.

B. Utilizing a color video inspection system (closed-circuit television) with data recording capabilities, the entire pipe section to be lined shall be recorded on DVD or other digital storage hardware acceptable to the Owner. A digital copy of the video media and two (2) copies of a suitable log shall be submitted to the Engineer. The interior of the pipe shall be carefully inspected to determine the location of potential issues that may prevent the proper installation of the geopolymer liner, and it shall be noted so that these conditions can be corrected.

C. A 360-degree Pan-and-Tilt view camera shall be used to inspect the pipe traveling upstream. At each connection, the operator shall stop and turn the camera lens toward the lateral thereby inspecting the first 8 to 12 inches of the lateral connection.

D. For each existing service connection determined by the Engineer 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 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 may 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.

H. Additional payment may be authorized for work necessary to bring the structures into acceptable conditions. Any additional work must be authorized by the Engineer prior to performing this work.

3.4 PREPARATION AND PRE-LINING REPAIRS

A. If the cleaning process reveals that the pipe invert, crown or sidewalls are deteriorated, measures shall be taken to provide a continuous slope to the pipe, including the use of flowable fill or the introduction of the wall lining material onto the pipes surface.

B. Any open joints shall 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 shall be sealed prior to application of the lining material.

E. Use quick-setting mortars or chemical grouts for stoppage of active leaks. All products employed in the stoppage of active leaks shall be pre-approved by the Engineer and used in accordance with the Manufacture's recommendations.

1. Chemical grouts shall comply with Section 33 01 30.61 – Packer Injection Grouting.
2. Quick-setting mortars shall utilize hydraulic water-stop cement.

F. If additional repair procedures must be undertaken by the Contractor to prepare the existing structure for lining, a plan shall be submitted to the Engineer for approval prior to proceeding.

G. Accurately measure the size of each individual manhole.

H. Accurately measure the size of each individual pipe section.

I. Stop all leakage prior to lining any structures.

J. Take precautions while chipping the existing pipe material to transition the geopolymer liner smoothly. All debris shall be collected and disposed as per contract specifications. Efforts shall made to avoid creating an unnecessary additional joint or lip.

K. Install stainless steel anchors and angles, as per the plans, to facilitate partial lining operations before spraying activities can begin.

3.5 BYPASS PUMPING

A. Comply with Section 01 57 15 – Temporary Sewer Bypass Pumping.

3.6 PREPARATION OF GEOPOLYMER LINING MATERIAL

A. Mix geopolymer material in accordance with Manufacturer's recommended water-cement ratio. Precision metering of water in a continuous mixing chamber is required to maintain the strict water to material ratio. Maintain the specified water to geopolymer ratio throughout the application process. Closely adjust and monitor the addition of water using a sight tube system.

B. Mixing water temperatures shall be determined before blending operations begin. The mixing water temperature shall be recorded in the daily operation log at multiple times throughout the day during the installation process. If water temperatures exceed 80ºF, then the water shall be chilled to 80ºF or lower. Use industrial electronic chillers of a suitable capacity to provide the

proper amount of water and at the required temperature. Use water chillers to maintain the water at the proper temperature for applications at an ambient temperature greater than 80ºF .

C. The geopolymer lining material shall be mixed in a high shear mixer. Ensure 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 shall be performed so that minimal dust is released into the surrounding environment.

E. Use continuous automated mixing and pumping, taking steps to eliminate human error and mechanical issues associated with maintaining consistent water/material ratio, mix time, mix speed, and dwell time prior to pumping. Automate dry material feed rate, precise metering of water, and pump rate eliminates wet/dry and thick/thin variations in order to result in a uniform structure regardless of the pumping distance.

F. Pumps shall be equipped with multiple sensors that stop the pump if material either runs out or is overflowing.

G. Multiple spin-casting units shall be onsite to address any application issues that arise during the lining process.

H. Multiple spin cast nozzles shall always be onsite to address any application issues or failure of the nozzle.

3.7 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 proper consistency, then the materials shall be pumped through a material plaster hose for delivery to the appropriate 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 shall be cable of bidirectional operation.

E. The spin cast nozzle shall be attached to a reciprocating head. The reciprocating head shall allow 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 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 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. The retrieval rate of the spin head shall be measurable and constant. At the beginning of each pipe segment the retraction device shall be calibrated. The calibration process shall include setting the digital readout to the desired retrieval rate and shall be done in the presence of the Engineer. Then lay out the retrieval system and mark to show the distance traveled in two minutes. The rate obtained shall be within 5% of the expected speed.

J. The geopolymer liner shall be applied to a specified uniform minimum thickness in one or multiple passes.

K. Material thickness shall 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 excessively out of round, hand spray apply the geopolymer lining to bring it into round shape and to repair irregularities in the contour of the pipe walls.

N. Hand spraying shall be performed by starting at the bottom of the structure and progressing up the wall.

O. Trowel the geopolymer liner 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 shall be utilized.

3.8 CURING OF GEOPOLYMER LINING

A. Follow Manufacturer's recommended cure schedule in curing of the geopolymer liner. The material shall be allowed to cure a minimum of two (2) hours or more until the material has reached an initial set condition, whichever is longer prior to the release of bypass or flow through the pipe.

B. Proper steps shall be taken to ensure the material is cured in a moist and moderate climate. Use a wind barrier and fogging spray when situations of dry and/or hot conditions are present.

C. The geopolymer liner shall not be placed when the ambient temperature is 37ºF and falling or when the temperature is anticipated to fall below 32ºF during the next 24 hours, unless specific precautions are employed.

D. Comply with ACI 305R-99 Hot Weather Concreting. Do not apply geopolymer liner material when ambient and surface temperatures are 100ºF and above. Shade the material and prepare the surface to keep it cool. In order to extend working time, mix the material with chilled water. Be certain the substrate is saturated surface dry (SSD) before application begins.

E. Comply with ACI 306R-88 Cold Weather Concreting. At temperatures below 45ºF, warm the material and monitor substrate temperatures. Properly ventilate the area when heating. Protect the new liner from freezing in the first six (6) hours after application.

3.9 TERMINATION AND SEALING AT MANHOLE OUTLETS

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.

3.10 INTERNAL RECONNECTION OF LATERAL SERVICES

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

3.11 APPLICATION OF LIQUID SEALANT

A. For sanitary sewers and manholes, an approved post geopolymer sealant shall be applied.

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 shall be allowed to cure for a minimum of six (6) hours to ensure that the surface has dried prior to releasing bypass.

3.12 POST APPLICATION INSPECTION

A. Perform a post-installation television inspection that meets NASSCO PACP requirements. The video shall show the completed work, including condition of restored connections.

B. Utilizing a color video inspection system (closed-circuit television) with data recording capabilities, the entire pipe section to be lined shall be recorded on DVD or other digital media acceptable to the Owner, and a copy shall be provided to the Engineer for approval.

C. All manhole/junction box work and annular seals shall be completed at time of Post-TV, with Post-TV being verification of completion.

D. Perform work in conformance with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.

3.13 FINAL CLEAN-UP

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

END OF SECTION 33 01 30.71

SECTION 33 01 30.72 - CURED-IN-PLACE SEWER LINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cleaning and flushing of existing sanitary sewers and adjacent manholes as preparation for lining.
2. Taking video of existing sewers to confirm their condition.
3. Field verification of size, length and depth of sewer reaches to be lined.
4. Flow control.
5. Installing a resin-impregnated tube pipe liner.
6. Reestablishing service connections.

B. Related Requirements:

1. Section 01 57 15 – Temporary Sewer Bypass Pumping.
2. Section 03 60 00 – Grouting.
3. Section 31 23 33 – Trenching and Backfill.
4. Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
5. Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning.
6. Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. ASTM International:

1. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
2. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
3. ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
4. ASTM D3681 - Standard Test Method for Chemical Resistance of “Fiberglass” (Glass–Fiber–Reinforced Thermosetting-Resin) Pipe in a Deflected Condition.
5. ASTM F1216 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
6. ASTM F1743 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP).
7. ASTM F2019 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP).

8. ASTM D5813 - Standard Specification for Cured-in-Place Thermosetting Resin Sewer Pipe.
9. ASTM D2990 - Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics.

1.3 COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

C. Provide and maintain temporary facilities, including piping and pumps, to meet these requirements.

1.4 PRE-INSTALLATION MEETINGS

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Convene minimum one (1) week prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Contractor’s Qualifications:
1. Submit with the Bid a copy of manufacturer’s licensee certificate.
2. Submit proof of meeting minimum qualifications as described in the minimum qualifications for bidding.
3. Provide project information for proof of minimum qualifications such as length of project, pipe diameter, date complete, and project cost.
4. Submit manufacturer's approval of installer.

C. Product Data:

1. Submit manufacturer information regarding liner material, curing chemicals, and lubricants.
2. Submit Manufacturer’s Material Data Sheets (MSDS).
3. Submit complete description of proposed wet-out procedures.
4. Submit from the proposed manufacturer of the CIPP, test data of the proposed CIPP that confirms that the CIPP material meets the chemical resistance requirements. of Section 6.4 of ASTM D5813 and Appendix X2 of ASTM F1216.
5. Submit testing data from an independent laboratory confirming the long-term creep response of the CIPP for flexural modulus and flexural strength reduction. Testing shall determine the projected 50 years values in accordance with ASTM D2990 - Standard Test

Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics, based on testing conducted at 25% of the short-term yield strength of the material.

6. Submit the liner manufacturer's detailed installation procedures.
7. Submit the resin manufacturer's recommended curing cycle as well as the recommended cooling rate.
8. Submit two (2) samples of liner material in both uncured and cured state.
9. Manufacturer Instructions:
    a. Submit detailed description of liner placement and curing procedures for piping.
    b. Include description of procedures for sealing liner material at manholes and reestablishing service connections.

10. Submit manufacturer's requirements for receiving, handling, and storage of materials.
11. Submit the liner manufacturer's recommended storage and delivery procedures. Include storage and delivery temperatures, maximum time from wet-out to installation, and other pertinent information.
12. Submit written certification from the manufacturer that all materials used in the Work were manufactured and tested in accordance with this Specification and are being used or installed in conformance with the manufacturer's recommendations.
13. Test Results:
    a. Prior to the use of any materials, submit the results of testing of the proposed materials by an independent laboratory in conformance with these Specifications. All submitted test data shall have been performed on field-installed samples within the last twelve (12) months. Any material not meeting the requirements of these Specifications shall be completely removed from the project and replaced with materials in full compliance with the Specifications.
    b. Submit testing by an independent laboratory shall verify that the products to be used meet all minimum strength standards as set forth in ASTM F-1216, Table 1 as well as the design values to be carried forth for the project. Testing shall also verify that any product to be used on the project meets the minimum chemical resistance requirements as established in Section 6.4 of ASTM D5813 and Appendix X2 of ASTM F1216.

14. Continuous temperature monitoring system being used for the lining.
15. Submit methods, materials, equipment, and procedures to seal annular space between the CIPP and the existing pipe at the manholes.
16. Liner wet-out logs including, at a minimum, the sewer reach, date/time, liner size, resin type, and resin volume.
17. Odor mitigation plans for each site including location of blowers and barriers to prevent odor from migrating upstream and downstream of Work areas.

D. Shop Drawings:

1. Indicate liner dimensions for each pipe size to be relined.
2. Submit liner thickness calculations for each manhole-to-manhole section and furnish them to the Engineer with supporting assumptions. Calculations shall be done after cleaning, televising, and other field inspections have been accomplished. Design parameters given in this Specification shall be used in calculations.

3. Submit plans showing points of insertion and methodologies.

E. Pre-lining video and logs: Submit a copy of the pre-lining video and two (2) copies of the logs to the Engineer noting addresses and documenting existing conditions after Contractor has cleaned the line. Comply with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.

F. Liner Thickness Calculations: Submit liner thickness calculations for each manhole-to-manhole section with supporting assumptions. Calculations shall be sealed by a Licensed Professional, as defined in this spec, registered in the state of Michigan and submitted after cleaning, televising, and other field inspections have been accomplished. Design parameters specified herein shall be used in calculations.

G. Digital video media: Submit the final television inspection that shows the rehabilitated sewer along with reinstated service connections.

1. Submit video recordings of piping sections as follows:
   a. Show condition of existing pipe and pipe joints and location of existing service connections after cleaning and prior to relining.
   b. Show cured liner and reestablished service connections after relining Work has been completed.

H. Source Quality-Control Submittals: Submit results of shop tests and inspections.

I. Field Quality-Control Submittals:

1. Submit results of Contractor-furnished tests and inspections. Submit a copy of the cure logs for each manhole-to-manhole installation. Each cure log shall clearly indicate the project name, project number, and the manhole section that was lined.
2. Submit temperature logs for liner from time of wet-out to installation to the Engineer at the time of installation.
3. Submit temperature logs for water during liner curing.

J. Repair Methods: Submit written descriptions of the methods and equipment for the repair of defects in the CIPP liner observed during the post-installation inspection. Defects are defined as dry spots, lifts, delaminating, tears, holes in liner wall or wrinkles in the liner greater than 5 percent of the inside diameter.

K. A flow control/bypass pump plan for the mainline sewer, side sewers and laterals in accordance with Section 01 57 15 – Temporary Sewer Bypass Pumping.

L. A spot repair of sewers plan including sealing of active infiltration (categorized as runners and gushers by the NASSCO's PACP Defect Rating Codes).

M. Materials Resources Certificates:

1. Certify recycled material content for recycled content products.
2. Certify source for regional materials and distance from Project Site.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of each service connection.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three (3) years documented experience in installation of liner materials. Installer must be approved by manufacturer.

C. Licensed Professional: Professional Engineer experienced in design of specified Work and licensed in State of Michigan.

D. Pipeline Assessor:

1. Person specializing in assessing condition of sewer pipelines prior to and following relining.
2. Currently certified in Pipeline Assessment and Certification Program (PACP) of the National Association of Sewer Service Companies (NASSCO).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Thermal cure CIPP materials shall be delivered to the job site in a covered refrigerated truck while UV cure liners shall be handheld and delivered as specified in ASTM F2019. Prevent exposure to sunlight and maintain the temperature of the product within manufacturer's recommendations to avoid premature curing.
2. Delivery of material shall be coordinated with other trades to avoid delays.
3. Pipe preparations and field inspections shall be completed prior to delivery of liner to site.

B. Storage of Materials:

1. Material shall be stored in the delivery truck in order to prevent exposure to sunlight and to maintain the temperature of the product to within manufacturer's recommendation to avoid premature curing.
2. No material shall be stored in the open or in contact with the ground.
3. Temperature logs of liner from time of wet-out to installation shall be submitted to the Engineer at the time of installation.

C. Handling: Handle all products with care. Only sound, undamaged products will be accepted.

D. Store materials according to manufacturer instructions. Material shall be delivered and stored in a refrigerated truck to minimize exposure to sunlight and maintain temperature per manufacturer's recommendations.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication including size, length and depth of sewer reaches to be lined.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Provide a one (1) year warranty period for all materials and workmanship. Warranty period will commence on the date of substantial completion of the Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fabric Tube: The flexible fabric tube shall consist of one (1) or more layers of flexible needled felt or an equivalent woven and/or non-woven material capable of carrying resin, withstanding installation pressures and curing temperatures, and compatible with the resin system used. The tube shall be sized to accommodate the forces of installation, host pipe configuration, and any other pertinent factors to assure a tight fitting final product with a smooth finish.

B. Resin System: The resin system shall be a polyester or vinyl ester resin and catalyst system compatible with the insertion process. The resin system shall not contain fillers or additives, except those required for viscosity control, fire retardant, modulus enhancement, chemical resistance, or life extension. The additives shall not interfere with the visual inspection of the cured-in-place liner pipe or its required properties: thixotropic agents added for viscosity control, the opaqueness of the plastic coating, and resins that may contain pigments, dyes, or colors. The initiation temperature for cure shall be as recommended by the resin manufacturer. At a minimum, temperature monitoring devices shall be installed at all exposed portions of the pipe (beginning and end of run) for each inversion or run of installed liner pipe between the host

pipe and the CIPP liner. The resin shall have sufficient thixotropic properties to obtain non-draining characteristics when impregnated into the fiber fabric.

C. The tube shall be vacuum impregnated with resin (wet-out) under controlled conditions. The volume of resin used shall be sufficient to fill all voids in the tube material at nominal thickness and diameter and an allowance for migration of resin into the cracks and joints in the host pipe. The method of tube impregnation shall uniformly distribute the resin throughout the tube and control wall thickness to within the specified limits.

D. Inverting and Curing Medium: Potable water or other water source accepted by Engineer shall be utilized. In no instance will sewage be used to invert or cure liners or calibration tubes. If a private water source is proposed for use, a written agreement shall be obtained from the owner of the private water source and a copy of said agreement given to the Engineer.

2.2 EQUIPMENT

A. All equipment required for the installation and curing of the resin impregnated flexible fabric tube, including cables, sleeves, rollers, compressors, generators, pumps, valves, gauges, water heaters, and accessories required for complete installation shall be in accordance with manufacturer's recommendations.

2.3 PERFORMANCE AND DESIGN CRITERIA

A. Each tube shall be designed to withstand internal and/or external pressures as dictated by site and pipe conditions as well as the installation process used by the Contractor. Calculations shall reflect the water table to be within the elevation range noted in Table 33 01 30.72-1.

B. Design all liners as fully deteriorated liners in accordance with Appendix X1 of ASTM F1216 to support dead loads, live loads, groundwater load and any other expected loads or loads identified on the Contract Drawings assuming that the existing pipe cannot share loading or contribute to structural integrity of liner.

C. Design liner such that any thickness reduction is more than offset by improved flow characteristics such the relined pipe has a hydraulic capacity equal to or greater than the current host pipe.

D. Design liner material to eliminate infiltration and exfiltration that could compromise long term structural stability of the pipe.

E. Identify design and installation provisions for shrinkage control to prevent future misalignment of service reconnections.

F. Determine the minimum thickness of the CIPP liner as the minimum thickness required to meet the design structural requirements for both internal and external loadings, excluding any sacrificial membranes or other materials that may be used for protection of the product during installation. Use a nominal tube size greater than the minimum thickness required. The

minimum finished CIPP wall thickness shall be subject to the minimum wall thickness allowed by the manufacturer.

G. Design Criteria: The following values shall be used in liner thickness calculations and, where indicated by an ASTM standard, shall serve as the minimum acceptable strength requirements for the final cured liner.

Table 33 01 30.72-1: CIPP Design Criteria

Design Criteria	Value
Factor of Safety (N)	2 for gravity pipe; 3 for pressure pipe
Enhancement Factor (K)	7
Creep Retention Factor for Long-Term Flexural Modulus and Flexural Strength	The 50 year projected value as determined by an ASTM D2990 test carried out at 25% of the yield strength of the CIPP product
Ground Water Depth	Design depth between 0 and 3 feet below ground surface
Depth of Sewer	As indicated in the Contract Documents and field verified by Contractor
Ovality of Host Pipe	Minimum of 3% unless a greater ovality is indicated in the CCTV inspection.
Soil Modulus	1000 psi for heights of cover greater than 10 feet and 700 psi for heights of cover of 10 feet or less
Soil Density	120 pcf
Live Load	AASHTO HS-20 design vehicle for all locations other than railway crossing. Cooper E80 live load for railway crossings
Minimum Flexural Strength (ASTM D790)	4,500 psi for non-reinforced tubes and 6500 psi for reinforced tubes
Minimum Flexural Modulus of Elasticity (ASTM D790)	250,000 psi for non-reinforced tubes and 725,000 psi for reinforced tubes
Minimum Liner Tube Thickness	6 mm

2.4 INVERTED, RESIN-IMPREGNATED TUBE PIPE LINER

A. Description:

1. Fabric Tube:
   a. One (1) or more layers of absorbent, non-woven felt fabric, felt/fiberglass, or fiberglass.
   b. Comply with ASTM D5813, F1216, F1743, and F2019.

c. Capable of absorbing and carrying resins.

2. Resin:
   a. Corrosion-resistant polyester or vinyl ester resin and catalyst system.
   b. Comply with ASTM F1216, F1743, F2019 as applicable.

3. Wet-Out Fabric Tube: Furnish uniform thickness and excess resin distribution that, when compressed at installation pressure, will meet or exceed design thickness after cure.

4. Curing Medium: Potable water, steam, or another water source approved by the Engineer for thermal cures and UV light for UV cures. Potable water, at no additional cost, must be metered. Steam shall not be used when ambient temperature is less than 32 degrees Fahrenheit.

5. Equipment: All equipment required for the installation and curing of the resin impregnated flexible fabric tube, including cables, sleeves, rollers, compressors, generators, pumps, valves, gauges, water heaters, and accessories required for complete installation shall be in accordance with manufacturer's recommendations.

6. Temperature Monitoring: For all liners 8-inches or greater in diameter, all liners being cured with steam, and where specified on the drawings a continuous temperature monitor curing system shall be used during liner curing. Continuous temperature monitor curing system shall be VeriCure, Zia System LLC, or approved equal.

2.5 MIXES

A. Grout: As specified in Section 03 60 00 - Grouting.

2.6 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Inspection and Testing:

1. Provide shop inspection and testing of completed assembly.
2. Physical Testing: For every occurrence of an inversion of CIPP lining installed, perform sampling and testing to determine the installed CIPP lining's flexural properties and thickness.
3. For host pipes up to 18" in diameter, prepare samples as per Clause 8.1.1 of Practice F1216. For larger diameter pipes, prepare samples as per Clause 8.1.2 of Practice F1216.

C. Owner Witnessing:

1. Allow Owner-witnessing of factory inspections and tests at wet out/manufacturer's test facility. Locations greater than 50 miles from Site shall be at the Contractor's expense.
2. Notify Owner at least seven days before inspections and tests are scheduled.

D. Certificate of Compliance: Submit certificate of compliance indicating Work performed at wet out facility conforms to Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify location of piping to be relined.

C. All sewer pipe liner materials shall be carefully inspected for defects prior to installation. The liner shall be homogeneous throughout, uniform in color, free of tears, holes, foreign materials, blisters, or other deleterious faults.

D. Any material found during the progress of the Work to have flaws or defects shall be rejected. All defective materials furnished or installed shall be promptly removed from the project site. Replace all such material found defective in manufacture or damaged in handling or installation.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

C. Cleaning: Clean existing sewer pipes of debris, sedimentation, and mineral deposits with high-velocity cleaner, bucket and scraper, root saws, rolling or balling units as specified in Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning.

D. Initial Video Inspection and Repair:

1. Conduct inspection of sewer by method of:
   a. Closed-circuit video inspection as specified in Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
   b. Alternatively: Multi-Sensor Inspection (MSI).
2. Determine condition of existing piping, degree of offset of joints, and locations of crushed walls and obstructions.
3. Determine sizes and locations of service entrances and connections.
4. Evaluation of pipe conditions, performed by pipeline assessor.
5. Inspection of Work, performed by a NASSCO Inspector Training and Certification Program (ITCP)-certified inspector.
6. Clear obstructions, service piping protrusions, and other materials from bottom of existing pipe to ensure that inserted pipe liner directly contacts existing pipe wall.

7. Seal active infiltration categorized as runners and gushers by the NASSCO's PACP Defect Rating Codes.

E. Bypassing Sewage:

F. Laterals: Lateral pipes protruding into the pipe shall be trimmed flush with the inside of the pipe wall prior to lining.

3.3 FLOW CONTROL

A. Comply with Section 01 57 15 – Temporary Bypass Pumping.

B. If required or as directed by the Engineer, set up bypassing pump system to isolate each section of piping for relining.

C. Undertake flow control measures such as working during off-peak hours, the use of sewer cleaning equipment to lower downstream flow levels or blocking/plugging of sewer.

D. Provide the Engineer with at least 48 hours' notice and proposed method of flow control before undertaking flow control measures for sewers larger than 18 inches in height.

E. All engines and powered equipment for operation outside of normal working hours shall be equipped in a manner to keep noise to a minimum. Noise control to include the use of appropriate baffles or other means of noise control.

F. Use sewer plugs to stop or reduce sewer flow that tether to and are removable from the ground surface.

G. Maintain bypass pumping until lining is totally formed and service connections have been reestablished.

H. Monitor flow levels upstream of a plugged sewer at all times to ensure flooding of public or private property does not occur.

3.4 INSTALLATION

A. Excavate for point repairs only on emergency basis and as permitted by Engineer.

B. Perform relining and reestablish service connections without need for excavation while minimizing disruptions to adjacent occupied buildings and traffic.

C. Inverted, Resin-Impregnated Tube Pipe Liner:

1. Coat layer of fabric tube (before inversion or pull-in, as applicable) with an impermeable, flexible membrane that will contain resin and facilitate, if applicable, vacuum

impregnation and monitoring of resin saturation during resin impregnation (wet-out) procedure.

2. Prior to installation, and as recommended by manufacturer, place remote temperature gages or sensors inside host pipe to monitor temperature during cure cycle.
3. Positioning:
   a. Position wet-out tube in pipeline using method specified by manufacturer.
   b. Do not damage tube during installation.

4. Cure installed liner by using appropriate medium according to manufacturer's recommended cure schedule.
   a. The equipment used shall be muffled to reduce excess noise during the curing process.
   b. Where a continuous temperature monitor curing system is required as per this Section, the temperature monitor curing system shall be placed in the invert of the host pipe and run the full length of the reach being cured to confirm, in real time, that the required temperature for complete curing is achieved at all points in the liner.

5. Allow installed pipe liner to cool according to manufacturer instructions.
6. Annular Spaces:
   a. Verify that no gap or annular space exists between finished liner and existing pipe.
   b. Install watertight seals to host pipe at beginning and end of installed liner.

7. Any material not meeting the requirements of testing standards shall be removed and replaced with a material acceptable to the Engineer.

D. Manholes: The invert shall be continuous and smooth through manholes. If the liner is installed through a manhole, the bottom portion of the liner shall remain and the bench of the manhole shall be grouted and shaped as necessary to support the liner. The cost of this Work shall be included in the cost of this Specification.

E. Service Connections:

1. Reestablish existing sewer service connections through use of closed-circuit television camera and remote-controlled cutting device.
2. Accurately field-locate all existing active service connections. Restore and reconnect, without any delay, all missed or faulty reconnections.
3. Match invert of reestablished service with previously existing invert.
4. Maintain minimum of 95 percent of original service connection opening.
5. Reestablish sewer service connection with uniform cuts free of burrs and sharp edges.
6. After reestablishing service connection, flush piping clean.

3.5 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Testing of Completed Pipe Liner: Test every inversion as specified in ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 2 days on-site for installation, inspection, and field testing.

D. Liner Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Liner shall be free of dry spots, wrinkles, lifts and delamination.
3. If liner fails to form, remove failed liner and install new liner in a manner acceptable to the Owner.
4. Conduct closed-circuit video inspect completed relining Work, confirming no visual defects, including foreign inclusions, dry spots, pinholes, cracks, or delamination as specified in Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
5. Confirm that service connections are complete and unobstructed.
6. No infiltration of groundwater is permitted.
7. Make final adjustments to liner per manufacturer's instructions.
8. Any liner installation not meeting the testing requirements of this Specification shall be removed and replaced with a product acceptable to the Owner at the total expense of the contractor. The re-inspection requirements as listed above shall apply to this re-installed section of line.

E. Structural Design Reconciliation

1. If all installed liner properties are in excess of design values, the installations shall not require a Design Reconciliation.
2. In instances where any installed properties are less than the design values based on acceptance testing, a Design Reconciliation shall be carried out by the Engineer responsible for Standard and Special Designs as follows:
   a. Perform a post-construction design review to ensure that the completed CIPP meets all design checks. The design review will utilize the measured values for flexural strength, flexural modulus, and CIPP thickness from the testing samples.
   b. CIPP modulus and strength values will be further reduced to account for creep based on the creep reduction values recommended in ASTM D2990.
   c. The use of full enhancement factors in this analysis will be limited to liners that are confirmed by visual classification to be close-fit liners based on the post-lining inspection.

3. Perform necessary remedial measures to confirm that a CIPP deemed as structurally deficient will comply with all stipulated design life requirements such as additional sampling, confirmation of actual ovality, determination of a more representative groundwater elevation locally through monitoring, more precise information on height of cover and/or supplemental strength testing and thickness measurements at the Contractor’s expense.

4. Repair sections of CIPP removed for supplemental testing by placing a full circumference internal point repair of the same thickness as the full segment liner over and extending 12" beyond each side of the cut section.
5. Install a supplemental CIPP of the required thickness to structurally enhance the installed CIPP if supplemental testing fails to confirm the CIPP will meet the 50 year design life requirement.
6. Review remedial action with the Engineer prior to implementation.

END OF SECTION 33 01 30.72

SECTION 33 01 30.78 – GLASS REINFORCED PLASTIC SEGMENTAL SEWER LINER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Quality Assurance.
2. Certification.
3. Delivery, Storage, and Handling.
4. Testing and Factory Testing.
5. Contractor Requirements.
6. Submittal Requirements.
7. Design and Structural Requirements.
8. Acceptable Manufacturers.
9. Grout Materials and Grouting.
10. Epoxy.
11. Pipe Testing and Inspection.
12. Installation.
13. Access Pit.
14. Service Connection Reinstatement.
15. TV inspection.
16. Cleanup
17. Field Testing and Acceptance.
18. Certification Testing.

B. Related Requirements:

1. Section 01 57 15 – Temporary Bypass Pumping.
2. Section 01 58 13 – Temporary Project Signage.
3. Section 03 60 00 – Grouting.
4. Section 31 23 19 – Dewatering.
5. Section 31 23 33 – Trenching and Backfill.
6. Section 31 41 16 – Sheet Piling.
7. Section 31 50 00 – Excavation Support System.
8. Section 31 62 16 – Steel Piles.
9. Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
10. Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning.
11. Section 33 01 30.61 – Packer Injection Grouting.
12. Section 33 05 61 – Concrete Manholes.

1.2 DEFINITIONS

A. Rigid Pipes: Vitrified clay pipes, reinforced concrete pipes, and ductile iron pipes shall be considered as rigid pipe materials.

B. Non-rigid Pipes: Pipe materials other than vitrified clay pipes, reinforced concrete pipes, and ductile iron pipes shall be considered non-rigid pipe materials.

1.3 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T 180 – Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM D3262 – Standard Specification for Fiberglass Sewer pipes.
2. BS 5480 – Standard Specification for Glass Reinforced Plastic (GRP) pipes and fittings for water supply and sewerage.
3. ASTM D638 – Standard test method for tensile properties of plastic.
4. ASTM D790 – Standard test method for flexural properties of plastics.
5. ASTM D2412 – Standard test method for stiffness by parallel plate method.
6. ASTM D2583 – Standard test method for indentation hardness by means of Barcol Impressor.
7. ASTM D2584 – Standard test method for ignition loss cured reinforced resins.
8. ASTM D3567 – Standard practice for determining dimensions of “fiberglass pipe and fittings”.
9. ASTM D3681 – Standard method for chemical resistance of fiberglass pipe in deflected condition.
10. IGN 4-34-02 – Information and Guidance Note, No. 4-34-02; Specification for Glassfibre Reinforced Plastics (GRP) Sewer Linings.

1.4 COORDINATION

A. Comply with Section 01 30 00 – Administrative Requirements.

B. Notify MISS DIG and affected utility companies at least 72 hours prior to construction.

C. Coordinate Work of this Section with users connected to system. Notify Engineer, homeowners and businesses at least 48 hours in advance of expected disruption of sanitary service.

D. Provide and maintain temporary facilities, including pipes and pumps, to meet requirements.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Contractor's Qualifications: Submit a copy of manufacturer's licensee certificate with the Bid. Submit a list of at least two reference projects within the previous 5 years totaling at least one thousand (1,000) feet of the segmental liner approved for this Project. The references shall include diameter of pipe, length of installation, project cost, size of bypass pumping required to perform the Work, name and telephone number of pipe owner and date of installation. Submit manufacturer's approval of installer.

C. Product and Installation Data:

1. Submit the proposed panel system (one piece, two pieces, etc.) for each location and details, including the proposed jointing system and articulation of the panel sections to accommodate variations in line and grade.
2. Submit the length and weight of GRP panel sections to be supplied.
3. Select the installation method and procedures and follow the liner manufacturer's recommendations. Prior to commencement of grouting, submit grouting plan and method to Owner for review and approval. The grouting plan and method shall consist of grout mix specification; grout installation method (pumped, gravity flow, other); volume of grout to be used; placement of grouting ports, overflow ports and monitoring ports; method of dealing with service connections; method for determining adequate fill of space; grout set up time; and method for securing liner and grout at the liner termination points. If grout holes in the liner are proposed to install the grout, these holes shall be seated flush to the liner per manufacturer's recommendations.
4. Submit Structural calculations prepared by a licensed professional engineer showing the ability of the GRP liner to resist buckling and deformation due to flotation and grout pressure during grouting.
5. Submit Results of manufacturer's sampling and testing for conformance with ASTM or IGN 4-34-02 Standards.
6. Submit Linear blocking size, spacing and number.
7. Submit Product data for all materials used including certified test reports on materials manufactured for this Project.
8. Submit the following, 30 days prior to beginning work, to the Owner for approval:
    a. Detailed information regarding the accesses (existing, enlarged existing or new) that will be required to install the liner at each site including number of accesses required for each location, location of access, size, interfering utilities and traffic control schematics.
    b. Detail liner installation method and any utility work that may be required.
9. Submit Sheeting, shoring, and dewatering design and specified in Section 31 41 16 – Sheet Piling, Section 31 50 00 – Excavation Support Systems, Section 31 62 16 – Steel Piles, and Section 31 23 19 – Dewatering.
10. Submit description of required preparation of existing sewers including cleaning and necessary spot repairs.
11. Submit reinstatement sequence and details for lateral sewer and service connections.

12. Submit linear details including accommodations of bends, obstructions, and pipe transitions.
13. Submit layout schedules for linear sections for each reach including markings.
14. Submit a complete list of equipment including cameras, robotic service connection cutters, reamers, and among other items to be dedicated to the Work, specifying quantity, type and manufacture.
15. Submit flow control plan and details.
16. Submit Project Schedule including work hours and dates at each location. Side sewer flow shall be maintained at all times.

D. Shop Drawings:

1. Indicate liner dimensions for each pipe size to be relined.
2. Submit initial (used for bidding) and final (after the Contractor's inspection) structural design calculations prepared and signed and sealed by a Professional Engineer showing the required liner thickness, grout thickness and steel reinforcing (if any) requirements of the installation.
    a. Liner design calculations shall be supported by field analysis, technical assumptions, and requirements of this specification and shall be designed and manufactured in accordance with WRC standards (Type I) and the Quality Assurance Standards.
    b. A list of all assumptions and field data used for the design calculations shall be included with the design calculations submittal.
    c. Liner design shall be approved by manufacturer, with the manufacturer's approval noted on the Submittal.
    d. All calculations shall be prepared, signed and sealed by a Professional Engineer registered in the state of Michigan and show the ability of the internal bracing system to conform to the installation requirements and to resist buckling and deformation due to flotation and pressures experienced during the grouting operations.

E. Resident Notifications: Submit a copy of the initial resident notification as described herein. Submit a copy of the second and third resident notifications.

F. Digital Video Media: Submit the final television inspection that shows the rehabilitated sewer along with reinstated service connections.

1. Submit video recordings of piping sections as follows:
    a. Show condition of existing pipe and pipe joints and location of existing service connections, noting addresses, after cleaning and prior to relining.
    b. Show liner and reestablished service connections after relining Work has been completed.

G. Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for liner thickness.

H. Source Quality-Control Submittals:

1. Submit results of shop tests and inspections.
2. Submit installation certificate from equipment manufacturer's representative.

I. Field Quality-Control Submittals: Submit results of Contractor-furnished tests and inspections.

J. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, licensed professional, pipeline assessor, and inspector.
2. Submit manufacturer's approval of installer.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record and submit actual locations of pipe runs, service connections, manholes, and cleanouts.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Closed-Caption Television (CCTV) Inspection:

1. Comply with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
2. All sewers, manholes, inlets and other appurtenances shall be CCTV and visual inspected prior to Substantial Completion of the sewer items.
3. The CCTV inspections shall be performed after completion of the sewer items and before Substantial Completion is issued.

1.7 QUALITY ASSURANCE

A. This section contains references to the following documents. They are part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section, as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organizations, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following list, references to those documents shall mean the specified document version

associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

C. Design Procedures for Circular and Non-Circular Pipes: Water Research Centre (WRC) Sewerage Rehabilitation Manual Type I – Design Method.

1.8 QUALIFICATIONS

A. Manufacturer: The manufacturer of the segmental lining shall have experience of manufacturing a minimum of 50,000 linear feet (LF) of sanitary or combined sewers.

B. Contractor Requirements: The Contractor who will perform the liner installation shall have previous successful experience in installation of the approved Segmental Lining system in circular and non-circular sewers owned by public agencies or municipalities. Submit a minimum of two reference projects within the previous 5 years totaling at least one thousand (1,000) feet of the segmental liner approved for this Project. The references shall include diameter of pipe, length of installation, size of bypass pumping required to perform the Work, name and telephone number of pipe owner and date of installation. The stated experience requirements for the licensed Contractor or installation subcontractor must be projects which used the approved liner manufacturers. All referenced experience shall be for the projects completed within the United States and Canada. The Contractor installing the sewer lining shall be approved by the approved Segmental Lining liner manufacturer.

C. Field Superintendent: Submit the name(s) and qualifications for each scheduled superintendent for the Project. The superintendents named shall be those assigned to the Project and the qualified superintendent shall be present on the job during all construction activities. The superintendent shall have a minimum of one-year Segmental Lining supervisory field experience on at least two successfully completed projects totaling a minimum of 1,000 LF with the approved Segmental Lining system. The superintendent shall have supervisory field experience on at least one successfully completed non-round sewer lining project. The Contractor's bid will be deemed non-responsive if said Superintendent Qualifications are not submitted within the aforementioned time period. All referenced experiences shall be for projects completed within the United States and Canada.

D. Pipeline Assessor:

1. Person specializing in assessing condition of sewer pipelines prior to and following relining.
2. Currently certified in Pipeline Assessment and Certification Program (PACP) of the National Association of Sewer Service Companies (NASSCO).

E. The final decision to accept or reject the product, manufacturer, and/or installer lies solely with the Owner. The named Manufacturer, Field Superintendent, and Segmental Lining Installer must be employed to perform the Work, unless changes are specifically authorized by the Owner.

F. Certification:

1. All personnel directly involved with installing the liner shall receive training in the proper methods for handling, inserting, trimming and finishing the liner. Training shall be performed by a representative of the liner manufacturer.
2. This requirement may be satisfied by providing one day on-site training by the liner manufacturer in the presence of the Owner. Where the training is not witnessed by the Owner, provide a certification of training from the manufacturer for the superintendent and each crew member.
3. Testing: The Owner shall be notified of the place and time of testing a minimum of 4 weeks prior to the commencement of testing. Testing shall be completed, and certified results provided prior to shipping materials.
4. Factory Testing: Testing specified shall be completed and certified results provided.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Delivery of material shall be coordinated with other trades to avoid delays.
2. Pipe preparations and field inspections shall be completed prior to delivery of material to site.
3. Accept materials on-site in manufacturer's original packaging and inspect for damage.

B. Storage of materials:

1. Store materials according to manufacturer instructions.
2. Non-rigid pipe shall be stored to prevent bowing. Pipe and fittings with visible cracks, breakage or other defects shall not be used, or repaired and used, unless specifically accepted by Engineer in writing.

C. Handling: Handle all products with care. Only sound, undamaged products will be accepted. Any materials which, in the opinion of the Engineer, are not in conformity with the specifications or the Drawings will be rejected and shall be removed from the site immediately.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.
3. Plastic pipe shall be kept covered to prevent exposure from ultra-violet exposure of sun.
4. Block individual and stockpiled pipe lengths to prevent moving.
5. Lined pipe and fittings shall be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc., shall be placed inside the pipe and fittings for lifting, positioning, or laying. The pipe shall not be dropped or unloaded by rolling.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Construct a template and proof the line prior to fabrication.
2. Verify field measurements prior to submittal and fabrication including size, length and depth of sewer reaches to be lined.
3. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Warrant the installation and obtain from the manufacturer its warranty that the GRP conforms to these specifications and will be free from defects in design, materials and workmanship for a period of three (3) years from the date of substantial completion of this Contract. Said manufacturer's warranty shall be in a form acceptable to and for the benefit of the Owner and shall be submitted by the Contractor as a condition of final payment. Repair or replace, at the sole option of and at no cost to the Owner, any Work found to be defective within said warranty period. Such repair or replacement shall include the cost of removal and reinstallation.

C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exceptions to this provision will be allowed.

D. Warrant to the Owner that the materials used on this Contract, where covered by patents or license agreements, are furnished in accordance with such agreements and that the prices included herein cover all applicable royalties and fees in accordance with such license agreements. Defend, indemnify and hold the Owner harmless from and against any and all costs, loss, damage or expense arising out of or in any way connected with any claim of infringement of patent, trademark, or violation of license agreement.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Submit Design Calculations for the pipe proposed. The calculations shall be prepared by a Licensed Professional Engineer. These Design Calculations shall also include all loadings from hydrostatic, earth, and live loads that are applied to the GRP plus the specified safety factor.

2.2 STRUCTURAL REQUIREMENTS

A. General: It is the intent of this Specification to provide for rehabilitation of a pipeline by the installation of a glass fiber reinforced plastic (GRP) liner. The design life of the GRP liner shall be a minimum of 50 years.

B. Design Criteria:

1. The Sewer Lining system shall be a Glass Fiber Reinforced Plastic (GRP) Segmental Liner. The GRP sewer lining system shall provide a minimum service life of 50 years. The liner shall be designed and manufactured in accordance with WRC standards (Type I) and the standards previously listed. Design calculations shall be sealed by qualified Licensed Professional Engineer. Liner design shall be approved by manufacturer and submitted to the Owner for approval.
2. The lining shall be a single or multiple piece panel system (maximum 4 panels) manufactured from corrosion resistant isophthalic resin. The panels should be formed and configured to fit the existing conduit to maximize the open are for flow. The panels shall also be formed and configured to accommodate bends and changes in grade.
3. For multiple piece panel systems, the lower sections of the lining shall have U shaped grooves on the longitudinal edges, and the upper section shall have a tongue on the longitudinal edges, which locates and fits into the grooves of the lower section thus uniformly distributing any loads along the joint. Care shall be taken during the design of the units to position the joints at the crossover points of the theoretical positive and negative bending moments (i.e. the neutral axis). Lengths shall be joined by a bell and spigot arrangement that allow articulation of the panels to negotiate variations in line and level.
4. The inside surface (in contact with the sewage) of main structure of the liner shall incorporate a surface corrosion barrier reinforced with a 'C' glass tissue and of a minimum of 1.5 mm. This corrosion barrier shall be followed by layers of pre-formed powder bound, chopped strand glass mat consolidated with the isophthalic resin to give a resin/glass ratio of approximately 2.5 to 1. The center core shall consist of a silica sand/isophthalic resin matrix followed by further layers of powder bound mat and isophthalic resin to the design thickness. The outer surface (not in contact with the sewage) shall be treated with a bonded inert aggregate to enhance the adhesion of the back-fill substrate. The aggregate size shall be 3 mm and evenly and densely applied.
5. Where necessary, the lining shall be supplied in short lengths to account for restricted access and to allow for changes in direction. Verify any bends (vertical and horizontal) in the existing sewer, submitting liner variation to Owner for approval.
6. The Closed-Circuit Television (CCTV) and inspection reports of the sewers and manholes to be rehabilitated for the Contract, that were performed by the Owner, will be made available to the Bidder. This information, as well as sewer and manhole inspection forms and any available existing drawings from the Owner, will be provided to the Contractor for information only. The purpose of this additional information is to better determine the existing sewer and manhole conditions so that the Bidder can better estimate the cost of the Work and initially design the liner for each project site. This information in no way precludes the Contractor from performing all necessary inspections, field measurements, and all other preparatory work for the proper installation and design of all the Work sites in accordance with the Contract Documents.
7. The dimensions of the linings including thickness of the annulus shall be as approved by the Owner during the shop drawing review phase. The liner shall be fabricated to the size as shown on the Contract Drawings that closely follows the existing sewer and minimizes the loss of cross-sectional area. The liners shall have minimum thickness as shown in the plans. All dimensions shall be field verified prior to design of the liner. Allowances for

longitudinal and circumferential expansion shall be considered when sizing and installing the liner.

8. Design, manufacture, and install a transition fitting at any location along the length of the sewer to be rehabilitated where the internal dimension (either vertical or horizontal) changes by 15% or more. Fittings shall be designed and installed such that a smooth transition is provided between sewer liner segments of different size. The fittings shall not contain any lips or drop-offs.
9. The linings shall be designed and detailed to withstand handling, stacking and other temporary stresses induced during manufacture, delivery, unloading, storage and installation.
10. The GRP liners shall be capable of withstanding a uniform grout pressure of 5 psi during installation. The grout and grout pressures used to fill the space between the GRP liner shall conform to the requirements of the WRC Sewerage Rehabilitation Manual Type I Design. The pressure at the grout pump nozzle shall not under any circumstances exceed 7.25 psi. The liner shall be designed to withstand the grout pressure and shall not buckle, deform or collapse during grouting to fill the annular space around the entire circumference of the liner in a maximum of 3 lifts.
11. When installed, the liner shall form an impermeable liner that is resistant to chemicals found in domestic sewage and trace amounts of gasoline and other oil products commonly found in municipal sewage and soils adjacent to the pipe to be lined.
12. The length of the liner shall be that deemed necessary by the Contractor to effectively carry out installation and seal the liner at the inlet and outlet of each manhole.
13. Ensure that the correct liner is installed in each sewer being rehabilitated.
14. Liner Design calculations including thickness of GRP panels and annulus shall be submitted in accordance with this Section. Lining system dimension design calculations shall be computed and submitted for each individual sewer segment included in the Contract. The finished liner dimensions must conform to the minimum cross-sectional areas shown in the Contract Documents. The actual installed lining system dimensions, including the thickness of the GRP liner panels and the annulus, shall be within 2 percent of the approved design dimensions.
15. The following requirements shall be incorporated into the design.
    a. Single and multiple piece lining systems (with longitudinal joints) shall meet the requirements of a Type I lining in accordance with the WRC Sewerage Rehabilitation Manual Type I Design. Groundwater shall be assumed to be at ground surface level for the design of all lining.
    b. Flexural strength (bending stress): In determining liner thickness for Type I design, the long-term flexural strength shall be reduced by 50% to account for creep.
    c. Flexural modulus: In determining liner thickness for Type I design, the long-term flexural modulus shall be reduced to a maximum of 725,000 psi (5000 +/- N/mm2) to account for creep.

16. The liner shall be designed according to the following minimum criteria:
    a. Modulus of soil reaction, E's = 1,000 psi (fully deteriorated).
    b. Unit weight of soil = 125 pcf unless noted otherwise in Volume 2.
    c. Soil depth shall be the greatest depth of bury for each segment.
    d. Design Safety factor shall not be less than 2.0.

e. Surface loading of HS-20 as defined in AASHTO-SSHB including impact factor, shall be applied at all times.
f. Surface loading of Cooper E80 live loading as defined in AREMA – MRE, including impact factor, shall be used for sites in the vicinity of railroad tracks.
g. Assume full hydrostatic pressure over pipes (to ground surface, at the deepest part of the reach) unless otherwise noted in the plans.
h. Maximum long-term deflection shall be 5%.

17. Soil lateral pressure shall be represented by a fluid of equivalent weight of maximum 70 pounds per cubic foot and minimum 30 pounds per cubic foot, whose surface is at ground surface, at soil-dry condition. The more critical result of maximum or minimum shall be used for design in each location, in conjunction with other design loads including those due to groundwater.
18. Calculations shall be based on the worst-case pipeline size/dimensions stated in the plans and the design parameters listed above.
19. The finished liner dimensions must conform to the minimum cross-sectional areas shown in the Contract Documents.

2.3 ACCEPTABLE MANUFACTURERS

A. Channeline North America.

B. Approved Equal.

2.4 GROUT MATERIALS

A. Comply with Section 03 60 00 - Grouting.

B. The grout used to fill the space between the GRP Liner and existing pipe shall conform to the requirements of the WRC Sewerage Rehabilitation Manual Type I Design and shall be approved by the manufacture and submitted to the Owner.

C. The strength of the grout shall have a minimum 28-day compressive strength of 1,700 psi when tested in accordance with ASTM C39.

D. The water/solids ratio shall be kept as low as possible and in the range of 0.35 to 0.45. Adjust workability by variations in the water/solids ratio within specified limits. Use an approved plasticizing agent.

E. The specified gravity of the annulus fill shall be in the range of 1.6 to 1.7.

F. The components of the grout mix shall meet the following requirements, where applicable:

1. Cement shall be in accordance with ASTM C150.
2. Sand shall be in accordance with ASTM C778.
3. Admixtures shall be in accordance with ASTM C494.

4. Water shall be clean, potable, free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances.

G. Foam grout will not be permitted.

2.5 EPOXY

A. The circumferential bell and spigot joints shall be gasketed for circular liners or sealed with Sikaflex 1A or equal for non-circular liners. The longitudinal joints will be adhered using Plexus MA-320 or equal for all shaped liners.

2.6 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements.

B. Grout Testing: For each GRP liner segment installed, three (3) grout cylinders shall be taken. Compressive test strengths shall be conducted at 28 days. Test third cylinder in case of failure of either of the others. For each GRP liner segment installed, testing shall be conducted on the grout mix to verify no shrinkage and permissible expansion percentages in accordance with ASTM C 827 and ASTM C 1090. Should test results not meet Contract requirements or not meet submitted calculations, provide additional samples from inside of the installed liner to submit for additional testing. After removal of samples, apply an Owner-approved repair at the spot where samples were removed.

C. After the Work is completed, provide Owner with a videotape showing both the before and after internal pipe conditions including restored connections. Direction of travel of the camera shall be consistent between the before and after video inspection. The tape shall be submitted to Owner within one (1) week of completion of liner installation. Comply with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.

D. All defects discovered during the post-installation television inspection shall be corrected before the Work under the Contract will be considered for final completion. After the defects are corrected, the sewer shall be videotaped again. The post-installation television inspection tape shall be submitted to the Owner to review prior to the final completion milestone.

PART 3 - EXECUTION

3.1 PREPARATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

3.2 INSTALLATION

A. Sewer Bypassing and Dewatering:

1. Bypass sewer flow around the Work to maintain service. Dewater sewer lines in accordance with the requirements of Section 01 57 15 – Temporary Bypass Pumping and Section 31 23 19 – Dewatering. Protect the liner during any storm event (high flow), and any damage to the liner shall be repaired and replaced at no additional expense to the Owner.
2. All connections to project sewers shall be maintained at all times. Refer to Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning for side sewer/lateral flow maintenance requirements.

B. Sewer Template:

1. Prior to lining, clean and CCTV inspect the sewer line in accordance with Section 33 01 30 16 – Sanitary Sewer Pipeline Inspection, Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning, and measure the existing sewer, respectively. If CCTV inspection shows a major obstruction that would prohibit or otherwise damage the liner during installation, conduct a spot repair at no additional cost to the Owner.
2. Following TV inspection and measuring the sewer, construct a template and verify that the sewer is free of obstructions (proof the line) by pulling an 8-foot long template section through the existing sewer line. The template liner used for proofing the sewer shall have the same dimensions and shape as the intended liner.
3. Lateral pipes protruding into the pipe shall be trimmed flush with the inside of the pipe wall prior to lining.
4. No lining shall be performed until the sewer has been successfully proofed. Where the sewer is unacceptable for lining, review the CCTV inspection report and determine the location(s) where spot repair(s) or additional cleaning is required. Spot repairs shall not be done unless authorized by the Owner.

3.3 ACCESS PIT

A. Determine what type of access is required (existing, enlarged existing, or new) to install the liner. Where new access is required, identify whether this will be permanent, such as a new MH, or temporary (Shaft Location) such as an excavated and restored access pit.

B. Approximate access locations (Shaft Locations) have been provided on the drawings. If no location is shown on the drawing, then access to the existing sewer shall be through the existing manhole. Alternatively, install the liner through an upstream or downstream access pit and construct a manhole in accordance with DWSD Standards.

C. Excavation shall be in accordance with Section 31 23 33 – Trenching and Backfill and ASTM F585. Access pit dimensions shall be submitted to the Owner for approval.

D. When possible, access pit excavations shall coincide with service lateral connection points, location of bends, location of deformation or changes in the sewer size or grade.

E. At the access pit, the top of the existing sewer shall be removed down to the spring line. The edge of the existing pipe shall be smoothed to eliminate sharp edges that could damage the liner pipe.

F. Ensure that no wastewater overflows from the existing pipe into the access pit. If wastewater does overflow, contain the wastewater and return it to the existing pipe.

G. Upon successful completion of the grouting of the annular space as determined by the Owner, the existing pipe shall be closed as shown on the contract drawings and the access pit shall be backfilled in accordance with Section 31 23 33 – Trenching and Backfill.

H. Sheeting, shoring and bracing requirements shall be in accordance with Section 31 41 16 – Sheet Piling, Section 31 50 00 – Excavation Support Systems, and Section 31 62 16 – Steel Piles. Access pit sheeting, shoring and bracing systems shall remain completely separated from the pipe support system and shall be designed by the Contractor and sealed by a licensed Professional Engineer registered in Michigan and submitted to the Owner.

3.4 LINER INSTALLATION

A. No pipe shall be lined without submittal of pre-installation televising videotape to the Owner and prior to notification to the Owner. Owner will review videotape and, if satisfied with condition of segment, provide approval to proceed with the installation of the liner. Each liner shall be subject to inspection by the Owner immediately before it is installed. Defective liner will be rejected.

B. Installation of GRP Liner:

1. The GRP Liner shall be installed in accordance with the manufacturer's recommendations. The interior of the pipelines shall be inspected to determine the location of any conditions that may prevent proper installation of lining inside host sewer, and it shall be noted so that these conditions can be corrected. Infiltration shall be stopped using cementitious water-plug or pressure grouting at no additional cost to the Owner.
2. The integrity of the liner shall be sufficient to meet any design assumptions and the requirement for subsequent grouting behind the liner. The liner shall not move, float or shift out of required position during grouting. Any minor misalignment (such as joints) shall not present an impediment to flow or interfere with hydraulic performance or negatively affect long-term structural performance.

C. Invert through Manholes: The invert shall be continuous and smooth through all manholes. The liner shall be installed through existing manholes and once grouting is complete the manhole opening shall be restored. The bottom portion of the liner shall remain, and the bench of the manhole shall be grouted and shaped as necessary to support the liner. If the liner terminates on either side of a manhole, the invert shall be built up to form a continuous invert through the manhole and prevent ponding and debris buildup.

D. Sealing the Liner in Manholes: The liner shall make a tight seal at the manhole opening with no annular gaps. Any annular space at the termination points shall be sealed by filling with a resin mixture compatible with the liner. The transition between the liner ends and the host sewer shall be per the liner end detail shown on the contract drawings and rendered smooth to reinstate the sewer flow line.

E. Grouting shall comply with Section 03 60 00 – Grouting.

3.5 REINSTATEMENT OF SERVICE CONNECTIONS

A. The exact location and number of service connections and side sewers shall be verified during the initial television inspection. Accurately field-locate all existing service connections or side sewers. Reconnect all service connections or side sewers to the liner pipe as indicated in accordance with the Contract Documents.

B. Restore and correct, without any delay, all missed or faulty reconnections, as well as any damage caused to property Owner's for not reconnecting the services soon enough or for not giving notice to the property owners.

C. Any lateral not initially reinstated that proves to be active shall be reinstated at no additional cost to the Owner. Reimburse the Owner any resulting property damage or floods.

D. Service connections and side sewers shall not be disrupted during lining, or grouting operations. Locations of side sewers provided on drawings do not relieve Contractor from locating all service laterals and cleanouts. All service lateral connections should be located prior to lining installation. The connections shall be made from within the liner sewer. Service laterals shall be connected to the liner pipe as shown on the drawings and as recommended by the pipe manufacturer.

E. Provision shall be made to prevent any grout or other material from entering the existing service connection or the reinstatement connection. Where any grout or other material has entered the service connection, remove at no additional cost to the owner.

F. All service connections and side sewers to be reconnected to the main sewer shall be cleaned to a length of three feet from the inside face of the existing wall of the main pipe (one foot for mainline pipes smaller than 24-inches in diameter). All deposits within the first three feet of the service connection or side sewer (one foot for mainline pipes smaller than 24-inches in diameter) shall be removed, and laterals reinstated as shown in the Contract Drawings.

G. Notify all parties affected by construction. Notify the Engineer, and residents, tenants, and property owners of upcoming construction twice, approximately five (5) days prior or earlier, and then again approximately twenty-four (24) hours before construction is expected to begin adjacent to their property or in any location that will directly affect the use of their property. This notification shall be made by delivering a written notice to the residents, tenants or property owners. The notice form shall include the project name, the name and address of the Contractor, along with a daytime and emergency contact person and phone number for the

Contractor's representative and the Engineer. Submit for approval all property Owner notification letters to the Owner for approval.

H. Post signs at the project extents notifying residents of the upcoming Work at least 48 hours prior to the commencement of Work. The sign shall be submitted for approval by the Owner.

3.6 CCTV INSPECTION

A. After the installation of the liner prior to grouting and after annular space has been grouted, the liner shall be CCTV inspected in accordance with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection and submitted to the Owner. Where the CCTV inspection indicates the liner wall is damaged or forced out of round through grouting, the affected portion(s) of the liner shall be replaced at no additional cost to the Owner.

3.7 CLEANUP

A. After the Work has been completed, clean up the entire project area. All excess material and debris not incorporated into the permanent installation shall be disposed of off-site in a lawful manner by the Contractor.

3.8 FIELD TESTING AND ACCEPTANCE

A. Field acceptance of the liner shall be based on the Owner's evaluation of the installation including a review of CCTV videotapes. The Engineer may also perform a walk-through inspection of the installed product for final acceptance.

B. There shall be no visible infiltration through the liner.

C. After the annular space has been grouted, verify to the Engineer that all the annular space has been filled. Method shall be submitted and approved by the Engineer. Where the annular space indicates that the grout did not fully fill the area, the affected portion(s) of the liner shall be grouted at no additional cost to the Owner.

D. All service connections shall be open and clear. All service and manhole connections shall be watertight.

E. There shall be no evidence of splits, cracks, breaks, deformed or separated joints, or crazing in the liner.

F. If any defective liner is discovered after or during the installation of the liner, it shall be repaired per the manufacture recommendations at no additional cost to the Owner. No time extensions will be allowed in this case. Submit to the Owner for approval written manufacturer approved process prior to repair. Any damage to the liner shall be repaired at no additional cost to the Owner. Repair to damage or defects shall not accrue any additional cost or time extension.

G. Test for complete filling of the annular space with grout. This test shall be performed by sounding the entire circumference of the pipe at regular intervals.

END OF SECTION 33 01 30.78

SECTION 33 01 30.79 - FOLD-AND-FORM SEWER LINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cleaning and flushing of existing sanitary sewers as preparation for lining.
2. Taking video of existing sewers to confirm their condition.
3. Field verification of size, length, and depth of sewer reaches to be lined.
4. Flow control.
5. Installing fold-and-form pipe liner.
6. Installing deformed polyethylene pipe liner.
7. Reestablishing service connections.

B. Related Requirements:

1. Section 01 57 15 - Temporary Sewer Bypass Pumping.
2. Section 03 60 00 - Grouting.
3. Section 31 23 33 - Trench Excavation and Backfill.
4. Section 33 01 30.16 - Sanitary Sewer Pipeline Inspection.
5. Section 33 01 30.19 - Sanitary Sewer Pipeline Cleaning.
6. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. ASTM International:

1. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
2. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
3. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
4. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
5. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
6. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
7. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

8. ASTM D5260 - Standard Classification for Chemical Resistance of Poly (Vinyl Chloride) (PVC) Homopolymer and Copolymer Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
9. ASTM F1533 - Standard Specification for Deformed Polyethylene (PE) Liner.
10. ASTM F1606 - Standard Practice for Rehabilitation of Existing Sewers and Conduits with Deformed Polyethylene (PE) Liner.
11. ASTM F1867 - Standard Practice for Installation of Folded/Formed Poly (Vinyl Chloride) (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation.
12. ASTM F1871 - Standard Specification for Folded/Formed Poly (Vinyl Chloride) Pipe Type A for Existing Sewer and Conduit Rehabilitation.

1.3 COORDINATION

A. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

B. Provide and maintain temporary facilities, including piping and pumps, to meet requirements.

1.4 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Convene preinstallation meeting a minimum of one (1) week prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Contractor’s Qualifications: Submit with the Bid a copy of manufacturer’s licensee certificate. Submit list of ten (10) similar jobs within the past three (3) years as well. Provide project information such as length of project, pipe diameter, date complete, and project cost. Submit manufacturer's approval of installer.

C. Product Data:

1. Submit manufacturer information regarding liner material.
2. Samples: Submit two (2) samples of liner material.
3. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
4. Manufacturer Instructions:
    a. Submit detailed description of liner placement and installation procedures.
    b. Include description of procedures for sealing liner material at manholes and reestablishing service connections.
    c. Submit manufacturer's requirements for receiving, handling, and storage of materials.

5. Test and Evaluation Reports: Submit reports certifying that liner material meets ASTM testing standards as specified in this Section.

D. Shop Drawings:

1. Indicate liner dimensions for each pipe size to be relined.
2. Submit calculations for each manhole-to-manhole section and furnish them to the Engineer with supporting assumptions. Calculations shall be done after cleaning, televising, and other field inspections have been accomplished. Design parameters given in this specification shall be used in calculations.
3. Submit plans showing points of insertion and methodologies.

E. Resident Notifications: Submit a copy of the initial resident notification as described herein. Submit a copy of the second and third resident notifications.

F. Digital Video Media: Submit the final television inspection that shows the rehabilitated sewer along with reinstated service connections.

1. Submit video recordings of piping sections as follows:
   a. Show condition of existing pipe and pipe joints and location of existing service connections, noting addresses, after cleaning and prior to relining.
   b. Show liner and reestablished service connections after relining Work has been completed.

G. Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for liner thickness.

H. Source Quality-Control Submittals:

1. Submit results of shop tests and inspections.
2. Submit installation certificate from equipment manufacturer's representative.

I. Field Quality-Control Submittals: Submit results of Contractor-furnished tests and inspections.

J. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, licensed professional, pipeline assessor, and inspector.
2. Submit manufacturer's approval of installer.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents: Record and submit actual locations of each service connection.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three (3) years documented experience in installation of liner materials. Approved by manufacturer.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

D. Pipeline Assessor:

1. Person specializing in assessing condition of sewer pipelines prior to and following relining.
2. Currently certified in Pipeline Assessment and Certification Program (PACP) of the National Association of Sewer Service Companies (NASSCO).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Delivery of material shall be coordinated with other trades to avoid delays.
2. Pipe preparations and field inspections shall be completed prior to delivery of material to site.
3. Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage of materials: according to manufacturer instructions.

C. Handling: Handle all products with care. Only sound, undamaged products will be accepted.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to submittal and fabrication including size, length and depth of sewer reaches to be lined.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Provide a one (1) year warranty period for all materials and workmanship. Warranty period will commence on the date of substantial completion of the Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Design lining material to have sufficient structural strength to support dead loads, live loads, and groundwater load imposed, assuming existing pipe cannot share loading or contribute to structural integrity of liner.

B. Design Groundwater depth shall be as indicated in the Contract Documents, but not less than ½ sewer depth for lining design considerations.

C. Design liner shall be the least-practical thickness to minimize decreasing interior pipe diameter.

D. Design liner material shall provide jointless, continuous, and structurally sound construction able to withstand imposed static, dynamic, and hydrostatic loads on a long-term basis.

E. Identify design provisions for shrinkage control to prevent future misalignment of service reconnections.

2.2 FOLD-AND-FORM PVC PIPE LINER

A. Description:

1. Maximum Initial Standard Dimension Ratio (SDR): 35 unless a smaller SDR is shown on the Drawings.
2. Comply with ASTM F1871.
3. Effective Length: Match length of piping to be lined.
4. Sealer: As recommended by liner manufacturer.

B. Materials:

1. PVC compound shall meet or exceed requirements for Cell Classification 12222 as defined in ASTM D1784.
2. Limit additions and fillers, including stabilizers, antioxidants, lubricants, colorants, to 20 parts or less for each 100 by weight of PVC resin in compound.

2.3 DEFORMED POLYETHYLENE PIPE LINER

A. Description:

1. Maximum Initial Standard Dimension Ratio (SDR): 26 unless a smaller SDR is shown on the Drawings.
2. Effective Length: Match length of piping to be lined.

B. Materials:

1. Polyethylene (PE):
   a. Comply with ASTM D3350 cell classification 345434C or D.
   b. Comply with ASTM F1533 and F1606.

2. High-Density Polyethylene (HDPE):
   a. Comply with ASTM D3350 cell classification 345434E.
   b. Tensile Strength (Break):
      1) 4,500 psi.
      2) Comply with ASTM D638.
   c. Tensile Strength (Yield):
      1) 3,200 psi.
      2) Comply with ASTM D638.
   d. Impact Strength:
      1) 3.0 ft.-lb./in.
      2) Comply with ASTM D256, Test Method A.
   e. Flexural Modulus:
      1) 136,000 psi.
      2) Comply with ASTMD790.

3. Sealer:
   a. Hydrophilic seal material as recommended by liner manufacturer.
   b. Compatible with the polyethylene pipe and provides a watertight seal.

2.4 MIXES

A. Grout: As specified in Section 03 60 00 - Grouting.

2.5 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Inspection and Testing:

1. Inspect extruded material for defects and physical properties according to ASTM D1785.
2. Verify that the liner material is homogeneous and free of defects, cracks, holes, blisters, protrusions, foreign materials, or other deleterious faults.

3. Marking:
    a. For testing purposes, mark each production lot with identical marking number.
    b. Mark each reel of folded PVC pipe at intervals not to exceed 5 feet with coded number identifying manufacturer, size, cell class, machine, shift, and date when liner was extruded.

4. Chemical and Physical Testing: For every 1,000 linear feet of pipe with CIPP lining installed, perform sampling and testing to determine the installed CIPP lining's flexural properties and thickness. After 10,000 feet of acceptable test results have been received, the test sample frequency may be reduced to one sample every 2,000 feet from the same wet-out batch if samples continue to meet all minimum standards and sampling results are received in a timely manner. The testing frequency may be increased at no additional cost to the Owner when the required tests show the installed CIPP lining does not meet specifications.

C. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility. Locations greater than 50 miles from Site shall be at the Contractor's expense.
2. Notify Owner at least seven (7) days before inspections and tests are scheduled.

D. Certificate of Compliance: Submit Certificate of Compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify location of piping to be relined.

C. All sewer pipe liner material shall be carefully inspected for defects prior to installation.

D. Any material found during the progress of the work to have flaws or defects shall be rejected. All defective materials furnished or installed shall be promptly removed from the project site. Replace all such material found defective in manufacture or damaged in handling or installation.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

C. Cleaning: Clean existing sewer pipes of debris, sedimentation, and mineral deposits with high-velocity cleaner, bucket and scraper, root saws, rolling or balling units as specified in Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning.

D. Initial Video Inspection and Repair:

1. Conduct inspection of sewer by method of:
   a. Closed-circuit video inspection as specified in Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
   b. Alternatively: Multi-Sensor Inspection (MSI).

2. Determine condition of existing piping, degree of offset of joints, and locations of crushed walls and obstructions.
3. Determine sizes and locations of service entrances and connections.
4. Evaluation of pipe conditions performed by pipeline assessor.
5. Inspection of Work performed by a NASSCO Inspector Training and Certification - certified inspector.
6. Clear obstructions, service piping protrusions, and other materials from bottom of existing pipe to ensure that inserted pipe liner directly contacts existing pipe wall.
7. Seal active infiltration categorized as runners and gushers by the NASSCO's PACP Defect Rating Codes.

E. Bypassing Sewage:

1. If required, or as directed by the Engineer, set up bypassing pump system to isolate each section of piping for relining.
2. Maintain bypass pumping until lining is totally formed and service connections have been reestablished.
3. The bypass system shall be of sufficient capacity to handle existing three (3) times the peak dry weather flow shown on the contract drawings. Installer shall schedule the Work during periods of projected dry weather.
4. All engines and powered equipment for operation outside of normal working hours shall be equipped in a manner to keep nose to a minimum. Noise control shall include the use of appropriate baffles or other means of noise control.

F. Laterals: Lateral pipes protruding into the pipe shall be trimmed flush with the inside of the pipe wall prior to lining.

3.3 INSTALLATION

A. Excavate for point repairs only on emergency basis and as permitted by Engineer.

B. Perform relining and reestablish service connections without need for excavation while minimizing disruptions to adjacent occupied buildings and traffic.

C. Deformed Polyethylene (PE) Pipe Liner:

1. Establish access points with Engineer.
2. Excavate and backfill as specified in Section 31 23 33 – Trenching and Backfill.
3. Pulling of Liner:
    a. Pull liner through existing pipe through access points or using existing manholes. The end of the liner shall be prepared for attachment to the cable in accordance with the manufacturer's instructions. The connection between the pulling cable and the prepared end of the liner shall be a swivel device to prevent twisting of the liner as it is pulled through the host pipe. The heated liner coil shall be placed in such a manner as to prevent damage to the liner as it is pulled through the manhole and into the host pipe.
    b. Use sleeves and rollers to protect liner.

4. After deformed pipe liner is in place, cut pipe to length and attach processing manifolds at both pipe ends.
5. Attach temperature- and pressure-measuring instruments to deformed pipe at both ends.
6. Liner Forming:
    a. Use steam and air pressure to re-form pipe to conform to existing pipe wall.
    b. Gradually re-form pipe following manufacturer instructions.

7. Cool-Down: Cool re-formed pipe according to manufacturer recommendations.
8. Install finished lining continuous over entire length of piping free of visual defects, including foreign inclusions, pinholes, and delamination.
9. Test for leakage as specified in FIELD QUALITY CONTROL Article to confirm that lining is impervious and free of leakage from pipe to surrounding ground or from ground to inside of lined pipe.
10. Repair defects affecting integrity or strength of lining.
11. Verify that no gap or annular space exists between finished liner and existing sewer main observed at manholes, sewer service connections, or other exposed points within finished lined section.
12. Pump grout into annular space at manholes, sewer service connections, and where liner is exposed.
13. Seal new pipe liner watertight to rehabilitated piping at both ends, using sealing material compatible with pipe.

D. Fold-and-Formed Pipe Liner:

1. Establish access points with Engineer.
2. Excavate and backfill as specified in Section 31 23 33 – Trenching and Backfill.
3. Comply with ASTM F1867.
4. Apply steam heat to make folded pipe pliable.
5. Install finished lining continuous over entire length of piping free of visual defects, including foreign inclusions, pinholes, and delamination.
6. Pull pliable folded pipe into place, not exceeding pulling force of 2,000 lbf. The end of the liner shall be prepared for attachment to the cable in accordance with the manufacturer's instructions. The connection between the pulling cable and the prepared end of the liner

shall be a swivel device to prevent twisting of the liner as it is pulled through the host pipe. The heated liner coil shall be placed in such a manner as to prevent damage to the liner as it is pulled through the manhole and into the host pipe.

7. After folded pipe is inserted into existing pipe, cut off pipe at starting point, restrain pipe at terminating point, and introduce steam at insertion end inside folded pipe until minimum desired temperature is attained at terminating end.
8. Rounding:
    a. After material has reached manufacturer's recommended temperature, insert and pull specifically designed pressure-driven rounding device through folded PVC.
    b. Do not exceed manufacturer's insertion rate and pressure.
    c. Prevent scraping, tearing, abrasion, movement, or other damage to liner.
    d. Begin rounding process at starting manhole and progressively proceed to terminating manhole to force out liquid between existing pipe and liner, including sewage, and groundwater.
9. After rounding, apply air pressure according to manufacturer instructions.
10. After air pressure, introduce water until system is completely filled, then cool pipe and cut off both ends.
11. Test for leakage as specified in FIELD QUALITY CONTROL Article to confirm that lining is impervious and free of leakage from pipe to surrounding ground or from ground to inside of lined pipe.
12. Repair defects affecting integrity or strength of lining.
13. Verify that no gap or annular space exists between finished liner and existing sewer main observed at manholes, sewer service connections, or other exposed points within finished lined section.
14. Grouting: Pump grout into annular space at manholes, sewer service connections, and wherever liner is exposed.
15. Sealing:
    a. Seal new PVC liner watertight to host pipe in order to prevent water movement between two systems.
    b. Use end seal material compatible with PVC liner.

E. Manholes: The invert shall be continuous and smooth through manholes. If the liner is installed through a manhole, the bottom portion of the liner shall remain and the bench of the manhole shall be grouted and shaped to support the liner. The cost of this work shall be included in the cost of this specification.

F. Service Connections:

1. Reestablish existing sewer service connections through use of closed-circuit television camera and remote-controlled cutting device.
2. Accurately field-locate all existing active service connections. Restore and reconnect, without any delay, all missed or faulty reconnections.
3. Match invert of reestablished service with previously existing invert.
4. Maintain minimum of 95 percent of original service connection opening.
5. Reestablish sewer service connection with uniform cuts free of burrs and sharp edges.
6. After reestablishing service connection, flush piping clean.

3.4 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Testing of Pipe Liner: Test as specified in applicable ASTM Standard for PVC and PE installation.

C. Manufacturer’s Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 2 days on-site for installation, inspection, and field testing.

D. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. If liner fails to re-form, remove failed liner and install new liner in compliance with this specification.
3. Conduct closed-circuit video inspection of completed relining Work, confirming no visual defects, including foreign inclusions, dry spots, pinholes, cracks, or delamination as specified in Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
4. Confirm that service connections are complete and unobstructed.
5. No infiltration of groundwater is permitted.
6. Make final adjustments to liner per manufacturer's instructions.
7. Any liner installation not meeting the testing requirements of this specification shall be removed and replaced with a product in compliance with this specification at the total expense of the contractor. The re-inspection requirements as listed above shall apply to this re-installed section of line.

END OF SECTION 33 01 30.79

SECTION 33 01 30.81 – MANHOLE REHABILITATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The Work specified in this Section includes all labor, materials, accessories, equipment and tools necessary for the repair and rehabilitation of the sanitary sewer manholes shown on the Plans.
2. Manhole Rehabilitation as shown in the contract documents includes cleaning and surface preparation, filling all voids, stopping all leaks by repair and chemical grout injection, and applying a spray-on liner on the bench, barrel, and cone (terminating at the frame), or providing FRP insert liners, or providing polymer concrete insert liners for the existing manholes.
3. Structural Restoration.
4. Eliminate Inflow and/or Infiltration.
5. Step replacement or repair.
6. Base and channel repair.
7. Excavation.
8. Removal and disposal of all excess materials.
9. Restoration.
10. Backfill.
11. Permanent and temporary pavement replacement.
12. Clearing and grubbing.
13. Locating and raising buried manhole to grade.
14. Resetting manhole frame and cover.
15. Replacing manhole frame and cover.
16. Reconstruction of manholes above grade.
17. Dewatering.
18. Flow Control/Bypass Pumping.
19. Grouting.
20. Post-Rehabilitation Photographs.

B. Related Requirements:

1. Section 01 57 15 – Temporary Sewer Bypass Pumping.
2. Section 03 37 13 – Shotcrete.
3. Section 03 60 00 – Grouting.
4. Section 31 10 00 – Site Clearing.
5. Section 31 23 19 – Dewatering.
6. Section 31 23 23.33 – Flowable Fill.
7. Section 33 01 30.61 – Packer Injection Grouting.

1.2 STANDARDS

Except as modified herein, comply with the latest edition of the following standards:

A. American Concrete Institute (ACI):

1. ACI 506 - Standard Specification for Shotcrete.

B. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM C33 - Standard Specification for Concrete Aggregates.
3. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens).
4. ASTM C150 - Standard Specification for Portland Cement.
5. ASTM C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center Point Loading).
6. ASTM C457 - Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete.
7. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
8. ASTM C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
9. ASTM C596 - Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
10. ASTM C642 - Standard Test Method for Density, Adsorption, and Voids in Hardened Concrete.
11. ASTM C666 - Standard Test Method for Resistance of Concrete to Rapid freezing and Thawing.
12. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
13. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
14. ASTM C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
15. ASTM C900 - Standard Test Method for Pullout Strength of Hardened Concrete.
16. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
17. ASTM D412 - Standard Testing Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
18. ASTM D638 - Standard Testing Methods for Tensile Properties of Plastics.
19. ASTM D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
20. ASTM D695 - Standard Testing Methods for Compressive Properties of Rigid Plastics.
21. ASTM D790 - Standard Test Method for Flexural Properties of Unreinforced/Reinforced Plastics.
22. ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.

23. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
24. ASTM D2240 - Standard Testing Methods for Rubber and Durometer Hardness.
25. ASTM D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.
26. ASTM D3753 - Standard Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells.
27. ASTM F2551-09 - Standard Practice for Installing a Protective Cementitious Liner System in Sanitary Sewer Manholes.

1.3 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications.

C. Product Data: Submit information for products indicated and proposed materials at least 30 days prior to starting Manhole Rehabilitation.

D. Shop Drawings:

1. Detail of manhole liners including plans, elevations, sections, details, frames, covers, and mixes.
2. Field quality-control test reports.
3. Traffic control plans.
4. Manhole Liner Certification.
5. Flow Control/Bypass pump plan.

E. Contractor Qualifications:

1. Submit a copy of manufacturer's licensee certificate. If the Contractor is not licensed by the manufacturer, then a manufacturer's representative shall be on-site for the duration of the Work.
2. Submit qualification of each nozzlemen: Each nozzlemen is required to be ACI certified through the Nozzlemen Certification Program.
3. Submit a list of ten (10) similar regional projects completed within the last three (3) years including information such as number of manholes on project, type of rehabilitation, date of completion, and project cost.

F. Material Certifications: Submit the manufacturer's product data, installation instructions, applicable referenced work standards (ASTM, ACI, etc.), approved laboratory test reports that verify strength requirements of this Specification, and materials certification for each product used.

G. Material Safety Data Sheets: Submit Material Safety Data Sheets (MSDS) for all materials used for Manhole Rehabilitation.

H. Application Methods and Equipment: Submit a written description of the material application methods including the equipment that will be used.

I. Liner Thickness Design: Submit recommended liner thickness design to withstand groundwater pressure as specified within this Specification.

1.4 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record all changes made to manholes and submit to Engineer.

C. Identify and describe discovery of undocumented utilities.

1.5 QUALITY ASSURANCE

A. Contractor's Qualifications:

1. The Manhole Rehabilitation Contractor shall be a firm having a minimum of three (3) years continuous successful experience in the rehabilitation of manholes similar to that required of this Project.
2. The manhole lining Contractor shall be certified and trained by the lining material manufacturer to install the manhole liner if the material requires a certified applicator. Furnish an on-site manufacturer's representative for a minimum of four (4) working hours for each supplied material.
3. The flexible chimney seal installer shall be certified and trained by the material manufacturer to install their product if the material requires a certified applicator. Furnish an on-site manufacturer's representative for a minimum of four (4) working hours for each supplied material.
4. The testing laboratory shall be an independent material testing laboratory contracted and paid for by the Contractor and approved by the Owner.
5. The owner may perform Quality Assurance tests independently as necessary.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage, and Handling shall be no less than that of the Manufacturer's written recommendations.

1. Cementitious materials shall be stored in weather tight, original packaging to protect against moisture and contamination.
2. Polymer manhole lining materials shall be stored in unmixed containers in a sheltered area between 50 and 95 degrees Fahrenheit.

1.7 PROJECT CONDITIONS

A. Visit each site and examine the local conditions to be encountered, improvements to be protected, permit conditions, and complete other research necessary to assure a thorough understanding of all conditions and constraints which may be encountered during construction.

B. Conduct excavation and backfill operations in such manner as to cause no damage to any existing utility or affect the safety of the public or Contractor's employees during and after construction.

C. Comply with all the applicable OSHA regulations and all applicable requirements of EM385 and in particular 29 CFR1910.146, Permit Required for Confined Space Entry.

D. Provide a system to capture and remove cleaning material from the wet well without entry into the wet well.

E. Furnish and maintain all traffic control necessary by permit. Traffic control shall include flagging, all applicable signage, and/or detours as designated by the contract documents and Michigan Department of Transportation (MDOT).

F. Provide each potentially affected Utility with a minimum three (3) week notice of road closures.

G. Comply with all residence notification requirements in Section 33 01 30.18 – Security Clearances and Communications for all adjacent landowners within 150 feet of the Work.

H. Service to occupied facilities shall not be interrupted unless the requirements of Section 33 01 30.18 – Security Clearances and Communications have been followed and then only after arranging to provide temporary water and sewer service according to requirements indicated:

I. Use CAUTION when working in sewers, especially during rain events. Sewers may reach capacity quickly and/or head up.

1.8 WARRANTY

A. Comply with Section 01 70 00 – Execution and Close-Out Requirements.

B. Provide manufacturer's standard written guarantees and warranties dated from time of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cementitious Manhole Liner w/ Corrosion Resistance:

1. Standard Cements – Maximum CA.
2. Standard Cements – Reliner MSP.
3. BASF – MasterEmaco S488/S488-CI.
4. Milliken – GeoSpray.
5. SewperCoat PG – Kerneos.
6. Quadex AluminaLiner – Quadex, Inc.
7. SewperCoat – LaFarge Aluminates.
8. Strong-Seal MS2-C, High Performance Mix – Strong-Seal Systems.
9. CA Liner 100 – Parson Environmental.
10. PerpetuCrete CA – Protective Liner Systems.
11. Or Approved Equal.

B. Epoxy Manhole Liner:

1. SprayRoq Protective Lining Systems – SprayWall.
2. Raven 405 – Raven Lining Systems.
3. Cor-Cote SC – Sherwin-Williams.
4. PerpertuCoat PLS-613 – Protective Liner Systems.
5. RELINER Inside Drop Bowl – RELINER / Duran Inc.
6. Sauereisen SewerGard – Sauereisen.
7. Inland Product (Eco Cast).
8. Or Approved Equal.

C. Fiber Reinforced Plastic Manhole Liner:

1. Hobas.
2. Flowtite.
3. LFM Fiberglass Structure.
4. Or Approved Equal.

D. Polymer Concrete Manhole Liner:

1. US Composite Pipe, Inc.
2. Armorock.
3. Or Approved Equal.

E. Flexible Chimney Seal:

1. Cretex Specialty Products – Internal Chimney Seal.
2. NPC FlexRib Frame Chimney Seals.
3. Sealing Systems Inc. – Flex-Seal Utility Sealant.
4. WrapidSeal (CANUSA).
5. Or Approved Equal.

F. Manhole Casting Riser Ring:

1. American Highway Products – Stainless Steel Manhole Riser.

2. Concrete.
3. EJ Group INFRA-RISER Rubber Composite.
4. Or Approved Equal.

2.2 MATERIALS

A. Liner Thickness Design: Each lining system shall be designed and installed in accordance with the manufacturer's recommendation to withstand groundwater pressures. For manholes less than 12 feet in depth, the lining shall withstand the pressures associated with a groundwater depth of 12 feet measured from manhole bench to top of ground surface. For manholes greater than 12 feet in depth, the lining shall withstand the pressure associated with a groundwater depth equal to the manhole depth measured from manhole bench to top of ground surface.

B. Patching Material:

1. All non-leaking holes, cracks or voids shall be patched with a quick setting, non-shrink, fiber reinforced, corrosion resistant calcium aluminate or equivalent material that is compatible with the chosen liner system and shall be approved and applied in accordance with the manufacturer's recommendation for basecoat materials:
   a. Sikadur 31, HiMod Gel.
   b. Or Approved Equal.

C. Infiltration Control Material (Chemical Grout): Comply with Section 33 01 30.61 – Packer Injection Grouting.

D. Cementitious Liner:

1. The material shall be a 100% calcium aluminate mortar designed to stop infiltration, restore structural integrity, and provide protection against microbiologically-induced corrosion. It shall be spray applied to form a structurally enhanced monolithic liner covering all interior substrate surfaces with the following minimum requirements:
   a. Compressive Strength per ASTM C109: > 8,000 psi (28 Days).
   b. Tensile Strength per ASTM C900: > 800 psi.
   c. Flexural Strength per ASTM C293: > 1,200 psi (28 Days).
   d. Shrinkage @ 90% R.H. per ASTM C596: < 0.08% (28 Days).
   e. Freeze/Thaw per ASTM C666: No Damage After 300 Cycles.
   f. Air Void Content per ASTM C457: 2-4% (7 Days).
   g. Specific Gravity/Absorption Test per ASTM C642: 3-5% (7 Days).

2. The material thickness application shall be a minimum of three-eighths (0.375) inches and not more than 2 inches per pass. The minimal acceptable finished thickness shall be 1 inch from the inside face of the manhole wall. The final finished liner thickness shall be greater than 1 inch if determined to be necessary by the liner manufacturer to withstand groundwater pressures as specified herein.

3. The lining shall be applied in not more than two (2) passes from bottom to top. No more than 24 hours shall elapse between successful passes on each manhole. The second pass shall not be made until the first pass has achieved initial set. If more than 24 hours elapse between passes, then initial coat shall be removed and the process restarted.
4. Coordinate with the manufacturer to furnish and install product according to the manufacturer's recommendations. If manufacturer's recommendation conflicts with Specification, notify the Engineer prior to installation.

E. Epoxy Liner:

1. The material shall be 100% solids, solvent-free two (2)-component epoxy resin system with select inorganic fillers to minimize permeability and provide sag resistance acceptable to the following minimum requirements:
   a. Hardness, Shore D per ASTM D2240: 70.
   b. Tensile Strength per ASTM D638: > 7,000 psi.
   c. Flexural Strength per ASTM D790: > 10,000 psi.

2. Coordinate with the manufacturer to furnish and install product according to the manufacturer's recommendations. If manufacturer's recommendation conflicts with Specification, notify the Engineer prior to installation.
3. The final finished liner thickness shall be as recommended by the liner manufacturer to withstand groundwater pressures as specified herein.

F. FRP Manhole Liners:

1. In accordance with ASTM D3753.
2. The resins used shall be an unsaturated polyester resin or vinyl ester resin.
3. The reinforcing materials shall be type E glass in the form of continuous roving and chop roving, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin per ASTM D3753.
4. Interior Surfacing Material:
   a. The inner surface exposed to the chemical environment shall be a resin-rich layer of 0.010 to 0.020 inch thick.
   b. The inner surface layer exposed to the corrosive environment shall be followed with a minimum of two (2) passes of chopped roving of minimum length 0.5-inch to maximum length of two (2) inch and shall be applied uniformly to an equivalent weight of 3 oz./ft.
   c. Each pass of chopped roving shall be rolled prior to the application of additional reinforcement.
   d. The combined thickness of the inner surface and interior layer shall not be less than 0.10 inch.

5. Wall Construction Procedure:
   a. After inner layer has been applied the manhole liner wall shall be constructed with chop and continuous strand filament wound manufacturing process which insures continuous reinforcement and uniform strength and composition.

b. The cone section, if produced separately, shall be affixed to the barrel section at the factory with resin-glass reinforced joint resulting in a one (1)-piece unit.
c. Seams shall be fiber glassed on the inside and the outside using the same glass-resin jointing procedure.
d. Field joints shall not be acceptable by anyone except the manufacturer.

6. UV inhibitor shall be applied to the exterior surface of the manhole liner and shall have gray pigment and shall be a minimum thickness 0.125 inches.
7. Fillers and Additives:
   a. Fillers, when used, shall be inert to the environment and manhole construction.
   b. Sand shall not be accepted as an approved filler.
   c. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used to meet the requirements of this standard. The resulting reinforced-plastic material shall meet the requirements of this Specification.

8. Manhole Liner Design:
   a. All manholes shall have 0.50-inch minimum wall thickness. The final finished liner thickness may need to be greater than 0.50 inch as recommended by the liner manufacturer to withstand groundwater pressures as described in Part 2.2.A of this Section.
   b. All manhole liners shall be designed so that a ladder can be supported by the installed manhole liner. No manhole steps shall be installed.
   c. Manway cone sections shall be concentric with respect to the larger portion of the manhole liner diameters through 60 inches. Larger manhole liners may have concentric or eccentric manway reducer openings.
   d. The manhole liner shall provide an area for which grade rings to be installed to accept a manhole frame and cover and have the strength to support a traffic load without damage to the manhole liner.

9. Other Requirements:
   a. The exterior surface of the liner shall be smooth with no sharp projections. Hand-work finish may be acceptable if enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than 0.5 inch in diameter, delamination or fiber show.
   b. The interior surface shall be resin rich with no exposed fibers. The surface shall be free of crazing, delamination, blisters larger than 0.5 inch in diameter and wrinkles of 0.125 inch or greater in depth. Surface pits shall be permitted if they are less than 0.75 inch in diameter and less than 0.0625 inch deep. Voids that cannot be broken with finger pressure and that are entirely below the resin surface shall be permitted if they are less than 0.5 inch in diameter and less than 0.0625 inch thick.
   c. Any manhole liner repairs shall meet all requirements of this Specification.
   d. Manhole liner widths shall be in 6-inch increments +/- 2 inches.
   e. Tolerance of inside diameter shall be +/- 1% of required manhole diameter.

f. The complete manhole liner shall have a minimum dynamic-load rating of 16,000 lbs. when tested in accordance with ASTM 3753 8.4 (note 1). To establish this rating the complete manhole shall not leak, crack, or suffer other damage when load tested to 40,000 lbs. and shall not deflect vertically downward more than 0.25 in. at the point of load application when loaded to 24,000 lbs.

g. The manhole cylinder shall have the minimum pipe-stiffness values shown in the table below when tested in accordance with ASTM 3753 paragraph 8.5 (note 1).

STIFFNESS REQUIREMENTS

LENGTH (ft)	F/AY (PSI)
3 – 6.5	0.75
7 – 12.5	1.26
13 – 20.5	2.01
21 – 25.5	3.02
26 - 35	5.24

h. To determine soundness, apply an air or water pressure test to the manhole test sample. Test pressure shall not be less than 3 psig nor greater than 5 psig. While holding at the established pressure, inspect the entire manhole for leaks. Any leakage through the laminate is cause for failure of the test. Comply with ASTM 3753 paragraph 8.6.

i. The FRP manhole and all related components shall be fabricated from corrosion proof material suitable for atmospheres containing hydrogen sulfide and dilute sulfuric acid as well as other gases associated with the wastewater collection systems.

10. The required physical properties shall be as follows:

	Hoop Direction	Axial Direction
Tensile Strength (psi)	18,000	5,000
Tensile Modules (psi)	0.6 x 10^6	0.7 x 10^6
Flexural Strength (psi)	26,000	4,500
Flexural Modules (psi)	1.4 x 10^6	0.7 x 10^6
Compressive (psi)	18,000	10,000

11. All tests shall be performed as specified in ASTM D3753 latest edition, Section 8. Test method D-790 (note 5) and test method D-695.

12. Coordinate with the manufacturer to furnish and install product according to the manufacturer's recommendations. If manufacturer’s recommendation conflicts with Specification, notify the Engineer prior to installation.

G. Polymer Concrete Manhole Liners:

1. This application shall not be made unless ambient temperatures inside the structure is 50 degrees or higher and all surfaces that are to be coated are dry.

2. Polymer Concrete liners shall be designed manufactured to meet the design requirements of AASHTO HS-20 design live loading applied to manhole cover and riser sections and shall be designed based upon live and dead load criteria in ASTM C857.
3. Polymer mixture shall consist solely of thermosetting resin, sand and aggregate. No cementitious or calcium carbonate materials shall be allowed.
4. Thermosetting Resin:
    a. Resin used shall be unsaturated, certified, isophthalic polyester resins or vinyl ester resins.
    b. The resin shall have a minimum of deflection temperature of 158° F when tested at 264 psi (1.820 mPa) following Test Method D 648.
    c. The resin content shall not be less than 7% of the weight of the sample as determined by test method D 2584.
    d. Resin selection shall be suitable for applications in the corrosive conditions to which the structures will be exposed.
    e. Mixing lots of resin from different manufacturers will not be allowed.

5. The polymer manhole sleeve shall have a minimum wall thickness of 2 inches and an outside diameter clearance of 1.5 inches. The wall thickness of risers and conical tops shall be not less than that prescribed by the manufacturer's design by more than 5%. The final finished liner thickness may need to be greater than 2 inches as recommended by the liner manufacturer to withstand groundwater pressures as described in Part 2.2.A of this Section.
6. Steel reinforcement will not be required for circumferential reinforcement, joint reinforcement, or hoop reinforcement. Manufacturer shall determine the need for and type of reinforcement as it pertains to safety and lifting requirements.
7. Variations in height of two (2) opposite sides of risers and conical tops shall not be more the 5/8 inch. The under run in height of a riser or conical top shall not be more than ¼inch/foot of height with a maximum of ½ inch in any one (1) section.
8. Riser and cone section joints shall be of a flush flat edge design that on assembly with gaskets and/or butyl mastic will make a continuous and uniform manhole. Joint sealing surfaces shall be free of dents, gouges and other surface irregularities that would affect joint integrity.
   Polymer manhole riser and cone sections shall be provided in various lengths in combination to provide correct height with the fewest joints.
   Each manhole component shall be free of all defects that will detrimentally affect the strength and serviceability of the component part.
9. Epoxy coatings for bench area shall meet the requirements of the Epoxy Liner section above.
10. Minimum thickness to be applied in single application shall be no less than 250 mils and no more than 500 mils. No more than 1,000 mils shall be applied in any one (1) day of application.
11. Coordinate with the manufacturer to furnish and install product according to the manufacturer's recommendations. If manufacturer's recommendation conflicts with Specification, notify the Engineer prior to installation.

H. Manhole Frame and Cover: Comply with Section 33 05 61 – Concrete Manholes.

I. Frame and Cone Seal:

1. Applied seals shall be achieved by applying an aromatic urethane resin compound to the internal surface between the manhole frame and the cone section to stop inflow under the manhole frame. Sufficient material shall be applied to achieve a minimum thickness of 120 mils. The material shall comply with the following requirements:
   a. Hardness per ASTM D2240: 75.
   b. Tensile Strength per ASTM D412: 1,150 psi.
   c. Elongation per ASTM D442: 800%.
   d. Adhesive Strength per ASTM D903: 175 lb./l. inch.
   e. Tear Resistance per ASTM D1004: 155 lb./l. inch.
      1) Flex-Seal Utility Sealant – Sealing Systems Inc.
      2) Or Approved Equal.

J. Inside Drop Bowl:

1. Inside manhole drops shall be installed where indicated on the drawings.
2. Inside Drop Bowl size shall be determined by incoming pipe sizes and approximate flow rates. The bowl shall be installed as per manufacturer's instructions using stainless steel fasteners.
3. The drop pipe and turn-out at the base end of the drop pipe shall be PVC SDR 35 (main lines) or Schedule 40 (service laterals). The turn-out at the base end of the drop pipe shall be accomplished with an appropriately angled pipe elbow.
4. All brackets for attaching the drop pipe to inside of manhole shall be stainless steel adjustable clamping brackets and fasteners anchored to the manhole wall.
   a. RELINER Inside Drop Bowl – RELINER.
   b. Or Approved Equal.

K. Concrete: Comply with Section 03 30 00 – Cast-in-Place Concrete.

L. Water: All water used on this project shall be clean and potable water.

PART 3 - EXECUTION

3.1 FLOW CONTROL AND BYPASS PUMPING

A. Furnish, install and maintain control or bypass pump flow as necessary to accomplish the manhole repair and lining work.

B. When force main discharges are encountered, the Contractor may fabricate an apparatus to divert flow toward the bottom of the manhole thus reducing splash. Accepted materials for the temporary apparatus include PVC pipe, bends, fittings, Fernco couplings, and lay flat discharge

hose. The Detroit Water and Sewerage Department will assist by hand operating the lift stations while the Contractor installs the flow control apparatus.

C. If the Contractor proposes bypass pumping for this project, a detailed Bypass Pumping Plan shall be submitted, prior to installing any bypass pumping.

D. Comply with Section 01 57 15 – Temporary Sewer Bypass Pumping.

3.2 CLEANING

A. Comply with manhole cleaning requirements as listed in Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning.

B. Power Washing: Equipment shall produce a minimum of 5,000 pounds per square inch (psi) water blast to remove all foreign matter, loose mortar, grease, oil residues, rust, scale and to etch the surfaces

C. Chipping: If large deposits exist or power washing cannot remove all deposits, then the contractor shall remove the deposits by chipping. Remove all loose, broken or softened concrete bricks/blocks to sound material. Any voids left by chipping shall be repaired in accordance with Section 2.2.

D. Muriatic Acid: If the power washing or chipping cannot be utilized due to structural conditions in the manhole or if they do not remove all deposits, then a solution of muriatic acid (hydrochloric acid) shall be applied at a ratio of one (1) part acid to ten parts water by spraying from above the manhole. After the acid solution is applied it shall be washed off completely. The mixing, application, and removal of the acid solution shall be done in strict accordance with the manufacturer's Specification and safety procedures. The use of acid base cleaners is not permitted for polymer liners, no matter how diluted.

E. Steel Surfaces: Solvent clean steel surfaces to be coated with the polymer lining material. The steel surfaces may also be cleaned utilizing high (> 5,000 psi) or ultra-high (> 10,000 psi) water pressure cleaning or water with sand injection and approved rust inhibitors. The surface profile shall be minimum of 2 mils.

F. Fiberglass Surfaces: Only the polymer lining material is intended for use on fiberglass surfaces. Prepare fiberglass by rinsing, neutralizing, scarifying and cleaning with water or a mixture of water and solvent. Remove all dust and loose particles. The surface should be thoroughly dry before the application of the polymer material.

3.3 PATCHING HOLES OR VOIDS

A. All loose or disintegrated material shall be removed from the area to be patched.

B. Holes or voids around steps, joints or pipes, spalled areas, and cavities caused by missing or broken brick or mortar shall be repaired using patching material conforming to the requirements of this Specification.

C. The patching material shall be mixed and applied in accordance with the manufacturer's requirements.

3.4 STOPPING ACTIVE LEAKS AND INFILTRATION

A. All active leaks and infiltration shall be repaired using chemical grout conforming to the requirements of this Specification. Any areas that show evidence of leakage either active or non-active during inspection shall be injected.

B. At each point of leakage within the manhole structure, a hole shall be carefully drilled through the wall to the exterior of the manhole. Grout ports or sealant injection devices shall be placed in these holes in a way as to provide a watertight seal between the holes and the injection device.

C. Cementitious or hydraulic cement shall be pumped through the hole until material refusal is recorded on a pressure gauge mounted on the pumping unit. Care shall be taken during the pumping operation to ensure that excessive pressures do not develop and cause damage to the manhole structure.

D. Dewater the exterior of the manhole with a well-point system if necessary to facilitate the repair work. The dewatering shall continue for a minimum of 8 hours following completion of the repair work.

E. Upon completion of the injection, the ports shall be removed and the remaining holes filled with mortar and troweled flush with the surface of the manhole wall.

F. The injected section joints, pipe connection, holes, or seams shall be sealed with patching material conforming to the requirements of this Specification and smoothed flush with the surface of the manhole wall. In order to prevent the migration of infiltration leaks, comply with the following requirements for points of injection:

1. For Pre-cast Section Joint Leaks, furnish and install a minimum of four (4) injection points which shall be evenly spaced around the circumference of the manhole joint.
2. For Pipe Connection Leaks, injection points shall be furnished and installed around pipe connection by Contractor's means and methods.
3. For Pipe Invert Leaks, furnish and install a minimum of two (2) injection points, one (1) on each side of trough.
4. For Lift Holes and Voids furnish and install a minimum of one (1) injection point below the center of the lift hole or void.

3.5 REFORM/REPAIR EXISTING BENCH AND INVERT

A. Manhole inverts and benches shall be reformed as identified in the Plans using the patching material identified in this Specification. Fast setting hydraulic cement may be used to repair the invert.

B. The patch material shall be applied to the invert and bench at a minimum thickness of ½ inch, extending sufficiently to the wall to tie into the cementitious liner to be applied later.

C. The finished invert and bench shall be troweled to a smooth finish free of any ridges.

D. The bench shall be sloped a minimum of two (2) inches from the manhole wall toward the invert to prevent debris build-up on the bench.

E. Repairs on the invert shall not compromise grade.

F. The invert and bench shall be allowed to cure for a minimum of 30 minutes before being subject to active flow. Flow shall be bypassed by the requirements of Section 3.1 and the approved bypass plan.

3.6 BUILDING BENCH AND INVERT

A. Inverts and benches shall be constructed in manholes with no hard bottom and no defined invert (channel of flow) if a manhole is being rehabbed, using the patching material identified in this Specification. Fast setting hydraulic cement may be used to repair the invert.

B. The bench shall be constructed of brick or block and finished by troweling smooth with patching material and cast-in-place concrete.

C. The patching material shall have a minimum thickness of one (1) inch.

D. The finished invert and bench shall be troweled to a smooth finish free of any ridges.

E. The bench shall be sloped from the manhole wall toward the invert to prevent debris build-up on the bench. The invert and bench shall be allowed to cure for a minimum of 30 minutes before being subject to active flow.

F. Flow shall be bypassed in accordance with the requirements of this Specification and the approved bypass plan.

3.7 CEMENTITIOUS LINER APPLICATION

A. Pre-Construction Testing:

1. Shall be in accordance with the applicable provisions of ACI Standard 506.

2. Shall be conducted by an approved testing agency.

B. Surface Preparation:

1. All foreign material shall be removed from the manhole wall and bench using a high-pressure water spray (minimum 5,000 psi).
2. Loose or protruding brick, mortar and concrete shall be removed using a mason's hammer and chisel or scraper. All concrete or mortar that is not sound or has been damaged by chemical exposure shall be removed to a sound concrete surface.
3. All loose cementitious liner (previously installed) shall be removed by water blasting. Deteriorated epoxy or protective coatings shall be completely removed by sandblasting.
4. Any holes or voids shall be filled in accordance with this Specification. The surface to be repaired shall be clean and free of any loose materials.
5. Active leaks and infiltration shall be stopped in accordance with Section 3.3.

C. Step Removal: Steps in good condition shall remain; otherwise, prior to application of the cementitious liner, all steps shall be cut-off, ground flush with the manhole wall, removed, disposed off-site, and replaced.

D. Liner Application:

1. No application shall be made to frozen surfaces or if freezing is expected to occur inside the manhole within 24 hours after application. If ambient temperatures exceed 90 degrees, precautions shall be taken to keep the mix temperature below 90 degrees.
2. For each bag of product, use the amount of water specified by the manufacturer and mix for 30 seconds to one (1) minute using equipment per manufacturer's recommendation.
3. Manhole channels are not required to be lined unless indicated otherwise on the Drawings.
4. First Application:
    a. The surface prior to spraying shall be damp without noticeable free water, but totally saturated.
    b. Materials shall be applied using low-pressure spray equipment from the bottom of the wall (including the bench but not invert) to the top (terminating at the frame/cone connection), to a minimum uniform thickness to ensure that all cracks, crevices, and voids are filled and a relatively smooth surface remains after light troweling.
    c. Light troweling shall be performed to compact the material into voids and to set the bond.

5. Second Application:
    a. A second application is applied after the first application has begun to take an initial set (disappearance of surface sheen which could be 15 minutes to one (1) hour depending upon ambient conditions) to assure a minimum total finished thickness of one (1) inch.
    b. Application again shall be from the bottom up using low-pressure spray equipment.
    c. The surface shall then be troweled to a smooth finish being careful not to over trowel to bring additional water to the surface and weaken it.

6. Curing:
    a. Caution shall be taken to minimize exposure of applied product to sunlight and air movement.
    b. If application of second coat is to be longer than 15 minutes after completion of first coat, the manhole cover shall be set back in place.
    c. At no time should the finished product be exposed to sunlight or air movement for longer than 15 minutes before replacing the manhole cover.
    d. The final application shall have a minimum of four (4) hours cure time before being subjected to active flow.
    e. Flow shall be bypassed per the requirements of Section 3.1 and the approved bypass plan.
    f. Traffic shall not be allowed over manholes for 12 hours after application is complete.

3.8 EPOXY LINER APPLICATION

A. Surface Preparation:

1. All concrete or mortar that is not sound or has been damaged by chemical exposure shall be removed to a sound concrete surface. At a minimum, this shall be achieved with a low-pressure water cleaning equipment using a 0-degree rotating nozzle at 5,000 psi and 4 gpm.
2. Other methods such as high-pressure water jetting (refer to NACE Standard No. 5/SSPC-SP12), abrasive blasting, shot-blasting, grinding, scarifying, and/or acid etching may also be used.
3. The method(s) used shall be performed in a manner that provides a uniform, sound, clean, neutralized surface that is not excessively damaged.
4. Any holes or voids shall be filled in accordance with this Specification. The surface to be repaired shall be clean and free of any loose materials.
5. Active leaks and infiltration shall be stopped in accordance with this Specification.
6. When required on the Plans, the epoxy liner shall be applied over a back-build of cementitious surface.
    a. Exact minimum thicknesses of cementitious back-build shall be determined after deteriorated concrete has been removed to restore the inside diameter of the manhole to its original design dimension.
    b. The cementitious liner shall be applied in accordance with this Specification.
    c. The epoxy lining shall take place only after the cementitious liner has cured the appropriate length of time as recommended by the manufacturer.

B. Liner Application:

1. Spray application equipment approved by the coating manufacturer shall be used.
2. Manhole channels are not required to be lined unless otherwise indicated on the Drawings.
3. Surfaces shall be coated by spray application to a minimum dry film finished thickness of at least 100 mils including bench (not including invert) and walls (terminating at top of cone/frame joint). Thickness shall be achieved using a minimum of two (2) coats.

4. Subsequent top coating or additional coats should occur no later than the recoat window for the specified products. Additional surface preparation will be required if this recoat window is exceeded.

C. Spark Test:

1. The cured epoxy lining shall be spark tested for pinholes with a spark tester set at 10,000 volts minimum (100 V per mil).
2. All pinholes identified by the spark test shall be repaired.
3. All pinholes shall be marked off on surface areas containing pinholes to a point six (6) inches beyond all pinholes and patch with epoxy to a minimum additional thickness of 30 mils.
4. Blisters and uncured lining shall be completely removed and the areas recoated with epoxy to a point six (6) inches beyond the repair areas at a minimum thickness of 100 mils.

3.9 FRP MANHOLE LINERS

A. Take measurements of the existing manhole interior dimensions to confirm fit prior to submitting and ordering the FRP Manhole Liner.

B. The existing manhole shall be excavated to below the bottom of concrete cone section on the existing manhole. The existing concrete cone section shall be removed and legally disposed off-site.

C. All cuts through existing asphalt and or concrete pavement shall be saw cut with straight cuts.

D. All existing manhole steps shall be removed flush with the existing manhole wall.

E. FRP manhole liners shall be installed in strict conformance with the manufacturer's recommendations and these Specifications:

1. Safely lift the manhole liner.
2. Set the manhole liner into existing manhole. Mark the contour of the existing bench area onto the FRP liner. Remove the liner and cut along the contour mark. Restore any service connections within the manhole.
3. Set the liner into and concentric with the existing manhole. Use a non-shrinking grout to seal the area between the bottom of the liner and the existing bench area.
4. Any holes or voids shall be filled in accordance with this Specification. The surface to be repaired shall be clean and free of any loose materials.
5. Backfill around the excavated reducer section with stabilized sand or crushed stone. The material chosen shall be free of large lumps or clods which will not readily break down under compaction. Backfill material and compaction requirements shall be in accordance with Division 31 Earthwork.

F. Any required manhole wall penetrations shall be sealed with a water proof gasket assembly approved by Owner.

G. The manhole frame and cover shall be set on concrete grade rings and into a bed of clean, fresh mortar as indicated on the standard details, in order to place the ring and cover at the required grade. Set tops of frames and covers level with finished surface of manholes that are in pavements. Set tops of frames and covers three (3) inches above finished surface in non-pavement areas (i.e., fields or open areas) if no hazards exist in leaving manholes above grade, or as directed by the Engineer. Grade rings shall be no more than six (6) inches in height.

H. All exposed concrete/grout surfaces within manholes including manhole inverts shall be sealed with a 60-mil spray coating.

I. Pavement shall be replaced in-kind to match existing pavement depth and material or as required by permits. Non-paved areas shall be replaced in-kind to match existing conditions.

3.10 POLYMER CONCRETE MANHOLE LINERS

A. Take measurements of the existing manhole interior dimensions to confirm fit prior to submitting and ordering the Polymer-Concrete Manhole Liner.

B. The area around the manhole shall be excavated as necessary to provide for removal of existing cone and castings while preventing soil and debris from falling into the manhole.

C. Furnish, maintain and install equipment to maintain sewage flows without backup, overflow or spill.

D. Repairs shall be made to the existing manhole in order to receive the polymer inserts.

E. Remove by power wash any loose debris from wall areas. All dirt, grease, and debris shall be removed from the bench area to prepare bench surfaces for resurfacing. Debris shall not be allowed to enter the sewage system.

F. All active leaks shall be repaired, and the bench shall be leveled and repaired to prepare for the polymer insert installation.

G. The risers shall be offloaded and lifted into place with approved manufacturer's lifting device. No other handling apparatus shall be acceptable.

H. Installation of First Polymer Riser Section:

1. The first polymer riser section shall be saw-cut if necessary to accommodate pipe entry and bench slopes.
2. Depending on invert configuration, the bench area shall be prepared by building up the bench section with a Portland cement and sand mixture to provide a clean level surface to receive the riser. This build up shall allow for a level surface above the existing top of the highest pipe.
3. If pipe inverts are offset the initial polymer sleeve shall be modified in the field to accommodate the difference in bench slopes.

4. After grout has set, lower the first riser section, clean and wipe down the polymer riser wall above the bench to allow for application of the epoxy coating. This shall be done with a wet cloth.
5. When the new bench configuration is sufficiently dry and clean, a thin shell coating of the epoxy shall be built over the bench. The epoxy shall continue six (6) inches up the polymer riser face to allow for interlink between the coating and polymer riser section.
6. All non-booted or flexible coupler pipe entry areas shall be grouted by an epoxy patch kit provided by the manufacturer.

I. Completion of Installation:

1. After the initial bottom seal has cured the additional remaining riser sections and cone shall be installed using the appropriate wall alignment guides, gaskets and mastic.
2. Any holes or voids shall be filled in accordance with this Specification. The surface to be repaired shall be clean and free of any loose materials.

3.11 FRAME AND CHIMNEY (CONE) SEAL INSTALLATION

A. Applied Seal:

1. All foreign material, bituminous coating, rust or scale build-up, etc. shall be removed from the area to be coated by sandblasting in accordance with the manufacturers requirements. Wire brushing will not be allowed.
2. After the area is cleaned, it shall be completely dried prior to application of the seal material.
3. The urethane resin compound shall then be applied from the bottom three (3) inches of the frame to the top three (3) inches of the cone, including the grade adjustment area, to a minimum thickness of 120 mils.
4. Application shall be in accordance with the manufacturer's instructions.

3.12 CLEANING MANHOLE

A. Any rocks, pieces of broken pipe or any other debris discovered in the manhole or invert shall be removed and disposed off-site.

B. The bench and invert shall be pressure washed to remove organic material and return undisturbed wastewater flow to the invert.

3.13 PLUGGING ABANDONED LINE

A. Abandoned lines shall be filled in accordance with Section 31 23 23.33 – Flowable Fill.

B. Grout plug shall extend at least 1.5 times the thickness of the manhole wall.

C. Plugging abandoned lines shall be performed prior to cementitious lining.

3.14 RAISING MANHOLES

A. If buried, whether in-road or off-road, field-locate the manhole cover.

B. The frame shall be removed from the cone.

C. Clean the top of the cone and bottom of the frame in accordance with SSPC-SP3 Power Tool Cleaning to remove all rust and loose material.

D. Precast Concrete Grade Adjustment Ring:

1. A pre-cast grade ring shall be inserted to raise the manhole with ample butyl rubber mastic applied between the cone and grade ring and the grade ring and the frame.
2. If adjustment is made between the barrel and the cone section, butyl rubber shall be inserted between each joint.

E. Steel Grade Adjustment Ring:

1. Butyl rubber sealant or rope shall be used to seat the steel grade adjustment ring on the frame.
2. The grade ring shall be secured to the existing frame by four spot welds spaced equal distance around the circumference of the frame.
3. This method shall only be used to raise manholes prior to asphalt overlay of the road.

F. Rubber Composite Adjustment Riser:

1. EJ Group INFRA-RISER or approved equal.
2. Adjustment risers shall be of uniform quality, free from cracks, holes, and any other surface defects.

3.15 INSTALL FLAT TOP SLAB ON EXISTING SQUARE TOP MANHOLE

A. Existing square top slab, frame, and cover shall be removed.

B. Brick or block courses shall be removed to allow for the installation of new flat top slab to grade.

C. Standard approved precast concrete flat top slabs shall be used when applicable. Where standard size top slabs will not suffice, a custom precast concrete approved flat top slab shall be installed.

D. Frames shall be bolted to the flat top using stainless steel expansion bolts and butyl rubber mastic.

E. The finished elevation shall be level with the existing or proposed finished grade.

3.16 REALIGN AND RESET FRAME

A. Manhole frames shall be bolted to the cone section using stainless steel expansion bolts. Frame shall have a minimum of two (2) bolts (5/8” diameter, 4” in length).

B. Frames shall be sealed to the top of manhole with butyl rubber mastic.

C. Grout shall then be placed, on the inside and outside to the height of the adjustment.

D. Manholes installed in streets or roadways shall be constructed with a concrete ring (3,000 psi) six (6) inches thick and five (5) foot minimum O.D. securing the frame. The concrete ring shall lie embedded in the gravel base course and below the surface course of pavement.

3.17 MANHOLE BENCH AND CHANNEL

A. Manhole channels and benches shall be repaired.

B. Manhole channels and benches shall be field formed from concrete.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
2. Benches: Concrete, sloped to drain into channel.

C. Modify the inverts to provide a smooth flow line through the manhole.

D. Raise the bench to the top of the pipe, forming a "U" channel through the manhole and provide sufficient slope to make benches self-cleaning when benches must be modified.

3.18 GROUTING SECTION JOINTS

A. Section joints shall be repaired with cementitious material conforming to the requirements of this Specification.

B. Material shall be applied to fill any holes, voids, or cracks at the section joint.

C. The material shall be applied at an even thickness around the entire circumference of the joint and smoothed flush to the surface of the manhole wall.

3.19 GROUTING CHIMNEY

A. Manhole chimneys shall be repaired with calcium aluminate cementitious material conforming to the requirements of this Specification. Material shall be applied at a minimum thickness of one (1) inch.

B. The cementitious material shall be applied and smoothed to an even thickness around the entire circumference of the chimney.

3.20 ACCEPTANCE

A. Photographs:

1. Provide digital photographs of the finished manhole upon completion of repair and rehabilitation work.
2. The photograph shall be taken looking down into the manhole, oriented so that the effluent pipe is at the bottom of the photograph.
3. Photographs shall be named by the corresponding manhole number. When duplicate numbers occur, the photograph name shall also contain an approximate address or street location. These photographs shall be submitted to the Owner digitally on a USB flash drive, periodically to accompany pay applications.
4. Alternatively, PANORAMO digital scanning may be utilized for post-construction documentation.
5. Final project acceptance is contingent upon receiving all manhole photographs.

B. GPS:

1. Use GPS receivers capable of supplying mapping grade (sub-meter) locations and provide Northing and Easting coordinates of all repaired/rehabilitated manholes.
2. A list of manholes with corresponding coordinates shall be provided to the Engineer, in digital format, upon completion of the project.
3. Final project acceptance is contingent upon receiving all manhole GPS locations.

C. Performance Testing:

1. After the Manhole Rehabilitation and repair has been completed, the Work shall be visually inspected in the presence of the Detroit Water and Sewerage Department and its representative for compliance with these Specifications and the manufacturer's recommendations.
2. Each manhole shall be sounded by the Contractor at seven (7) days. The DWSD Inspector will witness these soundings performed by the Contractor. Defects shall be corrected per the contract documents and manufacturer's recommendation to the satisfaction of the Owner.
3. The Detroit Water and Sewerage Department or its representative will also inspect the Work during the warranty period. Any leakage or defects in the Work shall be corrected by the Contractor at no additional cost to the Owner.
4. If required, a qualified independent testing and inspecting agency shall be contracted by the Contractor or by the Owner as designated in the Contract Documents.

D. Spark Testing:

1. Manholes that are completely rehabilitated using epoxy liner shall be spark tested in accordance to Section 3.7 for epoxy lining.
2. If the manhole fails the initial test, necessary repairs shall be made in accordance to Section 3.7 for epoxy lining. Retesting shall continue until the manhole satisfactorily passes the test.
3. All tests shall be performed in the presence of the Owner.
4. Furnish all personnel, facilities, and equipment necessary to conduct the testing.

E. Material Testing:

1. Cementitious Liner:
   a. Cementitious liner shall be tested for 24-hour and 28-day compressive strength in accordance with ASTM C-109 and shall meet the following compressive strength requirements:
      1) 2,000 psi at 24 hours.
      2) 8,000 psi at 28 days.

   b. Three (3) samples shall be taken for every 50 bags of material used.
   c. Samples shall be sprayed from the nozzle. Use three (3) by six (6) inch diameter cylinders for testing.
   d. Cylinders shall be labeled with date, project, manhole number, and product batch number.
   e. Samples shall be sent to an independent testing agency for laboratory verification, results shall be provided to the Owner.
   f. A written log shall be maintained referencing the specific bags of cement (product batch numbers) used per manhole, for all manholes.

2. Epoxy Liner:
   a. Produce samples of epoxy liner. These samples shall be sprayed on concrete substrate (block), approx. 6 x 6 inch, approx. 60 mils thick, just prior to spraying the manholes.
   b. Samples shall be labeled with the date, project, manhole number, and product batch number.
   c. Samples shall be sent to an independent testing agency for laboratory verification and tested per ASTM D790 and ASTM D695 and shall meet the following flexural and compressive requirements:
      1) Flexural Modulus of Elasticity $\geq$ 730,000 psi at 24 hours.
      2) Compressive Strength $\geq$ 15,000 psi at 24 hours.

3.21 CLEAN-UP

A. After the Work has been completed and accepted by the Owner, clean-up the entire project area and return the ground cover to its original condition.

B. All excess material and debris not incorporated into the permanent installation shall be legally disposed of off-site.

END OF SECTION 33 01 30.81

SECTION 33 05 05.25 – VALVE OPERATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Provide all equipment, tools, labor, materials, and incidental services necessary to perform all work for mainline and hydrant valve turning.

1.2 REFERENCES

A. American Water Works Association (AWWA):

1. AWWA M44 – Distribution Valves: Selection, Installation, Field Testing, and Maintenance.

B. International Organization for Standardization (ISO):

1. ISO 2859-1 Sampling procedures for inspection by attributes

C. American National Standards Institute (ANSI) / American Society for Quality (ASQ)

1. ANSI/ASQ Z1.4 Level 1 Sampling Procedures and Tables for Inspection by Attributes

1.3 DEFINTIONS

A. Contractor: The term “Contractor” is defined as the firm (and/or any of its Contractors) retained to perform these services by the Owner.

B. Engineer: The term “Engineer,” as used in this scope of services, shall be defined as the Owner’s designated representative.

C. Owner: The term “Owner,” as used in this scope of services, shall be defined as the City of Detroit.

D. Water Distribution System: The term "Water Distribution System," as used in this scope of services, shall mean a water system carrying potable water flow to City of Detroit customers.

E. Hydrant Valve: The term “Hydrant Valve” is the valve located on the hydrant lead pipe which isolates the hydrant from the distribution system.

F. Mainline Valve: The term “Mainline Valve” is the valve located on a distribution system pipe which isolates sections of pipe.

1.4 SUBMITTALS

A. Submit a written description of testing procedures to be used to the Owner or Engineer, including equipment and personnel requirements complying with work plan submittal in Part 3 of this specification.

B. Submit electronic copies of valve data complying with Data Collection and Review Section in Part 3.

C. Test reports summarizing valve turn data shall be submitted digitally. Digital submittal shall be linked to an existing asset ID (CIPMOID) as determined by the GIS system. Contractor shall utilize electronic field equipment to collect data and create reports with an online GIS application supplied by the Engineer (i.e., ARC Collector) which shall be uploaded at the end of each work day.

1. The Engineer will provide the Contractor with electronic mapping products (ESRI Geodatabase, ESRI Shapefile, KML/KMZ, etc.) which define assets to be tested/inspected. Information provided by the Engineer will also include electronic templates and/or access to web-based data-entry forms to be used when submitting data. The Engineer will assign a unique Asset Identifier (CIPMOID) to each mainline and hydrant valve scheduled for inspection and will identify mainline and hydrant valves in the mapping resources provided. The Contractor shall use these unique asset identifiers when collecting and managing all valve turn data. Data shall be collected digitally and provided to Engineer digitally upon QAQC. Engineer will supply data format which shall be used.

D. Submit Traffic Control Plan to Engineer for review. Upon review from Owner or Engineer, Contractor shall submit to agency with jurisdiction for approval. Contractor shall receive approved Traffic Control Plan prior to start of testing.

E. Submit Health and Safety Plan (HASP) to Engineer prior to start of testing. Contractor shall be responsible for the health and safety of all workers on-site during testing.

F. Submit Security Plan to Engineer prior to start of testing. Comply with Section 01 57 33 – Temporary Security Measures.

1.5 QUALITY ASSURANCE

A. Contractor shall provide a QA/QC plan specific to valve turning.

B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. The Contractor shall submit a list describing all equipment to be used for review and approval of the Engineer. Equipment shall include but not be limited to:

1. Valve key or tool capable of operating hydrant and mainline valves. Due to the potential for safety issues, automatic/mechanical valve turners are not allowed.
2. Tools capable of finding valve box and clearing debris from valve box lid.
3. Tools capable of opening valve wells. Keys for locking covers shall be provided by the Owner.

PART 3 - EXECUTION

3.1 WORK PLANS

A. Prior to Work, Contractor shall provide detailed work plans including equipment and personnel requirements for mainline and hydrant valve turning. Work plans shall include at a minimum the following:

1. Description of operational method.
2. List of personnel (Contractor and Owner personnel).
3. Contractor to operate all valves unless permitted otherwise.
4. Data collection protocols and procedures.
5. Safety protocols.
6. Coordination plan with Owner (public communication).
7. Emergency contact plan (in case of valve rupture or failure).
8. Testing QA/QC plan.
9. Schedule.
10. In case of a valve rupture, malfunction, or refusal to turn, the field supervisor shall contact DWSD immediately and to insert comment in the field tablet.

3.2 IN-SITU TESTING

A. The Contractor shall coordinate with Owner or Engineer prior to any field testing. Contractor shall be accompanied by Engineer during all testing. Work plan shall be approved by Engineer prior to any field testing.

B. Coordinate with the Owner and practice the approved procedure for the valve turning operation; Contractor to coordinate with Engineer regarding other activities by the Owner or Engineer in the area.

3.3 DATA COLLECTION AND REVIEW

A. Contractor shall submit data collection and review protocols with work plan. Data collection shall at a minimum include items as noted on the Valve Condition Record form.

B. Contractor shall operate each hydrant and mainline valve as specified by the Engineer and at a minimum, complete one open and close cycle, and record the number of valve turns. If a valve is found to be inoperable, the Contractor must notify the Owner within 24 hours.

3.4 QUALITY CONTROL

A. The Engineer shall be entitled to audit the collected data and be present when tests are being executed. In accordance with ISO 2859-1 and ANSI/ASQ Z1.4 Level 1 requirements, the Engineer will randomly observe five (5) out of every seventy (70) tests. If two (2) or more tests are not in conformance with the QA/QC Plan specified in Paragraph 1.5.A or the Work Plan specified in Paragraph 3.1.A, all tests performed by the Contractor will be rejected, and the Contractor, without any additional compensation, shall correct deficiencies and repeat the tests.

B. Provide Activity Hazard Analysis (AHA) that describes step-by-step instructions for what the field technician will be doing, including all the means and methods.

END OF SECTION 33 05 05.25

SECTION 33 05 05.31 – HYDRANT FLOW AND PRESSURE TESTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Provide all equipment, tools, labor, materials, and incidental services necessary to accurately perform all work for hydrant flow testing and C-factor (roughness coefficient) testing.

1.2 REFERENCES

A. American Water Works Association (AWWA):

1. AWWA M17 – Fire Hydrants: Installation, Field Testing, and Maintenance.
   a. Field Procedure for Flow Tests.

B. National Fire Protection Association (NFPA):

1. NFPA 291 – Recommended Practice for Fire Flow Testing and Marking of Hydrants.
2. NFPA 25 – Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

C. International Organization for Standardization (ISO):

1. ISO 2859-1 Sampling procedures for inspection by attributes.

D. American National Standards Institute (ANSI) / American Society for Quality (ASQ).

1. ANSI/ASQ Z1.4 Level 1 Sampling Procedures and Tables for Inspection by Attributes.

1.3 DEFINTIONS

A. Contractor: The term “Contractor” is defined as the firm (and/or any of its Contractors) retained to perform these services by the Owner.

B. Engineer: The term “Engineer,” as used in this scope of services, shall be defined as the Owner’s designated representative.

C. Owner: The term “Owner,” as used in this scope of services, shall be defined as the City of Detroit.

D. Water Distribution System: The term "Water Distribution System," as used in this scope of services, shall mean a water system carrying potable water flow to City of Detroit customers.

E. Flow Hydrant: The hydrant or hydrants at which flow and/or pressure is measured.

F. Pitot Pressure: The pressure reading obtained on the Pitot gauge during a flow test.

G. Pitot Tube: An instrument that is used to measure the flow of water discharged from the hydrant outlet.

H. Residual Pressure: The pressure in the distribution system measured at the residual hydrant at a time the flow readings are taken at the flow hydrants.

I. Static Pressure: The pressure in the distribution system at a given point under normal distribution system flow conditions.

J. Mainline valve: The term "Mainline Valve" is the valve located on a distribution system pipe which isolates sections of pipe.

K. Hydrant Valve: The term "Hydrant Valve" is the valve located on the hydrant lead pipe which isolates the hydrant from the distribution system.

1.4 SUBMITTALS

A. Submit a written description of both hydrant testing and C-Factor testing procedures to be used to the Owner or Engineer, including equipment and personnel requirements complying with work plan submittal in Part 3 of this specification.

B. Submit electronic copies of hydrant testing data complying with Data Collection and Review Section in Part 3.

C. Submit electronic copies of C-Factor testing data complying with Data Collection and Review Section in Part 3.

D. Test reports summarizing hydrants flow rates and pipe segment C-factors shall be submitted digitally. Digital submittal shall be linked to an existing asset ID (CIPMOID) as determined by the GIS system. Contractor shall utilize electronic field equipment to collect data and create reports with online GIS application supplied by the Engineer (i.e., ARC Collector) which shall be uploaded at the end of each work day.

1. The Engineer will provide the Contractor with electronic mapping products (ESRI Geodatabase, ESRI Shapefile, KML/KMZ, etc.) which define assets to be tested/inspected. Information provided by the Engineer will also include electronic templates and/or access to web-based data-entry forms to be used when submitting data. The Engineer will assign a unique Asset Identifier (CIPMOID) to each hydrant, valve and pipe segment scheduled for testing and will identify all hydrants, valves and pipe segments in the mapping resources provided. The Contractor shall use these unique asset identifiers when collecting and managing all flow pressure and C-factor data. Data shall be collected digitally and provided to Engineer Digitally upon QA/QC. Engineer will supply data format which shall be used.

E. Submit Traffic Control Plan to Engineer for review. Upon review from Owner or Engineer, Contractor shall submit to agency with jurisdiction for approval. Contractor shall receive approved Traffic Control Plan prior to start of testing.

F. Submit Health and Safety Plan (HASP) to Engineer prior to start of testing. Contractor shall be responsible for the health and safety of all workers on-site during testing.

G. Submit Security Plan to Engineer prior to start of testing. Comply with Section 01 57 33 – Temporary Security Measures.

1.5 QUALITY ASSURANCE

A. Contractor shall provide a QA/QC plan specific to hydrant flow and pressure testing.

B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the Work.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. The Contractor shall submit a list describing all equipment to be used for review and approval of the Engineer. Equipment shall include but not be limited to:

1. Pitot tube with pressure gauge capable of reading 50% greater than the expected pitot pressure recorded in the hydrant flow stream.
    a. Both analog and digital pressure monitors may be used. Digital pressure monitors shall be capable of sampling four (4) times per second. An average of the data sampled shall be recorded once every one (1) second on all pressure monitors.

2. Outlet nozzle cap suitable to fit outlet nozzle of the residual hydrant equipped with a pressure gauge capable of reading 25-50% greater than the pressure expected in the residual hydrant.
    a. Both analog and digital pressure monitors shall be used. Digital pressure monitors shall be capable of sampling four (4) times per second. An average of the data sampled shall be recorded once every fifteen (15) seconds on all pressure monitors. Pressure gauges shall have an accuracy of +/- 1 psi.

3. Ruler or tool capable of accurately measuring the inside diameter of the outlet nozzle of each flow hydrant.
4. Hydrant wrench capable of operating hydrants. For locked hydrants, keys shall be provided by the Owner.
5. Discharge diffuser or similar device to absorb the energy from the hydrant flow so that it is redirected and/or contained to avoid property damage and to minimize impact to traffic.

6. Data collection equipment (e.g., tablet, notepad, etc.).
7. All dry barrel hydrants shall be drained after each test. Submersible drain pumps must be provided by the Contractor.
8. Drain plugs for hydrants.

PART 3 - EXECUTION

3.1 WORK PLANS

A. Prior to Work, Contractor shall provide detailed work plans including equipment and personnel requirements for both C-factor Testing and Hydrant Flow and Pressure Testing. Work plans shall include at a minimum the following:

1. Description of testing method including calculations.
2. Illustrations with valves positions, hydrants, and water main for each test.
   a. Information for hydrants, valves and watermain will be provided by Engineer.
3. List of equipment.
4. List of personnel (Contractor and Owner personnel).
   a. Contractor to operate all valves unless permitted otherwise.
5. Data collection protocols and procedures included sample field forms and results tables.
6. Safety protocols.
7. Problem reporting protocol.
8. Coordination plan with Owner (public communication).
9. Water safety assurance plan (i.e., preventing water pressure from dropping below 20 psi).
10. Methods to prevent the cause, or contribution to, a violation of a water quality standard.
11. Chlorination/De-Chlorination Methods:
    a. Where discharge cannot be sent to a location capable of accepting chlorinated water.
12. Testing QA/QC Plan.
13. Schedule.

3.2 IN-SITU TESTING

A. The Contractor shall coordinate with Owner or Engineer prior to any field testing. Contractor shall be subject to inspection of activities by the Engineer at any time. Work plan shall be approved by Engineer prior to any field testing.

B. Where discharge cannot be sent to a location capable of accepting chlorinated water, Contractor shall measure chlorine residual at the beginning and end of each test at one location for each test.

C. Discharge shall not cause or contribute to a violation of a water quality standard.

D. Hydrant shall flow until water is clear before test can begin.

E. Contractor to control the direction of flowing water from the hydrant in relation to the upcoming traffic and avoidance of property damage.

F. All hydrants shall be pumped dry immediately after completion of testing.

3.3 FIELD VERIFICATION

A. The Contractor shall follow the standard testing procedure as outlined in the DWSD Field Testing Plan.

B. The Contractor shall perform field verifications during flow testing with use of analog and digital pressure monitors.

1. The analog pressure monitor shall be used as a verification of the digital monitor. If variance is greater than 5%, Contractor shall recalibrate or replace defective monitor. Both measurements shall be recorded during testing.

C. During Hydrant and C-Factor Testing, pressure drops recorded must achieve a minimum 10 psi decrease from static pressure. Engineer will provide information on hydrants to be used for testing. The following are typical requirements.

1. C-Factor Tests:
   a. Typically require a minimum of one (1) flow hydrant and three (3) residual hydrants. However, additional flow hydrants may be needed to generate the required pressure decrease of 10 psi. In cases, where three (3) residual hydrants are not available for use, Contractor may be allowed to continue after receiving approval from the Engineer. Contractor shall comply with no additional cost to the Owner.
   b. All indicated valves shall be closed prior to beginning test and reopened after completion of each test. Contractor to provide signed verification of valve operation.

2. Hydrant Flow and Pressure Tests:
   a. Typically require a minimum of one (1) flow hydrant and two (2) residual hydrants. Engineer may specify more than two (2) residual hydrants all of which must be tested by the Contractor. However, additional flow hydrants may be needed to generate the required pressure decrease of 10 psi.

3.4 DATA COLLECTION AND REVIEW

A. Contractor shall submit data collection and review protocols with work plan. Data collection shall at a minimum include:

1. Location, Date and Time.
2. Digital picture of all hydrants and associated CIPMOID.
3. CIPMOID of all valves, hydrants, and pipe segments tested.

4. Valve positions prior to testing, valve positions during testing, valve positions after testing and valve turn count (for C-Factor Testing).
5. Hydrant nozzle inside diameters and ID of residual and flow hydrants for each test.
6. Internal barrel shape (sharp edge, projected inward or rounded edge).
7. Pipe material, diameter, location, and CIPMOID for all C-factor testing.
8. Electronic and manually recorded analog pressure data with data and time stamps.
9. Condition of hydrants including:
    a. If operable; Owner shall be notified of inoperable hydrants within twenty-four (24) hours.
    b. Any defects or abnormalities requiring hydrant maintenance.
    c. Presence of drain plugs.
    d. Ease of operation.
    e. Leaks.

3.5 QUALITY CONTROL

A. The Engineer shall be entitled to audit the collected data and be present when C-Factor tests are being executed. In accordance with ISO 2859-1 and ANSI/ASQ Z1.4 Level 1 requirements, the Engineer will randomly observe three (3) out of every sixteen (16) tests. If one (1) or more tests are not in conformance with the QA/QC Plan specified in Paragraph 1.5.A or the Work Plan specified in Paragraph 3.1.A, all tests performed by the Contractor will be rejected, and the Contractor, without any additional compensation, shall correct deficiencies and repeat the tests.

B. The Engineer shall be entitled to audit the collected data and be present when hydrant flow tests are being executed. In accordance with ISO 2859-1 and ANSI/ASQ Z1.4 Level 1 requirements, the Engineer will randomly observe three (3) out of every sixteen (16) tests. If one (1) or more tests are not in conformance with the QA/QC Plan specified in Paragraph 1.5.A or the Work Plan specified in Paragraph 3.1.A, all tests performed by the Contractor will be rejected, and the Contractor, without any additional compensation, shall correct deficiencies and repeat the tests.

C. All equipment shall be calibrated with calibration certification within one (1) year or within manufacturer's recommendations if more frequent than one (1) year.

END OF SECTION 33 05 05.31

SECTION 33 05 07 - TRENCHLESS INSTALLATION OF UTILITY PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Casing and jacking pipe.
2. Steel tunnel liner.
3. Carrier pipe.
4. Excavation for approach trenches and pits.

B. Related Requirements:

1. Section 03 60 00 - Grouting.
2. Section 31 23 19 - Dewatering.
3. Section 31 23 33 - Trenching and Backfill.
4. Section 31 50 00 - Excavation Support Systems.
5. Section 33 14 13 - Public Water Utility Distribution Piping.
6. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.
7. Section 33 42 00 - Storm Water Conveyance.

1.2 STANDARDS

Except as otherwise specified herein, comply with the latest version of the following standards:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO HB-17 - Standard Specifications for Highway Bridges.

B. American Welding Society (AWS):

1. AWS D1.1 - Structural Welding Code – Steel.

C. ASTM International:

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A139 - Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
3. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
4. ASTM A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.

5. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
6. ASTM C33 - Standard Specification for Concrete Aggregates.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).
9. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
10. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 COORDINATION

A. Coordinate Work of this Section with Detroit Water and Sewerage Department (DWSD) and utilities within the construction area.

1.4 DEFINITIONS

A. Casing Pipe or Tunnel Liner Plate: Pipe or casing through which the carrier pipe is installed.

B. Carrier Pipe: Conveyance pipe that will be placed within the casing pipe or tunnel liner plate.

C. Jacking Pit: Excavation from which the digger shield or tunnel boring machine and casing is launched, which incorporates a thrust block to spread reaction loads to the ground. A jacking pit is also referred to as launching shaft or jacking shaft.

D. Receiving Pit: Excavation to which the digger shield or tunnel boring machine is launched towards. A receiving pit is also referred to as a receiving shaft.

1.5 CONTRACTOR DESIGN RESPONSIBILITIES

A. Comply with the applicable regulations of OSHA 29 CFR 1926, Subpart S, “Underground Construction, Caisson, Cofferdams, and Compressed Air” as amended.

B. Design all trenches and pits required for the operation, including design and detailing of any excavation support systems that are necessary, for the protection of workers and the support of adjacent utilities and structures.

C. Design all equipment, methods, and other systems required to perform the operation.

D. Casing Pipe: Design casing pipe for anticipated jacking loads, ground loads, hydrostatic loads, surcharge loads, railroad impact loads, and any other temporary construction loads. Unless shown otherwise on the Drawings, casing pipe shall be sized adequately for installation of carrier pipe to the line and grade tolerances specified herein, to provide enough room for grade

control device and casing spacers for backfill grouting purpose, as well as to accommodate any line and grade correction necessary due to casing pipe misalignment.

E. Design support of carrier pipe during installation.

1.6 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 – Administrative Requirements.

B. Convene preconstruction meeting a minimum of one week prior to commencing Work of this Section.

1.7 SUBMITTALS

A. Comply with Section 01 33 00 – Administrative Requirements.

B. Product Data: Submit manufacturer's written information regarding pipe, casing, and tunnel liner plate, showing sizes, shapes, methods of attachment, connection details, and details of grout holes.

C. Trenchless Installation Plan: Provide drawings, narratives, cut sheets, and other supporting information for:

1. Digger shield or auger boring machine.
2. Guidance systems.
3. Jacking systems.
4. Installation methods for placing the carrier piping inside the casing pipe at the required line and grade.
5. Grouting work plan.

D. Shop Drawings:

1. Indicate types of initial support systems proposed.
2. Indicate details of casing, jacking head, sheeting, and other falsework for trenches and pits, field sketches, and other details to complete Work.
3. Indicate relationship of proposed installation to facility or natural features over installation, angle of installation, right-of-way lines, and general layout of built facilities.
4. Indicate cross-section(s) from field survey, showing installation in relation to actual profile of ground or facility.
5. Submit description of proposed construction plan, dewatering plan, and plan to establish and maintain vertical and horizontal alignments.

E. Submit calculations stamped and signed by a Professional Engineer licensed in the State of Michigan demonstrating that the casing pipe selected will safely support the maximum anticipated earth loads and superimposed construction and live loads, both static and dynamic, which may be imposed on the pipe during construction. Determine the additional stresses

imposed on the pipe during construction and upgrade the quality and strength of pipe and pipe joints to the extent necessary to withstand the additional stresses imposed by construction operation. Calculations shall clearly state the maximum allowable jacking capacity of the pipe together with the maximum joint angle deflection that can be accommodated under this load and the factor of safety against failure used in this condition.

F. Submit details of groundwater control methods in accordance with the General Provisions. Design of groundwater control methods shall be prepared, stamped, and signed by an engineer registered in the State of Michigan. Comply with Section 31 23 19 – Dewatering.

G. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

H. Welder Certificates: Submit Weld Procedure Specifications (WPS) and Procedure Qualification Records (PQR) for each welding process. Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

I. Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for tunnel liner.

J. If not furnished by the owner, submit appropriate encroachment permit for installations along or under public throughways and lands.

K. Submit emergency response procedures to handle situations when conduit is compromised and jeopardizes safety or integrity of installation.

L. Submit written report results of visual check of entire length of casing or liner prior to installation of carrier pipe to verify that there are no voids or defective joints.

M. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

N. Qualifications Statements:

1. Submit qualifications for installer and licensed professional.
2. Welders: Qualify procedures and personnel according to AWS D1.1.

1.8 Air Quality: Deal with noxious, flammable, or other hazardous gases or atmospheric conditions as may be encountered. Provide air quality monitoring and use of certified permissible equipment, in accordance with regulatory requirements, and other measures as required for safety.

1.9 Ventilation and Fire Safety:

A. Design the ventilation systems to force fresh air to and from the tunnel heading and base of the shaft during excavation. Design and orient the fresh air intake or exhaust air discharge at the surface to prevent the recirculation of exhaust air from the tunnel or shaft and to avoid the

introduction into the tunnel or shaft of air contaminated from other sources. Provide auxiliary ventilators to properly ventilate areas not adequately served by the main system.

B. Operate the ventilation systems whenever personnel are in the tunnel or shaft. After a shutdown, operate the ventilation system(s) for a sufficient length of time before personnel enter to assure the presence of air having satisfactory quality. Test the quality of the air and verify that it is satisfactory before permitting personnel to enter any excavation.

C. No internal combustion engines, except those fueled with diesel fuel shall be permitted in the tunnel or shaft.

D. Mechanized equipment operated in the tunnel, including the tunnel boring machine or shield, excavators, and trains shall be equipped with fire suppression systems or hand-operated fire extinguishers.

1.10 Control of Water:

A. Keep the tunnel free of water, insofar as is necessary for the proper construction of the work. Maintain water at least 3 feet below invert to avoid softening the excavation base. This shall include conducting water to pumps and dewatering to prevent interference with the progress or the quality of the work.

B. Prepare contingency plans to control drainage at the face and utilize stabilization methods to deal with running or fast-raveling conditions.

C. Use earth berms or other means to direct storm runoff away from open excavations.

1.11 Disposal of Oil:

A. Do not dispose of oil or oil-contaminated water in any watercourse or channel. Water contaminated with oil shall be separated from the oil in a manner conforming to the State of Michigan requirements.

B. Provide facilities and materials and remove from the site and dispose of oil encountered or separated from the wastewater.

1.12 Project Drawings:

A. Typical tunnel sections shown in the drawings illustrate the types of initial support that may be considered. Other types of initial support systems are subject to review by the Owner.

B. Excavation lines shown are not intended to be representative of anticipated ground conditions or amount of overbreak that may occur during tunnel excavation. For available geologic data, see the geotechnical data report.

1.13 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of casing or tunnel liner, carrier pipe, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.14 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this Section with minimum five years documented experience.

B. Welders: AWS qualified within previous 12 months for employed weld types.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

1.15 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept and preserve materials on-site in manufacturer's original packaging and inspect for damage.

B. Handling: Support casing and carrier pipes with nylon slings during handling.

C. Storage:

1. Store products according to manufacturer’s instructions.
2. Use wooden shipping braces between layers of stacked pipe.
3. Stack piping lengths no more than three layers high.
4. Store field joint materials in original shipping containers.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide temporary end caps and closures on piping and fittings and maintain in place until installation.
3. Protect piping system pieces from entry of foreign materials and water by installing temporary covers, completing sections of Work, and isolating parts of completed system.
4. Provide additional protection according to manufacturer instructions.

1.16 AMBIENT CONDITIONS

A. Comply with Section 01 52 00 – Temporary Facilities for product storage and installation for ambient condition control facilities.

1.17 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 CASING AND JACKING PIPE

A. Steel Casing Pipe:

1. Comply with ASTM A139 Grade B.
2. Minimum Yield Strength: 35,000 psi.
3. Minimum Wall Thickness: 0.375 inch or 1/200 the diameter, whichever is thicker.
4. Welded Joints:
   a. Comply with AWS D1.1.
   b. Full circumference.

B. Performance and Design Criteria:

1. Casing Pipe and Tunnel Liner: Leakproof.
2. Loading:
   a. Highways:
      1) Earth cover.
      2) H-20 live loading, according to AASHTO HB-17.
      3) Impact loading according to AASHTO HB-17.
   b. Railways:
      1) Earth cover.
      2) Cooper E-80.

3. Bracing, Backstops, and Jacks: Of sufficient rating for continuous jacking without stopping except to add pipe sections, and to minimize tendency of ground material to freeze around casing pipe.

2.2 STEEL TUNNEL LINER

A. Liner Plates:

1. Material: Structural steel.
2. Comply with ASTM A1011/A1011M.
3. Minimum Grade: 40.

B. Bolts and Nuts Used with Lapped Seams:

1. Minimum Diameter: 5/8-inch.
2. Bolts for Plate Thicknesses Greater Than or Equal to 0.209 Inches: Comply with ASTM A449.
3. Bolts for Plate Thicknesses Less Than 0.209 Inches: Comply with ASTM A307, Grade A.
4. Nuts: Comply with ASTM A307, Grade A.

C. Bolts and Nuts Used with Four-Flanged Plates:

1. Comply with ASTM A307, Grade A.
2. Thread: Coarse.
3. Diameter:
    a. Plate Thicknesses up to and Including 0.179 Inch: Minimum 1/2-inch.
    b. Plate Thicknesses Greater Than 0.179 Inch: Minimum 5/8-inch.

2.3 CARRIER PIPE

A. Public Water Utility Distribution Piping: Comply with Section 33 14 13 – Public Water Utility Distribution Piping.

1. Carrier pipe shall have restrained joints for the full length of pipe installed in casing.

B. Public Sanitary Sewerage Gravity Piping: Comply with Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.

C. Storm Conveyance Piping: Comply with Section 33 42 00 – Storm Water Conveyance.

2.4 MATERIALS

A. Soil Backfill for Trench Approaches and Pits to Finish Grade: Subsoil with no rocks 6 inches in diameter or greater, frozen earth, or foreign matter.

B. Filling and Sealing Grout at Pipe Ends: Concrete grout fill as specified in Section 03 60 00 – Grouting.

C. Pressure-Grout Mix: One-part Portland cement and six (6) parts mortar sand, mixed with water to consistency applicable for pressure grouting.

D. Mortar Sand: Comply with ASTM C33.

E. Portland Cement:

1. Comply with ASTM C150.
2. Type: I.

2.5 ACCESSORIES

A. Timber Supports and Insulators:

1. Description:
   a. Furnish notches to accommodate fastening.
   b. Treat notches at time of pipe installation with wood preservative.

2. Wood Preservative or Pressure Treatment: Creosote.
3. Species: Redwood.

B. Steel and Plastic Supports and Insulators:

1. Bands: 14-gage stainless steel.
2. Flange Bolts: 5/16-inch stainless steel.
3. Liner: Heavy-duty PVC.
4. Skids: Polyethylene or phenolic.

C. Steel Strapping: Comply with ASTM A36.

D. Tunnel Liner Coating: Zinc.

2.6 Casing Spacers: Casing spacers shall be bolt-on style with a shell made in two sections of Type 304 stainless steel. Connecting flanges shall be ribbed. The shell shall be lined with a PVC liner 0.090-inch thick with 85-90 durometer. Nuts and bolts shall be 18-8 stainless steel. Construct runners of ultra-high molecular weight polymer. Support runners by risers made of Type 304 stainless steel. Weld the supports to the shell and passivate the welds. Casing spacers shall be Cascade Waterworks Mfg. Co., PSI, APS, or equal.

2.7 Casing Seals: Casing seals shall be 1/8-inch-thick synthetic rubber, designed to fit snugly around pipe and casing. Casing seals shall be one piece with no field seams. Bands and hardware for attachment to pipe and casing outside diameter shall be stainless steel. Products: PSI or equal.

2.8 FABRICATION - STEEL TUNNEL LINER

A. Description: Fabricate plates to fit cross-section of tunnel and for connection by bolts on both longitudinal and circumferential seams or joints for erection from inside.

B. Grout Holes:

1. Description: To permit grouting as erection of liner plates progresses.
2. Diameter: 2 inches.

C. Plates:

1. Cold-form plates to provide pattern of corrugations or panels in skin section, which, along with circumferential flanges, develop effective sectional properties as shown in the submitted design.
2. Width: 16 inches.
3. Length: Adequate to obtain circumferential wall coverage in two or more multiples equivalent to 6, 12, 14, or 16 inches of diameter.
4. Maximum Weight of Single Plate without Bolts: 90 lb.

D. Plate Joints:

1. Description:
   a. Drill plates for bolting on both longitudinal and circumferential seams or joints.
   b. Fabricate to permit complete erection from inside.

2. Circumferential Flanges: Furnish bolt spacing not greater than 9-1/2 inches center-to-center and in multiples of plate length such that plates having same curvature are interchangeable and to permit staggering of longitudinal seams.
3. Longitudinal Flanges:
   a. Four-Flanged Plates: Three bolts in 16 inches of plate width.
   b. Two-Flanged Plates: Four bolts per foot in lapped seams.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Verify that connection to existing piping system, sizes, locations, and invert elevations are as indicated on Drawings.

3.2 PREPARATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Identify required lines, levels, contours, and datum locations.

C. Existing Utilities: Locate and identify utilities indicated to remain and protect from damage.

D. Construct elevations of casing or tunnel with not less than the minimum cover indicated on the Drawings.

E. Maintain access to existing facilities and other active installations requiring access.

3.3 INSTALLATION

A. Dewatering:

1. Comply with Section 31 23 19 – Dewatering.
2. Intercept and divert surface drainage precipitation and ground water away from excavation through use of dikes, curb walls, ditches, pipes, sumps, or other methods.
3. Develop substantially dry subgrade for subsequent operations.
4. Comply with requirements of local and state authorities for dewatering to any watercourse, prevention of stream degradation, and erosion and sediment control.

B. Pits or Approach Trenches:

1. Excavate approach trenches or pits according to installation plan, as indicated on Shop Drawings, and as Site conditions require.
2. Ensure that casing or tunnel entrance faces as near perpendicular in alignment as conditions permit.
3. Establish vertical entrance face at least 1 foot above top of casing or tunnel lining.
4. Install excavation supports as specified in Section 31 50 00 – Excavation Support Systems.

C. Casing Pipe:

1. Boring:
   a. Push pipe into ground with boring auger rotating within pipe to remove soil.
   b. Do not advance cutting head ahead of casing pipe, except for distance necessary to permit cutting teeth to maintain clearance for pipe.
   c. Arrange machine bore and cutting head to be removable from within pipe.
   d. Arrange face of cutting head to provide barrier to free flow of soft material.
   e. If unstable soil is encountered during boring, retract cutting head into casing to permit balance between pushing pressure and ratio of pipe advancement to quantity of soil.
   f. Grout to fill voids if voids develop greater than OD of pipe by approximately 1-inch.
   g. If boring is obstructed, relocate jack or tunnel as directed by Engineer.

2. Jacking:
   a. Construct adequate thrust wall normal to proposed line of thrust.

b. Impart thrust load to pipe through suitable thrust ring sufficiently rigid to ensure uniform distribution of thrust load on full pipe circumference.

3. Mining and Jacking: Use manual hand-mining excavation from within casing pipe as casing is advanced with jacks, allowing minimum ground standup time ahead of casing pipe.

D. General Installation Requirements:

1. The use of water or other liquids to facilitate casing emplacement and soil removal is prohibited.
2. Blasting is not permitted.
3. Control of Line and Grade:
   a. The Engineer will establish the baselines and benchmarks indicated on the plans. Check these baselines and benchmarks at the beginning of the contract period and report any error or discrepancies to the Engineer. Use these baselines and benchmarks to furnish and maintain all reference lines and grades for installation. Use these lines and grades to establish the starting location of the installation.
   b. Mount guidance laser system in a manner than isolates it from effects of movement by the digger shield or tunnel boring machine.

E. Tunneling:

1. Liner Plates:
   a. Advance excavation for tunnel lining in increments sufficient for erection of one ring of liners.
   b. Install liner plates immediately after each increment of excavation.
   c. Excavate to minimize voids behind liner plates.
   d. Force-grout voids immediately, using pressure as necessary to completely fill voids.
2. Excavate to lines, grades, dimensions, and tolerances as indicated on Drawings to accommodate initial support and permanent lining.
3. Tunnel Linings:
   a. Do not damage lining or coating.
   b. Ensure that edges are clean and free of material capable of interfering with proper bearing.
   c. Install liner plates and bolts according to liner plate manufacturer instructions and replace liner plates or bolts not meeting these requirements.
   d. Use liner plates for full length of tunnel of one type only, using either flanged or lapped-seam type of construction.
4. Place concrete invert.

F. Pressure Grouting: Pressure-grout annular space between casing pipe and surrounding earth. Grout annular space between casing pipe and carrier pipe if indicated in the Drawings.

G. Carrier Pipe:

1. Clean, inspect, and handle pipe as specified in Section 33 14 13 – Public Water Utility Distribution Piping, Section 33 31 11 – Public Sanitary Sewerage Gravity Piping, and Section 33 42 00 – Storm Water Conveyance.
2. Placement:
    a. Place carrier pipe as specified in Section 33 14 13 – Public Water Utility Distribution Piping, Section 33 31 11 – Public Sanitary Sewerage Gravity Piping, and Section 33 42 00 – Storm Water Conveyance.
    b. Prevent damage to pipe joints as carrier pipe is placed in casing.

3. Supports:
    a. Support pipeline within casing such that no external loads are transmitted to carrier pipe.
    b. Attach supports to barrel of carrier pipe; do not rest carrier pipe on bells.

4. Grout ends of casing to seal.

3.4 TOLERANCES

A. Comply with Section 01 40 00 – Quality Requirements.

B. Excavation: Do not overcut excavation by more than 1 inch greater than OD of casing pipe.

C. Casing Pipe Vertical and Horizontal Alignment: Plus, or minus 3 inches prior to installation of carrier pipe.

D. Pipe Bells: Minimum 1/2-inch clearance to casing.

3.5 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements.

B. Compaction Testing:

1. Comply with ASTM D1557 or ASTM D698 unless otherwise indicated on the Drawings.
2. If tests indicate that the Work does not meet specified requirements, remove Work, replace, and retest.
3. Testing Frequency: as indicated in Section 31 23 33 – Trenching and Backfill.

3.6 CLEANING

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Remove temporary facilities for casing or tunnel installation and jacking or tunneling operations.

3.7 PROTECTION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Protect plant life, lawns, rock outcroppings, and other features of final landscaping.

C. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, curbs, and other structures from excavating equipment and vehicular traffic.

END OF SECTION 33 05 07

SECTION 33 05 07.13 - UTILITY DIRECTIONAL DRILLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Directional Drilling of pipe 16 inches and less.
2. Pipes and accessories for Directional Drilling.
3. Testing of pipe installed by directional drilling.

B. Related Requirements:

1. Section 02 01 20 – Protecting Existing Underground Utilities.
2. Section 03 30 00 – Cast-in-Place Concrete.
3. Section 31 23 33 – Trenching and Backfill.
4. Section 31 50 00 – Excavation Support Systems.
5. Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.
6. Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
7. Section 33 14 13 – Public Water Utility Distribution Piping.
8. Section 33 14 17 – Water Services.
9. Section 33 14 17.81 – Lead Service Line Replacement.

1.2 STANDARDS

A. ASTM International:

1. ASTM C1173 - Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
2. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
3. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
4. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
5. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
6. ASTM F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

B. American Water Works Association (AWWA):

1. AWWA C800 - Underground Service Line Valves and Fittings.

2. AWWA C901 – Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in. for Water Service.
3. AWWA C906 – Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100mm Through 1,650mm), for Waterworks.
4. AWWA M55 – PE Pipe Design and Installation.

1.3 DESIGN REQUIREMENTS

A. Design Criteria:

1. Drilling Steering System: Remote with continuous electronic monitoring of boring depth and location.
2. Directional Change Capability: 90 degrees with 35-foot radius curve.
3. Minimum distance capability for single bores and between boring pits:

Table 33 05 07.13-1: Boring Distance

Pipe Size	Boring Distance
1 to 1-1/2 inches	400 feet
2 to 2-1/2 inches	350 feet
3 inches to 16 inches	300 feet

4. Ratio of Reaming Diameter to Pipe Outside Diameter:
   a. Nominal pipe diameter of 6 inches and smaller: 1.5 maximum.
   b. Nominal pipe diameter larger than 6 inches: Maximum increment of 6 inches per pass.

1.4 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings:

1. Submit technical data for equipment, method of installation, and proposed sequence of construction.
2. Submit an Installation Plan that describes the anticipated rig capacity, the proposed equipment and the method for advancing the borehole through expected soil conditions, angles, depth and exact location of the entrance pit, the pilot hole diameter, the proposed reaming plan, including the number and diameter of pre-reams, back-reams and diameter of the final reamed borehole if any, and the contingency equipment and plans for dealing with soil conditions that a soil engineer could reasonably expect to be encountered at the proposed directional drill installation site.
3. Submit contingency plan for the stopping of directional drill operation due to obstructions, max pull load exceeded, or any other disruption in advancement of directional drill.

4. Submit in the Installation Plan the anticipated hours of operation during the directional drill borehole drilling and installation process, the minimum number of personnel, and their responsibilities on-duty and on-site during all directional drilling operations.
5. Submit information pertaining to pits, dewatering, method of spoils removal, equipment size and capacity, equipment capabilities including installing pipe on radius, type of drill bit, drilling fluid, method of monitoring line and grade and detection of surface movement, name plate data for drilling equipment, and mobile spoils removal unit.
6. Submit a detailed Fracture Mitigation (frac-out) Plan including method of monitoring and capturing the return of drilling fluids with particular attention to prevention of in the event of escape of drilling fluids where they could undermine structures, infiltrate sewers, or cause environmental damage.

C. Product Data:

1. Identify source of water used for drilling.
2. Submit copy of approvals and permits for use of water source including permit stipulations for backflow preventers and other requirements.

D. Installer Qualifications: Submit history of previous work completed of equivalent nature and scope. Include qualification and experience of key personnel.

E. Personnel: Submit a list of field supervisory personnel and their experience with direction drilling operations.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Video Report of pre-installation video of sewers 24 inches and greater and post-installation video conditions for any sewer or lateral crossed as part of boring operation in conformance with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspections.

1.5 CLOSE-OUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of pipe and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Record actual depth of pipe at 25 feet intervals.

E. Record actual horizontal location of installed pipe.

F. Show depth and location of abandoned bores.

G. Record depth and location of drill bits and drill stems not removed from bore.

1.6 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this Section with minimum five (5) years and at least 30,000 feet documented experience in directional drilling of 6 inch to 24 inch water main pipe.

1. Work experience: Include projects of similar scope and conditions.
2. Furnish list of client references with contact information for recent similar project experience.

B. Personnel Experience

1. Field supervisory personnel shall have a minimum of three (3) years' experience in the Work specified.
2. Personnel performing fusion of HDPE pipe and fittings:
   a. The Contractor shall be certified by the manufacturer of the fusing equipment and shall have successfully completed training in:
      1) Handling replacement pipe materials.
      2) Butt fusion and electrofusion of pipe joints.
      3) Operation and maintenance of all equipment to be used.

   b. The supervisory personnel performing fusing of HDPE pipe and fittings shall have a minimum three (3) years' experience in the Work specified.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept and preserve materials on-site in manufacturer's original packaging and inspect for damage.

B. Handling: Support casing and carrier pipes with nylon slings during handling.

C. Storage:

1. Store products according to manufacturer's instructions.
2. Use wooden shipping braces between layers of stacked pipe.
3. Stack piping lengths no more than three layers high.
4. Store field joint materials in original shipping containers.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide temporary end caps and closures on piping and fittings and maintain in place until installation.

3. Protect piping system pieces from entry of foreign materials and water by installing temporary covers, completing sections of Work, and isolating parts of completed system.
4. Provide additional protection according to manufacturer instructions.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Conduct operations so as not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities, and landscape in immediate or adjacent areas.

1.9 WARRANTY

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Provide a one (1) year warranty period for all materials and workmanship. Warranty period will commence on the date of substantial completion of the Work.

PART 2 - PRODUCTS

2.1 DRILLING FLUID

A. Drilling fluid shall be liquid bentonite clay and water slurry; totally inert with no environmental risk formulated to move cuttings to the surface and lubricate the pipe during pullback.

B. Drilling fluid shall remain in the drilled hole to ensure the stability of the hole and reduce drag on the pulled pipe.

2.2 DRILL PIPE

A. Drill pipe shall be steel with sufficient strength to withstand the maximum rated pullback and pushing load of the drilling equipment. Drill pipe joints shall be flush and capable of transmitting maximum rated torque of the drilling equipment.

2.3 PIPE

A. Water Services:

1. Copper Pipe:
   a. Comply with Section 33 14 17 – Water Services.
   b. Fittings: Comply with Section 33 14 17 – Water Services.

B. Water Main:

1. Polyethylene (PE) Pipe:
   a. Comply with Section 33 14 13 – Public Water Utility Distribution Piping.
   b. Fittings: Comply with Section 33 14 13 – Public Water Utility Distribution Piping.

2.4 FILL MATERIALS

A. Backfill: Excavated subsoil or granular fill per Section 31 23 33 – Trenching and Backfill.

2.5 WATER SOURCE

A. Provide clean potable water for the mixing of drill fluid.

B. Contractor is responsible for transportation and storage of water.

C. If a DWSD hydrant is used for potable water, proper meter and backflow prevention shall be used according to permit requirements.

2.6 UNDERGROUND PIPE MARKERS

A. Tracer Wire: Electronic detection materials for non-conductive piping products. HDPE coated ten (10) gauge or thicker solid copper wire suitable for direct bury applications.

2.7 DRILLING EQUIPMENT

A. Drilling equipment shall have a maximum sound power level of 72 dBA (as defined in ANSI S1.4) at 10 feet when operating within 100 feet of a residential unit. Measure sound power level in accordance with ISO 3740 and ISO 3744.

B. Mixing, pumping, and holding/separation tanks shall be capable of delivering mixed drilling fluid to the cutting head. Drilling fluids circulating equipment shall be designed to minimize spillage.

2.8 DOWNHOLE TOOLS

A. Cutting heads, back-reamers, and hole openers shall be suitable for the soil conditions anticipated by the Contractor.

B. Grips, pulling heads, and swivels shall be compatible with the pipe material. Design to transmit without distortion the maximum rated pullback force of the equipment used. Grips, pulling heads, and swivels shall be specifically engineered for directional drilling applications.

C. Tracking equipment shall be capable of determining the location of the cutting head at depth within ±3 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 – Execution and Close-out Requirements.

B. Verify that connections to existing piping system, sizes, locations, and invert elevations are as indicated on Drawings.

C. Contractor shall contact the Owner and request existing CCTV video of sewers to be crossed during directional drill operation. The video may be used as a baseline for pre-existing conditions of the sewer prior to directional drill at the discretion of the Owner.

3.2 PREPARATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Identify required lines, levels, contours, and datum locations. Establish a Survey Grid Line and provide a program of monitoring and documenting the actual location of the borehole during drilling operations.

C. Monitor potential heave or settlement along the pipe centerline. Take digital photos of the ground surface conditions before and after drilling operations.

D. Existing Utilities:

1. Test Pits: Excavate test pits (soft digging) to field verify the locations, depth of bury, diameter, and pipe material of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Engineer if conflicts are encountered.
2. Locate, expose, and protect existing utilities, including water, sewer, and stormwater crossings owned by DWSD, per Section 02 01 20 - Protecting Existing Underground Utilities.
3. Notify the Engineer if minimum separation distance of 18 inches vertically and 10 feet horizontally from other utilities as required by Detroit Water and Sewerage Department standards cannot be achieved.

E. Construct utilities with not less than the minimum cover indicated on the Drawings.

F. Maintain access to existing facilities and other active installations requiring access.

G. Video Inspection: Perform a pre-bore video of any sewer 24 inches and greater to be crossed as a part of the directional drill installation. Perform a post-bore video of sewers and laterals of all sizes crossed after completing pipe installation per Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.

3.3 INSTALLATION

A. Dewatering:

1. Intercept and divert surface drainage precipitation and ground water away from excavation through use of dikes, curb walls, ditches, pipes, sumps, or other methods.
2. Develop and maintain substantially dry subgrade during drilling and pipe installation.
3. Comply with requirements of local and state authorities for dewatering to any watercourse, prevention of stream degradation, and erosion and sediment control.

B. Pits or Approach Trenches:

1. Excavate subsoil as specified in Section 31 23 33 – Trenching and Backfill.
2. Excavate approach trenches or pits in accordance with Shop Drawings and as Site conditions require. Minimize number of access pits.
3. Ensure that casing or tunnel entrance faces as near perpendicular in alignment as conditions permit.
4. Provide sump areas to contain drilling fluids.
5. Install excavation supports as specified in Section 31 50 00 – Excavation Support Systems.

C. Drilling:

1. Install the pipe in a manner that does not cause upheaval, settlement, cracking, movement, or distortion of the surface material
2. Drill pilot bore with vertical and horizontal alignment as indicated on Shop Drawings.
3. Guide drill remotely from ground surface to maintain alignment by monitoring signals transmitted from drill bit.
    a. Monitor depth, pitch, and position.
    b. Adjust drill head orientation to maintain correct alignment.

4. Inject drilling fluid into bore to stabilize hole, remove cuttings, and lubricate drill bit and pipe.
5. Continuously monitor drilling fluid pumping rate, pressure, viscosity, and density while drilling pilot bore, back reaming, and installing pipe to ensure adequate removal of soil cuttings and stabilization of bore.
    a. Provide relief holes when required to relieve excess pressure.
    b. Minimize heaving during pullback.

6. Calibrate and verify electronic monitor accuracy during first 50 feet of bore in presence of Engineer before proceeding with other drilling. Excavate minimum of four (4) test pits spaced along first 50 feet bore to verify required accuracy. When required accuracy is not met, adjust equipment or provide new equipment capable of meeting required accuracy.
7. Remove drill bit after completing pilot bore.

D. Drilling Obstructions:

1. When obstructions are encountered during drilling, notify Engineer immediately. Do not proceed around obstruction without Engineer's approval.
2. For conditions requiring more than three (3)foot deviation in horizontal alignment, submit new shop drawings to Engineer for approval before resuming work.
3. Maintain adjusted bore alignment within easement or right-of-way.

E. Pipe Installation:

1. Remove drill bit after completing pilot bore.
2. Install reamer and pipe pulling head. Select reamer with minimum bore diameter required for pipe installation.
3. Attach pipe to pipe pulling head. Pull reamer and pipe to entry pit along pilot bore.
4. Inject drilling fluid through reamer to stabilize bore and lubricate pipe.
5. Install piping with horizontal and vertical alignment as shown on Drawings.
6. Protect and support pipe being pulled into bore so pipe moves freely and is not damaged during installation.
7. Do not exceed pipe manufacturer’s recommended pullback forces.
8. Install trace wire continuous with each bore for non-conductive piping material. Splice trace wire only at intermediate bore pits. Tape or insulate trace wire to prevent corrosion and maintain integrity of pipe detection.
    a. Terminate trace wire for each pipe run at structures along pipe system.
    b. Provide extra length of trace wire at each structure so trace wire can be pulled 6-feet out top of structure for connection to detection equipment.
    c. Test trace wire for continuity for each bore before acceptance.
9. Provide sufficient length of pipe to extend past termination point to allow connection to other pipe sections.
10. Allow minimum of 12 hours for stabilization after installing water main pipe before making connections to existing water main pipe.
11. Anchor HDPE water main pipe with concrete anchor block and flex restraint as shown in the drawings after the minimum relaxation period.

F. Slurry Removal and Disposal:

1. Contain excess drilling fluids at entry and exit points until recycled or removed from site. Provide recovery system to remove drilling spoils from access pits.
2. Remove, transport and legally dispose of drilling spoils off-site.
    a. Do not discharge drilling spoils in sewers or other drainage systems.
    b. When drilling in suspected contaminated soil, test drilling fluid for contamination before disposal.

3. When drilling fluid leaks to surface, immediately contain leak and barricade areas from vehicular and pedestrian travel before resuming drilling operations. Follow all procedures for the submitted and approved Fracture Mitigation Plan.
4. Complete clean-up of drilling fluid at end of each work day.

G. Backfill:

1. Install backfill and compact as specified in Section 31 23 33 – Trenching and Backfill.
2. Backfill approach trenches and pits with subsoil fill to contours and elevations indicated on drawings or surrounding existing grade.

H. Video Inspection: Perform a post-bore video of any sewer and lateral crossed per Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection, after completing pipe installation.

3.4 TOLERANCES

A. Comply with Section 01 40 00 – Quality Requirements.

B. Maximum Variation from Horizontal Position: 12 inches.

C. Maximum Variation from Vertical Elevation: 3 inches.

D. Minimum Horizontal and Vertical Clearance from Other Utilities: 18 inches.

E. When pipe installation deviates beyond specified tolerances, abandon bore, remove installed pipe, re-bore, and reinstall pipe in correct alignment.

F. Fill abandoned bores greater than 3 inches in diameter with grout or flowable fill material.

3.5 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements.

B. Compaction Testing:

1. Comply with Section 31 23 33 – Trenching and Backfill.
2. If tests indicate that the Work does not meet specified requirements, remove Work, replace, and retest.

C. Comply with Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.

D. Comply with water main hydrostatic and leakage testing requirements of Section 33 14 13 – Public Water Utility Distribution Piping.

3.6 CLEANING

A. Comply with Section 01 70 00 – Execution and Close-out Requirements.

B. Upon completion of drilling and pipe installation, remove drilling spoils, debris, and unacceptable material from approach trenches and pits. Clean up excess slurry from ground.

C. Restore approach trenches and pits to original condition.

D. Restore all surfaces disturbed during mobilization, directional drilling operation and restoration to original condition.

E. Remove temporary facilities for drilling operations in accordance with Section 01 52 00 – Temporary Facilities and Controls.

3.7 PROTECTION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Protect plant life, lawns, rock outcroppings, and other features of final landscaping.

C. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, curbs, and other structures from excavating equipment and vehicular traffic.

END OF SECTION 33 05 07.13

SECTION 33 05 61 – CONCRETE MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modular precast concrete manholes and structures with tongue-and-groove joints, precast grade rings for transition to cover frame, covers, anchorage, and accessories.
2. Doghouse manhole connections to existing water main, sanitary, and storm sewer lines.
3. Bedding and cover materials.
4. Vertical adjustment of existing manholes and structures.

B. Related Requirements:

1. Section 03 10 00 - Concrete Forming.
2. Section 03 20 00 - Concrete Reinforcing.
3. Section 03 30 00 - Cast-in-Place Concrete
4. Section 31 23 33 - Trenching and Backfill.
5. Section 33 01 30.61 - Packer Injection Grouting.
6. Section 33 14 13 - Public Water Utility Distribution Piping.
7. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.
8. Section 33 42 00 – Storm Water Conveyance.

1.2 DEFINITIONS

A. Bedding: Specialized material placed under manhole prior to installation and subsequent backfill operations.

1.3 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Association of State Highway Transportation Officials (AASHTO):

1. AASHTO M306 - Standard Specification for Drainage, Sewer, Utility, and Related Castings.

B. American Concrete Institute (ACI):

1. ACI 530/530.1 - Building Code Requirements and Specification for Masonry Structures.

C. ASTM International:

1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
4. ASTM C55 - Standard Specification for Concrete Building Brick.
5. ASTM C140 - Standard Test Method for Sampling and Testing Concrete Masonry Units and Related Units.
6. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
7. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure.
8. ASTM C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
9. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections.
10. ASTM C877 - Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.
11. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
12. ASTM C923 - Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
14. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
15. ASTM D4101 - Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials.
16. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
17. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

1.4 COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Coordinate Work of this Section with connection to sewer utility service and trenching.

1.5 PREINSTALLATION MEETINGS

A. Participate in Pre-installation meetings in accordance with Section 01 30 00 - Administrative Requirements.

B. Convene minimum one (1) week prior to commencing Work of this Section.

1.6 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer’s catalog information for manhole sections, manhole frames and covers, joint sealing compounds component construction, features, configuration, and dimensions. Show dimensions and materials of construction by ASTM reference and grade. Show lettering on manhole covers.

C. Shop Drawings:

1. Indicate structure locations and elevations.
2. Indicate sizes and elevations of piping, penetrations, step locations, cones, grade rings, and casting dimensions.
3. Indicate wall thickness, strength of concrete, type, and steel reinforcement.
4. Provide proposed concrete mix design for manhole sections.
5. Furnish certified test reports for each type.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1. Certification of cementitious materials, aggregate, admixtures, and reinforcing steel.
2. Certification of gasket and gasket materials, including identification of basic polymer used.
3. Certification that joint lubrication conforms to all specified requirements for the specified gaskets supplied.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of factory tests, inspections, and Contractor’s testing lab.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statement:

1. Submit qualifications for manufacturers, which Shall be a member of the National Precast Concrete Association (NPCA).
2. Submit qualifications for personnel and equipment of Contractor’s testing lab.

1.7 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations and sizes of manholes and connections, invert elevations, and top of casting elevations.

1.8 QUALITY ASSURANCE

A. Perform work as specified herein. Provide Engineer with hard copies or the address online where each standard affecting Work of this Section is located.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

B. Precast Manufacturers Association.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on-site and inspect for damage. Verify manhole type and measurements prior to acceptance.

B. Handling: Comply with precast concrete manufacturer instructions and ASTM C913 for unloading and moving precast manholes and drainage structures.

C. Storage:

1. Store materials according to manufacturer instructions.
2. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
3. Store materials susceptible to deformations in higher temperatures in the shade away from direct sunlight.
4. Repair property damaged from materials storage.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.11 AMBIENT CONDITIONS

A. Cold Weather Requirements: Comply with ACI 530/530.1.

1.12 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 CONCRETE AND MASONRY MANHOLES

A. Manufacturers: Furnish materials according to Michigan Department of Transportation (MDOT) and Detroit Water and Sewerage Department (DWSD) standards.

B. Manhole Sections:

1. Materials:
   a. Reinforced Precast Concrete: Comply with ASTM C478 except that the wall thickness shall be 6 inches minimum. Minimum manhole diameter shall be 48 inches. Design manholes for the depths shown in the drawings, assuming a soil density of 130 pounds per cubic foot.
   b. Gaskets: Comply with ASTM C443 and ASTM C923.
   c. Manholes shall be constructed of precast units.

2. Joints:
   a. Comply with ASTM C443 and ASTM C913.
   b. Maximum Leakage: Manholes shall be leak tight.
   c. In addition to the gaskets, manhole joints shall be sealed with ConSeal CS-202 or approved equal.
   d. Pipe entering manholes at openings: Seal by means of flexible rubber gaskets, sleeves, or mechanically expandable seals.
   e. Joints shall be completely filled with mortar or non-shrink non-metallic grout as specified in Section 03 60 00 - Grouting.

C. Manhole Sections: Reinforced Cast-in-Place Concrete shall be as specified in Section 03 30 00 - Cast-in-Place Concrete.

D. Concrete, Mortar and Grout:

1. Cement for manholes and precast bases shall conform to ASTM C150, Type II.
2. Mortar: Type S.
3. Grout: Non-Shrink Non-Metallic Grout as specified in Section 03 60 00 - Grouting.

E. Reinforcement:

1. As specified in Section 03 20 00 - Concrete Reinforcing.
2. Minimum allowable steel shall be hoops of No. 4 wire cast into each unit at 4-inch spacing.

F. Shaft, Concentric, and Eccentric Cone Top Sections:

1. Pipe Sections: Reinforced precast concrete. Cast-in-Place with approved by the Owner. Precast top sections shall be eccentric cone except where shown otherwise in the drawings.
2. Joints:
    a. Lipped male/female.
    b. Design joints using a butyl rubber sealant per ASTM C990.

3. Sleeved to receive pipe or conduit sections.

G. Shape: As described in the Contract or indicated on the Drawings.

H. Clear Inside Dimensions:

1. As described in the Contract or indicated on the Drawings.
2. Inside diameter clear opening 48 inches minimum unless larger is shown on the Drawings.

I. Design Depth: As described in the Contract or indicated on Drawings.

J. Clear Cover Opening:

1. As described in the Contract or indicated on the Drawings.
2. Inside diameter clear opening 24 inches minimum.

K. Pipe Entry:

1. Openings shall be cast into precast manhole sections.
2. Furnish openings as described in the Contract or indicated on Drawings.

L. Structure Joint Gaskets: Comply with ASTM C361 and ASTM C443.

2.2 FRAMES AND COVERS

A. Manufacturers:

1. Furnish materials according to MDOT and DWSD standards.
2. Frames and Covers shall be designed for AASHTO H-20 as described in the Contract or indicated on Drawings.

B. Description:

1. Material:
    a. Cast iron or ductile iron.
    b. Comply with ASTM A48/A48M, Class 30B and AASHTO M306.
    c. Castings shall be of uniform quality, free from cracks, holes, porosity, shrinkage distortion, and other defects. Casting shall be ground smooth and well cleaned by shot blasting.
    d. Bearing surfaces between cover and frame shall be cast or machined with such precision to prevent the cover from rocking or rattling upon loading.

e. Covers shall fit flush with frame.

2. Lid:
   a. Bearing Surface: Machined flat.
   b. Configuration: Removable.
   c. Security: Nuts, bolts, and lock washers shall be Type 304 Stainless Steel. Counter-sunk to be flush.
   d. Tags: Type 304 Stainless Steel. Tag description will be furnished by the Owner.

3. Cover Design:
   a. As described in the Contract or indicated on the Drawings.
   b. All sanitary and combined sewer covers shall be gasketed to be air tight and bolted.

4. Live-Load Rating: As described in the Contract or indicated on the Drawings.
5. Gasketed: As described in the Contract or indicated on the Drawings.
6. Grate: As described in the Contract or indicated on the Drawings. Grates shall be bicycle safe.
7. Manhole and Gate Well covers shall be DWSD Standard EJIW ERGO covers labeled "Sewer" or "Water" as applicable.

2.3 RISER RINGS

A. Furnish materials according to MDOT and DWSD standards.

B. Riser Rings:

1. Thickness of 2 to 6 inches:
   a. Precast concrete: Comply with ASTM C478.
   b. Rubber Composite: INFRA-RISER Rubber Composite Adjustment Risers or approved equal.
   c. For every 2-inch section, reinforce with one No. 3 gage wire at minimum. In no case shall the riser rings exceed 18 inches total height.

2. Rubber Seal Wraps:
   a. Wraps and Band Widths: Comply with ASTM C877, Type III.
   b. Cone/Riser Ring Joint: Minimum 3-inch overlap.
   c. Frame/Riser Ring Joint: 2-inch overlap.
   d. Additional Bands: Overlap upper band by 2 inches.

2.4 MATERIALS

A. Comply with Section 31 23 33 – Trenching and Backfill.

B. Cover and Bedding: As described in the Contract or indicated on the Drawings.

2.5 ACCESSORIES

A. Steps:

1. Rungs: Formed Grade 60 steel reinforcing rod, ASTM A615, fully encapsulated in copolymer polypropylene, ASTM D4101.
2. Fabrication: Formed integral with manhole sections.
3. Diameter: ¾-inch.
4. Width: 14 inches minimum.
5. Spacing:
    a. 16 inches o.c. vertically, set into structure wall.
    b. Top step shall be not more than 16 inches below manhole cover or as directed by the Owner.
    c. Bottom step shall not be more than 18 inches above the bench or floor level.

B. Vertical spacing and alignment shall not vary by more than plus/minus ½-inch.

C. Foundation Slab:

1. Cast-in-Place concrete as specified in Section 03 30 00 – Cast-in-Place Concrete.
2. Precast bottoms may be used in lieu of cast-in-place concrete provided the bottoms are constructed monolithically with the bottom manhole riser section.
3. Top Surface: Level with smooth transitions to insure an unobstructed flow through the manhole.

D. Strap Anchors:

1. Shape: Bent steel.
2. Finish: Galvanized or Coated.

E. Joint Sealant: Comply with ASTM C990.

F. Fasteners: Stainless steel; ASTM F593.

G. Concrete: As specified in Section 03 30 00 - Cast-in-Place Concrete.

H. Soil Backfill from Above Pipe to Finish Grade:

1. Soil Type S1 and/or S2 as indicated on Drawings.
2. Subsoil: No frozen earth, or foreign matter, or rocks more than 6 inches in diameter.

2.6 PIPE CONNECTIONS FOR SEWER MANHOLES

1. Provide resilient watertight connectors between the manhole and piping in accordance with ASTM C923.

2. Connections shall consist of a chemically resistant neoprene EPDM flexible boot, locking ring, and pipe clamp(s). The locking ring shall be stainless steel and shall lock the boot into the preformed opening in the manhole. The pipe clamp shall be stainless steel.
3. Alternatively, cast the flexible boot in the manhole and eliminate the locking ring. Pipe connections shall be Kor-N-Seal (Dukor Corporation), Z-Lok (A-Lok Products, Inc.), or equal.

2.7 FINISHES

A. Bituminous Interior Manhole Coating:

1. As described in the Contract and/or indicated on Drawings.
2. Furnish materials according to DWSD standards.

B. Steel Galvanizing:

1. Hot-dip galvanize after fabrication.
2. Comply with ASTM A123/A123M.

2.8 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Provide shop inspection and testing of completed assembly.

C. Owner Witnessing of Tests and Inspection:

1. Allow Owner-witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.
3. Make completed manholes available for inspection at manufacturer's factory prior to packaging for shipment.
4. Notify Owner at least two (2) weeks before inspection is needed.

D. Certificate of Compliance: Submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

E. Tests:

1. Manholes shall be visually inspected for leaks and damage prior to placing them into service. Any visible leakage or damage shall be repaired by a method approved by the Owner.
2. Vacuum Test - Concrete Manhole Negative Air Pressure Test.
3. Perform air pressure test in accordance with ASTM C1244.

4. Perform tests for each item in accordance with the following methods of ASTM as a minimum:
    a. ASTM C140, Standard Test Method for Sampling and Testing Concrete Masonry Units and Related Units.
    b. ASTM C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that items provided by other Sections of Work are properly sized and located.

C. Verify that built-in items are in proper location and are ready for roughing into Work.

D. Verify that excavation base is ready to receive Work and excavations and that dimensions and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout.

B. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.

C. Coordinate placement of inlet and outlet pipe or duct sleeves as required by other Sections.

D. Inspect precast concrete manholes immediately prior to placement in excavation to verify that they are internally clean and free from damage; remove and replace damaged units.

3.3 INSTALLATION

A. Conduct operations to not interfere with, interrupt, damage, destroy, or endanger integrity of surface structures or utilities in immediate or adjacent areas.

B. Correct over-excavation with compacted coarse aggregate with acceptance by the Owner.

C. Remove large stones or other hard matter impeding consistent backfilling or compaction.

D. Protect manhole from damage or displacement while backfilling operation is in progress.

E. Excavating:

1. Comply with Section 31 23 33 – Trenching and Backfill, and locations and depths shown on the Drawings.
2. Provide clearance around sidewalls of manhole or structure for construction operations, granular backfill, and placement of geotextile fabric.
3. If ground water is encountered, prevent accumulation of water in excavations; place manhole or structure in dry trench.
4. Where possibility exists of watertight manhole or structure becoming buoyant in flooded excavation, anchor manhole or structure to avoid flotation.

F. Base and Alignment:

1. Place foundation slab and trowel top surface level or install manhole supported at proper grade and alignment on compacted coarse aggregate as indicated on Drawings.
2. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.
3. Place manhole sections plumb and level, trim to correct elevations, and anchor to foundation slab if required.

G. Attachments: Set cover frames and covers level to correct elevations without tipping. Covers shall fit flush to frame.

H. Backfilling: Comply with Section 31 23 33 – Trenching and Backfill or indicated on Drawings.

I. Coating: as described in the Contract or indicated on Drawings.

J. Precast Concrete Manholes:

1. Lift precast components only at lifting points designated by manufacturer.
2. When lowering manholes into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
3. Assembly:
    a. Assemble multi-section manholes by lowering each section into excavation.
    b. Install rubber gasket joints between precast sections according to manufacturer recommendations. All joints shall be sealed with a flexible sealant.
    c. Lower, set level, and firmly position base section before placing additional sections.
4. Remove foreign materials from joint surfaces and verify that sealing materials are placed properly.
5. Maintain alignment between sections by using guide devices affixed to lower section.
6. Joint sealing materials may be installed on Site or at manufacturer's plant.
7. Verify that installed manholes meet required alignment and grade.
8. Remove knockouts to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar and non-shrink non-metallic grout. All openings to be cast in at plant.
9. Cut pipe flush with interior of structure.
10. Shape inverts through manhole as indicated on Drawings.

K. Doghouse Manholes and Structures:

1. Stake out location and burial depth of existing sewer line in area of proposed manhole or structure.
2. Carefully excavate around existing sewer line to adequate depth for foundation slab installation.
3. Protect existing pipe from damage.
4. Cut out soft spots and replace with granular fill compacted to 100 percent maximum density.
5. Bear firmly and fully on compacted coarse aggregate and/or as indicated on Drawings.
6. Install or construct manhole around existing pipe according to applicable Paragraphs in this Section.
7. Grout pipe entrances as specified in Section 03 30 00 - Cast-in-Place Concrete and Section 03 60 00 - Grouting.

L. Sanitary Manhole Drop Connections: As indicated on Drawings.

M. Castings:

1. Set frames using mortar and non-shrink non-metallic grout as indicated on Drawings.
2. Grade rings shall be flush with inside of manhole.
3. Joints shall be completely filled with mortar or non-shrink non-metallic grout as indicated on Drawings and shall not exceed 3/8 inch in thickness on the face.

N. Installation Standards: Install Work according to MDOT and DWSD standards, Contract drawings, shop drawings, and manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Comply with Section 01 70 00 - Execution and Closeout Requirements.

C. Testing:

1. Cast-in-Place Concrete: As specified in Section 03 30 00 - Cast-in-Place Concrete.
2. Concrete Manhole Sections: Comply with ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.

D. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

3.5 ADJUSTING

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Vertical Adjustment of Existing Manholes and Structures:

1. Adjust top elevation of existing manholes and structures to finished grades as indicated on Drawings.
2. Frames, Grates, and Covers:
    a. Remove frames, grates, and covers cleaned of mortar fragments.
    b. Reset to required elevation according to requirements specified for installation of castings.
    c. Reset as indicated on the Drawings.

3. Reinforcing Bars:
    a. Remove concrete without damaging existing vertical reinforcing bars if removal of existing concrete wall is required.
    b. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.

4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in Section 03 30 00 - Cast-in-Place Concrete.

END OF SECTION 33 05 61

SECTION 33 05 63 – PRECAST CONCRETE VAULTS AND CHAMBERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Materials for and manufacture of precast reinforced concrete vaults and other underground chambers produced in accordance with the plans and these specifications.

B. Related Requirements:

1. Section 33 14 13 – Public Water Utility Distribution Piping.
2. Section 33 14 19 – Valves and Hydrants for Water Utility Service.
3. Section 07 12 00 – Built-Up Bituminous Waterproofing.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. Standard Specification for Highway Bridges.
2. Guide Specifications for Structural Design of Sound Barriers.

B. American Concrete Institute (ACI):

1. ACI 318 - Building Code Requirements for Reinforced Concrete.
2. ACI 305R-10 - Guide to Hot Weather Concreting.
3. ACI 306R-10 - Guide to Cold Weather Concreting.

C. ASTM International:

1. ASTM C857 - Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
2. ASTM C858 - Specification for Underground Precast Concrete Utility Structures.
3. ASTM C913 - Specification for Precast Concrete Water and Wastewater Structures.
4. ASTM C923 - Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

D. American Welding Society (AWS):

1. AWS D1.1 - Structural Steel.
2. AWS D1.4 - Reinforcing Steel.

1.3 SUBMITTALS

A. Comply with the requirements in Section 01 33 00 – Submittal Procedures.

1. Drawings and Data:
   a. The plans for precast concrete vaults shall be shop drawings furnished by the Precaster for approval by the Engineer. These drawings shall show complete design, installation, and construction information in such detail as to enable the Engineer to determine the adequacy of the proposed vaults for the intended purpose.
   b. Details of steel reinforcement size and placement and supporting design calculations shall be included.
   c. The drawings shall include a schedule that will list the size and type of precast concrete vault at each location where a vault is to be used.
   d. The precast concrete vaults shall be produced in accordance with the approved Drawings.
   e. All design calculations shall be performed, stamped, and signed by a licensed Civil Engineer registered in the State of Michigan.
   f. The Precaster shall provide documentation demonstrating compliance with ASTM testing standards.
   g. Precasters shall submit sample finishes for approval when required by the project documents. The sample finishes shall be approved prior to the start of production.

2. Certifications: The Precaster shall submit proof of certification by the National Precast Concrete Association's Plant Certification Program prior to and shall maintain such certification during production of the products for this project. The Precaster shall certify that proposed vaults meet the referenced Standards.

1.4 QUALITY ASSURANCE

A. Comply with the requirements specified in Section 01 40 00 – Quality Requirements.

B. Manufacturer's Qualifications: The Precaster shall have been in the business of producing precast concrete products similar to those specified for a minimum of five (5) years. Precaster shall demonstrate adherence to the standards set forth in the National Precast Concrete Association Quality Control Manual and shall maintain a permanent quality control department or retain an independent testing agency on a continuing basis. The agency shall issue a report, certified by a licensed civil engineer registered in the State of Michigan, detailing the ability of the Precaster to produce quality products consistent with the Industry Standards and the requirements of these specifications.

C. Testing: The Precaster shall demonstrate that the following tests are performed in accordance with the ASTM standards indicated. Tests shall be performed for each 150 cubic yards of concrete placed, but not less frequently than once per structure and per week.

Table 33 05 63-1: Testing

Test	Standard
Slump	C143
Compressive Strength	C31, C192, C39
Air Content (when air-entrained concrete is used)	C231 or C173
Unit Weight	C138

1. The Owner may place an inspector in the plant to witness the tests and manufacture when the products covered by this specification are being manufactured.
2. Notify Owner at least seven (7) days before inspections and tests are scheduled.

D. Clearances: Incorporate all clearances as identified on the Drawings around equipment, valves, fittings and materials. If no clearance is shown on the Drawings or is otherwise specified, provide minimum 2-inches clear around all pipe penetrations.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handling: Products shall be stored, handled and shipped in a manner to minimize damage. Lifting holes or inserts furnished for that purpose shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for the purpose of handling.

B. Minimum Strength: Products shall not be shipped until they are at least seven (7) days old, unless it can be shown that the concrete strength has reached at least 75% of the specified 28-day strength, and that no damage will be caused.

C. Acceptance: Final inspection and acceptance of the precast concrete vaults will be made by the Owner upon arrival at the job site.

1.6 WARRANTY

A. Provide all warranties and bonds in accordance with Section 01 70 00 – Execution and Closeout Requirements.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS.

A. Precast reinforced concrete vaults, meter pits, and other underground structures shall be designed and fabricated to withstand the following conditions as appropriate.

Table 33 05 63-2: Design Criteria

Design Criteria	Live Load	30% Impact Factor	AASHTO & ASTM C857 Design Load	Load Area
Incidental Traffic (AASHTO H-10-wheel load to be used in driveways, sidewalks, terraces, rights-of-way, and other areas of incidental vehicular traffic)	8,000 lbs.	10,400 lbs.	22,568 lbs.	10” x 10” Placed at any location on the roof
Roadway Traffic (AASHTO H-20 or HS-20, wheel load to be used in traffic way, parking lots, etc.)	16,000 lbs.	20,800 lbs.	45,135 lbs.	8” x 20”

1. Design precast vault to withstand soil and groundwater loads. Assume groundwater elevation to be at finished grade level at a minimum unless indicated otherwise. Horizontal external lateral loading shall be based on available soil data, but in no case shall be less than an equivalent fluid weighing 120 pounds per cubic foot, with no internal load applied.
2. Design precast vault to withstand internal hydrostatic. Assume internal fluid level to be at the top of the vault. Hydrostatic pressure shall be based on fluid weighing 65 pounds per cubic foot.
3. Design precast vault for additional surface surcharge related lateral pressure due to construction surcharge or live loads from Table 33 05 63-2; however, such lateral pressure shall not be less than 150 psf.
4. Design precast vault top slab to withstand additional concentrated loads from lifting hooks located directly above each valve, meter, or other equipment, where equipment is shown on the Drawings. Provide lifting hook capable of supporting the load, but not less than 2,500 pounds.
5. Precast vault components design shall consider the vehicle positions both above and alongside the vault including directly on each manhole cover.
6. Design the precast vaults to withstand hydrostatic uplift caused by a groundwater elevation at grade level or the top surface of the vault with the vault empty, whichever produces the most severe condition. Use only the weight of the vault and hold-down slab to resist the hydrostatic uplift with a minimum factor of safety of 1.20.
7. Design precast vault to withstand the load condition where the vault top slab is removed while the structure is backfilled to grade and subject to surcharge live and dead loads.
8. Walls and floor (base slab): minimum thickness of 6 inches. Cast lower wall section and base slab together in one monolith.
9. Top slab: minimum thickness of 8 inches.
10. Projection of base slab outside the exterior face of exterior walls of the vault: 6 inches minimum, unless shown otherwise on the Drawings**.**
11. Add drainage slopes and sump pit so that the water can be removed with a sump pump unless shown otherwise.

2.2 MATERIALS

A. Concrete: Raw materials for concrete shall meet the following standards. All concrete shall be normal-weight concrete.

Table 33 05 63-3: Concrete Material Standards

Material	Standard
Portland Cement	ASTMC150, Type I, II, or I/II
Aggregates	ASTM C33 or C330
Water	Potable
Air-entraining Admixtures	ASTM C260
Water reducing, retarding, accelerating high range water reducing Admixtures	ASTM C494
Pozzolans, fly ash and other mineral Admixtures	ASTM C618
Ground granulated blast furnace slag admixture	ASTM C989

B. Reinforcing Steel: Concrete reinforcement shall be steel bars or welded wire fabric, or a combination. Reinforcement shall meet the following standards:

Table 33 05 63-4: Reinforcing Steel Material Standard

Material	Standard
Deformed Billet-SteelBars	ASTMA615
Deformed Low-Alloy Steel Bars	ASTM A706
Plain Wire	ASTM A82
Deformed Wire	ASTM A496
Deformed Wire Welded Wire Fabric	ASTM A497
Epoxy Coated Reinforcing Bars	ASTM A775
Epoxy Coated Wire and Fabric	ASTM A884

C. Inserts and Embedded Metal: All items embedded in concrete shall be of the type required for the intended task, and meet the following standards:

Table 33 05 63-5: Embedded Material Standards

Material	Standard
Structural steel plates, angles, etc.	ASTM A36
Welded studs	AWS DI.1

D. Finishes (as required):

Table 33 05 63-6: Finish Standards

Material	Standard
Shop primer	Manufacturers' standards
Hot-dipped galvanized	ASTM A152
Zinc-rich coating	MIL-P-2135 self-curing, one component, sacrificial

E. Joint Sealant and Joint Gaskets:

Table 33 05 63-7: Joint Standards

Material	Standard
Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets	ASTM C443
External Sealing Bands for Noncircular Sewer, Storm Drain, and Culvert Pipe	ASTM C877
Joints for Concrete Pipe, Manholes, And Manufactured Box Sections Using Preformed Flexible Joint Sealants	ASTM C990
Specification for Elastomeric Joint Sealant	ASTM C920

F. Pipe Entry Connectors:

Table 33 05 63-8: Pipe Entry Standard

Material	Standard
Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals	ASTM C923

G. Grout:

Table 33 05 63-9: Grout Materials

Material	Requirements
Cement Group	Portland Cement with enough water for the required strength and sand for proper consistency. May contain mineral or chemical admixtures, if approved by Owner's representative.
Non-Shrink Grout	Pre-mixed, packaged expansive and non-expansive shrink resistant grout.

2.3 CONCRETE MIXES

A. Mix Proportions: Mix proportions shall be determined in accordance with ACI 318, Chapter 5.

B. Water-Cement Ratio and Air Content:

1. All Concrete shall contain entrained air.
2. Concrete shall have water-cement ratio of 0.45 or less if exposed to fresh water and 0.40 or less if exposed to deicer salts, or brackish water sea water.
3. Cement content shall be no less than 564 pounds per cubic yard.
4. The air content of concrete shall be within the limits shown in the table below.

Table 33 05 63-10: Content for Frost-Resistant Concrete

Aggregate Size	Air Content, %* Severe Exposure
3/8 in	6.0 to 9.0
1/2 in	5.5 to 8.5
3/4 in	4.5 to 7.5
1 in	4.5 to 7.5
1 1/2 in	4.0 to 7.0

*For specified compressive strengths greater than 5,000 psi, air content may be reduced 1%.

C. Compressive Strength: All concrete shall develop a minimum compressive strength of 5,000 psi in 28 days unless higher strengths are designated on the Drawings.

2.4 MANUFACTURE AND FABRICATION

A. Forms: Forms for manufacturing precast concrete products shall be of the type and design consistent with industry standards listed above. They shall be capable of consistently providing uniform products and dimensions. Forms shall be constructed so that no product damage will be caused by the forces and vibrations to which the forms will be subjected. Forms shall be cleaned of concrete buildup after each use. Coating of form release agents shall not be allowed to build on the forms.

B. Reinforcement:

1. Cages of reinforcement shall be fabricated either by tying the bars, wires or welded wire fabric into rigid assemblies or by welding where permissible in accordance with AWS D1.4.
2. Reinforcing shall be positioned as specified on the Drawings and so that the concrete cover conforms to the requirements. The tolerance on concrete cover shall be one-third of that specified but not more than 1/2 inch. Concrete cover shall not be less than 1-1/2 inch. Positive means shall be taken to assure that the reinforcement does not move significantly during the casting operations.

C. Embedded Items: Embedded items shall be positioned at locations specified in the Design Documents. Inserts, plates, weldments, lifting devices and other items to be embedded in precast concrete vaults shall be held rigidly in place so that they do not move during casting operations.

D. Placing Concrete:

1. Concrete shall be deposited into forms as near to its final location as practical. The free fall of the concrete shall be kept to a minimum and in any case shall not exceed 5 feet.
2. Concrete shall be consolidated in such a manner that segregation of the concrete is minimized and honeycombed areas are eliminated. Vibrators used to consolidate concrete shall have frequencies and amplitudes sufficient to produce well-consolidated concrete.

E. Cold Weather Requirements:

1. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather.
2. All concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact shall be free from frost.
3. Frozen materials or materials containing ice shall not be used.
4. Freshly constructed vaults shall be protected from freezing until the concrete has attained at least 75% of its 28-day design strength.
5. Comply with ACI 306R-10 Guide to Cold Weather Concreting.

F. Hot Weather Requirements:

1. During hot weather, proper attention shall be given to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the concrete member or structure.
2. Comply with ACI 305R-10 Guide to Hot Weather Concreting.

G. Curing by Moisture Retention: Moisture shall be prevented from evaporating from exposed surfaces until adequate strength for stripping is reached by one of the following methods.

1. Cover with polyethylene sheets a minimum of 8 mils thick.
2. Cover with burlap or other absorptive material and keep continually moist.
3. Curing compounds shall be applied at a rate not to exceed 200 sq. ft. per gallon or per manufacturer's recommendations.
4. Surfaces that will be exposed to weather during service shall be cured as above a minimum of three (3) days. Forms shall be considered effective in preventing evaporation from the contact surfaces. If air temperature is below 50°F, the curing period shall be extended.

H. Curing with Heat and Moisture: Concrete shall not be subjected to steam or hot air until after the concrete has attained its initial set. Steam, if used, shall be applied within a suitable enclosure, which permits free circulation of the steam. If hot air is used for curing, precautions shall be taken to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed 160 degrees F. These requirements do not apply to products cured with steam under pressure in an autoclave.

I. Finishes for Standard Formed Surfaces: Surfaces cast against approved forms using industry practice in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles and minor chips and spills will be tolerated but no major imperfections, honeycombs or other defects shall be permitted.

J. Finishes for Standard Unformed Surfaces: Surfaces finished with a vibrating screen, or by hand with a float. Normal color variations, minor indentations, minor chips and spills will be tolerated but no major imperfections, honeycombs, or other defects shall be permitted.

K. Special Finishes: Troweled, broomed or other finishes shall be according to the requirements of project documents and performed per industry standards or supplier specifications.

L. Stripping Products from Forms: Products shall not be removed from the forms until the concrete reaches the compressive strength for stripping required by the Manufacturer or Contract Drawings. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that no damage occurs.

M. Patching and Repairs:

1. No repair is required to formed surfaces which are relatively free of air voids and honeycombed areas, unless the surfaces are required by the design to be finished.
2. Repairing Minor Defects: Defects that will not impair the functional use or expected life of a manufactured precast concrete product may be repaired by any method, which does not impair the product.
3. Repairing Honeycombed Areas: When honeycombed areas are to be repaired, all loose material shall be removed and the areas cut back into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Proprietary repair materials shall be used in accordance with the manufacturer's instructions. If a proprietary repair material is not used, the area shall be saturated with water and, immediately prior to repair, the area shall be damp, but there shall not be excess water. A cement- sand grout or an approved bonding agent shall be applied to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.
4. Repairing Major Defects: Defects in precast concrete vaults which impair the functional use or the expected life of the vaults shall be evaluated by qualified personnel to determine if repairs are feasible and, if so, to establish the repair procedure.

2.5 ACCESSORIES

A. Access Hatch: The access hatch for sites outside of a paved road surface shall consist of an EJ Type AHS or CHS aluminum access hatch or a Bilco Type J or S steel access hatch or approved equal. Size shall be as shown on the Contract Drawings. All access hatches for vaults shall be designed to support an HS-20-wheel load. A flashing system clip shall be provided on the outside of the vault that shall lip the top of the riser with insulation, where noted in Drawings. The flashing clip shall be fastened watertight to the riser flange, so the insulation remains dry under all conditions.

1. Install the access hatch attachment system with ten (10) 1/4-inch diameter stainless steel flange bolts with nuts and 2 flat washers each, bedding compound sealant, 4504 Scotch polyfoam and single side adhesive coated 1/4-inch by 3-inch gasket materials.
2. The access hatch shall be provided with keyed entry and hasp. The entry lock shall be flush mounted protected from the element by a cover skirt. The entry lock shall be of pin tumbler type, dead bolt, with an inside safety release. Coordinate with DWSD security to provide a standard DWSD master pad lock with two keys.

B. Manhole Frames and Covers:

1. Conform to requirements of ASTM A48.
2. Manufacturers:
   a. Neenah Foundry.
   b. East Jordan.

3. Castings shall be free from scale, lumps, blisters and sand holes.
4. Machine contact surfaces to prevent rocking.
5. Thoroughly clean and hammer inspect.
6. Castings shall be capable of withstanding AASHTO HS-20 loading unless otherwise indicated or specified.

C. Access Ladder:

1. An all-fiberglass access ladder shall be provided. The complete access ladder shall be bolted into place, at a minimum of two (2) points both top and bottom, to be easily removable to facilitate equipment maintenance and located where noted in Drawings.
2. A ladder-up safety post shall be installed on the vertical centerline of the entrance ladder. The ladder-up safety post shall be spring balanced to move easily up and down and shall lock in the up position. The ladder-up safety post shall be made of steel of telescoping tubular section design. The up and down movement spring balance assembly shall be stainless steel.

D. Ventilation Equipment: Shall be as shown in the mechanical Drawings.

E. Lighting System: Shall be as shown in the Electrical Drawings.

F. Instrumentation: Shall be as shown on the Instrumentation Drawings.

G. Application: Install all mechanical items in accordance with Section 33 14 13 – Public Water Utility Distribution Piping and Section 33 14 19 – Valves and Hydrants for Water Utility Service. Slope water piping and arrange to drain at low points. Connect drain further outward from the vault per the requirements of civil drawings.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Site Access: Contractor will be provided access to the site to facilitate hauling, storage and proper handling of the precast concrete vaults.

B. Placement: Precast concrete vaults shall be installed to the lines and grades shown in the Contract Documents or otherwise specified. Vaults shall be lifted by suitable lifting devices provided by the Precaster. Except as otherwise shown on the Drawings, vaults shall be installed per the Precaster's recommendations.

C. Installation of Small Vaults Subject to Incidental Traffic: Unless otherwise specified, prepare the excavation approximately 6 inches deeper than the overall height of the vault. Minimum length and width of the excavation shall be determined by adding 6 inches to the overall length and width of the vault.

1. Place 6-inches of compacted sand or gravel. The compacted material shall be leveled so the top of the vault is flush to grade.
2. Place select backfill into the excavation at 12-inch lifts and compact either by mechanical compaction. The backfill shall be discontinued approximately 8 inches below finished grade. The final 8 inches of the excavation shall be finished with concrete.

D. Water tightness: Where water tightness is a necessary performance characteristic of the precast concrete vault's end use, watertight joints, connectors, and inserts shall be used to ensure the integrity of the whole system. The exterior surfaces of finished structure shall be waterproofed per the requirements of Section 07 12 00 – Built-up Bituminous Waterproofing.

E. Testing: When testing is required for an underground vault, one of the following methods shall be followed:

1. Vacuum test prior to backfill according to ASTM C 1244.
2. Water test according to Contract Documents and Precaster's recommendations

F. Equipment Placement: Place all equipment, valves, fittings and materials in accordance with clearances identified on drawings unless otherwise directed by Engineer.

END OF SECTION 33 05 63

SECTION 33 07 00 – INSULATION FOR WATER MAIN PIPE AND APPURTENANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The requirements for insulating water mains and their appurtenances installed with less than the recommended depth of cover as specified in Section 33 14 13 – Public Water Utility Distribution Piping or as detailed on the drawings.

B. Related Requirements

1. Section 03 30 00 – Cast-In-Place Concrete
2. Section 31 23 33 – Trenching and Backfill
3. Section 33 14 13 – Public Water Utility Distribution Piping

1.2 STANDARDS

Except as modified comply with the current edition of the following:

A. American Society for Testing and Materials (ASTM), latest edition.

1. ASTM C578 – Rigid, Cellular Polystyrene Insulation
2. ASTM D1621 - Test Method for Compressive Properties
3. ASTM C272 - Test Method for Water Absorption

1.3 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Requirements.

B. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

A. Rigid insulation must be closed cell extruded polystyrene foam meeting the requirements of ASTM C578, Type VI.

B. Minimum width of the insulation board must be 2 feet, the minimum length must be 4 feet, and the minimum thickness must be 2 inches.

C. The insulation must have the following properties:

1. Compressive strength of 40 pounds per square inch average, when tested in accordance with ASTM D1621.
2. Maximum water absorption of 0.l% by volume when tested in accordance with ASTM C272.

D. Furnish mastic approved by the insulation manufacturer for use with the insulation provided.

E. Sand backfill around insulation board must be of MDOT Class II fine aggregate, unless directed otherwise by the Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide insulation where water main pipe used for distribution, water service pipe and branch connections have less than 5 feet of cover, or where water main pipe used for transmission mains with less than 3 ½ feet of cover, when shown on the Drawings or as directed by the Engineer.

B. Store materials according to manufacturer instructions.

C. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

D. Contractor will be responsible for the final design of the support system for the polystyrene foam insulation panels. Support system shall provide support and protection for the polystyrene foam insulation panels.

E. Excavate the water main trench to the width required for the rigid board insulation.

F. Spread and compact sand beneath and around all sides of the insulation board. Do not damage the insulation board during compaction. Lay the insulation board flat with no breaks or cracks. Stagger joints of the insulation board not less than 1 foot joint to joint.

G. Panels broken during sand compaction, placement of concrete encasement and backfilling operations will not be accepted.

H. Insulation must consist of two (2) layers of insulation board. Minimum total thickness of insulation must be 4 inches.

I. Cover all joints with minimum 2-inch thick insulation board that is minimum 2 feet wide. Connect all joints together with mastic. The bond strength of all joints must be proved at least equal to the material strength before any backfill is placed.

J. Spread sand over the insulation board and compact it by suitable mechanical means prior to backfilling.

K. Cut and fit insulation board around valve and service boxes.

L. Accurately record locations of insulation installed to be submitted to the Engineer upon completion. Comply with the project record requirements of Section 01 78 39 – Electronic Project Record Documentation.

END OF SECTION 33 07 00

SECTION 33 14 13 - PUBLIC WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings for public lines, including potable water lines and fire service lines.
2. Tapping sleeves.
3. Pile support systems.
4. Bedding and cover materials.

B. Related Requirements:

1. Section 02 61 13 – Excavation and Handling of Contaminated Materials.
2. Section 03 20 00 – Concrete Reinforcing.
3. Section 03 30 00 – Cast-in-Place Concrete.
4. Section 31 23 23.23 – Flowable Fill.
5. Section 31 23 33 – Trenching and Backfill.
6. Section 31 62 16 – Steel Piles.
7. Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.
8. Section 33 05 63 – Concrete Vaults and Chambers.
9. Section 33 14 17 – Water Services.
10. Section 33 14 17.81 – Lead Service Line Replacement.
11. Section 33 14 19 – Valves and Hydrants for Water Utility Service.

1.2 STANDARDS

Except as modified herein, comply with the following standards:

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

B. ASTM International:

1. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A193 - Standard Specification for Alloy Steel and Stainless Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications.
3. ASTM A194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
4. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

5. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi tensile strength.
6. ASTM A536 - Standard Specifications for Ductile Iron Castings.
7. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12400 ft lbf/ft3 (600 kN m/m3).
8. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
9. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
10. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
11. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
12. ASTM F2164 - Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure

C. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
7. AWWA C153 - Ductile-Iron Compact Fittings.
8. AWWA C206 - Field Welding of Steel Water Pipe
9. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.
10. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 in. through 65 in., for Waterworks.
11. AWWA M55 – Manual of Water Supply Practices: PE Pipe – Design and Installation.

D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry:

1. MSS SP-60 - Connecting Flange Joints between Tapping Sleeves and Tapping Valves.

E. National Fire Protection Association (NFPA):

1. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

F. NSF International:

1. NSF 14 – Plastic Piping System Components and Related Materials.
2. NSF 61 – Drinking Water System Components - Health Effects.
3. NSF 372 – Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Coordinate Work of this Section with termination of water main connection at Site boundary, connection to municipal water utility service, and trenching.

1.4 PRE-INSTALLATION MEETINGS

A. Comply with Section 01 30 00 – Administrative Requirements.

B. Convene pre-installation meeting a minimum two (2) weeks prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Requirements.

B. Product Data: Submit manufacturer information regarding pipe materials, pipe fittings, valves, and hydrants.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

E. Preconstruction Photographs: Submit digital files of color photographs of Work areas and material storage areas as specified in Section 02 22 30 – Pre-Construction Video and Photographic Record.

F. Qualifications Statements: Submit qualifications for manufacturer and installer.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Valves: Mark valve body with manufacturer's name and pressure rating.

B. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

C. Perform Work according to this Specification.

D. Maintain one copy of each standard affecting Work of this Section on-site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum five (5) years' experience in installation of water distribution materials.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on-site in manufacturer's original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Do not place valves, pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.
4. Store PE materials out of sunlight.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.
3. Investigate existing utilities and potential conflicts in advance of the Work in or to avoid delays to the critical path timeline.

1.11 WARRANTY

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

1. Provide a five (5) year manufacturer warranty for valves and hydrants.

PART 2 - PRODUCTS

2.1 WATER PIPING

A. Ductile Iron Pipe:

1. Comply with AWWA C151.
2. Comply with NSF 61, stamped on the exterior wall of the pipe.
3. Bituminous Outside Coating: Comply with AWWA C151.
4. Pipe Mortar Lining:
   a. Comply with AWWA C104.
   b. Thickness: Double.

5. PE Encasement:
   a. Comply with AWWA C105.
   b. Minimum linear low-density polyethylene film: 8 mil thickness

6. Pipe Class:
   a. Comply with AWWA C151 unless shown otherwise on the Drawings.
   b. Special Thickness Class 52 minimum.

7. Fittings:
   a. Material: Ductile iron; comply with AWWA C110.
   b. Compact Fittings: Comply with AWWA C153.
   c. Coating and Lining:
      1) Bituminous Coating: Comply with AWWA C110.
      2) Cement-Mortar Lining: Comply with AWWA C104; double thickness.

8. Joints:
   a. Mechanical and Push-on Joints: Comply with AWWA C111.
   b. Flanged Joints: Comply with AWWA C115.
   c. Restrained Joints: Boltless, push-on type, joint restraint independent of joint seal.

B. High Density Polyethylene (HDPE) Pipe:

1. Comply with AWWA C906, DR 11 for 200-psi pressure rating.
2. Comply with NSF 61 and NSF 14, pipe shall be stamped “NSF-pw” on the exterior wall of the pipe.
3. Pipe shall be Ductile Iron Pipe Size (DIPS).

4. Fittings:
    a. Comply with AWWA C906.
    b. Type: DR 11 minimum; Molded or fabricated for 200-psi pressure rating.

5. Joints: Butt fusion.
6. Restrained Mechanical Joints with Stainless Steel Stiffener:
    a. EBAA Mechanical Joint Restraint for HDPE Pipe.
    b. Star Pipe Mechanical Joint Restraint for HDPE Pipe.
    c. Or Approved Equal

2.2 TAPPING SLEEVES

A. Tapping Sleeves:

1. Material: Ductile or cast iron.
2. Type: Dual compression.
3. Outlet Flange Dimensions and Drilling: Comply with ASME B16.1, Class 125, and MSS SP-60.

2.3 VALVES AND FIRE HYDRANTS

A. As specified in Section 33 14 19 - Valves and Hydrants for Water Utility Service.

2.4 PILE SUPPORT SYSTEMS

A. Steel Piles: As specified in DWSD Standard Specification Section 31 62 16 - Steel Piles, and as called for on the Drawings.

2.5 CONCRETE THRUST BLOCKS, ENCASEMENT, AND CRADLES

A. Concrete:

1. As specified in Section 03 30 00 - Cast-in-Place Concrete.
2. Compressive Strength: 4,000-psi at 28 days.
3. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 20 00 - Concrete Reinforcing.

C. Reinforced Concrete Anchor Block for HDPE connection to existing pipe shall be as shown in the Drawings with direction from the HDPE pipe manufacturer.

2.6 FINISHES

A. Steel: Hot-dip galvanized after fabrication, according to ASTM A123/A123M.

B. Protective Coating: Coal-tar epoxy or bituminous paint.

2.7 ACCESSORIES

A. Vaults: As specified in Section 33 05 63 - Concrete Vaults and Chambers.

B. Steel Rods, Bolt, Lugs, and Brackets:

1. Comply with ASTM A36/A36M or A307.
2. Grade A carbon steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that existing utility water main size, location, and elevation are as indicated on Drawings.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Preconstruction Site Photos:

1. Take photographs along centerline of proposed pipe trench to document the existing surface condition.
2. Show mailboxes, curbing, lawns, driveways, signs, culverts, and other existing Site features.
3. Include Project description, date taken, and sequential number on back of each photograph.

C. Pipe Cutting:

1. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.
2. Use only equipment specifically designed for pipe cutting; use of chisels or hand saws is not permitted.
3. Grind edges smooth with beveled end for push-on connections.

D. Remove scale and dirt on inside and outside before assembly.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Bedding:

1. Excavation:
   a. As specified in Section 02 61 13 – Excavation and Handling of Contaminated Materials and Section 31 23 33 – Trenching and Backfill.
   b. Trenches shall have sloping, sheeting, shoring, and bracing conforming to 29 CFR1926, Subpart P-Excavations, OSHA requirements, and the General Provisions.
   c. Hand trim for accurate placement of pipe to elevations as indicated on Drawings.
2. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.
3. Install pile support systems where indicated on the Drawings and as specified in Section 31 62 16 - Steel Piles.
4. Compaction:
   a. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches of compacted depth.
   b. Compact bedding as specified in Section 31 23 33 – Trenching and Backfill for trench backfill compaction requirements.

B. Piping:

1. Comply with AWWA C600, as applicable.
2. Comply with AWWA M55, as applicable
3. Handle and assemble pipe according to manufacturer instructions and as indicated on Drawings.
4. Steel Rods, Bolts, Lugs, and Brackets: Wrap all buried valves, mechanical joints, flanges, and joint restraint devices with wax tape in accordance with AWWA C217. Over-wrap wax tape with one wrap of polyethylene encasement in accordance with AWWA C105. Tightly tape the polyethylene wrap to seal all joints and folds.
5. Maintain 10 feet of horizontal separation and 18 inches of vertical separation between water main and sewer piping unless otherwise shown on Drawings.
6. Ductile-Iron Piping and Fittings: Comply with AWWA C600. Use Tyton push on joints for all joints.
7. Field Welding Materials: Comply with AWWA C206.
8. Flanged Joints: Do not use in underground installations except within structures.
9. Mechanical Joints: Use on ductile iron systems only if called for on the plans or as directed by the Engineer.
10. Mechanical Joints: Use on HDPE systems as specified.
11. Route pipe in straight line and re-lay pipe that is out of alignment or grade.

12. Bearing:
    a. Maintain bearing along entire length of pipe.
    b. Excavate bell holes to permit proper joint installation.
    c. Do not lay pipe in wet or frozen trench.

13. Prevent foreign material from entering pipe during placement.
14. Allow for expansion and contraction without stressing pipe or joints.
15. Close pipe openings with watertight plugs during Work stoppages.
16. Install access fittings to permit disinfection of water system performed under Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.
17. Cover:
    a. Establish elevations of buried piping with not less than five feet of cover.
    b. Measure depth of cover from final surface grade to top of pipe barrel.

C. Valves and Hydrants: As specified in Section 33 14 19 - Valves and Hydrants for Water Utility Service.

D. Tapping Sleeves and Valves: As indicated on Drawings and according to manufacturer' instructions.

E. Service Connections: Per Detroit Water and Sewerage Department Standards.

F. Backfilling: As specified in Section 31 23 33 – Trenching and Backfill

G. Disinfection of Potable Water Piping Systems: As specified in Section 33 01 10.58 - Disinfection of Water Utility Piping Systems.

H. Before placing a new main in service, two (2) consecutive samples shall indicate the absence of coliform bacteria.

3.4 TOLERANCES

A. Install pipe to indicated elevation within 1/4 inch and a horizontal tolerance of one (1) inch.

3.5 FIELD QUALITY CONTROL

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Testing:

1. Pressure test ductile iron piping system according to AWWA C600 and following:
    a. Test Pressure: Not less than 150-psig or 50-psi in excess of maximum static pressure, whichever is greater.
    b. Conduct hydrostatic test for a minimum of two (2) hours.

c. Test plug or cap shall be designed to withstand external test pressures as well as the required internal hydrostatic test pressures.
d. If the Engineer approves the hydrostatic testing against a valve, make provisions for measuring any leakage through the valve(s).
e. Slowly fill section to be tested with water; expel air from piping at high points.
f. Install corporation stops at high points.
g. Close air vents and corporation stops after air is expelled.
h. Raise pressure to specified test pressure.
i. Observe joints, fittings, and valves under test.
j. Remove and renew cracked pipes, joints, fittings, and valves showing visible leakage, and retest.
k. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
l. Maintain pressure within plus or minus five (5) psi of test pressure.
m. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
n. Compute maximum allowable leakage using following formula:
    1) $L = (SD \times (P)^{1/2})/C$.
    2) L = testing allowance, gph.
    3) S = length of pipe tested, feet.
    4) D = nominal diameter of pipe, inches.
    5) P = average test pressure during hydrostatic test, psig.
    6) C = 148,000.

o. If pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
p. Leakage:
    1) If test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
    2) Correct visible leaks regardless of quantity of leakage.

2. Pressure test HDPE piping system in accordance with AWWA M55-Chapter 9, ASTM F2164, ASTM F1492, and PPI Handbook of Polyethylene Pipe-Chapter 2.
    a. Prior to scheduling a test with the inspector, preform a pre-test to confirm compliance.
    b. Installed main shall be adequately anchored with a covering of at least six (6)-inches of initial backfill, if installed by an open trench method. The joints and fittings, particularly flange connections shall be left uncovered for visual leak inspection.
    c. Leak tests of HDPE water system shall be conducted in accordance with ASTM F2164. The pipeline should be slowly filled with potable water and all trapped air bled off. The main should undergo a hydrostatic pressure test using pressure at the lowest elevation in the system at 150 psi. The pressure shall be maintained constant for 4-hour period by adding makeup water. After 4-hour period is

completed, the pressure shall remain steady within 5% (7.5 psi) of a target 150 psi test pressure for one (1) hour.

d. The total test time should not exceed 8 hours. If the pipeline has to be retested – the pipe must be depressurized and allowed to "relax" for at least 8 hours before the next testing sequence.

e. In fused polyethylene water piping systems, no leakage shall be present. If leakage is observed at a fusion joint, complete rupture may be imminent. The Contractor shall move all personnel away from the joint and depressurize the main. Leaks, failure, or defective construction shall be promptly repaired by the Contractor at the Contractor's sole expense.

f. Pneumatic (compressed air) leakage testing of HDPE pressure piping is prohibited for safety reasons.

g. If the test section fails this test, the Contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the Owner.

C. Compaction Testing: As specified in Section 31 23 33 – Trenching and Backfill.

END OF SECTION 33 14 13

SECTION 33 14 13.05 – PUBLIC WATER UTILITY DISTRIBUTION SYSTEM REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water Main Repair.
2. Water Service Repair.
3. Hydrant Repair.
4. Valve Repair.
5. Filling Subgrade Voids.
6. Ice and Snow Removal.

B. Related Requirements:

1.	Section 02 22 30	Pre-Construction Video and Photographic Record.
2.	Section 03 30 00	Cast-in-Place Concrete.
3.	Section 31 23 23.23	Flowable Fill.
4.	Section 31 23 33	Trenching and Backfill.
5.	Section 31 50 00	Excavation Support Systems.
6.	Section 33 01 10.58	Disinfection of Water Utility Piping Systems.
7.	Section 33 05 63	Precast Concrete Vaults and Chambers.
8.	Section 33 14 13	Public Water Utility Distribution Piping.
9.	Section 33 14 17	Water Services.
10.	Section 33 14 17.81	Lead Service Line Replacement.
11.	Section 33 14 19	Valves and Hydrants for Water Utility Service.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. Detroit Water and Sewerage Department (DWSD):

1. DWSD Standard Details.

B. State of Michigan:

1. Michigan Department of Transportation (MDOT) Latest Edition of Standard Specifications for Construction.

C. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

D. ASTM International:

1. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A193 - Standard Specification for Alloy Steel and Stainless Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications.
3. ASTM A194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
4. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
5. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi tensile strength.
6. ASTM A536 - Standard Specifications for Ductile Iron Castings.
7. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12400 ft. lbf/ft. 3 (600 kN m/m3).

E. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
7. AWWA C153 - Ductile-Iron Compact Fittings.
8. AWWA C217 - Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
9. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.

F. NSF International:

1. NSF 61 – Drinking Water System Components - Health Effects.
2. NSF 372 – Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Comply with Section 01 30 00 – Administrative Requirements.

1.4 PRE-INSTALLATION MEETINGS

A. Comply with Section 01 30 00 – Administrative Requirements.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer information regarding pipe materials, pipe fittings, valves, and hydrants.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

E. Preconstruction Photographs: Submit digital files of color photographs of Work areas and material storage areas as specified in Section 02 22 30 – Pre-Construction Video and Photographic Record.

F. Qualifications Statements: Submit qualifications for manufacturer and installer.

1.6 CLOSE-OUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents:

1. Record actual locations of pipe alignment and elevations, hydrants, valves, services, curb stops, and connections.
2. Identify and describe unexpected variations in subsoil conditions or discovery of uncharted utilities.
3. Record drawings to be submitted to DWSD upon completion.

1.7 QUALITY ASSURANCE

A. Perform Work according to DWSD standard details and specifications .

B. Maintain one copy of each standard affecting the Work of this Section on-site.

C. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

1.8 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this Section with minimum five (5) years documented experience.

B. Licensed Plumber shall make all connections to the household/building water system and shall meet all plumbing permit requirements for water service installations.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Storage:

1. Store materials according to manufacturer instructions.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Do not place valves, pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.

B. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.10 WARRANTY

A. Comply with Section 01 70 00 – Execution and Close-out Requirements.

B. Provide a 5-year manufacturer warranty for valves and hydrants if furnished by the Contractor.

PART 2 - PRODUCTS

DWSD may elect to supply materials for water main system repair contracts as noted in the Contract Documents. Materials will be as provided, otherwise, the following material requirements will apply.

2.1 MATERIALS

A. Water Piping and Fittings:

1. As specified in Section 33 14 13 – Public Water Utility Distribution Piping.

B. Water Service Piping and Fittings:

1. As specified in Section 33 14 17 – Water Services.

C. Corporation Stop Assemblies:

1. As specified in Section 33 14 17 – Water Services.

D. Curb Stop Assemblies:

1. As specified in Section 33 14 17 – Water Services.

E. Tapping Sleeves:

1. As specified in Section 33 14 13 – Public Water Utility Distribution Piping.

F. Repair Clamps:

1. Material: Stainless Steel.
2. Comply with AWWA C230.
3. NSF 61 Certified.
4. Suitable for repairs on the pipe material requiring repair as listed by the manufacturer.
5. Manufacturer:
   a. PowerSeal Pipeline Products Corporation Clamps.
   b. Or Approved Equal.

G. Couplings:

1. Comply with AWWA C219.
2. NSF 61 Certified.
3. Suitable for repairs on the pipe material requiring repair as listed by the manufacturer.

H. Valves, Valve Boxes and Hydrants:

1. As specified in Section 33 14 19 – Valves and Hydrants for Water Utility Service.

I. Valves Vaults and Chambers:

1. As specified in Section 33 05 63 – Precast Concrete Vaults and Chambers.

J. Excavation Support:

1. As specified in Section 31 50 00 – Excavation Support Systems.

K. Concrete Thrust Blocks, Encasement, and Cradles:

1. As specified in Section 03 30 00 - Cast-in-Place Concrete.

L. Bedding and Backfill:

1. As specified in Section 31 23 33 – Trenching and Backfill.

M. Pitchers and Filters:

1. Pitcher Style Filters and Refill Filter Cartridges: NSF/ANSI 53 for lead removal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Inspect materials upon delivery to verify compliance with Specifications, direction of openings, size, and type of end connections.

C. Unload material carefully. Do not drop. Only hoists and slings with adequate load capacity to handle the weight of the materials shall be used.

D. DWSD will indicate the general area of the repair location as indicated by the surface evidence. Exact location of the repair shall be determined by the Contractor.

E. The Contractor shall operate any valves of 16-inch diameter or smaller, after approval and under the observation of the Engineer. Valves larger than 16-inches in diameter shall not be operated by the Contractor.

3.2 PREPARATION

A. Utilities to remain shall be located, identified, and protected from damage.

B. Pre-Construction Site Photos:

1. Take photographs along centerline of proposed pipe repair trench to document the existing surface condition.
2. Show mailboxes, curbing, lawns, driveways, signs, culverts, and other existing Site features.

C. Carefully excavate and expose the repair as to fully expose the break or leak without damaging the surrounding pipe and services.

D. Excavation area shall be kept to a minimum allowing sufficient space for repair work to be performed.

E. Storage of excavated material on site is prohibited unless otherwise approved by the Engineer. All excavated material shall be removed from the Site as soon as excavated and shall be disposed.

F. The Contractor shall have sufficient means available to remove any water from the excavation that could impede the installation or performance of the repair.

G. Pipe Cutting:

1. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

2. Use only equipment specifically designed for pipe cutting; use of chisels or hand saws is not permitted.
3. Grind edges smooth with beveled end for push-on connections.

H. Remove scale and dirt on inside and outside before assembly.

I. Do not interrupt existing utilities without permission and without making arrangements to provide temporary utility services.

1. Notify Engineer not less than seven (7) days in advance of proposed utility interruption.
2. Do not proceed without written permission from Engineer.

3.3 REPAIR AND INSTALLATION

A. Installation of all new pipe, valves, hydrants, structures, etc. shall comply with all requirements as listed in the Standard Specifications referenced in the materials section of this Specification.

B. During the course of the installation or repair, if it is determined that any existing storm sewers, catch basins, manholes, or appurtenances are found damaged due to breaks or leaks in the water main, they shall be repaired by the Contractor to the requirements of the Standard Specifications.

3.4 WATER MAIN TYPE "A" REPAIR

A. Type A is a repair that is not in close proximity to a service or a joint, greater than 18 inches from a service and greater than three (3) feet from a joint, requires a repair clamp and does not require replacement of pipe.

3.5 WATER MAIN TYPE "B" REPAIR

A. Type B is a repair that is in close proximity to a service or a joint (less than 18 inches from a service or less than three (3) feet from a joint) which will require replacement of at minimum three (3) feet of pipe.

3.6 WATER MAIN TYPE "C" REPAIR

A. Type C repair includes pipe replacement of asbestos cement pipe which will require replacement of pipe per the standard details. Contractor performing repair on the asbestos cement pipe shall provide a competent supervisor with adequate training to adhere to OSHA requirements.

3.7 WATER SERVICE REPAIR

A. Full replacement or installation of new services will comply with Section 33 14 17 – Water Services.

B. All materials for service repair will comply with the materials listed for new services in Section 33 14 17 – Water Services.

C. Water services that are three (3) inches and larger will be considered water mains and will comply with all repair and replacement criteria as specified.

D. Comply with Section 33 14 17.81 – Lead Service Line Replacement and the requirements of this specification for all lead services that are found to be lead from the curb stop to the customer meter, from the main to the customer meter, or on both.

E. Partial lead service line replacements or repairs are banned under the Michigan Lead and Copper Rule.

F. Services that are found leaking or broken and are not in use as determined by the Engineer shall have the corporation stop removed from the main, plug installed and be disconnected.

3.8 PIPE BLOCKING

A. Wood blocking, or other material as approved by the Engineer, shall be supplied by the Contractor and used for blocking or wedging of pipe on repairs as shown in the Standard Details.

B. The blocking and wedging shall remain in place as the required sand envelope is placed and compacted in order to not disturb the blocking and ensure all voids have been filled.

3.9 HYDRANT REPAIR

A. Full replacement or installation of new hydrant will comply with Section 33 14 19 – Valves and Hydrants for Utility Service.

B. All materials for hydrant repair will comply with the materials listed for new hydrants in Section 33 14 19 – Valves and Hydrants for Water Utility Service.

C. Flush and disinfect valves and hydrants with water mains as specified in Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.

D. Existing hydrants, standpipes, and all valves not reused shall be salvaged and delivered to DWSD.

E. Defrosting of hydrants may be required and will be performed in a manner that doesn't damage existing coatings or structure.

F. Major hydrant repair includes removal and replacement of major hydrant components:

1. Type I:
   a. Work includes removal and replacement of the standpipe, frost jacket, shoe, thrust block, polyethylene encasement, wax tape, and related piping or portion thereof to the shut-off valve.

2. Type IIA:
   a. Work includes removal and replacement of the hydrant shut-off valve and box, hydrant and water main thrust blocks, polyethylene encasement, wax tape, and related piping or portion thereof (15 feet plus or minus) to the existing hydrant tee.

3. Type IIB:
   a. Work includes removal and replacement of the hydrant piping and fittings (15 feet plus or minus) to the existing tapping sleeve and valve located on the street main, removal of the tapping sleeve and valve, installation of a hydrant tee and related fittings, gate valve and box, hydrant and water main thrust blocks, polyethylene encasement, wax tape, and related piping.

G. Minor hydrant repair will include:

1. Removal and replacement of the standpipe without requiring excavation or removal of frost jacket, installation of extension kits, defrosting hydrant and dewatering, replacement of breakaway stem coupling, cotter keys, gasket, bolts, and breakaway flange on a breakaway type hydrant.

3.10 VALVE REPAIR

A. Full replacement or installation of new valves will comply with Section 33 14 19 – Valves and Hydrants for Utility Service.

B. Flush and disinfect valves as specified in Section 33 01 10.58 – Disinfection of Water Utility Piping Systems or at the direction of the Engineer.

3.11 FILLING SUBGRADE VOIDS

A. If a large existing void is found either under pavement or in the berm caused by present or past water main breaks, the Engineer may direct to fill these voids with approved backfill material or flowable fill.

B. Suitable backfill material used to fill an existing void shall be sand or granular fill and shall comply with Section 31 23 33 – Trenching and Backfill. If flowable fill is used it shall comply with Section 31 23 23.33 – Flowable Fill.

C. If drilling holes in existing pavement is required, holes shall be drilled at locations approved by the Engineer. Holes shall be flushed with water prior to placement of suitable backfill or flowable fill.

D. Surrounding structures and utilities shall be monitored to ensure material used for filling voids does not fill structures. If any material enters surrounding structures or utilities it will be the responsibility of the Contractor to remove to the approval of the Engineer.

3.12 ICE AND SNOW REMOVAL

A. Snow removal, ice removal, and salting due to breaks and leaks in water mains or hydrant may be required in order to perform the necessary repairs and will be performed in order to facilitate safe pedestrian and vehicle traffic.

B. The locations will be as assigned by the Engineer and may require removal by loader, plow, or hand methods.

C. The Contractor shall be required to have at least two (2) crews, each consisting of at least a loader operator, three truck drivers, and three laborers, for requested snow and ice removal.

D. Removal of ice and snow will also apply to vehicles that are encased or trapped in ice. All vehicles shall be freed from ice.

3.13 PITCHER STYLE FILTER AND REFILL CARTRIDGE

A. Pitcher filters and refill cartridges in accordance with NSF/ANSI 53 will be delivered to every resident on the street where a Lead Water Service is replaced or disturbed. A resident will not necessarily have to have their own service replaced or disturbed in order to receive a Pitcher and Refill Cartridge. The pitcher and number of refill filters shall be sufficient for a six month supply.

3.14 PHOTOGRAPHIC RECORD

A. Photographic record shall be performed per Section 02 22 30 - Pre-Construction Video and Photographic Record as to quality and deliverable. Water system repair photography does not need to be performed by a professional photographer.

3.15 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements.

B. Compaction Testing for Bedding and Backfill: Comply with Section 31 23 33 – Trenching and Backfill.

C. Disinfection of valves, hydrants, water main, and appurtenances shall be in accordance with AWWA C651 and Section 33 01 10.58 Disinfection of Water Utility Piping Systems.

D. Testing:

1. Operate each valve through one (1) complete operating cycle.
2. Pressure test water mains, valves, and hydrants as specified in Section 33 14 13 - Public Water Utility Distribution Piping.
3. After main-line pressure testing, flush fire hydrants.

E. If tests indicate that the Work does not meet specified requirements, remove the Work, replace, and retest.

END OF SECTION 33 14 13.05

SECTION 33 14 17 - WATER SERVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings for water service connections to homes and businesses.
2. Corporation stop assemblies.
3. Curb stop assemblies.
4. Trenching, bedding, and cover.

B. Related Requirements:

1. Section 31 23 33 – Trenching and Backfill.
2. Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.
3. Section 33 05 07.13 – Utility Directional Drilling.
4. Section 33 14 13 – Public Water Utility Distribution Piping.
5. Section 33 14 17.81 – Lead Service Line Replacement.
6. Section 33 14 19 – Valves and Hydrants for Water Utility Service.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb. Rammer and an 18-in. Drop.

B. American Society of Mechanical Engineers (ASME):

1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

C. ASTM International:

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
2. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
4. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

D. American Water Works Association (AWWA):

1. AWWA C217 - Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
3. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.
4. AWWA C800 - Underground Service Line Valves and Fittings.

E. National Sanitation Foundation (NSF):

1. NSF 61 – Drinking Water System Components – Health Effects.
2. NSF 372 – Drinking Water System Components – Lead Content.

1.3 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer's information regarding pipe materials, pipe fittings, corporation stop assemblies, curb stop assemblies, meters, meter setting equipment, service saddles, backflow preventers, and accessories.

C. Manufacturer's Certificate:

1. Certify that products meet or exceed specified requirements.
2. Certify that products meet applicable NSF Standards.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Qualifications Statement: Submit qualifications of manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of services, curb stops, connections, and pipe alignment and elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Perform Work according to AWWA standards, as specified within these Specifications.

B. Maintain copies of each standard affecting Work of this Section on-site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on-site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Keep materials in original packaging until immediately prior to use.
3. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 WATER PIPING AND FITTINGS

A. Copper Tubing:

1. Comply with ASTM B88.
2. Type: K, annealed.
3. Joints: Compression connection or flared connection, to match existing or as specified.

2.2 CORPORATION STOP ASSEMBLIES

A. Corporation Stops:

1. Comply with ASTM B62.
2. Body: Brass or red brass alloy.
3. Valve Type: Ground Key.
4. Inlet End: Threaded for tapping according to AWWA C800.
5. Outlet End: Suitable for service pipe specified.
6. Components in contact with potable water shall comply with the latest requirements of the Federal Safe Drinking Water Act, and certified NSF 61.
7. Acceptable Products:
   a. Mueller H-15000N.

b. Ford F600.
c. A.Y. McDonald 74701.
d. Or Approved Equal.

B. Service Saddles:

1. Type: Double strap.
2. Designed to hold pressures in excess of pipe working pressure.
3. Acceptable Service Saddles:
   a. Mueller Company.
   b. Ford Meter Box Company, Inc.
   c. Or Approved Equal.

4. Acceptable Service Saddles for Connection to HDPE:
   a. JCM 406 Mechanical Service Saddle
   b. ROMAC 202N-H
   c. Or Approved Equal.

2.3 CURB STOP ASSEMBLIES

A. Curb Stops:

1. Body: Brass or red brass alloy.
2. Comply with ASTM B62.
3. Valve Type: Ori-Seal.
4. Sealing: Positive pressure.
5. Components in contact with potable water shall comply with the latest requirements of the Federal Safe Drinking Water Act, and certified NSF 61.
6. Acceptable Products:
   a. Mueller H-15204N.
   b. Or Approved Equal.

B. Curb Boxes and Covers:

1. Body: Cast iron.
2. Type: Buffalo 2.5-inch.
3. Base: Arch pattern.
4. Lid:
   a. Inscription: WATER.
   b. Plug/Nut: Pentagonal.

5. Acceptable Products:
   a. General Foundries.
   b. E.J. Prescott.
   c. Bingham and Taylor.
   d. Or Approved Equal.

2.4 MATERIALS

A. Bedding and Backfill: Comply with Section 31 23 33 – Trenching and Backfill.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Verify that building service connections and municipal utility water main sizes, locations, and inverts are as indicated on Drawings.

3.2 PREPARATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs and flush.

C. Remove scale and dirt from inside and outside of piping before assembly.

D. Prepare pipe connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Corporation Stop Assemblies:

1. Make connection for each different kind of water service, using suitable materials, equipment, and methods as approved by Engineer.
2. Provide service clamps for mains constructed of materials other than cast iron or ductile iron. Lined mains shall also have a service saddle.
3. Location:
    a. Screw corporation stops directly into tapped and threaded iron main at 10- and 2-o'clock positions along main's circumference.
    b. Locate and stagger corporation stops at least 12 inches apart longitudinally.
4. HDPE Mains:
    a. Provide full support for service clamp for full circumference of pipe, with minimum 2-inch width of bearing area.
    b. Exercise care against crushing or causing other damage to mains at time of tapping or installation of service clamp or corporation stop.
5. Use seals or other devices such that no leaks are present in mains at points of tapping.
6. Wrap corporation and service saddle with wax tape conforming with AWWA C217.

7. Do not backfill and cover service connections until installation has been inspected by the Engineer.

B. Bedding:

1. Excavate pipe trench as specified in Section 31 23 33 – Trenching and Backfill.
2. Place fill materials as specified in Section 31 23 33 – Trenching and Backfill.

C. Pipe and Fittings:

1. Maintain ten (10) feet of separation between water main and sewer piping measured from edge to edge.
2. Install pipe to allow for expansion and contraction without stressing pipe or joints.
3. Multiple couplings of copper tubing are not allowed. Exception shall be based on the length of the service and the size of the coil of tubing provided and shall be only as allowed by the Engineer.
4. Establish elevations of buried piping with not less than five (5) feet of cover.
5. Backfill trench as specified in Section 31 23 33 – Trenching and Backfill.

D. Curb Stop Assemblies:

1. Set curb stops on compacted soil.
2. Boxes:
   a. Center and plumb curb boxes over curb stops.
   b. Set box cover flush with finished grade.

E. Service Connections:

1. Install water service as indicated on drawing details.
2. Install water service through the curb stop, including any necessary size adaptors if the existing water service between the curb stop and customer is found to be copper.
3. Comply with Section 33 14 17.81 – Lead Service Line Replacement and the requirements of this specification for all lead services that are found to be lead from the curb stop to the customer, from the main to the customer, or on both.
4. Partial lead service line replacements are banned under the Michigan Lead and Copper Rule.
5. Assist Engineer in collecting service information in the DWSD Collector Application.

F. Directional Drilling (HDD) Installation of Water Services: Comply with Section 33 05 07.13 – Utility Directional Drilling.

3.4 TOLERANCES

A. Install pipe to indicated elevation to within tolerance of 1/4-inch.

3.5 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements for inspecting and testing.

B. Compaction Testing for Bedding and Backfill: Comply with Section 31 23 33 – Trenching and Backfill.

C. If tests indicate that the Work does not meet specified requirements, remove the Work, replace, and retest.

END OF SECTION 33 14 17

SECTION 33 14 17.81 – LEAD SERVICE LINE REPLACEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Replacement of existing lead service line with a new copper service line using a trenchless technique from the curb box at the right-of-way line to the customer meter of any lead service lines that are encountered during construction.
2. The removal and replacement of the existing lead service line from the water main to the curb box within the right-of-way will comply with all requirements of this specification and new water service installation under Section 33 14 17 – Water Services.
3. Partial lead service line replacements are banned under the Michigan Lead and Copper Rule.

B. Related Requirements:

1. Section 01 51 36 – Temporary Water Service.
2. Section 02 22 30 – Pre-Construction Video and Photographic Record.
3. Section 26 05 26 – Grounding and Bonding.
4. Section 31 10 00 – Site Clearing.
5. Section 31 23 33 – Trenching and Backfill.
6. Section 32 92 19 – Seeding.
7. Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.
8. Section 33 01 30.18 – Security Clearances and Communications.
9. Section 33 05 07.13 – Utility Directional Drilling.
10. Section 33 14 13 – Public Water Utility Distribution Piping.
11. Section 33 14 17 – Water Services.
12. Section 33 14 19 – Valves and Hydrants for Water Utility Service.

1.2 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. U.S. Environment Protection Agency:

1. EPA Lead and Copper Rule (LCR).

B. State of Michigan:

1. Michigan Act 399, as amended, Administrative Rule 325.10604f.

2. Public Health Code, Act 368, Part 54A: The Lead Abatement Act.

A. American Water Works Association:

1. AWWA C810 – Replacement and Flushing of Lead Service Lines.

B. American Society of Mechanical Engineers (ASME):

1. ASME B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

C. ASTM International:

1. ASTM B62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
2. ASTM B88 – Standard Specification for Seamless Copper Water Tube.

D. NSF International:

1. NSF 14 – Plastic Piping System Components and Related Materials.
2. NSF 61/ANSI 61 – Drinking Water System Components.
3. NSF 372 – Drinking Water System Components – Lead Content.

1.3 COORDINATION

A. Comply with Section 01 30 00 – Administrative Requirements.

1.4 PRE-INSTALLATION MEETINGS

A. Comply with Section 01 30 00 – Administrative Requirements.

B. Coordinate Construction Schedule and Operations with Owner a minimum of one (1) week prior to commencing lead service line replacements, representatives of DWSD, Contractor Representative, and Engineer will convene with each either in the field or in the office to discuss the Work Plan. Contractor's cost shall be at no additional cost to the Project.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit per Section 33 14 17 – Water Services.

C. Manufacturer's Certificate and Instructions:

1. Certify that products meet or exceed specified requirements.

2. Certify that products meet applicable NSF Standards.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

E. Qualifications Statement:

1. Submit qualifications of installer. Installer shall have a minimum of three (3) years' experience working on similar projects.
2. Submit installing plumber's current valid licensing information.
3. Submit the installer's security/police clearance records before entering the resident home.
4. Submit safety measures for trenching and traffic control and pedestrian protection.
5. Installer: Company specializing in performing Work of this Section with minimum three (3) years documented experience.
6. A licensed plumber shall make all connections to the household/building water system and shall meet all plumbing permit requirements for water service installations for City of Detroit.

F. Replacement of Existing Lead Service Lines:

1. Contractor shall submit a written descriptive summary of method to be used to replace existing lead service lines for approval. Submittal shall also provide or include secondary methods for replacement of lead services should the primary method fail. Use of the replacement method and any property restoration needed in any method will be at no additional cost to the contract.
2. Replacement of Existing Fire Service Line shall be in accordance with DWSD standards.

1.6 QUALITY ASSURANCE

A. Perform Work according to DWSD standards. Cable Pulling Method is not an approved method.

B. Perform Work according to AWWA current standards, as specified within these specifications.

C. Contractor shall maintain one (1) copy of each standard affecting the Work of this Section on-site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on-site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Keep materials in original packaging until immediately prior to use.

3. Install a cap at the end of the copper coil to keep copper coil dust and insect free.
4. Provide additional protection according to manufacturer instructions.

1.8 NON-SOLICITATION

A. Contractor and/or its employees shall not solicit or accept any business from DWSD customers, including tenants. The recommendation of a plumber or company and/or the performance of work outside the scope of this Contract is also prohibited.

1.9 IDENTIFICATION

A. Comply with Section 33 01 30.18 – Security Clearances and Communications.

B. Contractor's personnel shall always display DWSD-issued identification badges during the Work.

PART 2 - PRODUCTS

2.1 WATER PIPING AND FITTINGS

A. As specified in Section 33 14 17 – Water Services.

2.2 CORPORATION STOP ASSEMBLIES

A. As specified in Section 33 14 17 – Water Services.

2.3 CURB STOP ASSEMBLIES

A. As specified in Section 33 14 17 – Water Services.

2.4 BEDDING AND BACKFILL

A. As specified in Section 31 23 33 – Trenching and Backfill.

2.5 GROUNDING AND BONDING

A. As specified in Section 26 05 26 – Grounding and Bonding.

2.6 PITCHER AND REFILL CARTRIDGES

A. Pitcher style water filter and refill cartridges per EPA Lead and Copper Rule (LCR).

B. Comply with NSF/ANSI 61-G Certified filter/refill cartridge for lead removal.

2.7 SEALANT FOR FOUNDATION AND FLOOR PENETRATIONS

A. Waterproof penetration epoxy for foundation and floor shall be Hydrotite by Multi-Urethanes or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Review existing site conditions including all surface features and landscaping. Any landscaping that is removed due to the lead water service replacement shall be replaced in equal or better condition, to include, but not limited to trees, bushes, grass and fences.

B. Contractor shall document both the pre-and post-construction of the lead service line replacement:

1. Document the conditions within the right-of-way, the private property from the right-of way limit to the structure, and the point where the service connects to the meter (basement, crawl space, other). Refer to Section 3.7.
2. Provide photographs, videos, etc. in accordance with specification Section 02 22 30 – Pre-Construction Video and Photographic Record.

3.2 PREPARATION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

3.3 PRE-INSTALLATION PREPARATION

A. The Contractor shall be prepared to attend scheduled community meetings regarding the lead service line replacements.

B. If the Engineer determines the property is vacant (habitable), the Contractor shall replace the service line from water main to the water meter. If the Engineer determines the property is abandoned (in structurally bad condition), no new water service line will be provided. Leave emergency number door hanger for any properties left without water. Vacant lots (no structure) will not be provided with a new water service line.

C. The Contractor must cooperate with, assist, and work with the Engineer to notify residents of the lead service line replacement and obtain a water service replacement agreement.

D. Not less than 45 days prior to commencing lead service line replacement the Contractor shall provide notice to residents that they may experience a temporary increase of lead level in their drinking water. Residents will be notified that pitchers, filters and refill cartridges will be furnished and distributed by the Contractor. New pitcher filters and refill cartridges will be in accordance with EPA Regulations.

E. The Contractor shall be responsible for scheduling appointments with tenant/property owner at each property with a confirmed lead service line, a minimum of seven (7) days in advance of the intended date for service line replacement or as agreed to by the service customer. All scheduled appointments shall be tracked in an Excel spreadsheet and shall be submitted to the Engineer weekly. Appointments at properties that have meter issues identified by the Contractor or the Engineer shall have a DWSD Meter Operations Field Technician scheduled to attend for inspection and report if meter needs repair or a new install. If the Contractor must cancel or reschedule an appointment, the Contractor must notify the customer and the Engineer in writing or by successful telephone call at least forty-eight (48) hours before the scheduled appointment.

1. The Contractor shall assess the worksite and meter setting to prepare for lead service line replacement:

    a. Prior to work, Contractor shall take photos of meter setting and water service entering building.
    b. The Contractor assumes responsibility with all pre/post inspections and communication with the tenant/property owner.

2. If the customer fails to provide access at the time of the appointment, the Contractor will document the missed appointment and reschedule. If a customer has rescheduled the appointment more than three times, the Contractor may refuse further rescheduling and document for the project file.

F. Day of replacement, the Contractor shall be prepared to:

1. Notify resident that work is about to start and shut off water so that customer does not accidently use water during replacement that will contaminate interior plumbing.
2. Replace entirety of lead line with copper service.
3. Provide proper meter setting and reinstall existing meter if no repair or replacement is required.

G. If the replacement cannot be completed without overnight disruption, the Contractor will be prepared to provide a temporary connection to the water service to ensure the customer will not be without water overnight.

H. Contractor and licensed plumber will inspect newly installed service to ensure there are no signs of leaks, all adjustments have been made, and work is complete before leaving the customer premises.

I. The Engineer onsite during the service connections will complete the following:

1. Deliver and discuss the Water Main Replacement Full Lead Service Line Replacement (WMR FLSLR) Flushing Flier at each home.
2. Records whether the Contractor completed outdoor flushing.
3. If resident has no more filter cartridges, the Engineer shall inform them on how to get more.

3.4 INSTALLATION

A. Contractor shall comply with all installation requirements of Section 33 14 17 – Water Services as well as the quality assurance requirements listed in this specification.

B. Contractor shall comply with Section 33 05 07.13 – Utility Directional Drilling for installation of water services by method of directional drilling.

C. Contractor shall perform lead water service replacement work at times that are convenient to the customers and that will provide minimal disruptions to household or facility operations. The Contractor shall offer DWSD retail customers the option of having work performed on the customer's premises at any time that the customer finds convenient between 8:00 a.m. and 3:00 p.m. Monday through Friday. All expenses incurred by the Contractor beyond these hours as a result of scheduling requirements of the customer needed to replace the service (e.g. shift premiums & overtime) shall be at no additional cost to the Project.

D. At each curb box location, the Contractor shall perform an excavation by Hydro Vac method on both sides of the curb box to visually confirm the presence of copper, lead, or something else as the constituent material of the existing water service. Contractor is responsible for tracking the hydro vac operations in an Excel tracking sheet along with photographs and submitting to the Engineer weekly.

E. Where lead service lines are identified, Contractor shall remove existing curb box and install a new curb box and curb stop along with the new copper service line.

F. Where fire protection systems are affected, the Contractor shall notify the proper authorities of the pending interruption of service as directed by the Engineer.

G. Contractor shall perform a quick functionality check of the existing plumbing and fixtures and note the pressures and flows available before the service line replacement work.

H. Contractor shall use every precaution in operating both DWSD and customer valves; Contractor shall be responsible for replacement at no additional cost if valve operation results in breakage or damage. Replacement valves shall comply with DWSD standards.

I. Contractor shall contact the owner/tenant via phone or email to confirm the service line replacement schedule and access to the property no less than forty-eight (48) hours before the service line is scheduled to be replaced.

J. Contractor shall begin lead service line replacement work on a Customer's premises within thirty (30) minutes of the agreed appointment time.

1. Contractor's personnel shall not enter any homeowner's location unless the customer has approved access and is either present or the customer's adult designee is present.
2. Reconnection of the new water service by the Contractor following the replacement of the lead service lines shall be completed in a timely manner following the completion of new water main flushing. Service line replacements begun during daytime work hours will be completed before staff retires for the day; in no case shall a customer be left without water for a period longer than six (6) hours or overnight. Should the lead service line replacement fail, the Contractor shall, at his cost, establish a temporary service until the restoration of the permanent service the following day. Refer to Specification 01 51 36 Temporary Water Service.
3. Contractor shall not leave homeowner's premises where work has begun until installation of the new water service has been completed, all adjustments have been made, and connections to the new service shows no sign of leakage.
4. The Contractor shall leave door hanger with emergency contact number at each customer's premises and must respond to all emergency notifications within two (2) hours and shall complete all repairs to the newly installed copper service line within four (4) hours. If the Contractor is nonresponsive to the notification and the Engineer makes arrangements to complete any required repairs, the costs for these repairs will be deducted from the contract.

K. Contractor shall make every effort to avoid damage to any part of the customer's premises. Any damage caused by the Contractor shall be repaired at no additional cost to the Project.

L. The Contractor shall replace all existing lead services less than or equal to one-inch diameter with one-inch copper.

M. The Contractor shall replace all existing lead services of one and a half (1.5) inches and two (2) inches with new copper service of the same diameter as the existing service.

N. The Contractor shall properly dispose of the lead service piping removed during the lead service line replacement:

1. Disposal costs are to be included in Work as part of the Contractor's price.
2. Contractor shall submit verification to the Engineer of proper disposal of scrap lead service lines.

O. The Contractor shall inform the resident/owner when the Service Lead work has been completed and coordinate the flushing of the water system within the house for a duration of thirty (30) minutes per AWWA C810-17 requirements.

P. After all connections for the service line have been completed, the Contractor shall flush the water from an outside connection, such as a hose bib to remove particles in the service line and the point-of-entry into the home. Flushing is best done before the meter is connected using a jumper or straight pipe in place of the meter. The straight pipe will allow for a higher velocity flush and protects the meter from potential damage from lead pipe and other construction fragments. Flush

at maximum velocity for a minimum of ten (10) minutes. If the meter was replaced with a "jumper," reconnect the meter after flushing. All interior flushing shall be in accordance with AWWA C810-17 Section 4.4.2 requirements.

Q. Contractor shall flush all interior plumbing per AWWA C810-17 Section 4.4.2. requirements.

R. For flushing and chlorinating the water main, refer to Section 33 01 10.58 – Disinfection of Water Utility Piping Systems and Section 33 14 13 – Public Water Utility Distribution Piping.

3.5 GROUNDING AND BONDING

A. Comply with Section 26 05 26 – Grounding and Bonding.

B. All grounding and bonding required at the customer's meter and on private property will be performed according to the Grounding and Bonding specifications and DWSD Standard Details.

C. Grounding and bonding work required on private property shall be performed at the same time as the Contractor accesses private property for the lead service line replacement and meter access.

3.6 PITCHER STYLE FILTER AND REFILL CARTRIDGE

A. Pitchers, filters and refill cartridges are to be furnished and distributed by the Contractor.

B. New pitcher filters and refill cartridges shall be in accordance with NSF 61-G and shall be delivered to every premises that is along a street getting a water main replacement, and not just restricted to lead services work.

C. A resident will not necessarily have to have their own service line replaced or disturbed in order to receive a pitcher and refill cartridge.

D. The pitcher and number of refill filters shall be enough for a 6-month supply as specified on the pitcher and refill filter packaging per EPA Lead and Copper Rule (LCR).

3.7 PHOTOGRAPHIC RECORD

A. Photographic record shall be performed by the Contractor per Section 02 22 30 – Pre-Construction Video and Photographic Record as to quality and deliverable.

B. Lead service photography performed by the Contractor shall be of good quality but does not need to be done by a professional photographer. Photos associated with this specification do not count toward the number of project photographs required by 02 22 30 – Pre-Construction Video and Photographic Record or elsewhere in this specification.

C. Photographs shall have the following title block in the lower right corner of the digital photos:

1. Detroit Water and Sewerage Department.
2. Contact Number.
3. Project Title.
4. Address/Location.
5. Date photograph was taken.
6. Photo by: name of photographer.

D. Contractor shall take photographs of the water service line material on both sides of all exposed curb stops during hydro vac excavations and deliver to the Engineer weekly.

E. For every home receiving a lead service line replacement, the Contractor shall take photos inside of each home and in the yard where the service line work is performed before and after replacement has been completed and restored. Photos shall include meter and piping, wall penetrations, condition of walls, etc.

3.8 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements for Inspecting and Testing.

B. Comply with Section 31 23 33 – Trenching and Backfill for compaction testing requirements for bedding and backfill.

C. If tests indicate that the Work does not meet specified requirements, remove the work, replace, and retest.

D. Provide a five (5) year manufacturer warranty in accordance with Specification 33 14 17 Water Services.

END OF SECTION 33 14 17.81

SECTION 33 14 19 - VALVES AND HYDRANTS FOR WATER UTILITY SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Valves.
2. Valve Boxes.
3. Fire Hydrants.

B. Related Requirements:

1. Section 02 61 13 – Excavation and Handling of Contaminated Materials.
2. Section 03 30 00 – Cast-in-Place Concrete.
3. Section 31 23 33 – Trenching and Backfill.
4. Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.
5. Section 33 14 13 – Public Water Utility Distribution Piping.

1.2 STANDARDS

Except as modified herein, comply with the latest version of the following standards:

A. American Water Works Association (AWWA):

1. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
2. AWWA C502 - Dry-Barrel Fire Hydrants.
3. AWWA C503 - Wet-Barrel Fire Hydrants.
4. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
5. AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
6. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

B. National Fire Protection Association (NFPA):

1. NFPA 291 - Recommended Practice for Fire Flow Testing and Marking of Hydrants.

C. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Coordinate Work of this Section with installation of water mains.

1.4 PREINSTALLATION MEETINGS

A. Comply with Section 01 30 00 – Administrative Requirements.

B. Convene pre-installation meeting minimum two (2) weeks prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer information regarding component materials, fittings, assembly and parts diagram, and accessories. Indicate where on valve body manufacturer's name, pressure rating, and year of fabrication will be cast thereon.

C. Manufacturer's Certificate: Affidavit of compliance that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Source Quality-Control Submittals: Indicate results of proof-of-design factory tests and production tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Certification of Materials in Contact with Potable Water according to NSF 61 and NSF 372.

H. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of valves and hydrants.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

1.8 QUALITY ASSURANCE

A. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

B. Cast manufacturer's name, pressure rating, and year of fabrication into valve body.

C. Perform Work according to this Specification.

D. Submit records of all tests required in the specified standards.

E. Maintain one (1) copy of each standard affecting Work of this Section on-site.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three (3) years' experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Coated valves shall be shipped, handled, and stored in a manner that will prohibit damage to the coating.
2. Seal valve and hydrant ends to prevent entry of foreign matter.
3. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials in original, unopened packaging, according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 VALVES

A. Performance and Design Criteria:

1. Pressure Rating: 200-psig working pressure.
2. End Connections: Flanged, Mechanical joint, or Bell as shown on the Drawings.
3. Furnish valves of diameters 24 inches and larger with bypass valves and gear operators.
4. Coatings:
   a. Fusion-Bonded Epoxy in compliance with AWWA C550.
   b. Application: Interior and exterior.
   c. The interior coated surfaces of valve and hydrant parts shall be determined to be without holidays by testing in accordance with ASTM G62.
   d. Furnish a sworn statement that the inspection and all specified tests have been made and that the results comply with the requirements of the standard.

B. Double-Disc Gate Valves:

1. Description:
   a. Comply with AWWA C500.
   b. Materials:
      1) Body: Iron.
      2) Disc: Bronze.
      3) Trim: Bronze.
   c. Seat Type: Double disc; parallel.
   d. Stem:
      1) Type: Non-rising.
      2) Seals: O-ring.
   e. Type of valve ends:
      1) As shown on the Drawings.
      2) Bolt holes of end flanges shall be spot-faced in accordance with MSS SP-9.
   f. Operation:
      1) Square operating nut.
      2) Opening Direction: Clockwise.
      3) Position: As shown on the Drawings.

2. Manufacturers:
   a. Clow Valve Company (subsidiary of McWane, Inc.).
   b. Kennedy Valve Company (division of McWane, Inc.).
   c. Mueller Co.
   d. Val-Matic Valve and Manufacturing Corp.
   e. Or approved equal.

C. Resilient-Wedge Gate Valves:

1. Description:
    a. Comply with AWWA C509 or C515.
    b. Body: Ductile iron.
    c. Seats: Resilient.
    d. Stem:
        1) Type: Non-rising.
        2) Material: Bronze.
    e. Type of valve ends:
        1) As shown on the Drawings.
        2) Bolt holes of end flanges shall be spot-faced in accordance with MSS SP-9.
    f. Operation:
        1) Square operating nut.
        2) Opening Direction: Clockwise (right-hand).

2. Manufacturers:
    a. American Cast Iron Pipe Company.
    b. Clow Valve Company (subsidiary of McWane, Inc.).
    c. East Jordan Iron Works (EJIW).
    d. Kennedy Valve Company (division of McWane, Inc.).
    e. Mueller Co.
    f. NIBCO Inc.
    g. Or approved equal.

D. Tapping Valves:

1. Description:
    a. Comply with AWWA C500, C509, or C515.
    b. Type: Resilient Wedge or Double disc with non-rising stem.
    c. Inlet Flanges: Comply with ASME B16.1, Class 125, and MSS SP-60.

2. Mechanical Joint Outlets: Comply with AWWA C111.
3. Manufacturers:
    a. Mueller Co.
    b. U.S. Pipe Valve and Hydrant Division.
    c. East Jordan Iron Works (EJIW).
    d. Or approved equal.

2.2 FIRE HYDRANTS

A. Dry-Barrel, Breakaway Type, EJIW 5BR250, with Carroll Drain Assembly:

1. Comply with AWWA C502.
2. Body: Ductile iron.
3. Valve: Compression type.
4. Burial Depth: As indicated on Drawings.
5. Inlet Connection Size: 6 inches.

6. Valve Opening: 5-1/4 inches in diameter.
7. End Connections: Mechanical joint or Bell.
8. Bolts and Nuts: Galvanized steel or Stainless steel.
9. Interior Coating: Comply with AWWA C550.
10. Exterior coating: As shown on the Drawings.
11. Hydrant Opening Direction: Counterclockwise.
12. Hydrant 6-inch Valve:
    a. Per 2.1.C above.
    b. Open direction: clockwise.

B. Manufacturers:

1. East Jordan Iron Works.
2. Or approved equal.

2.3 VALVE BOXES

A. Description:

1. 12-inch Diameter Valves and Smaller:
    a. Material: ASTM A48 Class 35 Cast Iron.
    b. Type: Two piece; screw.

2. Valves Larger than 12-inch Diameter:
    a. Material: ASTM A48 Class 35 Cast Iron.
    b. Type: Three piece; screw.
    c. Base: Round.

3. Lid Inscription: WATER.

B. Manufacturers:

1. Ford Meter Box Company, Inc.
2. Mueller Co.
3. Tyler Utilities (Union Foundry Company).
4. East Jordan Iron Works (EJIW).
5. Or approved equal.

2.4 ACCESSORIES

A. Thrust Restraints: As specified in Section 33 14 13 – Public Water Utility Distribution Piping.

B. Valve Box Aligner: High-strength plastic device designed to automatically center valve box base and to prevent it from shifting off center during backfilling.

2.5 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Owner Inspection:

1. Make completed valves and hydrants available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least seven (7) days before inspection is allowed.

C. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven (7) days before inspections and tests are scheduled.

D. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Determine exact location and size of valves from Drawings.

C. Identify required lines, levels, contours, and datum locations.

D. Verify that elevations of existing facilities prior to excavation and installation of valves and hydrants are as indicated on Drawings.

E. Inspect valves upon delivery to verify compliance with this Specification, direction of opening, size and shape of operating nut, number of turns to open or close, and type of end connections. Visually inspect the seating surfaces should be performed to detect any damage during shipment or scoring of the seating surfaces. Look for bent stems, broken handwheels, cracked parts, loose bolts, missing parts and accessories, and any other evidence of mishandling during shipment. Each valve should be operated through one (1) complete opening-and-closing cycle in the position in which it is to be installed.

F. Unload valves carefully. Do not drop. Only hoists and slings with adequate load capacity to handle the weight of the valve or valves shall be used. Hoists shall not be hooked into or chains fastened around yokes, gearing, motors, cylinders, or handwheels.

G. Protect valves from the weather, sunlight, ozone, foreign materials and freezing temperatures.

H. Coatings damaged in shipment or by field handling shall be repaired at the jobsite provided materials and procedures recommended by the manufacturer are used and the applicable requirements of AWWA C550 are met.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Utilities to remain shall be located, identified, and protected from damage.

C. Do not interrupt existing utilities without permission and without making arrangements to provide temporary utility services.

1. Notify Owner not less than seven (7) days in advance of proposed utility interruption.
2. Do not proceed without written permission from Owner.

3.3 INSTALLATION

A. Perform trench excavation, backfilling, and compaction as specified in Section 31 23 33 – Trenching and Backfill and Section 02 61 13 – Excavation and Handling of Contaminated Materials.

B. Install valves and hydrants in conjunction with pipe laying.

C. Provide buried valves with valve boxes installed flush with finished grade.

D. Provide support blocking while installing fire hydrants.

E. Orientation:

1. Set valves and hydrants plumb.
2. Install gate valves in the closed position.
3. Set fire hydrants with pumper nozzle facing roadway.
4. Set fire hydrants with centerline of pumper nozzle 18 inches above finished grade and with safety flange not more than 6 inches nor less than 2 inches above grade.
5. Each valve shall be placed on firm footing in the trench to prevent settling and excessive strain on the connection to the pipe. Piping systems shall be supported and aligned to avoid damage to the valve.

F. Install valve box so as not to transmit loads or stress to the valve, valve stem, or piping system. Center the valve box over the operating nut of the valve with the box cover flush with the surface of the finished area or another level if otherwise shown on the Drawings.

G. Unless specified otherwise, valve excavations shall not be backfilled until pressure testing is complete.

H. Flush and disinfect valves and hydrants with water mains as specified in Section 33 01 10.58 – Disinfection of Water Utility Piping Systems.

I. Coatings: Wrap all buried valves, mechanical joints, flanges, and joint restraint devices with wax tape in accordance with AWWA C217. Over-wrap wax tape with one wrap of polyethylene encasement in accordance with AWWA C105. Tightly tape the polyethylene wrap to seal all joints and folds.

J. Install tracer wire connections in all valve boxes, vaults, hydrants and connections as shown in the Drawings.

3.4 FIELD QUALITY CONTROL

A. Comply with Section 01 70 00 – Execution and Closeout Procedures.

B. Testing:

1. Operate each valve through one complete operating cycle.
2. Pressure test valves and hydrants with water mains as specified in Section 33 14 13 - Public Water Utility Distribution Piping.
3. After main-line pressure testing, flush fire hydrants.

END OF SECTION 33 14 19

SECTION 33 31 11 - PUBLIC SANITARY SEWERAGE GRAVITY PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sanitary Sewerage Piping.
2. Connection to Existing Manholes.
3. Wye Branches and Tees.
4. Sanitary Laterals.
5. Bedding and Cover Materials.

B. Related Requirements:

1. Section 31 23 33 – Trenching and Backfill.
2. Section 31 50 00 – Excavation Support Systems.
3. Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
4. Section 33 01 30.19 – Sanitary Sewer Pipeline Cleaning.
5. Section 33 01 30.61 – Packer Injection Grouting.
6. Section 33 05 61 – Concrete Manholes.
7. Section 33 05 97 – Identification and Signage for Utilities.

1.2 DEFINITIONS

A. Rigid Pipes: Vitrified clay pipes, reinforced concrete pipes, and ductile iron pipes shall be considered as rigid pipe materials.

B. Non-Rigid Pipes: Pipe materials other than vitrified clay pipes, reinforced concrete pipes, and ductile iron pipes shall be considered non-rigid pipe materials.

1.3 STANDARDS

Except as modified herein, comply with the current edition of the following standards:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb.) Rammer and a 457 mm (18-in.) Drop.

B. American Water Works Association (AWWA):

1. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
6. AWWA C153 - Ductile-Iron Compact Fittings.

C. ASTM International:

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel.
3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
5. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
6. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
7. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m3).
8. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m3).
9. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
10. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
11. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
12. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
13. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
14. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
15. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
16. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
17. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
18. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

19. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.4 COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Notify affected utility companies at least three (3) days prior to construction occurring in proximity to utility infrastructure.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer information indicating proposed materials, accessories and details prior to the ordering or manufacture of the materials.

C. Submit detailed description of procedures for connecting new sewer to existing sewer line.

D. Submit detailed description of procedures for sewer line, directional drilling, and pipe jacking installation.

E. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

F. Manufacturer Instructions: Indicate special procedures required to install specified products.

G. Source Quality-Control Submittals: Furnish two (2) certified copies of the results of all materials tests and inspections to the Engineer.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, manholes, and cleanouts.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Closed-Caption Television (CCTV) Inspection:

1. Comply with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.

2. The CCTV inspections shall be performed by the Contractor on all sewers, manholes, inlets, and other appurtenances after completion of the sewer items, and before Substantial Completion is issued.

1.7 QUALITY ASSURANCE

A. The Owner shall at all times have access to all places of manufacture where materials are being fabricated or tested and shall be at liberty at all times to inspect all materials and observe all tests on the materials. Any materials which, in the opinion of the Engineer, are not in conformity with the specifications herein stated, or the drawings submitted to the Engineer as herein required, will be rejected and shall be removed from the site immediately.

B. Unless otherwise specified herein, materials shall be manufactured, tested and inspected by the manufacturer in the manner required by the latest version of ASTM specifications and AWWA/ANSI standards. Such tests shall be at the Contractor’s expense. Furnish to the Engineer two certified copies of the results of all materials tests and inspections.

C. Ductile Iron Pipe Epoxy Lining: The lining shall be applied by a firm with a successful history of applied linings to the interior of ductile iron pipe and fittings.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage. Any materials which, in the opinion of the Engineer, are not in conformity with the specifications or the Drawings will be rejected and shall be removed from the site immediately.

B. Storage:

1. Store materials according to manufacturer instructions.
2. Store valves in shipping containers with labeling in place.
3. Non-rigid pipe shall be stored to prevent bowing. Pipe and fittings with visible cracks, breakage or other defects shall not be used, or repaired and used, unless specifically accepted by Engineer in writing.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Plastic pipe shall be kept covered to prevent exposure to ultra-violet exposure from the sun.
3. Block individual and stockpiled pipe lengths to prevent moving.
4. Provide additional protection according to manufacturer instructions.
5. Lined pipe and fittings shall be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying. The pipe shall not be dropped or unloaded by rolling.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SANITARY SEWERAGE PIPING

A. Ductile-Iron Pipe:

1. Comply with AWWA C151.
2. Minimum Special Thickness Class: 52.
3. End Connections: Bell and spigot.
4. Outside Coating:
   a. Type: Asphaltic.
   b. Minimum Uniform Thickness: 1 mil.
   c. Comply with AWWA C151.

5. Lining:
   a. Type: Ceramic Epoxy Lining.
   b. “Protecto 401 Ceramic Epoxy” or approved equal.

6. PE Encasement: Comply with AWWA C105.

7. Fittings:
   a. Material: Ductile iron, Pressure Class 250 or greater.
   b. Comply with AWWA C110.

8. Joints:
   a. Rubber gasket joint devices.
   b. Comply with AWWA C111.
   c. Wrap MJ fittings, flanges, and couplings with wax tape per AWWA C217, then overwrap in accordance with AWWA Standard C105.

B. Reinforced Concrete Pipe:

1. Comply with ASTM C76, Class IV, with Wall Type B minimum.
2. All reinforced concrete pipe shall be manufactured using Type II Cement unless otherwise approved by the Engineer.
3. Reinforcement: Steel Wire Mesh.
4. End Connections: Bell and spigot.
5. Fittings: Reinforced concrete.
6. Joints:
    a. Rubber compression gasket.
    b. Comply with ASTM C443.

C. Plastic Pipe Inside Nominal Diameter: 4 to 15 inches:

1. Material: PVC.
2. Comply with ASTM D3034; SDR-26 minimum, unless shown otherwise on the Drawings.
3. End Connections: Bell-and-spigot style, with rubber-ring-sealed gasket joint.
4. Fittings: PVC.
5. Joints:
    a. Elastomeric gaskets.
    b. Comply with ASTM F477.

D. Plastic Pipe Inside Nominal Diameter: 18 to 48 inches:

1. Material: PVC.
2. Comply with ASTM F679, SDR 26.
3. End Connections: Bell-and-spigot style, with rubber-ring-sealed gasket joint.
4. Fittings: PVC.
5. Joints:
    a. Elastomeric gaskets.
    b. Comply with ASTM F477.

E. Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe (CCFRPMP) or Fiberglass Reinforced Polymer Mortar Pipe (FRPMP):

1. Manufacture and testing shall be in accordance with ASTM D3262. Strain Corrosion Resistance shall be determined in accordance with Appendix X1.2 for a 4% long-term limiting deflection. The method for determining glass content shall be in accordance with Appendix X3.1.1.
2. Open cut portions of sewer pipe shall have a minimum stiffness class of 72-psi when tested is accordance with ASTM D2412. Sewer pipe that is to be installed by pipe jacking shall have a design factor of safety of 2.5 and an allowable safe jacking load per manufacturer's recommendation.

3. Liner:
   a. The internal liner shall be suitable for service in a sewer pipe and shall be highly resistant to exposure to sulfuric acid as produced by biological activity from hydrogen sulfide gases.
   b. Comply with ASTM D3681.

4. End Connections:
   a. The pipe shall be field connected with glass reinforced plastic sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness.
   b. Comply with ASTM D4161.

5. Joints:
   a. Elastomeric Gaskets.
   b. Comply with ASTM F477 and ASTM D4161.

2.2 MANHOLES

A. As specified in Section 33 05 61 - Concrete Manholes.

2.3 MATERIALS

A. Bedding and Cover:

1. Bedding: Fill Type as specified in Section 31 23 33 – Trenching and Backfill.
2. Cover: Fill Type as specified in Section 31 23 33 – Trenching and Backfill.

2.4 MIXES

A. Grout: As specified in Section 03 60 00 - Grouting.

2.5 SOURCE QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Provide shop inspection and testing of pipe.

C. Certificate of Compliance: Submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that trench cut is ready to receive Work of this Section.

C. Verify that excavations, dimensions, and elevations are as indicated in Contract Documents.

D. Verify excavation for manholes to proper depth and proper placement of bedding material.

3.2 PREPARATION

A. Correct over-excavation with bedding material as specified in Section 31 23 33 – Trenching and Backfill.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.
3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:

1. Excavate pipe trench as specified in Section 31 23 33 – Trenching and Backfill.
2. Excavate to lines and grades as indicated in Contract Documents, or as required to accommodate installation of encasement.
3. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.
4. Provide sheeting and shoring as specified in Section 31 50 00 – Excavation Support Systems.
5. Pile Support Systems:
   a. Install pile support systems as specified in Section 31 50 00 – Excavation Support Systems.
   b. Install utilities on pile support systems as indicated in Contract Documents.

6. Placement: Place bedding material at trench bottom as specified in Section 31 23 33 – Trenching and Backfill.

B. Piping:

1. Install PVC pipe, fittings, and accessories according to ASTM D2321, and seal joints watertight.
2. Install ductile iron pipe, fittings, and accessories according to AWWA C600 unless otherwise noted on Contract Documents.
3. Install reinforced concrete pipe, fittings, and accessories according to ASTM C1479 unless otherwise noted on Contract Documents.
4. Install CCFRPM pipe according to manufacturer recommendations unless otherwise indicated on the Contract Documents.
5. Lay pipe to slope gradients as indicated in Contract Documents.
6. Begin pipe laying at downstream end of system and progress upstream.
7. Bedding: As indicated on the Drawings.
8. Lay bell-and-spigot pipe with bells upstream.
9. PE Pipe Encasement: Comply with AWWA C105, Method A. Seal all joints with polyethylene tape to prevent ingress of water.
10. Backfill and compact as specified in Section 31 23 33 – Trenching and Backfill.
11. Backfill each section of pipe as it is laid and as indicated at least up to centerline before next joint is made.
12. Do not displace or damage pipe when compacting.
13. Keep trenches and other excavations free of water until final inspection. Do not lay pipe or construct masonry work in water. Do not allow water to rise over the work until concrete or mortar has had ample time to set.
14. All lifting holes in reinforced concrete circular pipe shall be grouted with cement mortar or other approved material after the pipe has been placed. Repair lining following placement.
15. Connections to pipes of dissimilar size and/or material shall be made using a flexible coupling as shown in the Contract Documents.

C. Manholes: As specified in Section 33 05 61 - Concrete Manholes.

D. Connections to Existing Manholes:

1. Drilling:
   a. Core drill existing manhole to clean opening.
   b. Use of pneumatic hammers, chipping guns, sledge hammers will not be permitted.

2. Install watertight neoprene gasket and seal with non-shrink concrete grout.
3. Prevent construction debris from entering existing sewer line when making connection.

E. Wye Branches and Tees:

1. Concurrent with pipe-laying operations, install wye branches and pipe tees at locations indicated in the Contract Documents.

2. Use standard fittings of the same material and joint type as sewer main.
3. Maintain minimum five (5) foot separation distance between wye connection and manhole.
4. Use a saddle, wye or tee with stainless-steel clamps for taps into existing piping.
5. Mount saddles with solvent cement or gasket and secure with metal bands.
6. Lay out holes with an accurate template and cut holes with a mechanical cutter.

F. Sanitary Laterals and Services:

1. Construct laterals from wye branch to terminal point where connection to structurally sound existing lateral is achieved.
2. Where depth of main pipeline warrants, construct riser-type laterals from wye branch.
3. Minimum Depth of Cover over Piping: 2 feet.
4. Minimum Separation Distance between Laterals: 5 feet.
5. If constructing new laterals connecting to existing sewers:
    a. Encase sewer lateral with Grade "C" concrete to center line of pipe.
    b. Install magnetically locatable watertight plug, braced to withstand pipeline test pressure thrust, at termination of lateral.

G. Backfilling: As specified in Section 31 23 33 – Trenching and Backfill.

3.4 TOLERANCES

A. Comply with Section 01 40 00 - Quality Requirements.

B. Maximum Variation from Indicated Slope: 1/8-inch in 10 feet.

3.5 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 - Quality Requirements.

B. Request inspection by Engineer prior to and immediately after placing bedding.

C. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.
2. Pipe Testing:
    a. Pressure Testing: The air test shall, as a minimum, conform to the test procedure described in ASTM C828 clay pipe, ASTM C924 for concrete pipe and ductile iron pipe, ASTM F1417 for plastic pipe, and ASTM3212 for PVC pipe.
    b. Infiltration and Exfiltration Testing: The leakage infiltration or exfiltration shall not exceed 100 gallons per inch of pipe diameter per mile per day for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of two (2) feet of water.

c. Deflection Testing: Deflection tests shall be performed on all non-rigid pipe. The tests shall be conducted after the final backfill has been in place at least 30 days in order to permit stabilization of the soil-pipe system. No pipe shall exceed a deflection of five (5) percent of the inside diameter. If deflection exceeds five (5) percent, the pipe shall be excavated, replaced and retested. For piping 48-inch diameter or smaller, a rigid ball or mandrel shall be used for the deflection test which shall have a diameter not less than 95 percent of the base inside diameter. The tests shall be performed without mechanical pulling devices. All non-rigid pipe larger than 48-inch diameter shall have deflection measurements performed directly using extension rulers, tape measures, etc. at 10-foot increments, using the same criteria used for the mandrel device.

3.6 PROTECTION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

C. Cap open ends of piping during periods of Work stoppage.

D. Repair linings, coatings, and coverings damaged during construction with accepted materials equal to and compatible with original lining, coating or covering. Repair damaged galvanizing with zinc-rich paint.

E. Repair any existing utilities/structures or features damaged during installation of sanitary sewerage utilities to Owner's satisfaction, and at no cost to Owner.

3.7 Closed-Caption Television (CCTV) Inspection: Visually and CCTV inspect all installed piping in accordance with Specification Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.

END OF SECTION 33 31 11

SECTION 33 42 00 – STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stormwater drainage piping.
2. Manholes.
3. Catch basins.
4. Connection to existing manholes.
5. Concrete encasement and cradles.
6. Bedding and cover materials.

B. Related Requirements:

1. Section 03 60 00 - Grouting.
2. Section 31 23 19 – Dewatering.
3. Section 31 50 00 - Excavation Support Systems.
4. Section 33 01 30.16 - Sanitary Sewer Pipeline Inspection.
5. Section 33 05 61 - Concrete Manholes.
6. Section 33 23 33 - Trenching and Backfill.

1.2 DEFINITIONS

A. Catch Basin: A structure designed to collect stormwater run-off along the ground surface.

B. Manhole: A structure which provides access to underground services such as sewer, water or utility.

C. Invert: The lowest interior elevation of a sewer, culvert or tunnel.

D. Storm Sewer: A closed or open conduit that conveys stormwater that has been collected by inlets to an adequate outfall. It generally consists of laterals or leads and trunk lines or mains.

1.3 STANDARDS

Except as amended herein, comply with the latest edition of the following standards:

A. ASTM International:

1. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

2. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
3. ASTM C507 - Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
4. ASTM C828 - Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipelines.
5. ASTM C924 - Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
6. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.
7. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
8. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
9. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
10. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
11. ASTM F1417 REV A - Standard Practice for Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air.
12. ASTM F2306/F2306M - Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
13. ASTM F2648/F2648M - Standard Specification for 2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.

1.4 COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Notify affected utility companies at least 3 days prior to construction.

1.5 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer information indicating proposed materials, accessories and details prior to the ordering or manufacture of the materials.

C. Submit detailed description of procedures for connecting new sewer to existing sewer line.

D. Submit detailed description of procedures for horizontal directional drilling and pipe jacking installation.

E. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

F. Manufacturer Instructions: Indicate special procedures required to install specified products.

G. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, catch basins and manholes, and cleanouts.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Closed-Caption Television (CCTV) Inspection:

1. Comply with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
2. All sewers, manholes, inlets and other appurtenances shall be visually and CCTV inspected prior to Substantial Completion of the sewer items.
3. The CCTV inspections shall be performed after completion of the sewer items, before Substantial Completion is issued.

1.7 QUALITY ASSURANCE

A. The Engineer shall at all times have access to all places of manufacture where materials are being fabricated or tested and shall be at liberty at all times to inspect all materials and observe all tests on the materials. Any materials which, in the opinion of the Engineer, are not in conformity with the specifications herein stated, or the drawings submitted to the Engineer as herein required, will be rejected and shall be removed from the site immediately.

B. Unless otherwise specified herein, materials shall be manufactured, tested and inspected by the manufacturer in the manner required by the latest version of ASTM specifications and AWWA/ANSI standards. Such tests shall be at the Contractor’s expense. Furnish to the Engineer a copy of the results of all materials tests and inspections.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage. Any materials which, in the opinion of the Engineer, are not in conformity with the specifications or the Drawings will be rejected and shall be removed from the site immediately.

B. Storage:

1. Store materials in original packaging according to manufacturer instructions.
2. Non-rigid pipe shall be stored to prevent bowing. Pipe and fittings with visible cracks, breakage or other defects shall not be used, or repaired and used, unless specifically accepted by Engineer in writing.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Plastic pipe and accessories shall be kept covered to prevent exposure from ultra-violet exposure from the sun.
3. Block individual and stockpiled pipe lengths to prevent moving.
4. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 STORM DRAINAGE PIPING

A. Reinforced Concrete Piping:

1. Circular Piping: Comply with ASTM C76, Class IV, with Wall Type B minimum.
2. Elliptical Piping: Comply with ASTM C507, Class HE-1 through HE-IV or VE-II through VE-VI, as specified on the plans.
3. All reinforced concrete pipe shall be manufactured using Type II Cement unless otherwise approved by the Engineer.
4. Reinforcement: Steel Wire Mesh.
5. End Connections: Bell and spigot.
6. Fittings: Reinforced concrete.
7. Joints:
    a. Rubber compression gasket.
    b. Comply with ASTM C443.

B. PVC Piping: Plastic Pipe Inside Nominal Diameter: 4 – 15 inches:

1. Material: PVC.
   Comply with ASTM D3034, SDR-26 minimum, unless shown otherwise on the Drawings.
2. End Connections: Bell-and-spigot style, with rubber-ring-sealed gasket joint.
3. Fittings: PVC.
4. Joints:
   a. Elastomeric gaskets.
   b. Comply with ASTM F477.

C. Corrugated High-Density Polyethylene (HDPE) Piping:

1. Pipe:
   a. Comply with ASTM F2648.
   b. Type: Dual wall Smooth interior.

2. Fittings: Comply with ASTM F2306.
3. Joints: Reinforced integral bell & gasketed spigot, Comply with ASTM F2648.
4. Watertight, according to requirements of ASTM D3212.
5. Gaskets: Comply with ASTM F477.

2.2 MANHOLES

A. Comply with Section 33 05 61 - Concrete Manholes.

2.3 CATCH BASINS

A. Shaft and Top Section: Comply with Section 33 05 61 - Concrete Manholes.

B. Lids and Frames: Furnish according to City of Detroit Public Works Department – City Engineering Division Standards.

2.4 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. Description: Reinforced concrete as specified in Section 03 30 00 - Cast-in-Place Concrete.
2. Compressive Strength: 4,000-psi at 28 days reinforced concrete, air-entrained rough troweled finish.

B. Reinforcement: As specified in Section 03 20 00 - Concrete Reinforcing.

2.5 MATERIALS

A. Bedding and Cover:

1. Bedding: Fill Type as specified in Section 31 23 33 – Trenching and Backfill.
2. Cover: Fill Type as specified in Section 31 23 33 – Trenching and Backfill.

2.6 MIXES

A. Grout: As specified in Section 03 60 00 - Grouting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that trench cut is ready to receive Work of this Section.

C. Verify that excavations, dimensions, and elevations are as indicated in Contract Documents.

D. Verify excavation for manholes to proper depth and proper placement of bedding material.

3.2 PREPARATION

A. Correct over-excavation with bedding material as specified in Section 31 23 33 – Trenching and Backfill.

B. Remove stones 2 inches and greater or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.
3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Excavation and Bedding:

1. Excavate pipe trench as specified in Section 31 23 33 – Trenching and Backfill.

2. Excavate to lines and grades as indicated in Contract Documents, or as required to accommodate installation of encasement.
3. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation as specified in Section 31 23 19 - Dewatering.
4. Provide sheeting and shoring as specified in Section 31 50 00 – Excavation Support Systems.
5. Pile Support Systems:
    a. Install pile support systems as specified in Section 31 50 00 – Excavation Support Systems.
    b. Install utilities on pile support systems as indicated in Contract Documents.
6. Placement: Place bedding material at trench bottom as specified in Section 31 23 33 – Trenching and Backfill.

B. Piping:

1. Pipe, Fittings, and Accessories: Comply with ASTM C1479, ASTM D2321, ASTM F2306.
2. Seal joints watertight.
3. Install reinforced concrete pipe, fittings, and accessories according to ASTM C1479 unless otherwise noted on Contract Documents.
4. Lay pipe to slope gradients as indicated in Contract Documents.
5. Begin pipe laying at downstream end of system and progress upstream.
6. Bedding: As indicated on the Drawings.
7. Lay bell-and-spigot pipe with bells upstream.
8. Backfill and compact as specified in Section 31 23 33 – Trenching and Backfill.
9. Backfill each section of pipe as it is laid and at least to the centerline before next joint is made.
10. Do not displace or damage pipe when compacting.
11. Keep trenches and other excavations free of water until final inspection. Do not lay pipe or construct masonry work in water. Do not allow water to rise over the work until concrete or mortar has had ample time to set.
12. All lifting holes in reinforced concrete circular pipe shall be grouted with cement mortar or other approved material after the pipe has been placed. Repair lining

C. Manholes and Catch Basins: As specified in Section 33 05 61 - Concrete Manholes.

D. Connections to Existing Manholes:

1. Drilling:
    a. Core drill existing manhole to clean opening.
    b. Use of pneumatic hammers, chipping guns, sledgehammers will not be permitted.
2. Install watertight neoprene gasket and seal with non-shrink concrete grout.
3. Prevent construction debris from entering existing sewer line when making connection.

3.4 TOLERANCES

A. Comply with tolerance requirements in Section 01 40 00 - Quality Requirements.

B. Maximum Variation from Indicated Slope: 1/8-inch in 10-feet.

3.5 FIELD QUALITY CONTROL

A. Comply with inspecting and testing requirements in Section 01 40 00 - Quality Requirements.

B. Request inspection by Engineer prior to and immediately after placing bedding.

C. Testing:

1. Pressure Testing: The air test shall, as a minimum, conform to the test procedure described in ASTM C828 clay pipe, ASTM C924 for concrete pipe and ductile iron pipe, ASTM F1417 for PE pipe and ASTM3212 for PVC pipe.
2. Infiltration and Exfiltration Testing: The leakage infiltration or exfiltration shall not exceed 100 gallons per inch of pipe diameter per mile per day for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of 2 feet of water.
3. Deflection Testing: Deflection tests shall be performed on all non-rigid pipe. The tests shall be conducted after the final backfill has been in place at least 30 days in order to permit stabilization of the soil-pipe system. No pipe shall exceed a deflection of 5 percent of the inside diameter. If deflection exceeds 5 percent, the pipe shall be excavated, replaced and retested. For piping 48-inch diameter or smaller a rigid ball or mandrel shall be used for the deflection test which shall have a diameter not less than 95 percent of the base inside diameter. The tests shall be performed without mechanical pulling devices. All non-rigid pipe larger than 48-inch diameter shall have deflection measurements performed directly using extension rulers, tape measures, etc., at 10-foot increments using the same criteria used for the mandrel device.

3.6 PROTECTION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

C. Cap open ends of piping during periods of Work stoppage.

D. Repair any existing utilities/structures or features damaged during installation of sanitary sewerage utilities to Owner’s satisfaction, and at no cost to Owner.

3.7 CLOSED-CAPTION TELEVISION (CCTV) INSPECTION:

A. CCTV inspection shall be performed on all installed piping in accordance with Specification Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.

END OF SECTION 33 42 00

SECTION 33 42 13 - STORMWATER CULVERTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Corrugated steel pipe culvert.
2. Aluminum pipe culvert.
3. Concrete pipe culvert.
4. Concrete box sections.
5. Polyethylene (PE) pipe culvert.
6. Polyvinyl chloride (PVC) pipe culvert.
7. Bedding and cover materials.
8. Concrete encasement and cradles.
9. Slope protection at pipe end.

B. Related Requirements:

1. Section 03 60 00 – Grouting: Cementitious Grout.
2. Section 31 23 19 – Dewatering.
3. Section 33 23 33 – Trenching and Backfill.
4. Section 31 37 16.13 – Rubble-Stone Riprap.
5. Section 31 50 00 – Excavation Support Systems.
6. Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.

1.2 DEFINITIONS

A. Culvert: A structure designed to provide an opening under a road etc., usually for the transportation of water.

B. Geotextile: Flexible, permeable fabrics consisting of synthetic fibers or yarns oriented into a dimensionally stable network. Uses include, but are not limited to, as a blanket for filtration applications, liner, separator and for stabilization of subgrade and subbase materials.

C. Invert: The lowest interior elevation of a sewer, culvert or tunnel.

1.3 STANDARDS

Except as modified herein, comply with the latest version of the following standards:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M36 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
2. AASHTO M170 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
3. AASHTO M196 - Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.
4. AASHTO M245M - Standard Specification for Corrugated Steel Pipe, Polymer Precoated, for Sewers and Drains.

B. ASTM International:

1. ASTM A740 - Standard Specification for Hardware Cloth (Woven or Welded Galvanized Steel Wire Fabric).
2. ASTM A760 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains).
3. ASTM A762/A762M - Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains.
4. ASTM B745 - Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains).
5. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
6. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
7. ASTM C507 - Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
8. ASTM C1577 - Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD.
9. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3.
10. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
11. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
12. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
13. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
14. ASTM F758 - Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage.
15. ASTM F2306/F2306M - Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile- Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
16. ASTM F2648/F2648M - Standard Specification for 2 to 60-inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.

1.4 COORDINATION

A. Comply with Section 01 30 00 - Administrative Requirements.

B. Coordinate Work of this Section with termination of storm sewer, trenching, and connection to public storm sewer.

C. Notify affected utility companies at least 3 days prior to construction.

1.5 SUBMITTALS

A. Comply with requirements in Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer information indicating proposed materials, accessories and details prior to the ordering or manufacture of the materials.

C. Submit detailed description of procedures for horizontal directional drilling and pipe jacking installation.

D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

E. Manufacturer Instructions: Indicate special procedures required to install specified products.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

C. Closed-Caption Television (CCTV) Inspection:

1. Comply with Section 33 01 30.16 – Sanitary Sewer Pipeline Inspection.
2. All culverts and other appurtenances shall be CCTV or visual-inspected prior to Substantial Completion of the sewer items.
3. The CCTV inspections or visual inspections shall be performed after completion of the culvert items before Substantial Completion is issued.

1.7 QUALITY ASSURANCE

A. Perform Work according to DWSD standards.

B. Maintain one (1) copy of each standard affecting Work of this Section on-site.

1.8 QUALIFICATIONS

A. The Owner shall at all times have access to all places of manufacture where materials are being fabricated or tested and shall be at liberty at all times to inspect all materials and observe all tests on the materials. Any materials which, in the opinion of the Engineer, are not in conformity with the specifications herein stated, or the drawings submitted to the Engineer as herein required, will be rejected and shall be removed from the site immediately.

B. Unless otherwise specified herein, materials shall be manufactured, tested and inspected by the manufacturer in the manner required by the latest version of ASTM specifications and AWWA/ANSI standards. Such tests shall be at the Contractor's expense. Furnish to the Engineer two certified copies of the results of all materials tests and inspections.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage. Any materials which, in the opinion of the Engineer, are not in conformity with the specifications or the Drawings will be rejected and shall be removed from the site immediately.

B. Storage:

1. Store materials according to manufacturer instructions.
2. Non-rigid pipe shall be stored to prevent bowing. Pipe and fittings with visible cracks, breakage or other defects shall not be used, or repaired and used, unless specifically accepted by Engineer in writing.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Plastic pipe shall be kept covered to prevent exposure from ultra-violet exposure of sun.
3. Block individual and stockpiled pipe lengths to prevent moving.
4. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PIPE CULVERT

A. Corrugated Steel Pipe:

1. Comply with ASTM A762, A760, AASHTO M36, AASHTO M245M.
2. Finish: Galvanized-Polymer pre-coated comply with AASHTO M245M, ASTM A762 or metallic coated comply with AASHTO M36, ASTM A760.
3. Joints: HUGGER bands or approved equal with O-ring gaskets per Manufacturer recommendations.
4. Shape: Circular and pipe arch.
5. End Sections: Prefabricated units equal to the size, strength and material to which it is joined. Attached per manufacturer's recommendations.

B. Corrugated Aluminum Pipe:

1. Comply with ASTM B745, AASHTO M196.
2. Joints: HUGGER bands or approved equal with bolt, bar and strap connector and gasket per Manufacturer recommendations.
3. Shape: Circular and pipe arch.
4. End Sections: Prefabricated units equal to the size, strength and material to which it is joined. Attached per manufacturer's recommendations.

C. Reinforced Concrete Piping:

1. Circular Piping: Comply with ASTM C76, Class IV, with Wall Type B minimum.
2. Elliptical Piping: Comply with ASTM C507, Class HE-1 through HE-IV or VE-II through VE-VI, as specified on the plans.
3. All reinforced concrete pipe shall be manufactured using Type II Cement unless otherwise approved by the Engineer.
4. Reinforcement: Steel Wire Mesh.
5. End Connections: Bell and spigot.
6. Fittings: Reinforced concrete.
7. Joints:
    a. Rubber compression gasket.
    b. Comply with ASTM C443.

D. Precast Concrete Box Sections: Use precast concrete box sections as required and in accordance with ASTM C 1577.

E. Concrete End Sections:

1. Provide precast concrete end sections fabricated using material meeting the requirements of AASHTO M 170, for Class II, and as shown on the plans. Use tongue and groove joints to make connections to pipe culverts.
2. Steel Grates for end sections: as per MDOT standard plan R-92-C.

F. Corrugated High-Density Polyethylene (HDPE) Piping:

1. Pipe:
   a. Comply with ASTM F2648.
   b. Type: Dual wall Smooth interior.

2. Fittings: Conform to ASTM F2306.
3. Joints: Reinforced integral bell & gasketed spigot, Comply with ASTM F2648. And Watertight, according to requirements of ASTM D3212.
   Gaskets: Comply with ASTM F477.

G. Perforated PVC underdrain:

1. Smooth pipe ASTM D3034 Sewer SDR35, perforations comply with ASTM F758 with Cell Classification 12454 as defined in ASTM D1784.
2. Joints: solvent welded or elastomeric gasket joints conform to ASTM F477.
3. Underdrain outlets: Smooth pipe ASTM D3034 Sewer SDR 23.5.

H. Pipe for Downspouts:

1. Corrugated steel pipe as specified in Subsection 2.1.A.
2. Corrugated aluminum pipe as specified in Subsection 2.1.B.
3. HDPE Piping as specified in Section 2.1.F.

2.2 MATERIALS

A. Bedding and Cover:

1. Bedding: Fill Type as specified in Section 31 23 33 – Trenching and Backfill.
2. Cover: Fill Type as specified in Section 31 23 33 – Trenching and Backfill.

2.3 MIXES

A. Fill at Pipe Ends: Riprap as specified in Section 31 37 16.13 - Rubble-Stone Riprap.

B. Fill at Pipe Ends: Concrete grout fill as specified in Section 03 60 00 – Grouting.

2.4 ACCESSORIES

A. Geotextile Filter Fabric: As specified in Section 01 57 13 – Erosion Control Sedimentation and Containment of Construction Materials.

B. Rodent Screens:

1. Material:

a. Hardware cloth, comply with ASTM A 740 with an opening size no greater than 0.30 inch with wire of a nominal size of 0.057-inch and a minimum zinc coating weight of 0.59 ounce per square foot of uncoated wire surface, applied after weaving.
b. Type 304 stainless steel wire with an opening no greater than 0.30-inch and a 0.057-inch nominal wire diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that trench cut is ready to receive Work of this Section.

C. Verify that excavations, dimensions, and elevations are as indicated in Contract Documents.

D. Verify excavation for manholes to proper depth and proper placement of bedding material.

3.2 PREPARATION

A. Correct over-excavation with bedding material as specified in Section 31 23 33 – Trenching and Backfill.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.
3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Excavation and Bedding:

1. Excavate pipe trench as specified in Section 31 23 33 – Trenching and Backfill.
2. Excavate to lines and grades as indicated in Contract Documents or as required to accommodate installation of encasement.
3. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation as specified in Section 31 23 19 – Dewatering.

4. Provide sheeting and shoring as specified in Section 31 50 00 – Excavation Support Systems.
5. Pile Support Systems:
    a. Install pile support systems as specified in Section 31 50 00 – Excavation Support Systems.
    b. Install utilities on pile support systems as indicated in Contract Documents.
6. Placement: Place bedding material at trench bottom as specified in Section 31 23 33 – Trenching and Backfill.

B. Culvert:

1. Positioning:
    a. Lift or roll culvert into position; do not drop or drag culvert over prepared bedding.
    b. Shore culvert to required position and retain in place until after compaction of adjacent fills.
    c. Ensure that pipe remains in correct position and to required slope.
2. Backfilling and Compaction:
    a. Level fill materials in continuous layers not exceeding 8 inches in depth and compact to 95 percent maximum density.
    b. Do not displace or damage pipe while compacting.
    c. Install cover at sides and over top of pipe.
    d. Install cover to minimum compacted thickness of 12 inches and compact to 95 percent maximum density.
    e. Maintain optimum moisture content of bedding material to attain required compaction density.
    f. Place geotextile fabric over backfill as indicated on Drawings.
3. Install culvert end gratings.

C. Pipe Ends:

1. Place fill at pipe end at embankment slopes, or as indicated on Drawings.
2. Level fill materials in continuous layers not exceeding 8 inches in depth and compact to 95 percent maximum density.

3.4 TOLERANCES

A. Comply with Section 01 40 00 – Quality Requirements.

B. Maximum Variation from Indicated Slope: 1/8-inch in 10-feet.

3.5 FIELD QUALITY CONTROL

A. Comply with Section 01 40 00 – Quality Requirements.

B. Comply with Section 01 70 00 – Execution and Closeout Requirements.

C. Inspection: Request inspection from Engineer prior to placing aggregate cover over pipe.

D. Compaction Testing:

1. Comply with ASTM D698.
2. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.

3.6 PROTECTION

A. Comply with Section 01 70 00 – Execution and Closeout Requirements.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

C. Repair linings, coatings and coverings damaged during construction with accepted materials equal to and compatible with original lining, coating or covering. Repair damaged galvanizing with zinc-rich paint.

D. Repair any existing utilities/structures or features damaged during installation of sewerage utilities to Owner's satisfaction, and at no cost to Owner.

END OF SECTION 33 42 13

SECTION 33 44 20 – VERTICAL DRAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vertical drains.
2. Filter aggregate and fabric.
3. Bedding.

B. Related Requirements:

1. Section 31 05 17 – Aggregates for Storm Water Management.
2. Section 31 24 00 – Bioretention.

1.2 STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M304 – Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter.

B. ASTM International:

1. ASTM D1785 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
2. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow applications.
3. ASTM A536 – Standard Specification for Ductile Iron Castings.

1.3 COORDINATION

A. Comply with coordination requirements in Section 01 30 00 - Administrative Requirements.

B. Coordinate Work of this Section with the bioretention construction or other storm water management facilities as necessary.

1.4 SUBMITTALS

A. Comply with requirements in Section 01 33 00 - Submittal Procedures.

B. Product Data: Manufacturer information on pipe drainage products, pipe accessories, and filter fabric.

C. Shop Drawings: Indicate locations, and depths and lengths.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statement: Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of vertical drains and principal invert elevations.

1.6 QUALITY ASSURANCE

A. Perform Work according to DWSD standards.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on-site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PIPING

A. Suppliers: Furnish materials according to AASHTO standards.

B. Description:

1. Material: PVC.
2. Comply with AASHTO M304 and ASTM D1785.
3. Nominal Diameter: 12 inches.
4. Perforated, Prewrapped with Geotextile.
5. Unperforated.
6. Ends: Plain.
7. Fittings: PVC.

2.2 MATERIALS

A. Stone Aggregate and Backfill: Aggregate for pipe fill shall be clean, double washed AASHTO #57 stone, and backfill around the vertical pipe shall be clean, AASTHO #8 stone, as specified in Section 31 05 17 - Aggregates for Storm Water Management.

2.3 ACCESSORIES

A. Pipe Couplings: Solid PVC.

B. Filter Fabric:

1. Type: Water pervious.
2. Material: Black polyolefin or polyester.

C. Grate:

1. Type: Solid Cover.
2. Material: Ductile Iron complying with ASTM A536.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that augured hole is ready to receive Work. The augured hole shall be 6 inches wider than the pipe diameter to allow backfilling with aggregate of 3 inches around of the vertical pipe.

C. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Comply with Section 01 70 00 - Execution and Closeout Requirements.

B. Hand trim excavations to indicated elevations.

C. Remove large stones or other materials that could damage drainage piping or could impede consistent backfilling or compaction.

3.3 INSTALLATION

A. Install perforated and unperforated vertical pipe assembly in augured hole as per plans. If the top of the infiltration column is installed at the ground surface, the infiltration column shall be solid (non-perforated) for at least three (3) feet below any easily erodible materials such as bioretention planting soil, sand, or native soils. The infiltration column shall have perforations within the uniformly graded stone as depicted on the Construction Drawings. Perforations shall be three-eighths (0.375) inch diameter, drilled vertically and radially two (2) inches apart, on center, and offset one (1) inch every other row.

B. Install in accordance with ASTM D2321.

C. Place drainage piping on clean-cut subsoil.

D. Install pipe couplings. Top cover of infiltration column shall be twelve (12) inch diameter ductile iron solid cover per ASTM A536 70-50-05. Solid cover shall be lockable.

E. Aggregate Fill: Install AASHTO #57 aggregate inside vertical drain pipe; fill to the top. Install AASHTO #8 backfill stone around the pipe as depicted on Construction Drawings.

3.4 FIELD QUALITY CONTROL

A. Comply with testing, adjusting, and balancing requirements in Section 01 70 00 - Execution and Closeout Requirements.

B. Request inspection of installation by Engineer prior to placing aggregate inside vertical drain.

C. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

3.5 PROTECTION

A. Comply with protecting finished Work requirements in Section 01 70 00 - Execution and Closeout Requirements.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION 33 44 20