CITY OF REPUBLIC, MISSOURI
STANDARD SPECIFICATIONS AND DETAILS
FOR WATER AND SEWER CONSTRUCTION

September 2023

This page was intentionally left blank.

CITY OF REPUBLIC, MISSOURI
STANDARD SPECIFICATIONS AND DETAILS FOR
WATER AND SEWER CONSTRUCTION

TABLE OF CONTENTS

SPECIFICATIONS

STANDARD DETAILS

16 SEWER SERVICE CONNECTION
17 SLOPE ANCHOR
18 STANDARD MANHOLE DETAIL
19 STANDARD OUTSIDE DROP MANHOLE DETAIL
20 STANDARD INSIDE DROP MANHOLE DETAIL
21 STRADDLE BLOCK
22 TAPPING SLEEVE AND VALVE
23 THRUST BLOCK
24 VALVE EXTENSION BOX
25 WATER SERVICE DETAIL
26 BACKWATER VALVE DETAIL
27 EMBEDMENT OF PIPE
28 ASPHALT STREET REPAIR
29 CONCRETE STREET REPAIR
30 TYPICAL STREET SECTIONS
31 CONCRETE CURB AND GUTTER
32 CONCRETE SIDEWALK AND DRIVEWAY
33 CURB RAMP TYPE I
34 CURB RAMP TYPE II
35 CONCRETE JOINT DETAILS
36 CURB INLETS 18” OR LESS
37 CURB INLET 21” OR GREATER
38 TOP SLAB REINFORCEMENT
39 RING AND COVER FOR CURB INLETS
40 CONCRETE CULVERT CAP-DRIVEWAYS
41 RIPRAP

SECTION 010000 – DEFINIITIONS, SUBMITTALS, AND PROCEDURES:

A. BASIC DEFINITIONS – general terms used in these Construction Specifications for Public Improvements are covered in this Section.

City
The City of Republic, Missouri. The governmental entity which will assume ownership of the completed Public Improvements Work from the Developer/Owner following the City's inspection of the completed Public Improvements Work and finding that the completed Public Improvements Work meets all the requirements set forth by the City for the construction of public improvements in the City of Republic, Missouri.

Contractor
Any person, firm or corporation with whom the Developer/Owner enters into an agreement to perform the Work for the Project, including any Public Improvements.

Developer/Owner
The person, firm, or corporation owning the property being developed and owning the Public Improvements Work until the Public Improvements Work is completed, approved and accepted by the City. The person, firm, or corporation who will transfer ownership of the Public Improvements Work to the City upon completion of the Public Improvements Work and the approval and acceptance thereof by the City.

Engineer
The person, firm, or corporation, licensed to perform engineering services in the State of Missouri, whom the Developer/Owner employs to prepare drawings and specifications covering the Work, including any Public Improvements, and whom the Developer may designate as a representative to communicate with the Public Works Department.

Inspector
The person, firm, or corporation, designated to perform inspections and oversee the construction of Work for the Project on behalf of the City of Republic

Nonconformance

Non-conformance
Any work found to be non-compliant by the Builds Administrator or his designee with these specifications, references and codes adopted by the City, and references and codes applicable to the construction project as required by the State of Missouri.

Project
The total construction of which the Work to be provided under the Construction Specifications may be the whole, or part as indicated elsewhere in the Construction Specifications or on the City approved construction drawings.

Right of Way Manager
The appropriate governmental entity responsible for the management and oversight of a public right of way affected by the proposed work. For the City of Republic roads, the Public Works Director or his designee. For County roads the Greene County Highway Department Administrator or his designee. For State roads the Missouri Department of Transportation Southwest District, District Engineer or his designee.

Work
The entire completed construction of the various separately identifiable parts thereof required to be furnished under the Construction Specifications and the City approved construction drawings. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all as required by the Construction Specifications.

B. PROJECT MEETINGS

1. Preconstruction

   a. Public Works Department will administer a meeting prior to commencement of any improvements to establish a working understanding between the parties as to their relationships during conduct of the Work.

   b. Preconstruction conference shall be attended by:

      (1) Contractor and their superintendent.

      (2) Representatives of principal Subcontractors and Suppliers.

      (3) Public Works Department staff.

      (4) Developer/Owner or their representative.

   c. Agenda:

      (1) Projected construction schedules.

      (2) Critical Work sequencing.

      (3) Project coordination.

      (4) Procedures and Processing of:

         (a) Field decisions.

         (b) Substitutions.

         (c) Submittals.

         (d) Procedures for testing.

         (e) Procedures for maintaining record documents.

C. SUBMITTALS

1. Compliance Submittals include shop drawings and product data which are prepared by the Contractor, Subcontractor, manufacturer, or Supplier and submitted by the Contractor to the Engineer as a basis for approval of the use of EQUIPMENT AND MATERIALS proposed for incorporation in the Work or needed to describe installation, operation, maintenance, or technical properties.

a. Shop drawings include custom-prepared data of all types including drawings, diagrams, material schedules, templates, instructions, and similar information not in standard printed form applicable to other projects.

b. Product data includes standard printed information on materials, products and systems; not custom-prepared for this Project, other than the designation of selections from available choices.

c. Compliance submittals shall include, but are not limited to the following:

(1) Manufacturer's specifications.

(2) Catalogs, or parts thereof, of manufactured equipment.

(3) Shop fabrication and erection drawings.

(4) Concrete mix design information.

(5) All drawings, catalogs or parts thereof, manufacturer's specifications and data, samples, instructions, and other information specified or necessary.

(6) Record drawings

2. Submittals shall be complete with respect to dimensions, design criteria, materials of construction, and other information specified to enable Engineer to review the information effectively.

3. All words and dimensional units shall be in the English language. Metric dimensional unit equivalents may be stated in addition to the English units.

4. Contractor shall maintain in a safe place at the site one record copy of all Drawings, Specifications, and Addenda in good order and annotated to show all changes made during construction. Upon completion of the Work, these record documents will be delivered to the Engineer who shall provide reproducible copies of the revised drawings to the City.

D. TEMPORARY BARRIERS AND CONTROLS

1. Protection of Work and Property.

a. General

(1) Provide protection, at all times, against rain, wind, storms, frost, freezing, condensation, or heat so as to maintain all Work and Equipment and Materials free from injury or damage. At the end of each day all new Work likely to be damaged shall be appropriately protected.

(2) Notify Inspector immediately at any time operations are stopped due to conditions which make it impossible to continue operations safely or to obtain proper results.

(3) Construct and maintain all necessary temporary drainage and do all pumping necessary to keep excavations, floors, pits, trenches, manholes, and ducts free of water.

b. Property Other than Developer's/Owner's:

(1) Report immediately to the owners thereof and promptly repair damage to existing facilities resulting from construction operations.

(2) Names and telephone numbers of representatives of agencies and utilities having jurisdiction over streets and utilities in the Work area can be obtained from the City for the agencies listed below. Concerned agencies or utilities shall be contacted a minimum of 48 hours prior to performing Work, closing streets and other traffic areas, or excavating near underground utilities or pole lines.

(a) Water.

(b) Gas.

(c) Sanitary sewers.

(d) Storm drains.

(e) Pipeline companies.

(f) Telephone.

(g) Electric.

(h) Municipal streets.

(i) Fire.

(j) Police.

(k) Right of Way Manager

(3) Operation of valves or other appurtenances on existing utilities, when required, shall be by or under the direct supervision of the owning utility.

(4) Where fences are to be breached on private property, the owners thereof shall be contacted, and arrangements made to ensure proper protection of any livestock or other property thus exposed.

(5) The applicable requirements specified for protection of the Work shall also apply to the protection of existing property of others.

(6) Before acceptance of the Work by City, restore all property affected by Contractor's operations to the original or better condition.

2. Barriers.

a. Furnish, install, and maintain suitable barriers as required to prevent public entry, protect the public, and to protect the Work, existing facilities, trees, and plants from construction operations. Remove when no longer needed or at completion of Work.

b. Barriers shall be required on all unattended excavations and at the direction of the Inspector.

c. Materials may be new or used, suitable for the intended purpose, but must not violate.

d. requirements of applicable codes and standards or regulatory agencies.

e. Barriers shall be of a neat and reasonable uniform appearance, structurally adequate for the required purposes.

f. Maintain barriers in good repair and clean condition for adequate visibility.

g. Relocate barriers as required by progress of Work.

h. Repair damage caused by installation and restore area to original or better condition and clean the area.

3. Environmental controls.

a. Dust Control

(1) Provide positive methods and apply dust control materials to minimize raising dust from construction operations; and to prevent airborne dust from dispersing into the atmosphere.

b. Water and Erosion Control

(1) Provide methods to control surface water to prevent damage to the Project, the site, or adjoining properties.

(2) Plan and execute construction and earthwork by methods to control surface drainage from cut, fill, borrow, and waste disposal areas, to prevent erosion and sedimentation.

(a) Hold the areas of bare soil exposed at one time to a minimum.

(b) Provide temporary control measures such as berms, dikes, drains and erosion barriers.

(3) Control fill, grading, and ditching to direct surface drainage away from excavations, pits, tunnels, and other construction areas; and to direct drainage to proper runoff.

(4) Provide, operate, and maintain hydraulic equipment of adequate capacity to control surface and groundwater.

(5) Dispose of drainage water in a manner to prevent flooding, erosion, or other damage to any portion of the site or to adjoining areas.

c. Debris Control and Clean-Up:

(1) Keep the premises free at all times from accumulations of debris, waste materials, and rubbish caused by construction operations and employees. Responsibilities shall include:

(a) Adequate trash receptacles about the site, emptied promptly when filled.

(b) Periodic cleanup to avoid hazards or interference with operations at the site and to maintain the site in a reasonably neat condition.

d. Pollution Control:

(1) Provide methods, means, and facilities required to prevent contamination of soil, water, or atmosphere by the discharge of hazardous or toxic substances from construction operations.

(2) Provide equipment and personnel, perform emergency measures required to contain any spillages, and to remove contaminated soils or liquids. Excavate and dispose of any contaminated earth off-site in approved locations deemed acceptable by the appropriate regulatory agency and replace with suitable compacted fill and topsoil.

(3) Take special measures to prevent harmful substances from entering public waters, sanitary sewers, storm sewers, or waters of the state.

4. Traffic control and use of roadways.

a. Provide, operate, and maintain equipment, services, and personnel, with traffic control and protective devices, as required to expedite vehicular traffic flow on haul routes, at site entrances, on-site access roads, and parking areas. This includes traffic signals and signs, flagmen, flares, lights, barricades, and other devices or personnel as necessary to adequately protect the public. Traffic control measures shall be reviewed and approved by the Right of Way Manager.

b. Remove temporary equipment and facilities when no longer required. Restore grounds to original, better, or specified condition when no longer required.

c. Provide and maintain suitable detours or other temporary expedients if necessary.

d. Bridge over open trenches where necessary to maintain traffic.

e. Consult with governing authorities to establish public thoroughfares which will be used as haul routes and site access. All operations shall meet the approval of owners or agencies having jurisdiction.

f. Repair roads, walkways, and other traffic areas damaged by operations. Keep traffic areas as free as possible of excavated materials and maintain in a manner to eliminate dust, mud, and hazardous conditions.

g. All operations and repairs shall meet the approval of owners or agencies having jurisdiction.

E. NON-CONFORMANCE CORRECTIVE ACTION PROCEDURE

1. All instances of non-conformance will be reported as follows:

   a. 1st Non-conformance Report (NCR): The General Contractor will receive a verbal warning/ discussion on site of how contractor will resolve the non-conformance issue. The warning will be inclusive of repercussions for the next NCR.

   b. 2nd NCR: The General Contractor would be required to stop work for the remainder of the working day. A formal letter or email shall be sent to the Builds Department stating, in detail, the corrective action taken to resolve the NCR.

   c. 3rd NCR: The General Contractor would be issued a stop work order. A formal meeting shall be held in the Builds Department between the General Contractor and the Build's Department Project Manager and Inspector to discuss stoppage of work and planned resolution to resolve the NCR(s).

2. Timeframe:

   a. The General will be given seven (7) calendar days at the issuance of an NCR to resolve the issues.

F. ENGINEER'S FINAL CERTIFICATION OF COMPLETION

1. The Engineer shall perform site inspections as necessary to provide the City with a Certificate of Completion. Certificate shall state that all improvements have been constructed in general compliance with the City approved construction drawings and City Construction Specifications. Certificate of Completion shall bear the name, signature, current date and Missouri Registration Number of the Engineer.

2. Upon completion of the sanitary sewer line the Engineer shall submit a copy of the duly executed "Application for Letter of Authorization" along with all testing data to the City of Republic and to the Missouri Department of Natural Resources. Upon the City's receipt of the Letter of Authorization from Missouri Department of Natural Resources the sanitary sewer line will be allowed to be placed in service.

3. Upon completion of the water main the Engineer shall submit a copy of the duly executed "Application for Water Main Extension - Final Construction Approval" along with all testing data to the City of Republic and to the Missouri Department of Natural Resources. Upon the City's receipt of the Final Construction Approval from Missouri Department of Natural Resources the water main will be allowed to be placed in service.

END OF SECTION 010000

This page was intentionally left blank.

SECTION 012000 – RIGHT OF WAY TECHNICAL SPECIFICATIONS:

PART 1 - GENERAL

1.01 RELATED SPECIFICATIONS

A. Work related to the following shall be covered in Section 312050 – Site Preparation and Earthwork:
   1. Subgrade preparation.
   2. Excavating.
   3. Trenching.
   4. Sheeting & Shoring
   5. Filling.
   6. Embankment construction.
   7. Backfilling including controlled low-strength material (CLSM).
   8. Compacting.
   9. Grading.
   10. Riprapping.
   11. Topsoiling.

B. Section 329200 – Seeding and Sodding

PART 2 - CONSTRUCTION

2.01 SUMMARY OF WORK:

A. Work Covered by These Specifications: shall consist of any and all utility work performed or to be performed in, under, or through easements, rights-of-way, streets, or alleys owned by the City of Republic, including but not limited to water supply, sanitary sewer, storm sewer, telephone, fiber optic cable, gas pipelines, electrical conduit or conductors, cable television lines, and telecommunication facilities. It is to include repair of street cuts, required final grading, clean up, disposal of surplus materials and seeding or sodding.

B. Work Sequence: Permit Holder, or their Contractor shall schedule their work to allow emergency vehicle access to public and private property at all times. Private drives and public streets and alleys shall be opened for use at the end of each workday, unless prior written consent issued by the City.

C. The Permit Holder shall confine construction equipment, storage of materials and equipment, and operations or workers to areas within the public right-of-way and easements of record as indicated on the drawings or as directed by the Engineer. If Permit Holder proposes to use any private property for their use, they shall be solely responsible for making arrangements for such use with the property owner. The City shall not be liable for any damages caused by Permit Holder's use of such property.

2.02 EXISTING INSTALLATION AND STRUCTURES

A. Utility poles, pipelines and other existing above ground and underground installations and structures in the vicinity of the Work are to be indicated on the plans according to the best information available to the Permit Holder, City and Engineer.

B. Permit Holder shall make every effort to protect such installations and structures. They shall contact the Owners of such installations and structures and prospect in advance of trench excavation. Any delays or extra cost to the Permit Holder caused by such installations and structures, whether shown on the plans or not, or found on locations different than those indicted, shall not constitute a claim against the City for extra work, additional payment, or damages.

C. Damage to existing above ground and underground installation or structures caused by the Permit Holder shall be repaired by the Permit Holder as directed by the Owner of such installation or structure. The Owner of such installation or structure shall be notified immediately of any such damage and repairs made as soon as possible to keep the interruption of service to a minimum. The Permit Holder shall bear any costs assessed because of such repairs and shall hold the City

harmless

2.03 TRAFFIC CONTROL & SAFETY

A. The Permit Holder shall conduct their work as to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, the Permit Holder shall at their own expense provide and maintain suitable and safe bridges, detours or other temporary expedients for the accommodations of public and private travel, and shall give reasonable notice to the Owners of private drives before interfering with them. Prior to interfering with the public travel in any way, the Permit Holder shall notify the City with information as to the extent of the interference and the length of time of such interference.

B. All streets, roads, highways, and other public thoroughfares, which are closed to traffic, shall be protected by means of effective barricades on which shall be placed acceptable warning signs. Barricades shall be located at the nearest intersecting public highway or street on each side of the blocked sections.

C. All barricades, signs, lights and other protective devices shall be installed and maintained in conformity with the Manual of Uniform Traffic Control Devices and applicable statutory requirements, and where within highway rights-of-way, as required by the authority having jurisdiction there over.

D. All open trenches and other excavations shall be provided with suitable barriers, signs and lights to the extent that adequate protection is provided to the public. Obstructions, such as material piles and equipment, shall be provided with similar warning signs and lights. All barricades and obstructions shall be illuminated by means of warning lights at night. All lights used for this purpose shall be kept burning from sunset to sunrise. Materials stored upon or alongside public streets shall be so placed, and the work at all times shall be so conducted, as to cause the minimum obstructions and inconvenience to the traveling public.

2.04 INFRASTRUCTURE INSTALLATION

A. Infrastructure to be installed and dedicated to the City shall be installed in compliance with all applicable sections of this specification.

B. Infrastructure to be owned and operated by an entity other than the City Shall be installed in conformance to owners individual specifications and shall not interfere with the City's Infrastructure.

2.05 PIPE EMBEDMENT

A. Granular fill material shall be used as shown on the detail plans. Granular fill may be crushed rock or gravel and shall meet the requirements for Type 2 Aggregate for Base, Gradation B, Missouri Standard Specifications for Highway Construction. For water mains the granular fill shall be placed under and around the pipe up 12" above top of pipe. For sewer lines granular fill shall be placed under and around the pipe up to an elevation at least 12 inches above the barrel of the pipe. Natural gas lines may be directly bedded, without granular fill, if so directed by the Engineer for the installing natural gas utility. Granular fill material shall be placed in a manner as to provide uniform and continuous support and shall not disturb alignment of the pipe during placement.

B. Compacted Backfill:

1. 90% compaction will be required where the line passes under lawns, pasture, and within the street right-of-way.
2. The average density of the trench backfill shall be 90% of maximum density. Material shall be placed in lifts as required for adequate compaction with variations in lift thickness depending on soil and on method of compaction. Completed backfill shall have no less than 90% density, excluding the top few inches to be used as seedbed or for bedding sod.

3. Compaction may be by hand tamping, tamping machine, or other methods approved by the Engineer. Permit Holder will prepare test pits for sampling and testing and evaluation of compaction procedures to be conducted by the Permit Holder at Inspectors request.
4. 95% compaction will typically be required under streets, driveways, and walkways. Flowable fill may be used instead of compacted backfill.
5. Placement of material and compaction for 95% compacted backfill shall be as described above for 90% compacted backfill except a minimum of 95% of maximum density must be maintained throughout the backfill.
6. Wherever the terms " % of Maximum Density" or "Optimum Moisture" are used, Maximum Density and Optimum Moisture shall be determined by the Standard Compaction Test as defined by ASTM D698.
7. Field Density Test: Field density shall be obtained using the sand cone method (ASTM D1556), by the balloon method (ASTM D2167), or nuclear density gauge (ASTM D2922). The calculated density obtained in this test is divided by the Maximum Density as determined by the Standard Compaction Test to determine the percent compaction obtained.

C. Responsibility of Permit Holder for Backfill Settlement:
1. Where 90% and 95% compaction is called for, the Permit Holder shall be responsible financially, and otherwise, for a period of one year after completion of work, for
   a. All settlement of trench and other backfill which may occur from time of original backfilling
   b. The refilling and repair of all backfill settlement and the repair or replacement to the original or a better condition of all pavement, top surfacing, driveways, walks, surface structures, utilities, drainage facilities, and sod which have been damaged as a result of backfill settlement or which have been removed or destroyed in connection with backfill replacement operations.
   c. All damage claims or court actions against the City for any damage directly or indirectly caused by backfill settlement.
2. The Permit Holder shall make, or cause to be made, all necessary backfill replacements, and repairs or replacements appurtenant thereto, within thirty days after due notification by the Engineer or City.

2.06 DRAINAGE MAINTENANCE

A. Trenches across roadways or driveways adjacent to drainage ditches or water courses shall not be backfilled prior to the completion of backfilling of the trench on the upstream side of the roadway to prevent the impounding of water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by the Permit Holder. Backfilling shall be done so that water will not accumulate in unfilled or partially filled trenches. All material deposited in roadway ditches or other water courses crossed by the line of trench shall be removed immediately after backfilling is completed and the section grades and contours of ditches or water courses shall be restored to their original condition. Surface drainage shall not be obstructed longer than necessary.

2.07 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. All excess excavated materials shall be disposed of away from the site of the Work. The Permit Holder shall be responsible for locating areas for disposal of such materials.

B. Excavated rock in excess of the amount permitted to be actually installed in trench backfill, junk, and debris encountered in excavation work, and other similar waste material shall be disposed of away from the site of the Work.

PART 3 - CLEAN UP AND RESTORATION

3.01 GENERAL

A. The Permit Holder shall restore all surfaces equal to or better than its original condition unless otherwise approved by the City. Restoration includes pavement, sidewalks, alleys, lawns, etc.

B. Seeding and fertilizing is required where any utility excavation crosses established lawns, pastureland or right-of-way of the City or in other areas regularly grassed and mowed and shall be in conformance with Section 329200 – Seeding and Sodding

3.02 STREET, DRIVEWAY, ALLEY, AND SIDEWALK REPAIRS:

A. Crushed Stone Surface:

1. Six inches of compacted stone base meeting Missouri Standard Specifications for Highway Construction, Section 1007.1, Type 1 Aggregate, is to be placed over cut portion of street or alley.

B. Concrete, Asphaltic Concrete and Other Asphaltic Surfaces:

1. All materials used shall conform to City of Republic specifications for such use.
2. All pavement is to be saw cut prior to removal. Repairs to streets, driveways, and alleys disturbed by Work in City rights-of-way are to be made as follows:
   a. New pavement shall have a width of at least 12” greater than the trench width. Each repair area in concrete or asphalt streets shall be first cut on each side for the full depth with a concrete saw. The material shall be removed so that no damage occurs to the surrounding pavement. If any damage occurs to the surrounding pavement, then the damaged areas will be removed.
   b. For concrete pavements, the concrete thickness of the repair shall be at least 8” minimum thickness or shall match existing pavement thickness, whichever is greater. Reinforcement shall be placed with #5 bars at 18” o.c., transverse and a minimum of three #4 bars longitudinal. Concrete used for repair shall meet Missouri Standard Specifications for Highway Construction for Pavement Concrete (501.2.2), and shall have a minimum cement content of 6.5 bags per cubic yard, a maximum slump of 4 inches, and a minimum compressive strength of 4000 psi at 28 days. To maintain or improve workability of the concrete material, approved admixtures may be added to the mix. No water shall be added to the mix to increase workability.
   c. For full depth asphaltic concrete pavements, the asphalt thickness of the repair shall be 4” or equal to thickness of existing pavement, or whichever is thicker. Replace the pavement with hot-mix asphalt and compact thoroughly in lifts not to exceed 4 inches each. Hot-mix asphalt shall be of a commercial mix design equivalent to Missouri Standard Specification Type I-C (403.3).
   d. For other asphalt surfaces and base preparation, the thickness shall be a total of at least 10”, consisting of 6” of rolled stone base (MoDOT Type I, or Type 3), compacted to 100% of Maximum Dry Density, and 4” of thoroughly compacted bituminous surfacing layer consisting of an approved commercial asphalt-aggregate mixture (Cold-mix).
   e. The top of all pavement repairs shall be flush with the existing pavement.
   f. Curbs and gutters to be replaced as required to match existing. Curbs and gutters are to be constructed of Concrete (6.5 bag mix).

PART 4 - SEPARATION OF WATER MAINS, SANITARY AND STORM SEWERS

4.01 PARALLEL INSTALLATION

A. Water mains shall be laid at least 10 feet horizontally from any existing or proposed sewer. The distance shall be measured edge to edge.

4.02 CROSSINGS

A. Water mains crossing sewers shall be laid to provide a minimum vertical clear distance of 18" between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. At crossings, the full length of water pipe shall be located so both joints will be as far from the sewer as possible.

B. Where 18" of vertical separation cannot be met, the lower utility main shall be encased in concrete, 10 feet in both directions from the crossing creating a 20 feet total length encasement.

4.03 SEWER MANHOLE

A. No waterline shall be located closer than 10 feet to any part of a sewer manhole.

4.04 PROTECTION OF WATER SUPPLIES

A. Cross Connections. There shall be no physical connections between a public or private potable water supply system and a sewer or appurtenance that would permit the passage of any wastewater or polluted water into the potable supply.

B. Relation to Water Works Structures. Sewers shall be laid at least fifty feet (50') in a horizontal direction from any existing or proposed public water supply well or other water supply sources or structures.

4.05 EXCEPTION

A. The Missouri Department of Natural Resources must specifically approve any variance from the requirements of Part 4 of this section, when it is impossible to obtain the specified separation distances. The Engineer shall request any such variance after all other remedies have been evaluated by the Engineer and City

PART 5 - INSURANCE REQUIREMENTS

5.01 WORKER'S COMPENSATION:

A. The coverage must include Employer's Liability with a minimum limit of $1,000,000 for each accident and cover all employees meeting Statutory Limits in compliance with the applicable state and federal laws.

5.02 COMPREHENSIVE GENERAL LIABILITY:

A. Coverage shall have minimum limits of $1,000,000 per Occurrence, Combined Single Limit for Bodily Injury and Property Damage Liability. This shall include: Premises and Operations, Independent Contractors, Products and Completed Operations, Broad Form Property Damage and XCU Coverage, and a Contractual Liability Endorsement.

5.03 BUSINESS AUTO LIABILITY:

A. Coverage shall have minimum limits of $1,000,000 per Occurrence, Combined Single Limit for Bodily Injury and Property Damage Liability, including Owned, Hired, and Non-owned Vehicles and Employee Non-ownership.

5.04 SPECIAL REQUIREMENTS:

A. The City of Republic is to be included as an Additional Insured on the Comprehensive General, Business Auto Liability and Builder's Risk Policies.

B. An appropriate Hold Harmless Clause shall be included.

C. Current, Valid insurance policies meeting the requirements herein identified shall be maintained during the duration of the named project. Renewal certificates or cancellation notices shall be sent to the CITY 30 days prior to any expiration date.

D. It shall be the responsibility of the contractor to ensure that all subcontractors comply with the

same insurance requirements that he is required to meet.

E. Certificates of insurance meeting the required insurance provisions shall be forwarded to the Public Work's Administrative Office.

END OF SECTION 012000

This page was intentionally left blank.

SECTION 221313 – SANITARY SEWERS:

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Work Specified Elsewhere:

1. Site Preparation and Earthwork: SECTION 312050.
2. Manhole Rim Adjustments: SECTION 330130.86.
3. Pipe Installation: SECTION 333150.
4. Utility Valves and Accessories: SECTION 331216.
5. Television Inspection of Sewers: SECTION 330130.11.

1.02 SUMMARY:

A. This Section includes:

1. Pipe and fittings.
2. Non-pressure and pressure couplings.
3. Expansion joints and deflection fittings.
4. Backwater valves.
5. Cleanouts.
6. Encasement for piping.
7. Manholes.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):

1. ACI International (ACI):
   a. ACI 318 - Building Code Requirements for Structural Concrete and PCA Notes.
   b. ACI 350/350R - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   c. ACI 350M/350RM - Metric Code Requirements for Environmental Engineering Concrete Structures and Commentary.
2. American Water Works Association (AWWA):
   a. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
   b. AWWA C110 - Ductile-Iron and Gray-Iron Fittings for Water.
   c. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
   e. AWWA C153 - Ductile-Iron Compact Fittings for Water Service.
   f. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   g. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   h. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 12 In. (100 mm through 300 mm), for Water Distribution.
   i. AWWA M23 - PVC Pipe - Design and Installation.
   j. AWWA M41 - Ductile-Iron Pipe and Fittings.
3. ASME International (ASME):
   a. ASME A112.14.1 - Backwater Valves.
   b. ASME A112.36.2M - Cleanouts.
4. ASTM International (ASTM):
   a. ASTM A48/A48M - Specification for Gray Iron Castings.
   b. ASTM A74 - Specification for Cast Iron Soil Pipe and Fittings.

c. ASTM A185/A185M - Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
d. ASTM A536 - Specification for Ductile Iron Castings.
e. ASTM A615/A615M - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
f. ASTM A674 - Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
g. ASTM A746 - Specification for Ductile Iron Gravity Sewer Pipe.
h. ASTM A888 - Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
i. ASTM B29 - Specification for Refined Lead.
j. ASTM C150 - Specification for Portland Cement.
k. ASTM C478 - Specification for Precast Reinforced Concrete Manhole Sections.
l. ASTM C478M - Specification for Precast Reinforced Concrete Manhole Sections .
m. ASTM C564 - Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
n. ASTM C890 - Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
o. ASTM C913-02 - Specification for Precast Concrete Water and Wastewater Structures.
p. ASTM C969-17 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
q. ASTM C1173 - Specification for Flexible Transition Couplings for Underground Piping Systems.
r. ASTM C1277 - Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
s. ASTM C1440 - Specification for Thermoplastic Elastomeric (TPE) Gasket Materials for Drain, Waste, and Vent (DWV), Sewer, Sanitary and Storm Plumbing Systems.
t. ASTM C1460 - Specification for Shielded Transition Couplings for Use with Dissimilar DWV Pipe and Fittings above ground.
u. ASTM C1461 - Specification for Mechanical Couplings Using Thermoplastic Elastomeric (TPE) Gaskets for Joining Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems for above and below Ground Use.
v. ASTM C1540 - Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
w. ASTM D1785 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
x. ASTM D2321 - Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
y. ASTM D2466 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
z. ASTM D2467 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
aa. ASTM D2774 - Practice for Underground Installation of Thermoplastic Pressure Piping.
aa. ASTM D2855 - Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
bb. ASTM D3034 - Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer

Pipe and Fittings.

cc. ASTM D3262 - Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
dd. ASTM D3753 - Specification for Glass-Fiber-Reinforced Polyester Manholes and Wet wells.
ee. ASTM D3839 - Guide for Underground Installation of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
ff. ASTM D3840 - Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Non-pressure Applications.
gg. ASTM D4101 - Specification for Polypropylene Injection and Extrusion Materials.
hh. ASTM D4161 - Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
ii. ASTM D5926 - Specification for Poly(Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems.
jj. ASTM F477 - Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
kk. ASTM F679 - Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
ll. ASTM F794 - Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
mm. ASTM F891 - Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core.
nn. ASTM F949 - Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.
oo. ASTM F1417 11a(2015) - Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.
pp. ASTM F1668 - Guide for Construction Procedures for Buried Plastic Pipe.

5. Cast Iron Soil Pipe Institute (CISPI):
   a. CISPI 301 - Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   b. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   c. Cast Iron Soil Pipe and Fittings Handbook, 2002.
6. Uni-Bell PVC Pipe Association (UNI):
   a. UNI-B-6 - Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe.

1.04 A. DEFINITIONS:
FRP: Fiberglass-reinforced plastic.

1.05 A. ACTION SUBMITTALS:
Product Data: For the following:
1. Expansion joints and deflection fittings.
2. Backwater valves.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.06 INFORMATIONAL SUBMITTALS:

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles to horizontal scale of not less than 1-inch equals 50 feet (1:600) and to vertical scale of not less than 1-inch equals 5 feet (1:60). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.08 PROJECT CONDITIONS:

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by the City or others, unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify the City no fewer than one week in advance of proposed interruption of service.
2. Do not proceed with interruption of service without the City's written permission.

PART 2 - PRODUCTS

2.01 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS:

A. Pipe and Fittings: ASTM A74.

B. Gaskets: ASTM C564, rubber.

C. Calking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.02 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS:

A. Pipe and Fittings: ASTM A888 or CISPI 301.

B. CISPI-Trademark, Shielded Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Dallas Specialty & Mfg. Co.
   c. Mission Rubber Company; a division of MCP Industries, Inc.
   d. Stant; a Tompkins company.
   e. Tyler Pipe.
   f. Engineer-approved equal.
2. Description: ASTM C1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Shielded Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Clamp-All Corp.
   c. Dallas Specialty & Mfg. Co.

d. Mission Rubber Company; a division of MCP Industries, Inc.
e. Stant; a Tompkins company.
f. Tyler Pipe.
g. Engineer-approved equal.

2. Description: ASTM C1277 and ASTM C1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Shielded Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. MG Piping Products Company.
b. Engineer-approved equal.
2. Description: ASTM C1277 with ASTM A48/A48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

E. Unshielded Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ANACO-Husky.
b. Engineer-approved equal.
2. Description: ASTM C1277 and ASTM C1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.03 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS:

A. Pipe: ASTM A746, for push-on joints.
B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
C. Compact Fittings: AWWA C153, ductile iron, for push-on joints.
D. Gaskets: AWWA C111, rubber.

2.04 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS:

A. Push-on-Joint Piping:
1. Pipe: AWWA C151.
2. Standard Fittings: AWWA C110, ductile or gray iron.
3. Compact Fittings: AWWA C153.
4. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.

B. Mechanical-Joint Piping:
1. Pipe: AWWA C151, with bolt holes in bell.
2. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
3. Compact Fittings: AWWA C153, with bolt holes in bells.
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

2.05 PVC PIPE AND FITTINGS:

A. PVC Cellular-Core Sewer Piping:
1. Pipe: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
2. Fittings: ASTM D3034, SDR 35, PVC socket-type fittings.

B. PVC Corrugated Sewer Piping:
   1. Pipe: ASTM F949, PVC corrugated pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
   3. Gaskets: ASTM F477, elastomeric seals.

C. PVC Profile Sewer Piping:
   1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D3034, PVC with bell ends.
   3. Gaskets: ASTM F477, elastomeric seals.

D. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM D3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D3034, PVC with bell ends.
   3. Gaskets: ASTM F477, elastomeric seals.

E. PVC Gravity Sewer Piping:
   1. Pipe and Fittings: ASTM F679, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

F. PVC Pressure Piping:
   1. Pipe: AWWA C900, Class 200 PVC pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: AWWA C900, Class 200 PVC pipe with bell ends.
   3. Gaskets: ASTM F477, elastomeric seals.

G. PVC Water-Service Piping:
   1. Pipe: ASTM D1785, Schedule 80 PVC, with plain ends for solvent-cemented joints.
   2. Fittings: ASTM D2467, Schedule 80 PVC, socket type.

2.06 NONPRESSURE-TYPE TRANSITION COUPLINGS:

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Cast-Iron Soil Pipes: ASTM C564, rubber.
   2. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
   3. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
   4. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dallas Specialty & Mfg. Co.
      b. Logan Clay Pipe.
      c. Mission Rubber Company; a division of MCP Industries, Inc.
      d. NDS.
      e. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
      f. Engineer-approved equal.
   2. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cascade Waterworks Mfg.
      b. Dallas Specialty & Mfg. Co.
      c. Mission Rubber Company; a division of MCP Industries, Inc.
      d. Engineer-approved equal.
   2. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   3. Shielded couplings are only allowed on 4-inch pipe.

E. Ring-Type, Flexible Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Logan Clay Pipe.
      b. Mission Rubber Company; a division of MCP Industries, Inc.
      c. Engineer-approved equal.
   2. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

F. Nonpressure-Type, Rigid Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Engineer-approved equal.
   2. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling, molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.07 PRESSURE-TYPE PIPE COUPLINGS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cascade Waterworks Mfg.
   2. Dresser, Inc.
   3. Ford Meter Box Company, Inc. (The); Pipe Products Div.
   4. JCM Industries, Inc.
   5. Romac Industries, Inc.
   6. Smith-Blair, Inc.; a Sensus company.
   7. Viking Johnson.
   8. Engineer-approved equal.

B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

C. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 200-psig minimum pressure rating and ends of same sizes as piping to be joined.

D. Center-Sleeve Material: Manufacturer's standard.

E. Gasket Material: Natural or synthetic rubber.

F. Metal Component Finish: Corrosion-resistant coating or material.

2.08 EXPANSION JOINTS AND DEFLECTION FITTINGS:

A. Ductile-Iron, Flexible Expansion Joints:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. EBAA Iron, Inc.
      b. Romac Industries, Inc.
      c. Star Pipe Products.
      d. Engineer-approved equal.
   2. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Expansion Joints:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dresser, Inc.
      b. EBAA Iron, Inc.
      c. JCM Industries, Inc.
      d. Smith-Blair, Inc.; a Sensus company.
      e. Engineer-approved equal.
   2. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for expansion indicated.

C. Ductile-Iron Deflection Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. EBAA Iron, Inc.
      b. Engineer-approved equal.
   2. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for up to 15 degrees of deflection.

2.09 BACKWATER VALVES:

A. PVC Backwater Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Rectorseal Clean Check Extendable Backwater Valve
      b. Engineer-approved equal.
   2. See Detail #26 for Backwater Valve detail.
   3. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

2.10 CLEANOUTS:

A. Cast-Iron Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company.

b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.
d. Tyler Pipe.
e. Watts Water Technologies, Inc.
f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
g. Engineer-approved equal.

2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
3. Top-Loading Classifications: Light Duty, Medium Duty, Heavy Duty, and Extra-Heavy Duty. If more than one loading classification is required, show location on each on drawings.
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. eCanplas, LLC.
b. IPS Corporation.
c. NDS.
d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.
g. Engineer-approved equal.
2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to clean out of same material as sewer piping.

2.11 ENCASEMENT FOR PIPING:

A. Standard: ASTM A674 or AWWA C105.
B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.
C. Form: Sheet or tube.
D. Color: Black or natural.

2.12 MANHOLES:

A. Standard Precast Concrete Manholes:
1. Description: ASTM C478 (ASTM C478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum, unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4 inch (100 mm) minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness of length to provide depth indicated.
6. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990 (ASTM C990M), bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.

9. For Manhole Rim Adjustments see SECTION 330130.86

B. Designed Precast Concrete Manholes:
   1. Description: ASTM C913; designed according to ASTM C890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
   2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
   3. Joint Sealant: ASTM C990 (ASTM 990M), bitumen or butyl rubber.
   4. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.
   5. For Manhole Rim Adjustments see SECTION 330130.86

C. Fiberglass Manholes:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Associated Fiberglass Enterprises.
      b. Containment Solutions, Inc.
      c. L. F. Manufacturing, Inc.
      d. Engineer-approved equal.
   2. Description: ASTM D3753.
   3. Diameter: 48 inches minimum, unless otherwise indicated.
   4. Ballast: Increase thickness of concrete base as required to prevent flotation.
   5. Base Section: Concrete, 6-inch minimum thickness.
   6. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.

D. Manhole Frames and Covers:
   1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch minimum-width flange and 26-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
   2. Material: ASTM A536, Grade 60-40-18 ductile iron, unless otherwise indicated.

E. Manhole-Cover Inserts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. FRW Industries; a Syneco Systems, Inc. company.
      b. Knutson Enterprises.
      c. L. F. Manufacturing, Inc.
      d. Parson Environmental Products, Inc.
      e. Engineer-approved equal.
   2. Description; Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
   3. Type: Solid.

2.13 CONCRETE:

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:
   1. Cement: ASTM C150, Type II.
   2. Fine Aggregate: ASTM C33, sand.
   3. Coarse Aggregate: ASTM C33, crushed gravel.
   4. Water: Potable.

B. Portland Cement Design Mix: 4,000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A185, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A615, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4,000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   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. Invert Slope: 2% through manhole, unless otherwise approved by the City.
   3. Benches: Concrete, sloped to drain into channel.
      a. Slope: 4%, unless otherwise approved by the City.
      b. No sewer, service connection, or drop manhole shall discharge onto the surface of the bench.

D. Ballast and Pipe Supports: Portland cement design mix, 3,000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A185, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A615, Grade 60 deformed steel.

PART 3 - EXECUTION

3.01 EARTHWORK:

A. Excavating, trenching, and backfilling are specified in Division 31.

3.02 PIPING INSTALLATION:

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Location. Manholes shall be installed –
   1. At the end of each line;
   2. At all changes in grade, size or alignment;
   3. At all sewer pipe intersections; and
   4. At distances appropriate for sufficient cleaning and maintenance of sewer lines.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of micro tunneling.

F. Design and install gravity-flow, nonpressure, drainage piping according to the following:
   1. Slope. All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than two feet (2') per second.
   2. Install piping with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.

3. All sewers shall either have minimum cover of thirty-six inches (36-inches), or sufficiently insulated with other material such as concrete encasement to prevent freezing and to protect them from superimposed loads.
4. Heavier weight pipe is required when at depths of 9 feet or greater.
5. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
7. Install ductile-iron, gravity sewer piping according to ASTM A746.
8. Install PVC cellular-core sewer piping according to ASTM D2321 and ASTM F1668.
9. Install PVC corrugated sewer piping according to ASTM D2321 and ASTM F1668.
10. Install PVC profile sewer piping according to ASTM D2321 and ASTM F1668.
11. Install PVC Type PSM sewer piping according to ASTM D2321 and ASTM F1668.
12. Install PVC gravity sewer piping according to ASTM D2321 and ASTM F1668.
13. Install fiberglass sewer piping according to ASTM D3839 and ASTM F1668.

G. Install force-main, pressure piping according to the following:
1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
2. Install piping with 42-inch minimum cover.
3. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
4. Install ductile-iron special fittings according to AWWA C600.
5. Install PVC pressure piping according to AWWA M23 or to ASTM D2774 and ASTM F1668.
6. Install PVC water-service piping according to ASTM D2774 and ASTM F1668.

H. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A674 or AWWA C105:
1. Hub-and-spigot, cast-iron soil pipe.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints and deflection fittings.

I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.03 PIPE JOINT CONSTRUCTION:

A. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
5. Join PVC cellular-core sewer piping according to ASTM D2321 and ASTM F891 for solvent-cemented joints.
6. Join PVC corrugated sewer piping according to ASTM D2321.
7. Join PVC profile sewer piping according to ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
8. Join PVC Type PSM sewer piping according to ASTM D2321 and ASTM D3034 for

elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.

9. Join PVC gravity sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
10. Join fiberglass sewer piping according to ASTM D4161 for elastomeric-seal joints.
11. Join dissimilar pipe materials with nonpressure-type, rigid couplings.

B. Join force-main, pressure piping according to the following:
1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
3. Join PVC pressure piping according to AWWA M23 for gasketed joints.
4. Join PVC water-service piping according to ASTM D2855.
5. Join dissimilar pipe materials with pressure-type couplings.

C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
a. Shielded rigid couplings for pipes of same or slightly different OD.
b. Unshielded, increaser/reducer-pattern, rigid couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
2. Use pressure pipe couplings for force-main joints.

3.04 MANHOLE INSTALLATION:

A. General: Install manholes complete with appurtenances and accessories indicated.
B. Install precast concrete manhole sections with sealants according to ASTM C891.
C. Install FRP manholes according to manufacturer's written instructions.
D. Form continuous concrete channels and benches between inlets and outlet.
E. Install manhole-cover inserts in frame and immediately below cover.

3.05 BACKWATER VALVE INSTALLATION:

A. Install horizontal-type backwater valves in piping manholes or pits.
B. Install combination horizontal and manual gate valves in piping and in manholes.
C. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

3.06 CLEANOUT INSTALLATION:

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.
C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.07 SEWER SERVICE CONNECTIONS:

A. See Standard Detail #16 for Sewer Service Connection Detail.

B. All service connections to the sewer main shall be watertight and cannot protrude into the sewer. This will be required for all new construction, in addition to existing service connections being replaced or repaired.

3.08 SEWER MAIN SPOT REPAIRS:

A. Contractor shall use HYMAX style coupling only when within 15 feet of the installation of a new manhole on existing sewer main. If distance is further than 15 feet from installation of a new manhole on existing main, either HYMAX style coupling or a rigid (PVC) knock-on coupling may be used.

3.09 CLOSING ABANDONED SANITARY SEWER SYSTEMS:

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
   2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
   1. Remove manhole and close open ends of remaining piping.
   2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Division 31.

3.10 IDENTIFICATION:

A. Materials and their installation are specified in Division 31. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
   1. Use detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.11 FIELD QUALITY CONTROL:

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
   1. Submit separate report for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: No pipe shall exceed a deflection of five percent (5%) of the inside pipe diameter.
      c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping per ASCM C969–17.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.CCTV: CCTV is acceptable for quality control.
   a. Refer to SECTION 330130.11.
   b. Review of the CCTV and discretion of defects requiring repair based on NASSCO's PACP to be determined by the City.
5. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.
   a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
   b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
6. Manhole , Inspection and Testing:
   a. Exfiltration testing for concrete sewer manholes, shall conform to test procedures in ASTM C969 – 17 Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
   b. Vacuum testing for concrete sewer manholes, shall conform to the test procedures in ASTM C1244 – 11(2017) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

C. Leaks and loss in test pressure constitute defects that must be repaired.
D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.12 CLEANING:

A. Clean dirt and superfluous material from interior of piping.

3.13 ALTERNATIVE EFFLUENT SEWER SYSTEMS:

A. Alternative sewer systems shall not to be used in lieu of conventional gravity sewers but may be acceptable when it can be shown in the engineering report that it is not feasible to provide conventional gravity sewers. This will be designed in conjunction with the approval of Greene County and DNR standards and requirements.
B. The continuing authority must be responsible for the operation and maintenance and modernization of an alternative sewer system collection system.
C. Flood protection shall apply to new construction and to existing facilities undergoing major modification. The wastewater facility structures, electrical equipment, and mechanical equipment shall be protected from physical damage by not less than the one hundred- (100-) year flood elevation.
D. Facilities shall be readily accessible by authorized personnel from a public right-of-way at all times.
E. Fencing is required around facility siters to discourage entrance by unauthorized people.
F. A 50' distance must be maintained between potable water sources and wastewater pumping stations.
G. Sewers shall be laid at least fifty feet (50') in a horizontal direction from any existing or proposed public water supply well or other water supply sources or structures.
H. There shall be no physical connections between a public or private potable water supply system and a sewer or appurtenance that would permit the passage of any wastewater or polluted water into the potable supply.
I. Pressure Sewers

1. Design shall be based on the most probable number of pumping units expected to operate simultaneously or on some other acceptable method of computing the peak pumpage rate.
2. A cleansing velocity of at least two feet per second (2 ft/s), at least once per day shall be achieved.
3. The minimum diameter sewer main pipe shall not be less than one and a half inches (1.5").
4. The manufacturer's recommended hydrostatic pressure testing procedures must be followed.
5. Locator wire must be utilized when sewer lines are installed within the public right-of-way.

J. Sewer Appurtenances
1. Appurtenances shall be compatible with the piping system and full bore with smooth interior surfaces to eliminate obstruction and keep friction loss to a minimum.

K. Isolation Valves
1. Isolation valves shall be comprised of resilient seated gate valve or ball valve with a position indicator.
2. Must be constructed from corrosion resistant materials.
3. Must be enclosed in a watertight and lockable valve box.
4. Isolation valves shall be installed on the upstream side of major pipe intersections; both sides of stream, bridge, and railroad crossings, and unstable soil; and the terminal end of the system to facilitate future extensions.
5. Proper support shall be provided for valves so the weight of the valve is not carried by the pipe.

L. Service line connections must have a minimum diameter of 1.25".

M. Grinder Pump Stations
1. Simplex grinder pump station shall not serve multiple equivalent dwelling units if owned, operated, and maintained by individual homeowners; and should not serve commercial facilities.
2. Multiple unit grinder pump stations must be owned, operated, and maintained by an approved continuing authority.
3. Grinder pump vaults shall be watertight.
4. A grinder pump vault shall have a storage volume of at least seventy (70) gallons.
5. The grinder pump vault must contain a shutoff valve accessible from the ground surface, a check valve to prevent backflow, and an anti-siphon valve.
6. When the continuing authority operates and maintains the grinder pump stations, provisions must be made for periods of mechanical or power failure.
7. The design and electrical requirements for submersible pump stations shall apply.
8. Water level controls must be accessible without entering the wet well.
9. Duplex pumps shall be provided where the design flow from the EDUs, or other, is one thousand five hundred (1,500) gallons per day or greater.

N. Septic Tank Effluent Pumped (STEP) Sewers
1. The design requirements of pressure sewers shall be applicable.
2. Provide at least one (1) septic tank to serve each EDU.
3. Provide at least one thousand (1,000) gallons capacity.
4. Provide twenty percent (20%) of the septic tank volume for freeboard and ventilation.
5. Existing septic tanks being proposed for reuse must be inspected and verified to be watertight.

O. Septic Tank Effluent Gravity (STEG) Sewers
1. The minimum diameter of sewer main pipe shall not be less than four inches (4").
2. Leakage tests shall be required unless the gravity sewer has a diameter of 27" or less and is constructed of PVC.

P. A pressure sewer system discharging to a downstream STEP or STEG sewer system shall not be permitted.

END OF SECTION 221313

This page was intentionally left blank.

SECTION 312050 – SITE PREPARATION AND EARTHWORK:

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:

1. All subgrade preparation.
2. Excavating.
3. Trenching.
4. Filling.
5. Embankment construction.
6. Backfilling including controlled low-strength material (CLSM).
7. Compacting.
8. Grading.
9. Riprapping.
10. Topsoiling.
11. All related items necessary to complete the Work indicated or specified.

1.03 RELATED REQUIREMENTS:

A. 329200 – Seeding and Sodding

1.04 REFERENCE STANDARDS:

A. Applicable Standards:

1. ASTM International (ASTM):
    a. ASTM C33/C33M – Standard Specification for Concrete Aggregates.
    b. ASTM C88 – Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
    c. ASTM C94/C94M – Standard Specification for Ready-Mix Concrete.
    d. ASTM C144 – Standards Specification for Aggregate for Masonry Mortar.
    e. ASTM C150/C150M – Standard Specification for Portland Cement.
    f. ASTM C173/C173M – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
    g. ASTM C231/C231M – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
    h. ASTM C403/C403M – Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.
    i. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
    j. ASTM C939/C939M – Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
    k. ASTM C940 – Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
    l. ASTM D75/D75M – Standard Practice for Sampling Aggregates.
    m. ASTM D422 – Standard Test Methods for Particle-Size Analysis of Soils.
    n. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft^3.

o. ASTM D1140 – Standard Test Methods for Determining the Amount of Material in Soils Finer than the No. 200 Sieve in Soils by Washing.
p. ASTM D1241 – Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses.
q. ASTM D1556/D1556M – Standard Test Method for Density and Unit Weight of Soil In-place by the Sand Cone Method.
r. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft³.
s. ASTM D2167 – Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
t. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
u. ASTM D3776/D3776M REV A – Standard Test Methods for Mass per Unit Area (Weight) of Fabric.
v. ASTM D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
w. ASTM D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
x. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
y. ASTM D4546 – Standard Test Methods for One-Dimensional Swell or Settlement Potential of Cohesive Soils.
z. ASTM D4632/D4632M REV A – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
aa. ASTM D4751 – Standard Test Method for Determining the Apparent Opening Size of a Geotextile.
bb. ASTM D4832 – Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
cc. ASTM D4833/D4833M – Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
dd. ASTM D5084 – Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
ee. ASTM D5239 – Standard Practice for Characterizing Fly Ash for use in Soil Stabilization.
ff. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

2. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR Part 1926 - Safety and Health Regulations for Construction.
3. Standard Specifications for Road and Bridge Construction, State of Missouri.

1.05 SUBMITTALS:

A. Submit as specified in Division 01.
B. Includes, but not limited to, the following:
   1. Test results from laboratory testing of proposed borrow material.
   2. Test results from laboratory testing of granular material and trench stabilization material.
   3. Test results from laboratory testing of CLSM.
   4. Erosion control plan.
   5. Dewatering Plan.
   6. Sheeting and Shoring Excavation Plan.

C. Where selecting an option for excavation, trenching, and shoring in compliance with local, state, or federal safety regulations such as OSHA 29 CFR Part 1926 or successor regulations, which require design by a registered Professional Engineer, submit the following:
   1. Copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems prepared by or under the supervision of a Professional Engineer legally authorized to practice in the jurisdiction where the Project is located.
   2. Documents provided with evidence of registered Professional Engineer's seal, signature, and date in accordance with appropriate state licensing requirements.

1.06 QUALITY ASSURANCE:

A. Sampling and Testing:
   1. Tests to determine conformance with all requirements of this Specification for quality and properties of all Contractor -secured materials, including borrow materials both on- or off-site proposed for use, shall be performed by an independent, commercial laboratory retained and compensated by Contractor, and approved by Engineer.
   2. When incorporating materials into the Project, quality control testing will be performed during construction by a testing laboratory retained and compensated by the Contractor.

1.07 PROJECT CONDITIONS:

A. Carefully maintain all benchmarks, monuments, and other reference points and replace as directed by Engineer if disturbed or destroyed.

B. Temporary Erosion and Sediment Controls: Furnish, install, construct, and maintain temporary measures to control erosion and minimize the siltation of intermittent streams and the pollution of private properties. Erosion and sediment controls must be installed prior to commencement of work. Temporary erosion and sediment control measures shall be constructed in substantial compliance with local, state, federal, and jurisdictional agency's regulations and Contract Drawings (if applicable). Temporary erosion and sediment control measures shall be maintained until completion of the Work. The Contractor shall be responsible for submitting the Stormwater Pollution Prevention Plan (SWPPP) after review and approval by Engineer.

C. Disposition of Utilities:
   1. Existing underground utilities are shown on Contract Drawings using the best information available at the time of Drawing preparation. Contractor shall identify, locate and protect all underground utilities which may be affected by construction under this Contract before starting excavation or other Site construction activities which could damage existing utilities.
   2. Remove or relocate only as indicated, specified, or directed. Provide a minimum 1-week notice to Engineer and receive written notice to proceed before interrupting any utility service.
   3. Adequately protect from damage all active utilities and remove or relocate only as indicated or approved.
   4. Report active, inactive, and abandoned utilities encountered in excavating and grading operations that are not indicated on Contract Drawings. Remove, plug, or cap as directed by Engineer.
   5. Provide as-constructed Drawings of underground facilities either not shown or found at locations that differ from those shown on Contract Drawings.

D. Survey Work, to accurately determine locations, elevations, and quantities of Contract pay items, shall be performed during the course of construction by Professional Surveyor registered

in the state of Missouri. Surveyor shall be retained and compensated by Contractor. Contractor shall notify Engineer prior to commencing survey work.

PART 2 - PRODUCTS

2.01 MATERIALS ENCOUNTERED:

A. Suitable Materials: Materials suitable for use in embankment and fill include material that is free of debris, roots, organic matter, frozen matter, and which is free of stone having any dimension greater than 2 inches in areas requiring a high degree of compaction, or 4 inches in other embankment and fill areas. The City reserves the right to make the final determination on the suitability or unsuitability on materials encountered. Suitable materials may consist of the following:
   1. Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands generally exclusive of clayey and silty material with the following properties:
      a. Are free-draining.
      b. Impact compaction will not produce a well-defined moisture-density relationship curve.
      c. Maximum density by impact methods will generally be less than by vibratory methods.
      d. Generally, less than 15% by dry weight of soil particles pass a No. 200 square-mesh sieve.
   2. Cohesive materials include materials made up predominately of silts and clays generally exclusive of sands and gravel with the following properties:
      a. Impact compaction will produce a well-defined, moisture-density relationship curve.
      b. Are not free draining.

B. Unsuitable Materials: Materials unsuitable for use in embankment and fill include all material that contains debris, roots, organic matter, frozen matter, shale particles, or material containing gravel or stone with any dimension greater than 2 inches in areas requiring a high degree of compaction or 4 inches in other embankment and fill areas, or other materials that are determined by Engineer as too wet or otherwise unsuitable for providing a stable subgrade or stable foundation for structures. Any material not defined in Section 2.01 Paragraph A, Suitable Materials, shall be considered unsuitable. The City reserves the right to make the final determination on the suitability or unsuitability on materials encountered.

C. Material used for embankment or fill:
   1. Low Volume Change (LVC) material for all locations and elevations but specifically below grade support floors. LVC material can be a clay soil having a maximum Liquid Limit (LL) of 45 and a maximum Plastic Index (PI) of 23 or a granular material having at least 18% low plasticity fines. Place a minimum of 24 inches of LVC on top of native soil or engineered fill beneath grade supported slabs and 12 inches of LVC o top of native soils or engineered fill beneath pavements.
   2. Berm construction: Prior to placement of fill, expose native soil subgrade. Proof roll using a loaded dump truck or scraper having a minimum gross weight of 20 tons. Remove and replace any unsuitable areas.
   3. Crushed Aggregate Pavements: In locations where crushed aggregate pavements are to be used place a geotextile on the soil subgrade prior to placement of the aggregate. A minimum of 8 inches of crushed aggregate must be place on top of geotextile.

D. Materials to be excavated shall be classified as follows for purpose of payment:
   1. Common Excavation: Includes all materials excavated other than rock excavation and all

boulders or detached pieces or solid rock, (prior to blasting,) less than 2 yds.^{3} in volume.

2. Rock Excavation: Includes boulders 2 yds.^{3} or more in volume and materials that cannot be removed without systematic drilling and blasting such as materials in ledges or aggregate conglomerate deposits that are so firmly cemented as to possess the characteristics of solid rock. Hard and compacted materials such as cemented gravel, glacial till, shale, and relatively soft or disintegrated rock that can be loosened by a large tractor-mounted hydraulic ripper without continuous and systematic drilling and blasting will not be considered as "rock". Material will not be considered as "rock" because of intermittent drilling and blasting that is performed merely to increase production.
3. Approximate location of rock to be excavated on Drawings is based on Engineer's opinion only, resulting from analysis of subsurface data obtained for design purposes, and is not guaranteed to be an accurate representation of the extent or composition of rock to be excavated.
    a. Subsurface data will be used as a basis to determine the rock quantities for Bid purposes.
    b. Final quantities will be adjusted based on actual field measurements. Adjustments to the Base Bid for this final quantity will be made using unit prices and the following guidelines.
        (1) When layers of rock and soil are encountered, the excavated soil between the layers of rock will be considered as rock excavation if the thickness of the soil layer does not exceed 6 inches.
        (2) When rock is encountered, the overburden material shall be removed to expose the rock surface. The top of the rock surface shall be surveyed by a Licensed Surveyor retained by Contractor at minimum 25 ft. centers before and after the rock is excavated. Engineer will use the survey data to determine excavated rock quantities.
4. If/when rock is encountered within the limits of the excavation, notify Engineer immediately. Proceed with excavation only after measurements are made for establishing the volume of rock excavation.
5. Submit one copy of survey notes and field cross-sections, on the date completed, to Engineer and distribute other copies as specified in Division 01.
6. Designate a responsible person on the Site during construction to maintain records of survey notes and field cross-sections. Report survey data to Engineer on daily basis.
7. Excavate rock to limits required by the Drawings. If limits are not shown on drawings, excavate rock to the following limits. Excavation exceeding the limits will be considered as unauthorized and will not be measured for payment.
    a. One ft. below finish grade in areas designated to be seeded or sodded.
    b. Six inches below finish subgrade for all pavement areas.

E. Waste Materials:
1. Waste materials, as described for purposes of this Section, consist of unsuitable materials, excess suitable material, rock, demolition debris, and other materials considered unacceptable for use as fill, and which are not environmentally contaminated. Waste materials shall not include environmental pollutants, hazardous substances, contaminated products, by-products, samples, or waste materials of any kind that are regulated under environmental laws.
2. Environmentally contaminated waste materials include environmental pollutants, hazardous substances, contaminated products, by-products, samples, or waste materials of any kind that are regulated under environmental laws. Environmentally contaminated waste also include soil containing concentrations of hazardous constituents at levels requiring special handling and disposal methods.
3. Dispose of waste materials in accordance with Paragraph 3.03G.

2.02 BORROW MATERIALS:

A. Suitable fill materials, granular materials, and topsoil obtained from locations arranged for by Contractor (off the Site). Required to the extent sufficient suitable materials are not obtained from excavation and trenching.

B. Obtain, excavate, haul, handle, place, and compact borrow materials.

C. Borrow materials shall not exhibit characteristics of high shrink-swell potential as determined from Atterberg limit tests (ASTM D4318) and/or swell tests (ASTM D4546) unless otherwise specified herein.

2.03 GRANULAR MATERIAL:

A. Crushed stone or crushed gravel indicating a loss of not more than 15% after five cycles when tested for soundness with sodium sulfate as described in ASTM C88 and conforming to one of the following gradations:

Standard Square Mesh Sieve U.S. Size or No.	MoDOT Section 1006 Grade A Percent Passing
1 inch	100
3/4 inch	80 to 100
3/8 inch	--
No. 4	60
No. 10	10 to 35
No. 200	0 to 10

B. Use at all locations where granular material is required unless otherwise indicated or specified.

C. Granular material shall be crushed limestone conforming to MoDOT Grade 5.

2.04 EMBANKMENT AND FILL MATERIAL:

A. Material shall be free of roots or other organic matter, refuse, ashes, cinders, frozen earth, or other unsuitable material.

B. Use suitable material sufficiently friable for embankment to provide a dense mass free of voids and capable of satisfactory compaction.

C. Do not use material containing gravel, stones, or shale particles greater in dimension than one-half the depth of the layer or lift to be compacted.

D. Moisture content shall be that required to obtain specified compaction of the soil or as indicated.

E. Perform moisture curing by wetting or drying of the material as required to attain required compaction criteria.

2.05 TRENCH STABILIZATION MATERIAL:

A. Granular material as specified or conform to ASTM D1241, Gradation A or B, well-graded, with not more than 10% passing No. 200 sieve.

2.06 RIPRAP:

A. Riprap Material:

1. All stone shall be durable and of suitable quality to ensure permanence in the structure and in the climate in which it is to be used.
2. Boulders or quarried rock may be used and shall be graded as per the construction drawings/specifications.
3. Quantity of rock with an elongation greater than 3:1 shall not exceed 20% of the mass. No stone shall have an elongation greater than 4:1.

4. Stone shall be free from cracks, seams or other defects that would tend to increase its deterioration from natural causes.
5. Objectionable quantities of dirt, sand, clay, and rock fines will not be permitted. Final determination of objectionable quantities will be made by the Public Works Director.
6. Not more than 10% of the stone shall show splitting, crumbling, or spalling when subjected to five cycles of the sodium soundness test as required by AASHTO T104.
7. Contractor may be required to furnish a sample of stone as part of the submittal process to the Public Works Department for acceptance.
8. In lieu of conforming to above specified test requirements, material with a proven history of satisfactory performance may be approved for use in the Work provided certification of this history is acceptable to Engineer.
9. Refer to Standard Detail #40, Riprap for additional information.

B. Bedding/Filter Materials:
1. Filter Blanket:
   a. Material shall be crushed rock with the following gradation:

Standard Square-Mesh Sieve

U.S. Size or No.	Percent Passing by Weight
4 inch	100
3 inch	80 to 100
2 inch	70 to 90
3/4 inch	45 to 60
No. 4	20 to 30
No. 10	5 to 15
No. 40	0 to 5

   b. Gradation shall not vary from low limit on one sieve to high limit on adjacent sieve or vice versa.
   c. Sampling procedure shall conform to ASTM D75/D75M.
   d. Material shall not have a loss of more than 15% after five cycles when tested for soundness with sodium sulfate as described in ASTM C88.
2. Geotextile Fabric:
   a. Geotextile Fabric shall be a nonwoven fabric consisting of continuous chain polymeric filaments or yarns of polyester, or polypropylene formed into a stable network by needle punching.
   b. Geotextile Fabric shall be resistant to mildew and rot, ultraviolet radiation, insects and rodents.
   c. Geotextile Fabric shall conform to the following minimum requirements which shall be the minimum average roll values for the roll of geotextile:
      (1) Weight: 15 oz./yd.^{2} as determined by ASTM D3776/D3776M REV A.
      (2) Puncture Strength: 195 lbs. as determined by ASTM D4833/D4833M.
      (3) Grab Tensile Strength: 380 lbs. as determined by ASTM D4632/D4632M REV A.
      (4) Elongation at Failure: 50% as determined by ASTM D4632/D4632M REV A.
      (5) Apparent Opening Size: 100 sieve as determined by ASTM D4751.

2.07 CONTROLLED LOW-STRENGTH MATERIAL (CLSM OR FLOWABLE FILL):

A. Materials:

1. Portland cement Type I or Type II conforming to ASTM C150/C150M.
2. Fly ash conforming to ASTM C618 for Class C.
3. Fine aggregate (sand) conforming to ASTM C33/C33M or C144.
4. Water, clean and potable, conforming to ASTM C94/C94M.
5. Shrinkage compensator shall be proportioned in accordance with the manufacturer's recommendations, and as tested by ASTM C940.
6. Admixtures for air entrainment or other purposes conforming to ASTM C173/C173M or C231/C231M, or other appropriate standards referenced by manufacturer.
7. Bentonite in proportions indicated or as required for the Project within areas of U.S. Army Corps of Engineers flood protection systems.

B. Mix Design:

1. Mix design for CLSM (flowable fill) shall be in accordance with the requirements of APWA 2602.2H.
2. Submit details of the proposed mix design along with strength test results from an approved laboratory retained by Contractor. Commercial brand mixtures that have documented prior mix design strength history may be used with prior submittal of appropriate test results, mix design indicating conformance with these requirements, and approval by Engineer.
3. Mix design shall permit adjustments in proportions of fine aggregate and/or water to achieve proper solid suspension and optimum flowability with approval of Engineer, and providing for the calculated yield to be maintained at 1 $yd.^3$ for the given batch weights.
4. Mix design shall meet requirements for minimum and/or maximum strengths indicated.
5. Consistency of the mix shall be that of a batter, not thin and/or watery.
6. Typical design for trial mixes of CLSM (flowable fill), unless otherwise indicated to provide a minimum volume of 1 $yd.^3$, is as follows:
   a. Nonremovable CLSM:

(1)	Cement	100 lbs.
(2)	Class C Fly Ash	300 lbs.
(3)	Sand	2766 lbs.
(4)	Water	417 lbs.
(5)	Air Entrainment	4%
(6)	Shrinkage Compensator	In accordance with manufacturer

7. CLSM shall be used unless otherwise specified or indicated.
8. Bentonite powder, if required, shall be blended with the cement and fly ash prior to adding any water to the mix, with a minimum of 20% by dry weight of combined cement and fly ash cementitious material. Blending and mixing of bentonite shall be complete and uniform, without balling-up or concentration of bentonite in clumps. Proportions of mix and mixing placement shall not adversely affect overall physical properties required for the in-place CLSM, yet provide for self-healing of any cracks that may develop over time due to shrinkage or other forces upon CLSM.
9. Flowable fill (CLSM) shall exhibit the following physical properties:
   a. CLSM Mixes:
      (1) Minimum unconfined compressive strength of 500 psi at 28 days.
   b. Provide for set-up within 12 hours.
   c. Evaporation of bleed water shall not result in shrinkage of more than 1/8 inch per foot of flowable fill (CLSM) thickness.
   d. Unit weight of 120 to 80 lbs. per cf, as measured at the point of placement after transport.

PART 3 - EXECUTION

3.01 DEMOLITION:

A. Remove existing structures and improvements as required (as indicated) to perform new construction.
B. Carefully dismantle, in a manner to avoid damage, all materials and equipment indicated to be relocated or returned to the City.
C. Material or equipment, specified or indicated to be relocated or returned to the City, that is damaged due to Contractor's negligence shall be repaired or replaced, as determined by Engineer, at no additional cost to the City.
D. Materials not indicated or specified to be relocated or returned to the City shall become property of Contractor and be disposed of as specified in "Waste Materials," this Part.
E. Perform demolition work to protect existing facilities, structures, and property which are to remain, against damage from operations, falling debris, or other cause.
F. Make provisions for temporarily accommodating flows in existing facilities that are to be relocated or disturbed.
G. Take precautions to guard against movement or settlement, and provide shoring and bracing as necessary.
H. If at any time safety of existing structure to remain is endangered, cease operations, notify Engineer, and do not resume operations prior to approval.
I. Remove concrete by jack hammering, sawing, core drilling, or other approved method.
J. Remove existing pavement by jack hammering, sawing, scarifying, or other approved methods except as follows:
    1. Existing asphaltic or Portland cement concrete pavement shall be sawed at point where pavement indicated to remain ends and pavement indicated to be removed begins.
    2. Existing Portland cement concrete pavement shall be removed back to the nearest joint unless otherwise indicated or approved by Engineer.

3.02 SITE PREPARATION:

A. Sediment (Silt) Fence:
    1. Install silt fence as indicated and as follows:
        a. On the downslope side(s) of all disturbed areas.
        b. On the downslope side(s) of all stockpile areas.
        c. Silt socks may be allowed in lieu of silt fences.
    2. Inspection:
        a. Daily in areas of active construction or equipment operation.
        b. Weekly in areas with no construction or equipment operation.
        c. Within 24 hours of each 0.5 inch or greater rainfall event.
        d. Complete inspection reports after each inspection and submit to Engineer within two working days.
    3. Maintenance:
        a. Remove sediment from behind silt fence when it reaches one-third the height of fence. Place removed sediment in topsoil stockpile areas.
        b. Any silt fence damaged so it cannot perform its intended function shall be replaced as indicated or as directed by Engineer.
        c. Remove silt fence after area has been surfaced or seeded and has been accepted by Engineer.
        d. Payment for silt fence replacement shall conform to the Unit Price for Silt Fence stated in Agreement.

B. Construction Access:
   1. Immediately remove by shoveling and/or sweeping all sediment tracked from the construction area onto Site access roads. Place sediment in stockpile areas.

C. Clearing and Grubbing:
   1. Perform as designated on plans, required for construction, or as designated by the Engineer.
   2. Protect tops, trunks, and roots of existing trees which are to remain on Site.
   3. Clear areas and dispose of other trees, brush, and vegetation before starting construction.
   4. Remove tree stumps and roots larger than 3 inches in diameter and backfill resulting excavations with compacted, suitable material.
   5. Dispose of debris from clearing and grubbing at a location off the Site, as arranged for by Contractor, at no additional cost to the City.

D. Stripping:
   1. Remove topsoil from areas within limits of excavation, trenching and borrow, and areas designated to receive embankment and compacted fill.
   2. Scrape areas clean of all brush, grass, weeds, roots, and other material.
   3. Strip to depth of approximately 6 inches or to a sufficient depth to remove excessive roots in heavy vegetation or brush areas and as required to segregate topsoil, or as directed by Engineer.
   4. Stockpile topsoil in areas where it will not interfere with construction operations or existing facilities. Stockpiled topsoil shall be reasonably free of subsoil, debris, and stones larger than 2 inches in diameter.
   5. Remove waste from the Site.

3.03 EXCAVATION AND TRENCHING:

A. Sheeting and Bracing:
   1. Design, furnish, place, maintain, and subsequently remove, to extent required, a system of temporary supports for cut and cover, open cut, or trench excavations, including bracing, dewatering, and associated items to support sides and ends of excavations where excavation slopes might endanger in-place or proposed improvements, extend beyond construction rights-of-way, or as otherwise specified or indicated.
   2. Provide all materials on Site prior to start of excavation in each section, and make such adjustments as are required to meet unexpected conditions.
   3. Space and arrange sheeting and bracing as required to exclude adjacent material and according to stability of excavation slopes.
   4. Assess existing conditions including adjacent property and possible effects of proposed temporary works and construction methods; and select and design such support systems, methods, and details as will assure safety to the public, adjacent property, and the completed Work.
   5. Modify or relocate underground facilities, at no additional cost to the City, if existing underground facilities interfere with Contractor's proposed method of support.
   6. Use caution in areas of underground facilities, which shall be exposed by hand or other excavation methods acceptable to the City.
   7. Perform sheeting, shoring, and bracing in accordance with safety and protection requirements of the Contract Documents.
   8. Provide sheeting, shoring, and bracing for trench excavation in subgrade of excavation when required to prevent movement of the main excavation support system.
   9. Provide shoring, sheeting, and bracing as indicated or as needed to meet the following requirements:
      a. Prevent undermining and damage to all structures, buildings, underground facilities,

pavements, and slabs.

b. Perform excavations with vertical banks where necessary for construction activities or as indicated, and also within all limits of excavation noted on Drawings.

c. Design excavation support system and components to support lateral earth pressures, unrelieved hydrostatic pressures, utility loads, traffic and construction loads, and building and other surcharge loads to allow safe and expeditious construction of permanent structures without movement or settlement of the ground, and to prevent damage to or movement of adjacent buildings, structures, underground facilities, and other improvements. Design shall account for staged removal of bracing to suit the sequence of concrete placement for permanent structures and backfill.

d. Except as otherwise specified herein, shoring and sheeting materials may be extracted and reused at Contractor's option; however, Contractor shall remove and replace any existing structure or underground facility damaged during shoring and sheeting. Remove sheeting and bracing as backfill progresses. Fill voids left after withdrawal with sand or other material approved by Engineer.

e. Where shoring and sheeting materials must be left in place in the completed Work to prevent settlements to or damage within adjacent structures or as directed by Engineer, backfill the excavation to 3 ft. below finished grade and remove the remaining exposed portion of shoring before completing backfill. If soldier piles and wood lagging are used for shoring, remove wood lagging to within 3 ft. of finished grade in incremental steps of approximately 6 inches as backfill is placed, or to Contractor's design if more stringent. Location of all shoring and sheeting left in-place shall be documented on Contractor-furnished construction record Drawings and provided to Engineer and the City.

10. Contractor shall be solely responsible for proper design, installation, operation, maintenance, and any failure of any component of the system. Review by Engineer of Drawings and data submitted by Contractor shall not in any way be considered to relieve Contractor from full responsibility for errors therein or from the entire responsibility for complete and adequate design and performance of the sheeting and shoring system.
11. Provision for Contingencies:
    a. Performance of components of the support system shall be monitored for both vertical and horizontal movement daily.
    b. Provide a contingency plan or alternative procedure for implementation, if system does not adequately perform.
    c. Keep materials and equipment necessary to implement the contingency plan readily available.
12. Damages:
    a. Document all existing damage to adjacent facilities and submit information to the City prior to performing any excavation. Documentation shall include a written description, diagrams, measurements, and appropriate photographs.
    b. Repair all damage resulting from Contractor's excavation and remove and replace all undermined pavements with equal approved by the City, either concrete or asphalt, at no expense to the City.

B. Explosives: Blasting will not be permitted unless directed by the City or other Authority Having Jurisdiction (AHJ) A blasting permit application must be filled and submitted to the Builds Department for review and approval. No blasting will occur before A blasting plan will be required and must be approved and executed by a properly trained and licensed Blaster-in-Charge (BIC). Inspection of utilities before and after blasting will be required within the blast area.

C. Excavation for Structures:
   1. Excavate area adequate to permit efficient erection and removal of forms.
   2. Trim to neat lines where details call for concrete to be deposited against earth.
   3. Excavate by hand in areas where space and access will not permit use of machines.
   4. Notify Engineer immediately when excavation has reached the depth indicated.
   5. Overexcavate and replace any localized zones of excessively wet, unstable, organic, yielding, or low bearing capacity materials as directed by Engineer. Restore bottom of excavation to proper elevation with compacted fill in areas overexcavated. Correct at no additional cost to the City when overexcavated without authority or to stabilize bottom rendered unsuitable through negligence or improper dewatering or other operations.
   6. Top with 3-inch concrete seal coat where indicated and where required to provide satisfactory subgrade for structural base slabs. Payment for seal coats not indicated but required by Engineer shall conform to the Unit Price stated for Additional Concrete in the Agreement.
   7. Use sides of trenches to form sides of duct banks where possible and where sides of trench are vertical, stable and excavated to the proper line.

D. Trenching for Underground Utilities:
   1. Side Walls:
      a. Make vertical or sloped within specified trench width limitations below a plane 12 inches above top of pipe.
      b. Make vertical or sloped (stepped) as required for stability, above a plane 12 inches above top of pipe.
      c. Excavate without undercutting sidewalls.
   2. Trench Depth:
      a. Excavate to depth sufficient to provide the minimum bedding requirements for the pipe being placed.
      b. Do not exceed that indicated where conditions of bottom are satisfactory.
      c. Increase depth as necessary to remove unsuitable supporting materials.
      d. Maintain a minimum of 3.5 ft. of soil cover above top of pipe.
   3. Trench Bottom:
      a. Protect and maintain when suitable natural materials are encountered.
      b. Remove rock fragments and materials disturbed during excavation or raveled from trench walls.
      c. Restore to proper subgrade with trench stabilization material or timber mat topped with trench stabilization material when overexcavated.
         (1) Correct at no additional cost to the City when trench is overexcavated without authority or to stabilize bottom rendered unsuitable through negligence or improper dewatering or other operations.
         (2) Placement of Trench Stabilization Materials:
            (a) Compact in lifts not exceeding 6-inch loose thickness:
               1). With pneumatic or vibratory equipment.
               2). To density specified for granular pipe embedment.
   4. Trench Width:
      a. Excavate trench to a width which will permit satisfactory jointing of pipe and thorough tamping of bedding and backfill.
      b. Do not exceed following trench widths:
         (1) For single pipe installation, maintain trench widths below a plane 12 inches above top of pipe as follows:

Nominal Pipe Size	Trench Width Minimum	Maximum
Less than 24 inches	Pipe od + 1 ft.	Pipe od + 2 ft.
24 inches to 60 inches	Pipe od + 2 ft.	Pipe od + 4 ft.
Larger than 60 inches	Pipe od + 3 ft.	Pipe od + 5 ft.

(2) For multiple pipe installations maintain trench widths below a plane 12 inches (300 mm) above the top of the largest pipe as follows:

Nominal Pipe Size Of Outside Pipe	Trench Clearances Minimum from Outside Pipe	Maximum from Outside Pipe
Less than 24 inches	6 inches	12 inches
24 inches to 60 inches	12 inches	24 inches
Larger than 60 inches	18 inches	30 inches

(3) Above plane defined in (1) and (2), no maximum limit.
(4) Maximum trench width limitations shall apply in all areas more than 3 ft. (1 m) from manhole or structure walls.
(5) Maximum width shall be as near the minimum specified as can be controlled by construction equipment and methods used.

5. Fill and Embankment Areas: Perform trenching only after compacted fill or embankments have reached an elevation of not less than 1 ft. above top of pipe.
6. Limit maximum length of open trench to 50 ft. in advance and to 50 ft. behind pipe installation.
7. Test Pits:
   a. Excavate test pits sufficiently in advance of trenching to enable adequate planning of construction procedure.
   b. Locate as follows:
      (1) When unstable material is suspected that may require special protective measures.
      (2) Where groundwater may require special handling methods.
      (3) Where indicated or otherwise approved.
      (4) Where interference or conflict with other utilities or structures could affect alignment of pipe.
   c. To depth required to obtain information desired.

E. Dewatering:
1. Control grading around excavations to prevent surface water from flowing into excavation areas.
2. Drain or pump as required to continually maintain, including days not normally worked, all excavations free of water or mud from any source, and discharge to approved drains or channels. Commence when water first appears and continue as required to keep excavation free of standing water during entire time excavation is open.
3. Use pumps of adequate capacity to ensure rapid drainage of area, and construct and use drainage channels and subdrains with sumps required.
4. When water is found in excavation due to Contractor negligence, remove unsuitable excessively wet subgrade materials and replace with approved compacted fill material as directed by Engineer and at no additional cost to the City.

5. Design:
   a. Designate and obtain services of a qualified dewatering specialist or expert to provide a dewatering plan as may be necessary to complete the Work. Provide dewatering plan at time of Bid submission. Plan items shall include, but not be limited to, the following:
      (1) Drawings indicating general location and size of berms, dikes, ditches, all deep wells, observation piezometer wells, wellpoints, jet eductors, sumps and discharge lines, including their relation to water disposal ditches.
      (2) Make, model, and capacities of pumps, prime movers, power generators, and standby equipment.
      (3) Design calculations, including any computer modeling, to show adequacy of system and selected equipment, estimated flow rate of water to be discharged, and estimated duration for groundwater to be drawn down to elevations required for excavation.
      (4) Detailed description of dewatering procedure and maintenance method.
      (5) Description of emergency plan to protect in-place construction during an unanticipated rise in groundwater due to loss of power or other unexpected conditions or inundation from surface water.
      (6) Additional details, as requested by Engineer.
      (7) Specific items to be included addressing dewatering operations using wells, wellpoints, or jet eductors shall consist of the following:
         (a) Diameter of hole drilled.
         (b) Type of equipment and method of well installation.
         (c) Diameter and material type of well casing inserted.
         (d) Elevation of top of each well.
         (e) Screen opening sizes.
         (f) Screened interval or elevations of segments in well that are screened.
         (g) Backfill gravel pack zone elevations.
         (h) Gravel pack gradation.
         (i) Size of pumps.
         (j) Anticipated pumping capacity.
         (k) Drawdown in well with time during pumping.
         (l) Drawdown in piezometers with time during pumping.
         (m) Number and location of wells.
         (n) Number and location of piezometers.
         (o) Wellpoint details.
         (p) Certification license of well-driller, where required.
   b. In preparing dewatering plan, consider all available information, together with Site constraints, excavation/sheeting requirements, and construction schedule. Other potential problems may require specific reference and amplification within dewatering plan.
   c. After completion of dewatering installation and prior to commencement of excavation, submit to the City for review a detailed plan of dewatering system as constructed, together with test data and computations demonstrating that the system is capable of achieving specified results.
   d. Contractor shall be solely responsible for proper design, installation, operation, maintenance, and any failure of any component of system. Notice to Proceed issued by the City or submittal of dewatering plans and data by Contractor shall not relieve Contractor from full responsibility for errors therein or for complete and adequate design and performance of system in controlling water level in excavated

areas and for control of hydrostatic pressures to depths specified.

e. Contractor shall be responsible for accuracy of Drawings, design data, and operational records required by this Section.

f. Piezometers and Groundwater Monitoring:

(1) Install as a minimum 2 piezometers, in addition to any required by regulating agencies having jurisdiction, at locations prior to excavation below the groundwater level for purpose of monitoring groundwater elevations in vicinity of excavation. Design and location of piezometers will be subject to review by Engineer.

(2) Observe and record twice daily the elevation of groundwater in all piezometers on a daily basis seven days a week, and furnish a daily written summary of observations to Resident Project Representative. Record groundwater elevations to nearest 0.1 ft., with observations conducted throughout duration of any dewatering, and until dewatering is no longer required.

(3) Monitor upstream and downstream river/stream levels to anticipate rising groundwater levels.

(4) Repair or replace within 24 hours piezometers that become inactive, damaged, or destroyed. If required, suspend excavation and construction activities in areas where piezometers are not functioning properly until reliable observations can be made. Add or remove water from piezometer risers and demonstrate that piezometers are functioning properly.

(5) Remove and grout piezometers when dewatering is completed, and in accordance with jurisdictional agencies. Notify Missouri Geological Survey upon removal of piezometers.

6. Damages:

a. Repair without additional cost to the City any damage to Work in-place, other contractors' equipment, utilities, residences, highways, roads, railroads, private and municipal well systems, adjacent structures, and the excavation, including damage to the bottom due to heave and including but not limited to, removal and pumping out of the excavated area that may result from Contractor's negligence, inadequate or improper design and operation of dewatering system, and any mechanical or electrical failure of dewatering system.

b. Remove subgrade materials rendered unsuitable by excessive wetting and replace with approved backfill material at no additional cost to the City.

7. Maintaining Excavation in Dewatered Condition:

a. Dewatering shall be a continuous operation. Interruptions due to power outages, or any other reason shall not be permitted.

b. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until critical period of construction and/or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation, or other hydrostatic pressure imbalance.

c. Provide standby equipment on Site, installed, wired, and available, for immediate operation if required to maintain dewatering on a continuous basis in event any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such work as may be required to restore damaged structures and foundation soils at no additional cost to the City.

d. Subsequent to completion of excavation and during installation of all Work in the

excavated area, maintain the excavation in a dewatered condition.

e. System maintenance shall include but not be limited to 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components, and any other work required to maintain the excavation in a dewatered condition.

8. System Removal:
   a. Remove all dewatering equipment from Site, including related temporary electrical service.
   b. All wells shall be removed or cut off a minimum of 3 ft. below the final ground surface, capped, and abandoned in accordance with regulations by agencies having jurisdiction.
   c. Removal work required under this Paragraph does not include any Site cleanup work as required elsewhere in these Specifications.
9. River/Stream Crossings:
   a. River/Stream crossings exist as indicated along this Project, requiring excavation below potential stream or river phreatic levels. Dewatering methods shall incorporate means to account for rising or varying water levels associated with these bodies of water and their interconnected waterways, whether surface or subsurface, to prevent threatening integrity of the excavation, existing facilities, and Work under construction.
   b. Conform to applicable requirements in all related Sections.
   c. Maintain area drainage during construction.
   d. Complete channel protection expeditiously following excavation.

F. Waste Materials:
1. Remove unsuitable materials from Work area as excavated.
2. Material shall become property of Contractor and shall be disposed of off-site at locations arranged for by Contractor. Grade waste areas and leave free-draining with an orderly, neat appearance. Side slopes shall not be steeper than three horizontal to one vertical. Topsoil, seed, and mulch waste areas.
3. Submit to Engineer a plan for approval for handling, transportation, and disposal of excess soils. The soil management plan shall include the following information:
   a. Procedures for characterizing excess soil, including frequency of sample collection. Contractor shall be responsible for testing and laboratory fees associated with soil characterization.
   b. Procedures for handling and transporting soil off-site.
   c. Procedures for disposing of soil, including disposal facility, property, etc. If property, provide details regarding property location and use.
      (1) Excess soils shall be disposed of in accordance with the regulations outlined in the Revised Statutes of Missouri (RSMo) Chaper 260 Environmental Control and other applicable environmental laws.

3.04 EARTHWORK:

A. Subgrades:
1. General:
   a. Excavate or backfill as required to construct subgrades to elevations and grades indicated.
   b. Remove all unsuitable material and replace with acceptable fill material and perform all wetting, drying, shaping, and compacting required to prepare subgrade.
   c. Proofrolling: Exposed area to receive fill, backfill, or embankment shall be proofrolled to detect localized zones of excessively wet, unstable, organic, or low bearing capacity materials as follows:

(1) Proofroll as a single-pass operation with conventional compaction equipment during subgrade preparation and prior to placement of fill, and as a spot check process without the need for complete coverage per unit area of tire. Soft spots shall be overexcavated, backfilled, and compacted with suitable material.
(2) Proofroll new pavement and berm fill areas using a loaded, tandem axle dump truck having a minimum gross weight of 20 tons prior to placing pavements.
(3) Proofroll within limits of proposed construction of footings, slabs, mats, or pavement and to extent of 10 ft. beyond proposed exterior walls and stated limits, or as otherwise noted. Proofroll with loaded dump truck, loaded pan scrapper, 15-ton light class pneumatic tired roller compactor, or equivalent. Ground contact pressure of 80 psi and average speed of 5 miles per hour shall be maintained and continue until extent of soft spots is determined with not less than one pass per unit area of tire. Soft spots shall be overexcavated, backfilled, and compacted with suitable material.

2. Subgrade for Fills and Embankments: Roughen by discing or scarifying and wet or dry top 6 inches as required to bond with fill or embankment.
3. Subgrade for Roadways, Drives, Parking Areas:
   a. Extend subgrade the full width of pavement or base course, plus 1 ft. in each direction.
   b. Cohesive Soil Subgrades: Compact the top 6 inches of subgrade for traffic areas and railroads in embankment or excavation
      (1) If LL<40 compact to a minimum of 95% standard Proctor dry density within the moisture content range from 2% below optimum to 2% above optimum.
      (2) If LL>40 compact to a minimum of 95% standard Proctor dry density from 0% below optimum to 4% above optimum.

      Optimum moisture and maximum dry density shall be determined by ASTM D698.
   c. Cohesionless Soil Subgrades: Compact the top 6 inches of subgrade for traffic areas and railroads in embankment or excavation to not less than 70% of relative dry density as determined by ASTM Methods D4253 and D4254.
4. Subgrades for Concrete Slabs on Grade, Mats, and Footings:
   a. Compact cohesive soil subgrades.
      (1) For LL<40 compact to a minimum of 95% standard Proctor dry density within the moisture content range from 2% below optimum to 2% above optimum.
      (2) For LL>40 compact to a minimum of 95% standard Proctor dry density from 0% below optimum to 4% above optimum.

      Optimum moisture and maximum dry density shall be determined by ASTM D698.
   b. Where subgrade consists of cohesionless granular materials, compact to not less than 70% relative density as determined by ASTM D4253 and D4254.

B. Pipe Embedment:
1. Pipe bedding shall be as indicated, using granular material.
2. Place granular embedment as follows:
   a. With level bottom layer at proper grade to receive and uniformly support pipe barrel throughout its length.
   b. Form depression under each joint so that no part of bell or coupling is in contact with trench when pipe is placed in position.
   c. Add second layer simultaneously to both sides of pipe with care to avoid displacement.

d. Complete promptly after completion of jointing operations.
e. Substitute for any part of earth backfill to within 2 ft. of final grade at Contractor's option.

3. Compact granular embedment as follows:
   a. In loose lifts not exceeding 12 inches in depth.
   b. Rod, spade, or use pneumatic or vibratory equipment:
      (1) As required to obtain not less than 70% relative density as determined by ASTM Method D4253 and D4254.
      (2) Throughout depth of embedment.
   c. Compaction using flooding or water spraying techniques will not be allowed.
4. Earth pipe embedment shall be as indicated and shall be used at impervious trench checks. Shape trench bottom to fit pipe and backfill throughout depth of trench with impervious materials. Compact cohesive soil subgrade
   a. For LL<40 compact to minimum of 95% standard Proctor dry density within the moisture content range from 2% below optimum to 2% above optimum.
   b. For LL>40 compact to minimum of 95% standard Proctor dry density from 0% below optimum to 4%above optimum.

   Optimum moisture and maximum dry density shall be determined by ASTM D698.

C. Backfilling:
1. Backfill for structures and trenches shall be as specified in "Embankments and Fills," this Section, with the following additional provisions:
2. Structures:
   a. Backfill only after concrete has attained 70% design strength.
   b. Backfill adjacent to structures only after a sufficient portion of structure has been built to resist imposed load.
   c. Remove all debris from excavation prior to placement of material.
   d. Place backfill in level loose lifts of thickness within compacting ability of equipment used but not to exceed 8 inches in thickness.
   e. Perform backfilling simultaneously on all sides of structures.
   f. Exercise extreme care in use of heavy equipment in areas adjacent to structures. Equipment operated within 10 ft. of any wall shall not exceed 20,000 lbs. gross weight.
   g. Material above a 45-degree plane intersecting the footing shall not include rock fragments incapable of passing a 6-inch screen, and no shale whether disintegrated or not.
3. Trenches:
   a. Backfill for trenches shall be as specified for structures and as follows:
      (1) Complete promptly upon completion of pipe embedment and approval to proceed.
      (2) Use hand methods to a plane 12 inches above top of pipe.
      (3) Mechanical methods shall be acceptable where hand backfill is not required.
      (4) Backfill in lifts of thickness within compacting ability of equipment used, but not greater than 8 inches.
      (5) Until compacted depth over conduit exceeds 3 ft., do not drop fill material over 5 ft. Distance may then be increased 2 ft. for each additional ft. of cover.
4. Controlled Low-Strength Material (CLSM):
   a. Place CLSM (flowable fill) by means of chute, drop pipe, pump, bucket, or other method approved by Engineer to maintain consistency, flowability, and strength of

in-place final product. Fill all voids and place to indicated grades or minimum elevations noted without use of a vibrator.

b. Open ends of area to be backfilled shall be plugged or built-up with a temporary bulkhead arrangement to prevent loss of CLSM during placement or during curing.

c. Prevent movement of any adjacent structure or pipe conduit:
   (1) Anchor pipe or structure to prevent uplift or movement prior to placement of CLSM.
   (2) Prevent intrusion of CLSM into interior sections of structure or pipe.
   (3) If any such movement or intrusion occurs, affected structures or pipe shall be cleaned and may require excavation, removal, and replacement of CLSM to intended final fill elevation.

d. CLSM is intended for placement within a hole that is dry or maintained with a positive dewatering operation. If it is necessary to place CLSM under water, method for placement and mix design shall be submitted to Engineer for approval at least 10 working days prior to any intended pours.

e. Monitor surface elevation of placed CLSM and document any shrinkage or settlement of initial placement volume. Provide information of shrinkage and/or settlement of initial lift to Engineer prior to placement of any additional layers or completion of CLSM placement to final indicated elevation.

f. CSLM shall not be covered with soil or other imposed loading until a minimum compressive strength of 30 psi is attained or until a minimum of 12 hours' cure time has elapsed. Minimum strengths shall be demonstrated by laboratory test results or if permitted by Engineer, by failure to deform or crush the fill with an equivalent 30 psi applied loading in the field.

g. Protect CSLM from freezing while curing with insulated blankets or other approved methods.

h. Where air may become trapped under slabs due to grade beams or other structural components, holes shall be drilled at locations indicated, or as directed by Engineer to allow for uniform placement of CLSM entirely within the void region. Plugs shall be installed to confine CLSM, as needed. It is not intended that raising or leveling of any slabs or structural elements shall occur from placement methods.

D. Site Grading:

1. Excavate, fill, compact fill, and rough grade to bring Project area outside buildings to subgrades as follows:
   a. For surfaced areas, to underside of respective surfacing or base course.
   b. For areas to receive topsoil, to a minimum of 4 inches below finished grade.
   c. When rock is encountered in grading areas outside buildings, overexcavate to depth specified and backfill to grade with compacted fill:
      (1) Under surfaced areas, to 4 inches below top of respective subgrades for such areas.
      (2) Under lawn and planted areas, to 24 inches below finished grade, except that boulder or protruding rock outcrop, if so indicated, shall be left undisturbed.

2. Grading:
   a. Grade and compact all areas within Project area, including excavated and filled sections and adjacent transition areas, reasonably smooth, and free from irregular surface changes.
   b. Degree of finish for rough grading shall be that ordinarily obtained from blade grader or scraper operations except as otherwise specified with due allowance for topsoil.

c. Finished grades shall generally be not more than 0.1 ft. above or below those indicated.
d. Finish all ditches, swales, and gutters to drain readily.
e. Unless otherwise indicated, slope the subgrade evenly to provide drainage away from all structures in all directions at a grade not less than 1/4 inch per ft. for a minimum distance of 10 ft.
f. Provide roundings at top and bottom of banks and at other breaks in grade.

3.05 TOPSOILING:

A. Material: Use the most suitable material obtained from stripping operations and borrow when required.
1. Placement:
a. Clear areas free of vegetation, rock, and other materials which would interfere with grading and tillage operations.
b. Bond topsoil to subgrade by scarifying subgrade to a depth of 2 inches.
c. Spread topsoil to a minimum depth of 4 inches where grading operations have left less than 4 inches of topsoil in place.
d. Grade topsoil to bring areas to grades as indicated, to ensure that all surfaces are left in an even and properly compacted condition, and to prevent ponding of water in depressions.
2. Cleanup:
a. Clean surface free of all stones or other objects larger than 2 inches in least dimension, all roots, brush, wire, grading stakes, and other objectionable materials.
b. Keep paved areas clean and promptly remove rock and dirt dropped upon surfacing.

3.06 RIPRAP:

A. Foundation Preparation:
1. Uniformly trim and dress areas on which filter blankets are placed, conforming to cross sections indicated within an allowable tolerance of ±1 inch from indicated slope lines and grades of subgrade.
2. Fill areas below tolerance limit with suitable material and compact.
3. Do not place riprap until the base has been accepted by Engineer.

B. Placement of Filter Blanket Materials:
1. Place on slopes within limits as indicated.
2. Spread material uniformly on prepared base, in a neat and satisfactory manner to a thickness of 6 inches.
3. Place and spread material by methods which will not segregate particle sizes within the filter.
4. Any damage to surfaces of filter blanket foundation during placing of filter blanket material shall be repaired before proceeding with the Work.
5. Compaction of filter blanket material will not be required, but it shall be finished to present a reasonably even surface free from mounds, depressions, or windrows.

C. Placement of Riprap:
1. Trim and dress areas requiring riprap to conform with lines as indicated within an allowable tolerance of 3 inches from indicated slope lines and grades of filter blanket material. (When regrading is required, existing geotextile fabric shall be removed and then replaced when slope meets specified tolerance.)
2. Place stone to full course thickness in one operation and in a manner to avoid displacing underlying material or damaging geotextile fabric.

3. Place stone on prepared base to produce a reasonably well-graded mass of stone in close contact and with a minimum of voids.
4. Place within a tolerance of ±3 inches from the theoretical slope lines and grades.
5. Finished riprap shall be free from pockets of small stones and clusters of larger stones. Hand place if necessary to secure the desired results.
6. Maintain riprap protection until accepted; replace any material displaced.

3.07 MAINTENANCE:

A. Protect newly graded and topsoiled areas from actions of the elements.
B. Fill and repair settling or erosion occurring prior to acceptance of the Work, and reestablish grades to required elevations and slopes.
C. Contractor shall be responsible for maintaining seed and straw until seed growth is established to the satisfaction of the City and the Engineer.
D. Under provisions of the guarantee, correct any settlement of embankment, fill, or backfill and damages created thereby within one year after acceptance of the Work. Make repairs within 10 days after notification by the City of settlement.

3.08 FIELD QUALITY CONTROL:

A. Compaction:
1. The City will, through services of an independent laboratory, test all embankments, fills, and subgrades under this Contract to determine conformance with specified density relationships.
2. Method of test may be either of the following at Engineer's option:
a. ASTM D1556/D1556M.
b. ASTM D2167.
c. ASTM D6938.
3. The frequency of in-place compaction testing including density and moisture content will be as follows:
a. At least one test for every 1,000 yds.^{3} of material placed in a mass fill.
b. At least one test for every 200 yds.^{3} of fill placed in trenches or surrounding structures.
c. At least one test per 2,500 ft.^{2} per lift of compacted soil liner or fill in roadbed.
d. At least one test for every 2,500 ft.^{2} of subgrade for fill or soil liner.
e. At least one test for every 100 ft. of roadway for road subgrades and crushed rock base course.
f. At least one test for every 500 ft.^{2} per lift in structural fill or on subgrades for foundations.
g. At least one test for every shift of compaction operations on a mass fill.
4. At least one test when Engineer suspects quality of moisture control or effectiveness of compaction. Remove or scarify fill failing to meet required densities and recompact as necessary to achieve specified results.
5. Removal of in-place material and replacement with approved new material will be required if scarifying and recompaction do not produce the required densities.
6. Perform at least one classification test (ASTM D2487) and one moisture-density test (ASTM D698) on soil used in fill or backfill operations during construction.
a. Each sample shall be taken from trenches or other excavations as directed by Engineer and should be generally representative of distinguishably differing materials encountered and used for backfill or fill.
b. Perform one set of tests at the beginning of excavation and one additional set of tests when material properties vary from the material initially tested.
c. Additional tests shall be performed when directed by Engineer.

B. Controlled Low-Strength Material (CLSM):
   1. Determine unconfined compressive strength using cylinders of CLSM sampled, handled, cured, and tested in accordance with ASTM D4832. Perform a minimum of one set of four cylinders for every 150 yds.^{3} of CLSM placed but not less than one set for each day's placement, unless otherwise directed by Engineer.
   2. Determine bearing strength, if required by Engineer, using penetration testing in accordance with ASTM C403/C403M.
   3. Test flow of CLSM, if required by Engineer, in accordance with ASTM C939/C939M.

C. Subgrades:
   1. Engineer will inspect all subgrades to determine conformance with indicated lines and grades.
   2. Subgrades for roadways, drives, parking areas, and railroads shall have a maximum deviation of not more than 1/2 inch in any 10 ft. when tested with a 10 ft. straightedge applied parallel with and at right angles to centerlines of subgrade areas. Actual grade shall not be more than 0.1 ft. from indicated grade.

END OF SECTION 312050

This page was intentionally left blank.

SECTION 329200 – SEEDING AND SODDING

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes seedbed and sod bed preparation, seeding, sodding, mulching, and fertilizing of areas indicated and/or disturbed by Contractor's construction
B. activities.
Maintenance of seeded and sodded areas.

1.02 A. RELATED REQUIREMENTS:
Section 312050 - Site Preparation and Earthwork.

1.03 A. REFERENCE STANDARDS:
Applicable Standards:

1. American Society for Testing and Materials (ASTM): Equivalent AASHTO standards may be substituted as approved.
   a. D977 – Emulsified Asphalt.

1.04 SUBMITTALS:

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
B. Certificates: Includes, but not limited to, the following:
   1. Seed shall be accompanied by certificate from vendor that seed meets requirements of these Specifications. Original hardcopy shall be submitted to the City for approval.
   2. Fertilizer shall be accompanied by certificate from vendor that fertilizer meets requirements of these Specifications. Original hardcopy shall be submitted to Engineer or the City for approval.

PART 2 - PRODUCTS

2.01 FERTILIZER:

A. Fertilizer shall be a standard commercial grade.
   1. Uniform in composition.
   2. Shall be free flowing and suitable for application with approved equipment.
   3. Shall be spread by mechanical means.
B. Deliver to Site in labeled bags or containers.

2.02 SEED:

A. Provide fresh, clean, new crop seed complying with tolerance for purity and germination established by Official Seed Analysts of North America and as required below.
B. Seed shall conform to all applicable laws of the State of Missouri.
C. Seed shall be labeled according to the U.S. Department of Agriculture Federal Seed Act and shall be furnished in containers with tags showing seed mixture, purity, germination, weed content, name of seller, and date on which seed was tested.

1. Seed Mixture:
   a. Meet the following minimum percentage requirements for purity and mix ratio:

Common and Botanical Name	Minimum Pure Live Seed (%)	Rate of Pure Live Seed (Pounds per Acre)
Alta Fescue or Kentucky 31 Fescue (Festuca Elatior, variation Arundinces)	75	100
Rye Grass (Lolium perenne or L. Multiflorum)	80	25
Kentucky Blue Grass (Pac Pratensis)	75	15
Creeping Red Fescue (Festura Ruera)	85	10
Total		150

2. Moldy seed or seed that has been damaged in storage shall not be used.

2.03 MULCH:

A. Vegetative Mulch: Mulch shall be straw from stalks of wheat, rye, or oats and shall be free of noxious and undesirable seed and material. Hay shall not be used as a mulching material. Mulch shall be preferably from the previous year's crop and shall be partially decomposed.

B. Tackifiers:
   1. Asphalt Emulsion: Conform to ASTM D977, Type SS-1.
   2. Polymeric Glue: HydroBond^{TM} as manufactured by JRM Chemical or approved equal.

C. Wood Cellulose Fiber:
   1. Fiber shall be produced from nonrecycled wood such as wood chips or similar wood materials and shall be of such character that the fiber will disperse into a uniform slurry when mixed with water. Fiber shall not be produced from sawdust, paper, cardboard, or other recycled materials.
   2. Mulch shall not contain germination or growth-inhibiting ingredients.
   3. Mulch shall be dyed an appropriate color to aid in visual inspection.
   4. Mulch material shall be easily and evenly dispersed when agitated in water.
   5. Supply in packages of not more than 100 pounds gross weight, and be marked by the manufacturer to show the air-dry weight content of the wood cellulose fiber.
   6. Mulch shall not be water-soluble and shall comply with the following properties:
      a. Moisture content: 15% maximum.
      b. Organic matter: Wood fiber (oven-dried basis), 90% maximum.
      c. pH: 4.3 to 8.5.
      d. Water holding capacity (grams of water/100 grams fiber), minimum: 1,000.
   7. Submit wood cellulose fiber material and application rates for approval by Engineer or the City.

2.04 EROSION-CONTROL:

A. Jute Netting:
   1. Netting shall consist of a uniform, open, plain-weave mesh of smolder-resistant, unbleached single jute yarn.
   2. Yarn shall be of loosely twisted construction and shall not vary in thickness by more than

one-half its normal diameter.

3. Jute mesh shall be furnished in rolled strips and shall be as follows:
   a. Minimum width of 42 inches.
   b. 76 warp ends per width (tolerance +3).
   c. 41 weft ends per yard (tolerance +3).
   d. Weigh not less than 0.9 pound per square yard.
4. Overlap blanket ends by 7 inches and edges by 4 inches.
5. Anchor the blanketing per manufacturer's recommendations. Size and material of blanket anchors shall meet the manufacturer's recommendations.
6. All erosion-control blanketing shall be laid within 24 hours of seeding application.
7. Submit jute netting material sample and installation instructions for approval by Engineer or the City.

B. Plastic Netting:
1. Netting shall be an extruded rectangular mesh plastic:
   a. Color: Black or green.
   b. Weight: 2.6 lbs./1,000 sq. ft. (+1/2 lb.).
   c. Width: 3-3/4 feet.
   d. Mesh Opening: 3/4 inch by 1 inch approximately.
2. Netting shall be rolled on a 3-inch outside-diameter cardboard core and paper wrapped in trailer loads or less.
3. Netting shall be as manufactured by Conweb Corp. or approved equal.
4. Overlap blanket ends by 7 inches and edges by 4 inches.
5. Anchor the blanketing per manufacturer's recommendations. Size and material of blanket anchors shall meet the manufacturer's recommendations.
6. All erosion-control blanketing shall be laid within 24 hours of seeding application.
7. Submit plastic netting material and installation instructions for approval by Engineer or the City.

C. Excelsior Blanket:
1. Excelsior blanket shall consist of machine-produced mat of curled wood excelsior of 80% 6-inch or longer fiber lengths, with consistent thickness and fibers evenly distributed over the entire area of the blanket.
   a. The top side of each blanket shall be covered with netting having a maximum mesh size of 1-1/2 by 3 inches, composed of cotton cord, twisted Kraft paper yarn, or biodegradable extruded plastic mesh.
   b. The blanket shall be furnished in rolled strips and shall be as follows:
      (1) Minimum width: 48 inches.
      (2) Minimum dry weight: 0.8 pound per square yard.
      (3) Smolder resistant.
   c. Overlap blanket ends by 7 inches and edges by 4 inches.
   d. Anchor the blanketing per manufacturer's recommendations. Size and material of blanket anchors shall meet the manufacturer's recommendations.
   e. All erosion-control blanketing shall be laid within 24 hours of seeding application.

D. Erosion-Control Fabric:
1. Fabric shall be "Hold Gro" erosion-control fabric as manufactured by Gulf States Paper Corporation or an approved equal.
2. Fabric shall be furnished in rolled strips with a 4-foot minimum width and an area of 200 square yards.
3. Approximate weight of fabric shall be 0.2 pound per square yard.
4. Overlap blanket ends by 7 inches and edges by 4 inches.
5. Anchor the blanketing per manufacturer's recommendations. Size and material of

blanket anchors shall meet the manufacturer's recommendations.

6. All erosion-control blanketing shall be laid within 24 hours of seeding application.

2.05 SOD:

A. Sod shall be at least three years old and densely rooted.
B. Cut sod in strips of uniform thickness with a minimum thickness of 1-1/2 inches.
   1. Each strip shall contain at least one-half (1/2) but not more than one square yard.
   2. Strips shall be not less than 12 inches in width.
C. At the time of sodlifting, the top growth shall not exceed 3 inches in length.
D. Moisten sod to depth at which it is to be cut when stripped during dry periods.

PART 3 - EXECUTION

3.01 SEEDBED AND SODBED PREPARATION:

A. Dispose of any growth, rocks, or other obstructions which might interfere with tilling, seeding, sodding, or later maintenance operations.
B. Thoroughly loosen and pulverize topsoil to a depth of at least 3 inches. Minimum depth of topsoil at seeded areas shall be 4 inches.
C. Maintain tilled areas until seeded and mulched, or sodded, to provide a smooth area with no gullies or depressions.

3.02 APPLICATION - FERTILIZER:

A. Apply fertilizer at the rate of 300-325 pounds per acre to properly prepared seedbeds and areas that are to receive sod.

B. Incorporate fertilizer into the soil to a depth of at least 2 inches by disking, harrowing, or raking. Fertilizer may be applied hydraulically on slopes 2 horizontal to 1 vertical or steeper. If fertilizer is applied hydraulically to these slopes, incorporation into the soil will not be required.

3.03 APPLICATION - SEED:

A. Dry Seeding: Accomplish sowing by use of approved equipment, having drills no more than 4 inches apart.
   1. Drill seed to an average depth of 1/2 inch.
   2. Overlap successive seed strips to provide uniform coverage. Repeat where skipped areas appear after a show of green.
   3. Cover seed with soil to an average depth of 1/4 inch by raking or other approved methods.
B. Hydraulic Seeding: Mix seed with water and constantly agitate. Do not add seed to water until immediately prior to application. Do not let seeds remain in tank for more than 30 minutes.
   1. On slopes flatter than 2 horizontal to 1 vertical, apply seed separately from fertilizer. Mechanically incorporate fertilizer into the soil prior to seeding activities. Cover seed with either hydraulic mulch or soil. If hydraulic mulching is not used, cover seed with soil to an average depth of 1/4 inch by raking or other approved methods.
   2. On slopes 2 horizontal to 1 vertical and steeper, seed and fertilizer may be applied in a single operation. Incorporation into the soil will not be required. Hydraulic mulching will be required.
C. Seasonal Limitations: Perform seeding only during the following seasons:
   1. The City prefers seeding be done between September 1 and October 30, if possible.
   2. If the time period above is not possible, the City's second choice would be seeding

between March 1 and June 15. March or April would be preferable for this option.

D. Temporary Seeding: The City may require temporary seeding outside of the limits specified herein. In this case, the Contractor will be required to submit a temporary seeding mixture for City Approval.

3.04 APPLICATION - MULCH:

A. Apply mulch covering to all seeded areas within 24 hours after seeding. Mulch is not required on areas that are to be covered by an excelsior blanket or by an erosion-control fabric. Jute netting alone will not be considered an erosion-control fabric.

B. Apply vegetative mulch at the rate of 2.5 tons per acre by means of a mechanical spreader or other approved methods.

C. Apply wood-cellulose-fiber mulch hydraulically at the rate of 2,000 pounds per acre.
   1. Mulch and seed may be applied in a single operation on slopes 2 to 1 or steeper.
   2. Apply mulch to achieve a uniform coverage of the soil surface.

D. Vegetative Mulch with Asphalt Emulsion:
   1. Temperature of mulch at time of application shall be between 125 and 175°F.
   2. Mulching machine shall inject emulsified asphalt at the proper rate directly into the air stream carrying the straw.
   3. Hand-spray near structures.

E. Immediately following the application of the mulch, water the seeded area in one watering, at a rate of 120 gallons per 1,000 square feet. Perform so as not to cause erosion or damage to the seeded surface.

3.05 APPLICATION - EROSION CONTROL:

A. Install netting or seeding mats in lieu of seed and straw on all ditches or slopes 3 to 1 or greater. Install netting immediately following mulching operations. Water the seeded area at a rate of 390 gallons per 1,000 square feet.

B. Roll netting, excelsior blanket, or erosion-control fabric loosely over the required areas. Lifting and stretching of the material will not be permitted.

C. Secure netting, excelsior blanket, or erosion-control fabric by staples spaced as per manufacturer's recommendations.

D. Lap joints in the direction of water flow with at least a 4-inch overlap.

E. Any seeded or mulched areas disturbed by the installation of the netting, excelsior blanket, or erosion-control fabric shall be repaired at the Contractor's expense.

3.06 APPLICATION - SOD:

A. Prior to placing sod, the soil surface shall be worked until it is relatively free from debris, washes, gullies, clods, and stones. Surface shall be worked to a depth of not less than 3 inches with a disk, tiller, or other equipment approved by the Engineer.

B. Fertilizer shall be placed prior to placement of sod.

C. Handle sod with care to prevent loss of native soil from roots.

D. Do not use frozen sod.

E. Do not place sod on frozen ground.

F. Sod shall be moist at the time it is placed.

G. Lay sod strips along contour lines, by hand, commencing at the base of the area to be sodded and working upward.
   1. Carefully lay sod to produce tight joints.
   2. Stagger transverse joints of sod strips.

H. Firm, water, and refirm sod immediately after it is placed.
   1. Accomplish firming by application of a smooth-wheel roller weighing not less than 60 or

more than 90 pounds per linear foot of roller.

I. On slopes of 3 horizontal to 1 vertical and steeper, anchor sod by wooden pegs after sod has been firmed.
   1. Pegs shall be 1/2 inch by 12 inches, driven into the ground on about 2-foot centers.
   2. Top of peg after driving shall be not less than 1/2 inch but not more than 1 inch above top of sod.

3.07 MAINTENANCE:

A. Mow grass to a height of 2 inches whenever average height of grass exceeds 5 inches.
B. Remove weeds by approved chemical treatment.
C. Erect and maintain signs or barricades to exclude traffic from seeded or sodded areas.
D. Seeded Areas: Contractor to perform maintenance until seed growth is fully established and the city approves.
   1. Water as required by good practice during the three-month maintenance period or until accepted by Engineer.
   2. Prior to acceptance, repair at Contractor's expense any portion of the seeded surface which becomes gullied or otherwise damaged or destroyed.
   3. To be acceptable, seeded areas shall have a good, uniform color and sturdy growth with no bare soil spots, over a minimum of 98% of the area seeded.
E. Sodded Areas: Perform maintenance for a period of three months after planting unless the desired cover is obtained in a shorter time and the shorter period of Contractor's responsibility is authorized by Engineer.
   1. Thoroughly water sodded areas daily for a period of 15 days after placing.
   2. Maintain sod in good live condition. Prior to acceptance, replace any sod not in good growing condition with fresh live sod at Contractor’s expense.
   3. Water thoroughly whenever sod shows evidence of excessive drying until sod is accepted.
   4. To be acceptable, sodded areas shall have a good, uniform color and sturdy growth with no bare soil spots, over a minimum of 98% of the area sodded.

3.08 MEASUREMENT AND PAYMENT:

A. Time of Completion: Completion time for seeding and sodding shall not apply to provisions for liquidated damages with respect to Contract completion time. Payment for seeding and sodding will be withheld until such Work is accepted.
B. Measurement and payment will be as directed in the Contract documents.

END OF SECTION 329200

This page was intentionally left blank.

SECTION 330130.11 – TELEVISION INSPECTION OF SEWERS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. Each designated pipe section shall be visually inspected by means of closed circuit television (CCTV) prior to starting any rehabilitation work. Each installed CIPP Liner and Service Connection Liner shall be inspected by means of CCTV for acceptance. Inspections shall be performed on one sewer segment (i.e. manhole to manhole) at a time.

B. Video recordings shall be made of the CCTV inspections and shall be submitted via the internet using the directions stated herein.

C. Gravity sewer segments shall be named based on the upstream and downstream manholes. For example, a gravity sewer main with flow entering from SMH1359 and discharging to SMH1358 shall be designated SMH1359_SMH1358.

1.02 SUBMITTALS:

A. All CCTV inspection shall be recorded in digital, color format as the Work is being conducted. Submit all videos along with inspection logs for review as the Work is being submitted for payment. Transmit copies of the videos and inspection logs via Email, Dropbox or USB and hard copy.

B. Both written and video reports shall use nomenclature as standardized by NASSCO's PACP to list defects found in the pipe.

C. For each CCTV uploaded via Dropbox, complete the CCTV record log on an approved Project Management Information System (PMIS).

D. Pre-Installation CCTV will be reviewed as an Informational Submittal. Post-Installation CCTV will each be reviewed as an Action Submittal. Include the appropriate suffixes in each sewer segment name.

1. "CIPP" for all segments to be lined
2. "PRE" for Pre-Installation CCTV (Example: SMH1359_SMH1358-CIPP-PRE, identifies CCTV inspection prior to installation of CIPP in the mainline sewer.)
3. "PST-CMP" for Complete Post-Lateral CCTV (Example: SMH1359_SMH1358-CIPP-PST-CMP, identifies CCTV inspection of CIPP in the mainline sewer, service lateral connection liners, and all repairs.)

1.03 RELATED WORK:

A. Cured-in-Place Pipe Lining is specified in Section 330130.72.

B. Removal of Protruding Service Connections in Section 330130.43

PART 2 -PRODUCTS

2.01 EQUIPMENT:

A. The CCTV camera used for the inspection shall be one specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear picture for the entire periphery of the pipe. The camera shall be operative in 100 percent humidity conditions. The CCTV camera shall be equipped with a pan and tilt head. The camera, television monitor and other components of the video system shall be capable of producing a minimum 470-line resolution video picture. Picture quality and definition shall be to the satisfaction of the Engineer and if unsatisfactory, equipment shall be removed, and no payment made for an unsatisfactory inspection.

B. The CCTV camera shall be moved through the line at a uniform rate, but in no case shall the CCTV camera be moved at a speed greater than 30 feet per minute. Transporters, 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 sewer conditions may be used to move the camera through the sewer. A lateral launching camera is not required for inspection of service lateral connections.

C. Whenever non-remote powered and controlled winches are used to pull the television camera through the line, telephones, radios, or other suitable means of communication shall be set up between the two manholes of the sewer line being inspected to ensure good communications among members of the crew.

D. Accurate measurements are crucial. Measurements for locations of defects shall be below ground by means of a meter device. Marking on cable, or the like, which would require interpolation for depth of manhole, will not be allowed. Measurement meters shall be accurate to a foot over the length of the sewer line section being inspected. Accuracy of the measurement meters shall be checked daily above ground by use of a walking meter, roll-a-tape, or other suitable device.

E. All television work shall be recorded in digital format as the work is being conducted.

PART 3 - EXECUTION

3.01 PRE-INSTALLATION PROCEDURE:

A. Move the camera through the line from upstream to downstream, stopping when necessary to locate service connections and ensure proper documentation of sewer main conditions, point repair locations, point repair joints, and service lateral conditions at the sewer main. Contractor shall be responsible for verifying each service connection as being active or inactive. If, during the inspection operation, the television camera will not pass through the entire sewer line section, the equipment shall be removed and repositioned in a manner so that the inspection can be performed from the opposite manhole. If, again, the camera fails to pass through the entire sewer line section, the Contractor shall remove the obstruction through heavy cleaning or by excavation and replacement of that section of pipe as directed by the Engineer.

B. At least 2/3 of the pipe diameter must be visible during CCTV inspection. The Contractor shall accomplish this visibility requirement through plugging or bypass pumping as necessary.

C. All CCTV videos for the project shall remain the property of the City once issued into the PMIS. If videos are deemed to be of inferior quality or coverage as determined by the engineer, the contractor shall be required to re-inspect and re-video that video at no extra cost.

3.02 POST-INSTALLATION PROCEDURE:

A. Prior to the start of post-installation CCTV inspection of each sewer section, isolate the section and make a cleaning pass to remove debris and excess water. Move the camera through the line from upstream to downstream, stopping when necessary to ensure proper documentation of any defects in the installed liner. Stop and rotate the camera to inspect results of service lateral reinstatement and identify subsequent installation of service lateral connection liners or service lateral connection repairs. At each stop to identify a defect or lateral reinstatement, also identify on screen the distance from upstream manhole and clock position.

B. Repeat the procedure after installation of service lateral connection liners, service lateral connection repairs, and sewer main liner repairs.

C. Within 30 days following the completion of all rehabilitation work associated with each gravity sewer main, the contractor shall issue the PST-CMP CCTV video.

3.03 RECORDING OF FIELD OBSERVATIONS:

A. Television Inspection logs
   1. Provide Pre-Installation CCTV inspection logs which clearly show the locations, in relation to adjacent manholes, of service connections, roots, cracked or collapsed sections, presence of scale and corrosion, sewer line sections that the camera failed to pass through, and reasons for the failure and other discernible features.
   2. Provide Post-Mainline CCTV inspection logs which clearly show the locations, in relation to adjacent manholes, of discernible defects in the liner. Inspection logs shall include a list of all service laterals abandoned or reconnected.
   3. Provide Post-Lateral CCTV Inspection logs which clearly show installation of service lateral connection liners, service lateral connection repairs, and sewer main liner repairs.
   4. CCTV Inspection Logs shall include the following information.

DATE	TIME
PROJECT NAME	PROJECT NUMBER
OPERATOR NAME	
STREET OR LOCATION	
UPSTREAM MANHOLE	DOWNSTREAM MANHOLE
DIRECTION OF INSPECTION	
PIPE DIAMETER	PIPE MATERIAL

B. Photographs
   1. Digital photographs of problem areas shall be taken as directed to document unusual, questionable, or severe conditions found during the course of the Work. Provide image files at lateral locations.

C. Digital Recordings
   1. Motion playback features shall be supplied at the option of the Contractor. Digital recordings shall be made in color.

3.04 SUBMITTAL OF CCTV:

A. CCTV shall be submitted electronically via Email, Dropbox, or USB or by hard copy as approved by the City.

3.05 CREATING A PMIS RECORD:

A. Once the CCTV is submitted and uploaded, create a record of the CCTV submittal in the approved PMIS.

END OF SECTION 330130.11

This page was intentionally left blank.

SECTION 330130.41 – CLEANING OF SEWERS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. Furnish all labor, materials, equipment and incidentals required to perform high pressure water jetting, cleaning, rodding, brushing, root cutting and flushing of designated sewer lines and sewer service laterals prior to internal inspection by closed circuit television, cured-in-place lining operations, and/or grouting.

1.02 RELATED WORK:

A. Television Inspection of Sewers is included in Section 330130.11.
B. Removal of Protruding Service Connections is included in Section 330130.43.
C. Cured-in-Place Pipe Lining is included in Section 330130.72.

PART 2 - PRODUCTS

2.01 EQUIPMENT:

A. Hydraulic Sewer Cleaning Equipment
   1. The equipment used shall be of a movable dam type and be constructed so that a portion of the dam may be collapsed at any time during the cleaning operation to protect against flooding of the sewer. The movable dam shall be the same diameter as the pipe being cleaned and shall provide flexible scraper around the outer periphery to ensure total removal of grease. If sewer cleaning balls or other such equipment which cannot be collapsed instantly are used, special precautions against flooding of the sewers and public or private property shall be taken.

B. High Velocity Jet (Hydrocleaning) Equipment
   1. The equipment shall have a selection of two or more velocity nozzles. The nozzles shall be capable of producing a scouring action from 15 degrees to 45 degrees in all sewer lines and manholes to be cleaned. Equipment shall also include a high velocity gun for washing and scouring manhole walls and floor. The gun shall be capable of producing flows from a fine spray to a long-distance solid stream. The equipment shall carry its own water tank, auxiliary engines, pumps and hydraulically driven hose reel. All controls shall be located so the equipment can be operated above ground.
   2. High velocity sewer cleaning equipment shall include a lateral cleaning launcher to clean service laterals from the mainline sewer.

C. Mechanical Cleaning Equipment
   1. Bucket machines shall be in pairs and with sufficient power to perform the work in an efficient manner. Machines shall be belt operated or have an overload device. Machines with direct drive which could cause damage shall not be acceptable.
   2. Power rodding machines shall be either sectional or continuous type capable of holding a minimum of 750 feet of rod. The rod shall be specifically treated steel. To ensure safe operation, the machine shall have a fully enclosed body and an automatic safety release clutch or relief valve.
   3. Root cutting machines shall be capable of removing roots such that cured-in-place pipe lining can be installed per manufacturer's recommendations.

PART 3 - EXECUTION

3.01 GENERAL:

A. Contractor is solely responsible for its means and methods of sewer and service lateral cleaning. Selection of cleaning equipment and the method for cleaning shall be based on the condition and/or pipe material of the sewer segment at the time work commences and shall comply with this Specification. FLUSHING OF ANY SANITARY SEWER TO FACILITATE CLEANING ACTIVITIES WITHOUT THE CAPTURE OF SOLIDS AND DEBRIS IS EXPRESSLY PROHIBITED.

B. Sewer line walls shall be cleaned adequately to discern structural defects, misalignment, and infiltration/inflow sources during CCTV inspection.

C. Start the cleaning operation with the upstream sewers in the system and proceed downstream with the direction of flow.

D. The City will furnish water for sewer pipe cleaning. A hydrant meter shall be secured by the contractor for purposes of tracking water used.

3.02 SAFETY:

A. Contractor shall be solely responsible for safety during the performance of all work. Take precautions to protect the sewer segments and appurtenances from damage that might be inflicted upon them by the use of cleaning equipment. Any damage inflicted upon a sewer segment or other public or private property as a result of the Contractor's cleaning operations, regardless of the cleaning method used and regardless of any other circumstance which may contribute to the damage, shall be repaired by the Contractor at no additional cost to the City.

B. Perform all work in accordance with the latest OSHA confined space entry regulations. 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 segment are used, take precautions to ensure that the water pressure utilized does not result in any damage or flooding to public or private property being served by the sewer segment(s) involved.

3.03 PREPARATION:

A. Selection of cleaning equipment shall be based on the condition of the pipe at the time the work commences. The equipment and methods selected shall be acceptable to the Engineer; however, acceptance of proposed method of cleaning does not relieve the Contractor of their responsibility to adequately clean the pipe to allow performance of other work.

1. The Contractor shall use high pressure water jetting equipment wherever possible.
2. The Contractor shall utilize mechanical or hydraulically propelled cleaning equipment where heavy cleaning is prescribed and where approved by the Engineer. Heavy cleaning of sewers and service laterals requires the contractor to perform the necessary cleaning passes with a high velocity jet nozzle and/or use of mechanical equipment for root/grease removal to achieve acceptable gravity sewer main preparation for CIPP lining. Equipment used for heavy cleaning shall be capable of removing scale, tuberculation, mineral deposits and roots (including root balls) from mainline sewers and service laterals. Authorization for heavy cleaning shall be based on the plans. Heavy cleaning conducted by the Contractor in sewers and service laterals not listed therein requires prior approval of the Engineer. If prior approval is not received, it shall be at the Contractor's expense.

3.04 PERFORMANCE:

A. Each designated sewer section and service lateral shall be cleaned prior to installation of the CIPP liner using hydraulically propelled, high velocity jet, or mechanically powered

equipment. Each service lateral shall be cleaned sufficiently to verify an active or inactive connection. The equipment selected for cleaning shall be capable of removing dirt, grease, rocks, sand, roots and other deleterious materials and obstructions from the sewer lines. If cleaning of an entire section cannot be successfully performed from one manhole, the equipment shall be set up on the other manhole and cleaning again attempted. If successful cleaning cannot be performed from the second manhole, or the equipment fails to traverse the entire length between manholes, it will be assumed that a major blockage exists and the cleaning effort shall be abandoned. Blockages, if any, shall be reported to the Engineer immediately.

B. During all sewer cleaning operations, satisfactory precautions shall be taken to protect the sewer or lateral 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 pipe section involved. The flow of sewage in the sewer lines shall be used to provide necessary pressures for hydraulic cleaning devices whenever possible.

C. All sludge, dirt, sand, rocks, grease, roots and other solid or semisolid residue, debris, and material resulting from 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.

D. Procedures may include the use of mechanical devices such as rodding machines, expanding cutters, and porcupines, or hydraulic procedures such as high-pressure jet cleaners.

E. All debris, residue and other materials resulting from cleaning operations shall be removed from the site 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., on the site of work beyond the stated time be permitted, unless prior written authorization is given for storage in totally enclosed containers.

3.05 BLOCKAGES PREVENTING CLEANING:

A. If cleaning of an entire sewer section cannot be successfully performed from one manhole, equipment shall be set up on the other manhole and cleaning again attempted (a reverse set-up). No additional payment allowance shall be made for reverse set-ups. If on a reverse set-up, successful cleaning also cannot be performed or equipment fails to traverse entire sewer line section, it shall be assumed that a major blockage or defect exists, and cleaning effort shall be abandoned.

B. Contractor shall determine the location of major blockage(s) by measuring length of hose or rod inserted from manholes at each end and immediately report location of blockage(s) to Engineer and Contractor shall note these conditions in its field log.

C. Contractor shall recognize that there are some conditions such as broken pipe and major blockages that prevent cleaning from being accomplished or where damage could result if cleaning were attempted or continued. Engineer shall be immediately notified by Contractor of any and all conditions which in the opinion of Contractor warrant termination of cleaning activities. If Contractor's cleaning equipment becomes lodged in a sewer, it shall be removed by Contractor at his expense. This shall include excavation and repair of the sewer, underground utilities, backfilling, and surface restoration.

3.06 REMOVAL AND DISPOSAL OF MATERIALS:

A. All sludge, dirt, sand, rocks, grease and other solid or semi-solid residue, debris, and material resulting from cleaning operations shall be removed at the downstream manhole of the section

of sewer being cleaned by Contractor. 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. In the event that sludge, dirt, sand, rocks, grease and other solid or semi-solid residue, debris, or material passes to downstream sewer segment(s), Contractor shall be responsible for cleaning such downstream sewer segment(s) at no additional cost to City.

B. 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 off-site by the Contractor. Contractor shall be responsible for any testing of materials prior to disposal. Under no circumstances will the accumulation of debris, residue, etc. on the site beyond the stated time be permitted, unless prior written authorization is given for storage in totally enclosed containers.

C. Continuously remove debris from the downstream manhole during sewer cleaning. Do not allow debris to be passed into the downstream sewer. Decant excess cleaning water and direct it to the sewer downstream of the sewer being cleaned.

D. Under no circumstances shall the removed sewage or solids be dumped onto streets or into ditches, catch basins, storm drains, sanitary or combined sewer manholes, or otherwise improperly disposed. If sewage is unintentionally spilled, discharged, leaked or other deposited in the open environment, Contractor shall be responsible for any clean-up and disinfection of the affected area. Contractor shall comply with all Local, State and Federal regulatory requirements regarding spills.

3.07 FIELD TESTING:

A. Acceptance of sewer or lateral line cleaning shall be contingent on satisfactory completion of the television inspection. If television inspection shows the cleaning to be unsatisfactory, the sewer or lateral line shall be re-cleaned and re-inspected, as specified in Section 330130.11, until the cleaning is shown to be satisfactory, at no cost to the City.

END OF SECTION 330130.41

This page was intentionally left blank.

SECTION 330130.43 – REMOVAL OF PROTRUDING SERVICE CONNECTIONS:

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. Furnish all equipment, labor and materials necessary to internally remove protruding taps and obstructions in those sewers identified in the plans, or as directed by the Engineer.
B. Remove all taps to within 1/8-inch of the sewer line wall to eliminate interference with CIPP lining.
C. Where possible, complete removal of protruding taps, and obstructions before conducting sewer line cleaning and CCTV inspection. Where this is not possible, the Contractor shall ensure that the sewer is clean of all dirt and debris.
D. Dirt and debris resulting from protruding tap removal or obstruction removal shall not be allowed to enter the wastewater flow and be carried to downstream reaches. This material shall be removed and disposed in accordance with requirements of Section 330130.41.

1.02 RELATED WORK:

A. Cleaning of Sewers is specified in Section 330130.41.
B. Television Inspection of Sewers is specified in Section 330130.11.
C. Cured-in-Place Pipe Lining is specified in Section 330130.72.

PART 2 - PRODUCTS

2.01 EQUIPMENT:

A. Remove protruding taps using an internal, remote-controlled intruding pipe remover or service lateral reinstatement machine. Excavation and replacement of protruding taps will not be allowed except under special situations authorized in writing by the Engineer.
B. The equipment shall consist of a main body containing a rotating head assembly equipped with carbide cutting edges or a robotic crawler with extendable cutting arm and camera. The rotating cutting head shall be driven by air, water or an electric motor and shall be capable of cutting asbestos cement, concrete, PVC and other materials commonly used for pipe construction with the exception of cast iron and steel.
C. The equipment shall be accurately positioned using a TV camera in conjunction with the cutter assembly.

PART 3 - EXECUTION

3.01 PERFORMANCE:

A. Remove all protruding taps, and obstructions from sewers identified in the plans, or as directed by the Engineer.
B. Maintain a complete record of all taps that were removed and submit a list for information.
    1. The list shall show the date, sub-area, street, sewer reach (by manhole numbers), station and location (left, right or top) of each tap removed.
    2. The list shall also show similar data for any taps that were not successfully removed, as well as the reason why removal was unsuccessful.
C. Where an obstruction cannot be removed by cleaning, the Contractor may propose a method of removal by other means as an alternative to point repair. The Contractor must receive approval by the Engineer prior to proceeding.
D. Protect existing sewer lines and service connections from damage caused by improper use of the

equipment. Damage to a sewer or service connection caused by removal of a tap or removal of an obstruction by other means shall be repaired immediately, as directed by the Engineer, at no additional cost to the City.

E. Remove and dispose of all dirt and debris from the sewer following completion of tap and obstruction removal in that reach as specified in Section 330130.11.

END OF SECTION 330130.43

This page was intentionally left blank.

SECTION 330130.72 – CURED-IN-PLACE PIPE LINING:

PART 1 – GENERAL

1.01 SCOPE OF WORK:

A. Furnish all labor, materials, equipment, and incidentals required to install and test the cured-in-place pipe (CIPP) lining and appurtenances complete and as specified herein, including, but not limited to services necessary for traffic control, bypass pumping and/or diversion of sewage flows, cleaning and television inspection of sewers to be lined, liner installation, reinstatement of service connections, quality control, providing samples for performance of required material tests, final television inspection, testing of lined pipe system and warranty work, all as specified herein.

B. Remove obstructions and protruding service connections as necessary to complete the CIPP rehabilitation prior to the pre-rehabilitation CCTV inspection.

C. Neither the CIPP system, nor its installation, shall cause adverse effects to any of the City's processes or facilities. The use of the product shall not result in the formation or production of any detrimental compounds or by-products in the system or at the wastewater treatment plant. The Contractor shall notify the Engineer and identify any by-products produced as a result of the installation operations. The Contractor shall test and monitor the levels of by-products and comply with any and all local waste discharge requirements. Clean up, restore existing surface conditions and structures, and repair any of the CIPP system determined to be defective. The Contractor shall conduct installation operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians, businesses, and property owners or tenants.

D. The Contractor shall not change any material, design values or procedural matters stated or approved herein, without written notification to the Engineer and receiving written approval of the change. Such changes shall result in rejection and removal of work performed with the unapproved materials or processes followed by rectification or replacement as directed by the Engineer, at no cost to the City.

E. This specification applies to CIPP lining installed by inversion and cured with hot water or steam.

1.02 RELATED WORK:

A. Television Inspection of Sewers is included in Section 330130.11.

B. Cured-in-Place Pipe Short lines are included in Section 330130.77.

1.03 SUBMITTALS:

A. Submit statement of qualifications, shop drawings, working drawings, product data, and information related to CIPP installation. Submit a statement of qualifications within 10 days of Notice to Proceed.

B. Submit a Statement of Qualifications for the installer performing CIPP work. The Statement of Qualifications shall include the following information:

1. A list of a minimum of five municipal clients that Contractor or CIPP Subcontractor has performed this type of work for without defects or performance problems for a period of five years after installation. The list shall contain the following:
    a. Names and telephone numbers of persons to be called to verify previous satisfactory performance.
    b. A full description of the actual work performed.
    c. Name of CIPP lining manufacturer and supplier for each referenced project.
2. Documentation of experience and references to demonstrate compliance with requirements of Paragraph 1.05 Qualifications.

C. Submit documentation of experience and qualifications of the CIPP materials manufacturer(s) including the following information:
   1. Name(s) of liner manufacturer and supplier.
   2. A certified statement that the Contractor or CIPP Subcontractor is certified or licensed by the CIPP liner manufacturer as an approved installer.
   3. Product names and information for CIPP felt tubes and resin materials to be used in this project.
   4. Five reports from independent testing laboratory analysis of liner materials, for projects within past two years, showing: Modulus of elasticity as determined by appropriate ASTM standard and flexural stress as determined by ASTM D790 standard. Lining shall be of same resin system and felt tube materials as proposed for this project.
   5. Verifiable references that CIPP materials manufacturer(s) have successfully supplied a minimum of 500,000 linear feet of the proposed liner and one million pounds of resin.

D. Shop drawings, working drawings, and product data submittals required shall include the following information:
   1. Detailed information on the CIPP installation procedures (wet-out, heating, curing, and cool down, if applicable) and all tools and equipment required for a complete installation. Identify which tools and equipment will be redundant on job site in the event of equipment breakdown. Equipment to be furnished for the project, including proposed back-up equipment, shall be clearly described. Contractor shall outline the mitigation procedure to be implemented in the event of key equipment failure during the installation process.
   2. Shop drawings and product data to demonstrate compliance with these specifications and identify materials of construction (including resins, catalysts, felt, etc.), felt manufacturer, location of the felt manufacturing facility, location of the wet-out facility, etc., flexible membrane (coating) material (including recommended repair/patching procedure, if applicable).
   3. Manufacturers' shipping, storage and handling recommendations for all components of the CIPP System.
   4. Safety Data Sheets (SDS) sheets for all proposed products and materials to be furnished for the project.
   5. Detailed sample collection, laboratory testing and quality control procedures, including schedule and shipping and storage requirements.
   6. Written description and a plan for odor control that will ensure that project specific odors such as styrene will be minimized at the project site and surrounding area.
   7. The end seal material(s) and description of their installation.
   8. A detailed description of the Contractor's proposed procedures for removal of any existing blockages in the pipeline that may be encountered during the cleaning process.
   9. Data on the maximum allowable stresses and elongation of the liner during installation and the means in which the Contractor will monitor stress and elongation (i.e., ideal inversion head and maximum cold head, minimum inversion head, maximum hot head).
   10. A detailed public notification plan shall be prepared and submitted including detailed staged notification to residences affected by the CIPP installation. Coordinate with General Requirements.
   11. A complete description of the wet-out procedure for the proposed technology. Identify the wet-out facility where all CIPP liner will be manufactured for this project. All CIPP liners shall be manufactured at the designated wet-out facility. Multiple wet-out facilities will not be allowed.
   12. A detailed quality control plan (QCP) that fully represents and conforms to the requirements of these specifications. At a minimum, the QCP shall include the following:

a. A detailed discussion of the proposed quality control.
b. Defined responsibilities of the Contractor's personnel for assuring that all quality requirements for this contract are met. These shall be assigned to specific personnel.
c. Proposed procedures for quality control including those pertaining to fit and finish, and product sampling and testing.
d. Proposed methods for product performance controls, including method of and frequency of product sampling and testing both in raw material form and cured product form.
e. A schedule for performance and product test result reviews between the Contractor and Engineer at a regularly scheduled job meeting.
f. Inspection forms and guidelines for quality control inspections in accordance with the standards specified in this contract.

13. Design data and specification data sheets listing all parameters used in the CIPP liner design and thickness calculations based on ASTM F 1216 for "fully deteriorated gravity pipe conditions."

E. Submittals before, during and after CIPP installation work shall include the following:
1. Prior to each shipment of CIPP lining, submit certified test reports that the CIPP lining for this Contract was manufactured and tested in accordance with all ASTM Standards specified and referenced herein.
2. CIPP lining schedules including field-verified lengths and diameters of all CIPP lining, appurtenances, and map(s) that show insertion points for all CIPP installations, required to show that the contractor has physically measured every pipe to be rehabilitated.
3. Detailed installation procedures and manufacturer's recommended cure method for each diameter and thickness of CIPP liner to be installed, including CIPP lining production schedule, acceptable inversion heads and pressures, inversion procedures, curing and cool-down procedures detailing the curing rate of temperature increases and cool down and the method of application, and times for each stage of the process.
4. Wet-out forms/reports for each CIPP segment with detailed information including but not limited to: date and time of wet-out, wet-out facility address, volumes and/or weights of resin, length and diameter of CIPP liner (both wet-tube and dry-tube), roller gap settings, start times, finish times, resin used (product name and batch/shipment number) and quantity, gel times, resin injection locations, thickness of CIPP liner (dry and wet), catalyst(s) name and quantity used, and any other pertinent data documenting the wet-out for each section of CIPP liner manufactured. The wet-out forms shall be submitted during the week of installation as informational submittals.
5. Furnish copies of CIPP liner field curing reports documenting the liner installation for all sewer segments to the RPR on a daily basis. The CIPP liner reports shall document all details of liner installation, including manhole numbers, street names/sewer location, project number, date, time, ambient temperature, heads used during the inversion process, pressures and/or heads (minimum inversion pressure, ideal head, maximum hot head and maximum cold head) used during curing (including cool down if applicable), curing temperature, curing time, rate of cool down, CIPP liner thickness, etc. A sample report shall be submitted to the Engineer for approval prior to the installation of any CIPP lining.
6. Pre-rehabilitation and post-rehabilitation closed-circuit television (CCTV) inspection data as further defined herein. All CCTV inspection data shall be submitted with each payment request including payment for CIPP lining in place.
7. Samples of installed liner(s) for testing to be performed by an ASTM-certified independent testing laboratory, as described further herein.

8. Information on any grouts, epoxy, or cements proposed for sealing at manholes or for other uses.
9. The Contractor shall submit daily production reports to the Resident Project Representative at the end of each workday.
10. A list of all service laterals (with distances and clock position) that were abandoned or re-established as part of the work as further defined herein.
11. Some new CIPP installations may result in the need to repair or replace a defective CIPP. The Contractor shall submit in writing, for review by the Engineer, specific repair or replacement procedures for potential defects that may occur in the installed CIPP. Repair/replacement procedures shall be as recommended by the CIPP system manufacturer and shall include the following:
    a. Defects in the installed CIPP that will not affect the operation and long-term life of the product shall be identified and defined.
    b. Repairable defects that may occur in the installed CIPP shall be specifically defined by the Contractor based on manufacturer's recommendations, including a detailed step-by-step repair procedure, resulting in a finished product meeting the requirements of these contract specifications. Repairable defects may include but are not limited to blisters, wrinkles, fins, pinholes, over- or under-cut lateral connections, and any voids found between liner and the host pipe.
    c. Un-repairable defects in the CIPP shall be clearly defined by the Contractor based on the manufacturer's recommendations, including a recommended procedure for the removal and replacement of the CIPP. Un-repairable defects may include, but are not limited to, less than minimum thickness, insufficient structural strength, lifts, shrinkage, folds, bulges, and delamination.
12. A list of all repair or replacement of CIPP defects that were executed by the Contractor including identification of segment, location of the repair, and type of repair.

1.04 REFERENCE STANDARDS:

A. American Society for Testing and Materials (ASTM), latest edition.
    1. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
    2. ASTM F1216 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
B. National Association of Sewer Service Companies (NASSCO)
    1. NASSCO Pipeline Assessment and Certification Program (PACP) Reference Manual, current edition, including addenda.
C. Water Research Centre, UK
    1. Sewerage Rehabilitation Manual, Type II Design, WRc Publications
D. Where reference is made to one of the above standards, the latest revision/update in effect at the time of bid opening shall apply.

1.05 QUALIFICATIONS:

A. CIPP Installer performing the lining work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a satisfactory manner and shall be certified and/or licensed as an installer by CIPP lining manufacturer.
B. Engineer reserves the right to approve or disapprove Superintendent and lead personnel based on submitted qualifications and a follow-up interview.

1.06 GUARANTEE:

A. CIPP lining placed shall be guaranteed by Contractor and manufacturer for a period of two years from date of Final Completion. During this period, serious defects discovered in CIPP lining, as determined by City and which may materially affect the integrity, strength, function and/or operation of pipe, shall be removed and replaced as recommended by the manufacturer in a satisfactory manner (to the City) by the Contractor at no cost to the City. The City may conduct an independent CCTV inspection, at its own expense, of CIPP lining work prior to completion of the warranty period. Defects replaced at that time shall be fully warranted by Contractor and manufacturer for a period of two years from date the defect is repaired. Wrinkles in flow stream, blisters that may affect the longevity of CIPP liner, dry spots where liner tube has no resin saturation, or other defects that may affect the integrity or strength of the CIPP or the flow capacity of the pipe, are unacceptable. Contractor shall be responsible to remove and repair, at no additional cost to the City, all such defects in a manner that is satisfactory to City. Defects also include but are not limited to the following:
   1. Leakage through the liner or between liner and pipe.
   2. Reduction of liner thickness of more than ten percent (10%) of the thickness designed and/or required. Final liner thickness shall be delivered by Contractor based on installed product physical properties and as specified in Contract requirements.
   3. Separation of liner from host pipe where an annular space is clearly noticed, shrinkages (longitudinal and/or circumferential), delamination of liner, cured lifts, dry spots, bulges due to external loading, reverse curvatures, splits, cracks, lifts, breaks, folds, wrinkles (as defined further herein), flats, pinholes, crazing and any other defects that in the CIPP lining will compromise the longevity of the installed product.
   4. Circumferential defects (wrinkle, fin, bulge, etc.) in the invert of pipe between 4:00 and 8:00 o'clock shall not exceed three percent of the host pipe diameter or 1/2-inches by visual measurement, whichever is smaller.
   5. Longitudinal wrinkles or fins shall not exceed maximum allowable height of five percent of equivalent host pipe diameter or 1-inch, whichever is smaller.
   6. Structural strength below the required limits

1.07 QUALITY ASSURANCE:

A. Install CIPP linings according to procedures in the quality control plan.

B. CIPP linings shall be furnished by a single manufacturer. Suppliers shall be responsible for provisions of all test requirements specified herein as applicable. In addition, CIPP lining to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory. Contractor shall require manufacturer's cooperation with these inspections. Cost of plant inspection of all CIPP lining approved for this Contract will be the responsibility of the Contractor.

C. Inspections of CIPP lining may also be made by the Engineer after delivery. CIPP lining shall be subject to rejection at any time on account of failure to meet any of the requirements specified, even though sample CIPP lining may have been accepted as satisfactory at the place of manufacture. CIPP lining rejected after delivery shall be marked for identification and shall be removed from the job site, at no cost to the City.

D. If an installation is rejected based on review of the post-rehabilitation CCTV inspection, the Contractor shall repair the sewer segment to the satisfaction of the Engineer at no additional cost to the City.

E. Along with the physical properties testing and post-installation CCTV survey, the Contractor shall deliver a certified copy of the curing log from the temperature monitoring system used in the control of the curing process for pipes.

1.08 DELIVERY, STORAGE AND HANDLING:

A. Care shall be taken in shipping, handling and laying to avoid damaging the CIPP liner. CIPP liner damaged beyond repair in shipment shall be replaced to the City's satisfaction, at no cost to the City.

B. Any CIPP liner showing a visible split, tear, or defect, shall be repaired per manufacturer's recommendations and to the satisfaction of the Engineer or, if not possible, provide a new CIPP liner at no cost to the City.

C. While stored, CIPP shall be adequately supported and protected in a manner as recommended by manufacturer.

D. CIPP liner shall be maintained at a proper temperature in refrigerated facilities to prevent premature curing at all times prior to installation. CIPP liner shall be protected from UV light. CIPP liner showing evidence of premature curing will be rejected for use and shall be immediately removed from the site. Provide a new CIPP liner at no cost to the City.

PART 2 - PRODUCTS

2.01 CIPP FELT LINER AND RESIN:

A. CIPP liner shall be Insituform by Insituform Technologies, LLC, National Liner by National EnviroTech Group LLC, SAK Liner by SAK Construction LLC, or Engineer approved equal.

B. CIPP liner shall be composed of tubing material consisting of one or more layers of a flexible non-woven polyester felt with or without additives such as woven fiberglass or other fibers and meet the requirements of ASTM F1216, ASTM F1743, and ASTM D5813. Felt content of CIPP liner shall be determined by the Contractor but shall not exceed 15 percent of the total impregnated liner volume. Fabric tube shall be capable of absorbing and carrying resins, constructed to withstand installation pressures and curing temperatures and stretch to fit irregular pipe sections. Contractor shall submit certified information from felt manufacturer on normal void volume in the felt fabric that will be filled with resin.

C. CIPP liner tube may be made of single or multiple layer construction, with any layer not less than 1.5 mm thick, unless the tube is made of fiberglass material. Wet-out fabric tube shall have a uniform thickness and void space for resin distribution that when compressed at installation pressures will produce a predictable finished thickness that meets or exceeds the design thickness after cure.

D. No material shall be included in fabric tube that may cause de-lamination in cured CIPP. No dry or unsaturated layers shall be acceptable upon visual inspection as evident by color contrast between felt fabric and activated resin containing a colorant.

E. Wall color of interior pipe surface of CIPP after installation shall be a light reflective green color so that a clear detailed examination with closed circuit television inspection equipment may be made. Hue of the color shall be dark enough to distinguish a contrast between fully resin saturated felt fabric and dry or resin lean areas.

F. Seams in the fabric tube, if applicable, shall meet the requirements of ASTM D5813.

G. The outside layer of the tube shall be coated with an impermeable material compatible with the resin and fabric.

H. Resin: Shall be a corrosion resistant polyester or vinyl ester resin and catalyst system or epoxy and hardener system manufactured specifically for sewer rehabilitation, that, and when properly cured within the tube composite, meets the requirements of ASTM F1216, the physical properties herein, and those, which are to be utilized in the design of CIPP for this project. Resin shall produce CIPP that will comply with or exceed structural and chemical resistance requirements of this specification. Liner material and resin shall be completely compatible. Generally, resin shall not contain fillers, except those required for viscosity control or fire

retardance or increase strength, and with applications for which inert fillers would facilitate better heat transfer and retention during installation. Liner contractor may add up to 5 percent by mass, a thixotropic agent for viscosity control, which will not interfere with visual inspection.

I. Resins may contain pigments, dyes, or colorants, that interfere with visual inspection of cured liner. Quantity of resin used for tube impregnation shall be sufficient to fill volume of air voids in tube with additional allowances for polymerization shrinkage and loss of resin through cracks and irregularities in original pipe wall. Use serial vacuum impregnation or pressure impregnation process (or approved equal) to provide maximum resin impregnation throughout the tube.

J. Prior to inversion, outside and/or inside layer of tube shall be coated with an impermeable, flexible membrane that will contain the resin and facilitate, if applicable, vacuum impregnation and monitoring of resin saturation during the resin impregnation (wet out) procedure.

K. Exterior of manufactured tube shall have distance markings along its length at regular intervals not to exceed 5 feet. Use these marks as a gauge to measure elongation during insertion. Should overall elongation of a reach exceed 5 percent, liner tube shall be rejected and replaced.

L. Engineer may inspect CIPP liner during manufacturing and wet-out. Engineer shall be given an opportunity to witness manufacturing of all CIPP liner for this project. City is responsible for costs associated with witnessing the manufacturing of CIPP liner.

M. Upon request by the Engineer, Contractor shall provide full access to witness wet-out process and shall provide any and all information related to manufacturing without delay and without claims of confidentiality or product privacy.

N. Application of resin to felt tubing (wet-out) shall be conducted under factory conditions using vacuum impregnation and materials shall be fully protected against UV light, excessive heat and contamination at all times. If on-site wet out is required, Contractor shall be required to maintain ambient conditions similar to those encountered during factory wet outs.

O. Liners that are impregnated at the factory and transported to the project site in refrigerated trucks shall be installed as soon as possible and no more than two (2) weeks after the date of impregnation at the factory.

P. CIPP liner shall form a continuous, tight-fitting, hard, impermeable liner that is chemically resistant to any chemicals normally found in domestic sewage per ASTM F1216.

Q. CIPP liner tube shall be manufactured or fabricated to a size that will tightly conform to the internal circumference of sewer after being installed and cured. CIPP liner shall conform into irregularly shaped pipe sections and through bends and dips within the pipeline. Allowance for longitudinal and circumferential expansion shall be taken into account when sizing and installing CIPP liner. Liner shall be properly sized to diameter and length of existing pipe and be able to stretch to fit irregular pipe sections and negotiate bends. Contractor shall determine minimum tube length necessary to effectively span designated run between manholes. Contractor shall field verify lengths prior to ordering and resin impregnation of liner, to ensure that liner will have sufficient length to extend entire length of the sewer. Length of sewer is defined as the length of the existing host pipe measured from the interior walls of the manholes, and/or from the ends of the pipe when/if the pipe extends into the manholes. Contractor shall measure inside diameter and circumference of existing pipelines at face of each manhole in field prior to ordering liner so that liner can be installed in a tight-fitted condition with little or no wrinkling.

R. Length of CIPP liner shall be as deemed necessary by Contractor to effectively carry out insertion of CIPP liner and sealing of CIPP liner at outlet and inlet manholes. Required diameter and length of each pipe segment shall be measured in advance of wet-out and a list of these

measurements shall be submitted to Engineer at least one week prior to installation of each CIPP liner.

S. Contractor is responsible for ensuring that correct liner is installed in each sewer reach being rehabilitated.

T. Contractor shall verify proposed CIPP liner thicknesses and submit associated calculations. Actual cured liner thickness shall be -5/+10 percent of approved design thickness and shall not include thickness of any non-structural membrane (inner/pre- liner). CIPP liner shall be designed in accordance with applicable provisions of ASTM F1216 for "fully or partially deteriorated gravity pipe conditions". CIPP liner shall meet following design conditions, unless Engineer agrees, in writing, of their change:

1. AASHTO H 20 Live Load.
2. Constrained soil modulus of native soil in the pipe zone of 1,000 psi.
3. Soil weight of 120 pounds per cubic foot and a coefficient of friction of Ku'=0.130r shall be used for the installed depths.
4. Long-term flexural modulus used in design calculations shall be estimated by multiplying lowest short-term flexural modulus used in design calculations by a retention factor of 0.50 (i.e., long-term retention of mechanical properties equal to 50 percent.)
5. Design safety factor of 2.0.
6. Typical groundwater levels shall be estimated at one half (1/2) the distance between crown of pipe and ground surface. If actual groundwater depth information is available from USGS or other sources, it shall be utilized in calculations. Groundwater depth used in calculations should be from estimated maximum groundwater level from surface to invert of interior pipe or at elevation specified for bidding purposes in Contract Documents.
7. Service temperature range shall be 40 to 100 degrees F.
8. Minimum ovality of host pipe of 2 percent.
9. Long-term retention of mechanical properties equal to 50 percent.
10. Thickness to be used for CIPP liner shall be largest thickness as determined by calculations for deflection, bending, buckling and minimum stiffness.
11. CIPP liner thickness for non-round pipes or circular pipes with greater than 10% ovality shall be designed in accordance with WRc Sewerage Rehabilitation Manual, Type II Design.
12. Minimum liner thickness before installation and curing for all pipes and larger shall be per the table below or as designed, whichever is greater. Thicknesses following installation and curing shall be based on design calculations provided by Contractor.

Minimum Liner Thickness

Sewer I.D.	Pipe Invert Depth 0'-15'	Pipe Invert Depth Over 15'
6"	4.5 mm	6.0 mm
8"	6.0 mm	7.5 mm
10"	6.0 mm	7.5 mm
12"	7.5 mm	9.0 mm
15"	9.0 mm	10.5 mm

13. CIPP liner shall provide a minimum service life of 50 years and, for design purposes, shall have the following minimum initial and long-term properties:

Property	Test Method	Initial (psi)	Long Term (psi)
Flexural Strength	ASTM D 790	4,500	2,250

Flexural Modulus of Elasticity	ASTM D 790	250,000*	175,000

*Minimum Initial Flexural Modulus of Elasticity for pipe diameters larger than 15 inches is 350,000 psi.

14. The CIPP shall be designed to withstand all imposed loads, including dead and live loads and, hydrostatic pressure. The liner shall have sufficient wall thickness to withstand all anticipated external pressures and loads that may be imposed after installation.

2.02 END SEALS:

A. End seals shall be composed of hydrophilic rubber and molded as a one-piece, three-inch wide cylinder which when installed will form a 360-degree seal between the host pipe and the newly installed liner. Use of caulking, rope or band type of an end seal shall not be allowed. Acceptable end seals are Insignia™ End Seals by LMK Enterprises or Engineer approved equal.

2.03 CIPP SHORT LINERS (CIPPSL):

A. Contractor shall install a sectional CIPPSL for areas where longitudinal shrinkage of the installed CIPP liner near the manholes is three inches or more, at no additional cost to the City, as specified in Section 330130.77.

PART 3 – EXECUTION:

3.01 PRE-INSTALLATION:

A. When available, examine City's CCTV video of each pipe segment before starting Work.

B. Notify all property owners or businesses that discharge sewage directly to sewer being lined and whose service lateral will be affected by lining work, that their service will be temporarily discontinued during installation of CIPP liner. Deliver written notification to each such resident or business at least 48 hours in advance, giving the date, start time and estimated completion time for the work being conducted, and any restrictions on use of sewage system facilities including exact days and hours when sewer system cannot be used. Method of notification and the text included in the notification shall be approved by the Engineer.

1. The maximum amount of time any home or business shall be without sanitary sewer service is 8 hours.
    a. Anything over 4 hours of out of service may require a pumping plan to be implemented.

C. Clean each length of pipe to be lined and dispose of all resulting material offsite as specified in Section 330130.41.

D. Conduct a pre-rehabilitation CCTV inspection of all sewers to be rehabilitated by CIPP lining methods in accordance with Section 330130.11. Inspection shall be for purpose of identifying defects in pipe, to document location of all service lateral connections, and to confirm point repair locations. The Contractor's project manager and/or superintendent shall review the pre-rehabilitation inspection videos to confirm the quality of the videos, locations of lateral connections, and locations of point repairs to be performed. Only after the Contractor has confirmed that the quality of the videos is adequate for a clear review of pipeline, shall the videos be submitted to the Engineer. Engineer will review pre-rehabilitation inspection photos to confirm locations of point repairs to be performed by Contractor. If a Resident Project Representative is on site or immediately available, Contractor shall allow the Resident Project Representative to view the pre-installation video to verify the pipe is ready for CIPP installation which includes proper cleaning, trimming protruding taps and mitigating and significant infiltration.

E. Verify active customer service connections prior to rehabilitation. Compare service connections from CCTV video with above ground measurements at approximate location of center of each

house or building. Any discrepancies between CCTV data and above ground measurements of laterals shall be brought to attention of the Engineer for a determination of lateral reinstatements. If Contractor discovers an error or addition to the list provided, Contractor shall immediately notify the Engineer for additional investigation. Upon completion of rehabilitation work, a list of all service laterals re-established as part of the work shall be submitted to the Engineer. Compiled list can be in the form of post-inspection installation inspection logs and shall include the following information:

1. Location of each service lateral based on CCTV inspection logs. Location shall include both accurate distance measured from centerline of starting manhole as well as a notation (by clock-reference) of where on circumference of pipe, the service lateral connects.
2. Status (Active or Inactive).
3. Address of each customer and associated active lateral location.

F. During pre-rehabilitation CCTV inspection and prior to installation of CIPP lining, all service lateral connections protruding into main line by 1/8-inch or more shall be internally cut or ground down flush with pipe wall as specified in Section 330130.43.

G. Any infiltration runners or gushers as defined by NASSCO PACP that are observed during the pre-rehabilitation CCTV shall be stopped by injecting a chemical hydrophilic grouting or CIPP short liner. Man-entry with hand-applied fast-setting epoxy can be performed to stop the infiltration, at the Contractor's discretion.

H. Maximum amount of time any home or business shall be without sanitary sewer service is 8 hours and not between 6:00 PM and 8:00 AM. Any service disruption longer than 8 hours shall be bypassed to a sanitary sewer at no additional cost to the City.

I. Service connection effluent may be plugged only after proper notification to affected residence and may not remain plugged overnight. Installation of liner shall not begin until the Contractor has installed all plugs or a sewage bypass system and all pumping facilities have been installed and tested under full operating conditions including bypass of mainline and side sewer flows. Once lining process has begun, existing sewage flows shall be maintained, until resin/felt tube composite is fully cured, cooled down, fully televised and CIPP ends finished.

J. Wastewater flows from existing sewers shall not be allowed to enter the new or rehabilitated facilities until the new or rehabilitated facilities have been cleaned and tested as required in the Contract Documents.

K. Provide hydrophilic end seals at all manhole penetrations/openings prior to installation of uncured CIPP liner.

L. If in the opinion of CIPP liner manufacturer and/or the Engineer, the rate of infiltration in a sewer segment is high enough to risk washout of resin, the Contractor shall perform measures, as required, to minimize infiltration prior to installation, including pre-liners, grouting, etc. If during pre-rehabilitation CCTV inspection, any infiltration runners or gushers (per NASSCO PACP) are observed, Contractor shall submit, in writing for approval by the Engineer, methods and materials for mitigating any adverse impacts from the infiltration.

M. Pressure gauges used for steam curing shall be pressure/vacuum gauges with a pressure range of 0 to 50 psi and ±0.25% test gauge accuracy.

3.02 INSTALLATION:

A. Provide CIPP liner in full length of sewer as shown on work orders. CIPP liner shall be installed via inversion using hydrostatic head or air pressure in accordance with ASTM F1216 and manufacturer's recommendations. Hydrostatic head and/or steam pressure used during installation process shall be sufficient to conform liner to pipe wall; produce dimples at all

service connections, and flared ends at two termination points (manholes/access structure/end-of-line assembly, etc). Contractor shall closely follow the requirements in the submitted liner field curing reports, including the minimum inversion pressure, ideal head, maximum hot head and maximum cold head for each installation.

B. If CIPP does not conform against original pipe at its termination points (manholes/access structure/end-of-line assembly, etc), at no additional cost to City, the full circumference of CIPP exiting host pipe shall be filled with a resin mixture compatible with CIPP, approved by the CIPP manufacturer and the Engineer. There shall be no leakage of groundwater between existing pipe and CIPP at manhole connection or service lateral connections. Any leakage shall be eliminated by the Contractor at no additional cost to the City. Any infiltration found at manhole and/or service connections shall be eliminated by the Contractor at no additional cost to the City. Any infiltration runners or gushers as defined by NASSCO PACP shall be stopped with chemical hydrophilic grouting or CIPP short liner as specified in Section 330130.77.

C. The full length from manhole to manhole of the installed resin-impregnated flexible felt tube CIPP liner in host pipes with less than 18-inch nominal diameter shall be cured using circulating heated water or steam in accordance with ASTM F1216 and manufacturer's recommendations, extending full length from manhole to manhole(s). CIPP liner in host pipes with 18-inch or greater nominal diameter shall be cured using circulated heated water in accordance with ASTM F1216 and manufacturer's recommendations. Resin shall be cured into a hard, impermeable pipe with minimum specified thickness, providing a structurally sound, uniformly smooth interior and tight-fitting liner within existing pipe. Cool-down procedures shall be in accordance with ASTM F1216 and manufacturer's recommendations. The cool-down shall follow manufacturer's guidelines, be measured digitally to allow inspector to inspect or record, be linear, and be gradual; no super cooled air shall be allowed to be injected.

D. Contractor may install CIPP lining in multiple sewer segments at one time where practical. When installing CIPP lining in multiple sewer segments at one time, the top one-half of CIPP liner in intermediate manhole shall be neatly removed, leaving the invert in place, and void between CIPP liner and existing channel shall be filled with non-shrink grout. Manhole bench shall be reconstructed as required to provide a smooth transition to new CIPP liner.

E. All cutting and sealing of CIPP liner at manhole connections shall provide watertight pipe and manhole seals. All cut edges of cured liner shall be thoroughly sealed with same resin as was used in liner. Catalyst or hardener used shall be compatible with resin/catalyst used in liner previously but shall not require an external heat source to begin exothermic reaction (curing). There shall be no leakage of groundwater into manhole between CIPP liner and existing sewer pipe and between existing sewer pipe and manhole wall.

F. Fit hot water source with monitors to accurately gauge temperature of incoming and outgoing water supply. Place another such gauge between CIPP liner and pipe invert at upstream and downstream ends to continuously monitor temperature and to determine the peak exotherm of the resin during curing process. Temperature in CIPP during curing process shall be as recommended by resin manufacturer. Length of time for allowing curing process to be completed shall be of duration recommended by the manufacturer, during which time the Contractor shall maintain required temperature throughout CIPP. Provide a written temperature data chart/curing log to the Engineer for review to ensure that curing temperatures for resin meet manufacturer's recommendations.

G. Fit steam source with monitors to accurately gauge temperature and pressure of steam supply. Place additional temperature and pressure gauges at incoming and outgoing stations. Place another gauge between CIPP liner and pipe invert at upstream and downstream ends to continuously monitor temperature and to determine the peak exotherm of the resin during curing process. Temperature in CIPP during curing process shall be as recommended by resin

manufacturer. Length of time for allowing curing process to be completed shall be of duration recommended by the resin manufacturer, during which time the Contractor shall maintain required temperature throughout CIPP. Provide a written data chart/curing log to the Engineer for review to ensure that the steam temperature and pressure at the source, incoming station and outgoing station are consistent throughout the installation. Include temperature data to ensure that resin curing temperatures meet manufacturer's recommendations. If significant pressure loss is observed, the Engineer may require additional air testing prior to reinstatement of service lateral connections.

H. Temperature monitoring systems with a sensor array along the full length of the liner are required for liners cured by heated water in all sewers with 18-inch or greater nominal pipe diameters with a heat sink, such as groundwater infiltration or proximity to a stream, river or lake. This system shall be installed at the invert of pipe and be installed per manufacturers recommended procedures. Temperature sensors shall be placed at upstream and downstream ends of reach being lined to monitor pressurized fluid (air or water) temperature during curing process. To monitor temperatures inside tube, wall and to verify proper curing, temperature sensors shall be placed between host pipe and liner in bottom of host pipe (invert) throughout the reach to record the heating and cooling that takes place on the outside of liner during processing. As a minimum, sensors shall be spaced apart at intervals no greater than 10 feet in host pipes with 18-inch or greater nominal pipe diameter. Additionally, sensors shall be strategically placed at points where a significant heat sink is likely to be anticipated. Monitoring of these sensors shall be by a computer that can record temperatures at this interface throughout processing of CIPP utilizing a tamper-proof database. Temperature monitoring systems shall be Zia Systems, Vericure by Pipeline Renewal Technologies or Engineer approved equal.

I. Prior to installing liner in host pipe, proper functioning of the continuous temperature monitoring system shall be confirmed by connecting the sensor array to the computer and verifying that sensors are reporting their ambient temperatures. No more than two sensors in sequence can be found faulty during this test. If three or more sensors in sequence are discovered faulty, a new sensor array shall be provided and installed at no additional cost to the City and the new array shall be tested for its proper functioning.

J. Curing of resin system shall be as per recommendations of CIPP system manufacturer of CIPP product. Temperatures achieved and duration of holding the liner at those temperatures shall be per System Manufacturer’s established procedures. If any sensor or sensors along reach indicates that there is a localized issue with respect to achieving proper curing per written installation procedure, Contractor shall address the issue prior to acceptance of the liner. Sensor array’s database required in above paragraph shall have an output report that identifies each sensor by its station in reach and shows maximum temperature achieved during processing of CIPP and time sustained at or above Manufacturer’s required curing temperature at each sensor. The temperature of the liner shall be recorded until the liner has completed the cool-down process.

K. If cool-down is to be accomplished by introduction of cool water into an inversion standpipe to replace water being drained from a small hole made in downstream end, the hardened liner shall be cooled down to a temperature below 100 degrees F (38 degrees C), or ambient temperature, whichever is lower, before relieving static head in inversion standpipe. Contractor shall take measures to ensure that, in release of static head, a vacuum will not be produced that could damage the newly installed CIPP liner.

L. The City will furnish water for sewer pipe cleaning. A hydrant meter shall be secured by the contractor for purposes of tracking water used.

M. Curing water may be discharged into the sewer immediately downstream of the liner.

3.03 REINSTATEMENT OF SERVICES:

A. After new CIPP has been cured and completely cooled down, if applicable, Contractor shall reconnect existing service laterals as designated by pre-rehabilitation television inspection report generated by the Contractor. This shall be done without excavation but from interior of pipeline by means of a television camera and a remote cutting device that reestablishes service connection to not less than 95 percent or better of original diameter and to a maximum of 100 percent of original diameter; overcut connections are not acceptable. All openings shall be clean and neatly cut and the cut shall be buffed with a wire brush to remove rough edges and provide a smooth finish. Bottom of openings shall be flush with bottom of lateral pipe and shall have smooth edges with no protruding material capable of hindering flow or catching debris.

B. Coupons shall be removed from laterals by any means possible including entering homes to flush the material via access from cleanout.

C. Excess resin that builds up and hardens in and around the lateral connections(s) must be removed and/or ground down prior to acceptance of the re-instatement. Contractor will be required to supply an extended lateral cutter bit to reach resin buildup beyond standard length bits.

D. Inactive service laterals will be abandoned by not reopening the service connection after installation of the cured-in-place pipe liner. If necessary, because of uncertainty of matching each tap in the sewer with each property, the Contractor shall dye test to verify if a service connection is active at the direction of the Engineer.

E. Service laterals that were determined to be inactive during CCTV inspection will be abandoned by not reopening service connection after installation of cured-in-place pipe liner. All lateral connections shall be identified as repaired or abandoned in post rehabilitation CCTV. Contractor to provide image file for all active lateral locations along a given pipe segment. Contractor to provide image file at location of lateral even if lateral connection has been abandoned.

F. Contractor shall not open abandoned/capped service connections except at the Engineer's direction. If an abandoned service connection is opened without the Engineer's approval, Contractor shall perform an internal spot repair to close connection, at no additional cost to the City.

G. Provide a fully operational backup device for reinstating service laterals. If there is any doubt about live vs. dead service based upon above property comparison with pipe connections, then Contractor shall verify with dye testing. If for any reason remote cutting device fails during reinstatement of a service lateral, Contractor shall immediately deploy standby device to complete reinstatement. Backup equipment shall be onsite throughout reinstatement process.

3.04 TESTING AND ACCEPTANCE:

A. Acceptance of CIPP lining will be based on Engineer's evaluation of installation, including a review of the CIPP liner curing data, review of post-rehabilitation CCTV inspection data, and review of certified laboratory test results for installed CIPP liner. All CIPP testing, and repairs to installed CIPP as applicable, shall be completed before final completion, meeting requirements of these specifications and documented in written form.

B. Cost of all manufacturer's testing to qualify products furnished to project site shall be the responsibility of the Contractor.

C. Testing of installed liner shall be performed by an approved, independent testing laboratory certified by the American Association for Laboratory Accreditation (A2LA). Contractor shall submit to the Engineer the name and location of independent testing laboratory, a certified statement from laboratory indicating that they are independent from and not associated with the Contractor in any way, and documentation of A2LA certification.

D. For every 1,000 linear feet of CIPP liner installed for the first 5,000 linear feet, the Contractor shall perform sampling and testing to determine the installed CIPP liner flexural properties and CIPP liner thickness. After the first five test results have been collected and all have passed the minimum standards per the specification, the Engineer may require collecting one sample per each shipment of liner. Frequency of testing may be reduced as approved by the Engineer after sufficient tests are performed to verify CIPP liner design, production and installation procedures. Likewise, frequency of testing may be increased by the Engineer and performed by the Contractor at no additional cost to the City when test results show that installed CIPP liner does not meet specifications. If a test is not passed, the Contractor shall re-evaluate liner thickness design to determine if installed physical properties meet minimum design requirements; if it does not, liner shall be replaced or relined with approval from the Engineer at no additional cost to the City.

E. Sampling and testing of the installed CIPP liner shall conform to the standards of ASTM F1216 and the following requirements:
   1. Remove one restrained sample of installed CIPP liner at least 18 inches in length. Sample shall be captured by installing CIPP liner through a section of PVC pipe (same diameter as existing sewer diameter) within the most downstream manhole of installation and at all intermediate manholes if multiple sewer segments are lined at same time.
   2. CIPP liner thickness shall be measured in accordance with ASTM D5813. Flexural properties shall be determined in accordance with ASTM D790. Label and date all samples and provide to Resident Project Representative same day of installation for shipping to independent testing laboratory. Furnish a copy of all transmittals to independent testing laboratory to the Engineer and submit testing results within 30 days after installation of CIPP liner.
   3. After recalculations performed per subsection 3.04.D, any CIPP lining that does not meet new calculated thickness requirements shall be removed and replaced or otherwise corrected. Options for correcting deficient CIPP liner installations that will be considered by the Engineer may include removal of the deficient CIPP liner and re-lining the sewer, open-cut replacement of sewer pipe from manhole to manhole, re-lining sewer with the deficient CIPP liner in place.

F. Perform a post-rehabilitation CCTV inspection of all sewers rehabilitated using CIPP lining methods in accordance with Section 330130.11. Post-rehabilitation CCTV inspection shall be performed following installation of CIPP liner and reinstatement of all active service laterals. The Contractor's project manager and/or superintendent shall review the post-rehabilitation inspection videos to confirm the quality of the videos and of the installed CIPP prior to submittal to the Engineer. If it is determined that any repairs are needed at any segment, a new CCTV inspection shall be performed of the entire segment(s) after the repairs have been completed.

G. Liner Installation Inspection - A visual inspection of the liner will be considered acceptable if liner shows no significant, wrinkles, lifts, ridges, splits, cracks, delamination, flats, dry spots, pinholes, shrinkage, foreign inclusions, crazing, reverse curvatures, or other type of defects in the CIPP lining. Significant defects shall be defined as those listed in paragraph 1.06 of this section; and/or any defect that may create a maintenance issue in future such as inhibiting CCTV cameras or allowing solids to get caught on defect, and/or any defect that appears to reduce long-term structural strength or stability of pipeline. Longitudinal wrinkles/fins in height up to a maximum of five percent of inside diameter of host pipe or 1 inch, whichever is smaller, may be acceptable and shall be evaluated by the Engineer for acceptance on a case by case basis. Defective lining shall be repaired or replaced at no additional cost to the City. If the pipe

is damaged during removal process, the Contractor shall provide a point repair at no additional cost to the City.

H. Post CCTV Video Inspection and Submittals: Contractor shall submit all digital CCTV of lined sewer within thirty calendar days for each pipe segment. Engineer shall review and approve payment based upon satisfactory completion of a liner that is free of significant defects as defined in paragraph 1.06 of this section.
   1. Removal of wrinkles or fins deemed significant at the discretion of the Engineer, shall be removed using a milling head, relined or replaced by the Contractor as directed by the Engineer at no additional cost to the City. There shall be no evidence of other major defects in the CIPP lining.
   2. CIPP liner longitudinal shrinkage of more than three inches from the face of the manhole shall be repaired with a fiberglass reinforced CIPP spot repair per section 3.05 of this specification at no additional cost to the City.
   3. Measure CIPP liner circular shrinkage via man entry to try to insert a $1/16^{th}$ inch thick ruler or similar into any gap more than 8 inches past the MH wall. The Contractor shall document these measurements with digital photos and submit documentation to the Engineer for approval. Circular shrinkage shall be repaired per manufacturer recommendations at no additional cost to the City.

I. The CIPP liner shall be watertight. Groundwater infiltration through the wall of the liner shall be zero.

J. All service connections shall be opened to a minimum of 95 percent and a maximum of 100 percent of opening so that a new lateral or lateral lining can be installed properly. Any overcuts more than 105 percent shall be repaired with hydrophilic seal hat connection, CIPP liner or other approved method by the Engineer.

K. All coupons and excess resin shall be removed from reinstated service laterals prior to acceptance of CIPP lining.

L. All pipe-to-manhole connections shall be watertight and free of infiltration.

M. After all installations are complete, inspected, post-rehabilitation CCTV has been reviewed and approved by the Engineer, and all work is satisfactory to the Engineer, Contractor shall cut and trim the new liner at each manhole wall.

3.05 CIPPSL:

A. Contractor shall install a sectional CIPP short liner in areas where longitudinal shrinkage of the installed CIPP liner near the manholes is three inches or more, at no additional cost to the City per specification 330130.77.

END OF SECTION 330130.72

This page was intentionally left blank.

SECTION 330130.74 – SERVICE LATERAL CONNECTION LINER:

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. It is the intent of this specification to provide for the rehabilitation of Service Lateral Connections (SLC) to rehabilitated (CIPP lined) and non-lined sewer lines, without excavation, by installation of a resin-impregnated, flexible liner in the form of an internal sleeve, consisting of a full-wrap in the main and extending a minimum length required to seal the first joint, with a minimum of 18 inches into the lateral, unless approved otherwise. Furnish all labor, materials, equipment and incidentals required to install the service lateral connection liner and appurtenances complete and verified through CCTV inspection.

B. Most SLC work will be performed on mainline sewers that have recently been lined with a CIPP product. Service laterals have been reinstated and protruding taps have been removed to within 1/8 inch of the mainline sewer wall.

C. Service lateral connections may be a combination of tees, wyes or break-in taps of varying sizes (3 inches-6 inches). The length of the SLC liner in each lateral will be dependent upon the configuration of the individual lateral. If the configuration of the lateral does not limit the length of the liner, the liner shall extend a minimum of 18 inches into the lateral, unless approved otherwise. The minimum length of the liner for each lateral will be determined from observation of the SLC during CCTV inspection, and in all cases shall extend beyond the first joint in the service lateral.

D. In some instances, two (or more) services that require lateral lining could be next to or across from each other. In this case, only one of the lateral liners can be a full-wrap style. The other lateral liner(s) must be a brim style.

E. There will be no access to the service pipe from an upstream cleanout on or off private property. All work must take-place from the mainline sewer.

1.02 RELATED WORK:

A. Television Inspection is included in Section 330130.11.

1.03 SUBMITTALS:

A. Submit the following information:

1. Shop drawings and schedules of all SLC liner and appurtenances required. Furnish design data and specification data sheets listing all parameters used in the liner design and thickness calculations.
2. Thickness Calculations. Liner thickness calculations shall be performed by a professional engineer and submitted to the Engineer with supporting assumptions. Calculations shall be done after cleaning, televising, and other field inspections have been accomplished. Perform separate calculations for each the following depth ranges: one range from 0-10 feet and separate ranges for each depth greater than 10 feet in one-foot increments. Identify the manufacturer's recommended design parameters used in calculations. The finished liner shall have a minimum thickness of 2 mm for 4-inch laterals and 3 mm for 6-inch laterals.
3. Detailed procedure for installing the SLC liner.
4. The name of the SLC liner manufacturer and the location of the facility where the SLC liner was manufactured.
5. Statement of Qualifications. Submit a copy of manufacturer's license certificate. The Contractor for installing a mainline/lateral connection and lateral repair system shall use a Manufactured System that has a minimum of a five-year history of satisfactory performance. A licensed and certified trainer and representative from the liner system manufacturer shall be on-site to assist in the work for a minimum of 2 weeks. This trainer shall submit list of ten (10) similar jobs within the past three (3) years that utilizes this

manufacturer's product as well. Provide project information such as name of project, number of services connection laterals, date complete, and project references. The Statement of Qualifications shall include the following information:

a. The number of years of experience in performing SLC lining projects.
b. The name of the SLC lining manufacturer and supplier for this work and previous work listed below. The Contractor shall be an approved installer as certified and/or licensed by the liner manufacturer.
c. A list of municipal clients that the Contractor has performed this type of work for without defects or performance problems.
    1) The list shall contain names and telephone numbers of persons to be called to verify previous performance.
    2) A full description of the actual work performed.
    3) The list of municipal clients and description of projects shall include the number of SLCs lined over the past 3 years.

6. Material Certifications. Written certification is required from the manufacturer that all materials used in the work were manufactured and tested in accordance with the appropriate ASTM standard, and are being used or installed in conformance with the manufacturer's recommendations.
7. Resident Notifications. The Contractor shall submit a copy of the initial resident notification as described in Paragraph 1.08.
8. Storage and Delivery Procedures. The Contractor shall provide the liner manufacturer's recommended storage and delivery procedures. This shall include storage and delivery conditions, maximum time from wet-out to installation, and other pertinent information.
9. Material Safety Data Sheets. The Contractor shall submit Safety Data Sheets (SDS) for each component of the SLC liner system.
10. Pipe Cleaning Narrative. The Contractor shall submit a narrative describing in sufficient detail the proposed methods of root cutting and cleaning the existing laterals. Prepare such narrative to include the degree of cleaning as recommended by the lining manufacturer. Such narrative shall indicate approval of proposed cleaning methods by the lining manufacturer's technical representative.
11. Curing Cycle. The Contractor shall submit the resin manufacturer's recommended curing cycle as well as the recommended cooling rate. The Contractor shall submit a copy of the cure logs for each lateral installation.
12. Post-lining CCTV Inspection Provide digital recordings, photographs and Post-Lateral CCTV Inspection logs for the mainline sewer after installation of Service Lateral Connections as specified in Section 330130.11 Television Inspection.

1.04 REFERENCE STANDARDS:

A. American Society for Testing and Materials (ASTM)
    1. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
    2. ASTM F1216 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
    3. ASTM D 5813 - Standard Specification for Cured-in-Place Thermosetting Resin Sewer Piping Systems.
B. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.

1.05 QUALITY ASSURANCE:

A. The purpose of the SLC liner is to provide for a permanent watertight seal of the annular space

of a lined sewer pipe after service lateral reinstatement, to lock the liner in place with the service connection, to provide a seal of the first joint or joints in the service lateral, and to provide for the repair of a tapped service in a lined sewer pipe.

B. The Contractor shall be capable of providing crews as needed to complete the work without undue delay and within the contract time allotted.

C. SLC liners shall be provided by a single manufacturer. The supplier shall be responsible for the provision of all test requirements specified herein as applicable. In addition, all SLC liners to be installed under this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory provided by the City, at their own expense. The Contractor shall require the manufacturer's cooperation in these inspections.

D. Inspection of the SLC liner may also be made by the Engineer after delivery. The SLC liner shall be subject to rejection at any time on account of failure to meet any of the requirements specified, even though sample liner may have been accepted as satisfactory at the place of manufacture. Liner rejected after delivery shall be marked for identification and shall be removed from the job site at once.

1.06 SYSTEM DESCRIPTION:

A. The SLC liner shall be a one-piece or two-piece, tight fitting, corrosion resistant and verifiable non-leaking, cured-in place pipe with a sealing component between the SLC lining product and the host lateral and mainline pipe walls as recommended by the manufacturer. The mainline portion of the lateral lining system that connects to the main/lateral interface shall be a full-wrap in 8-inch and larger diameter sewers and shall be a brim style in 6-inch diameter sewers. In all cases, the junction between the mainline portion and the lateral sleeve must be watertight. The wall thickness shall be uniform. The carrier packer shall be specifically designed for 3-inch to 6-inch diameter service connections. It shall be manufactured to conform to either a wye, tee, break-in type connection and other non-standard connections found commonly in the system. A corrosion resistant resin compatible with the installation process shall be used.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Care shall be taken in shipping, handling and storage to avoid damaging the SLC liner, especially during adverse weather conditions. Any liner damaged in shipment shall be replaced at no cost to the City.

B. Any liner showing a split or tear, or which has received a blow that may have caused damage, even though damage may not be visible, shall be marked as rejected and removed at once from the job site.

B. The liner shall be maintained at a proper temperature in refrigerated facilities to prevent premature curing at all times prior to installation. The liner shall be protected from UV light prior to installation. Any liner showing evidence of premature curing will be rejected for use and will be removed from the site immediately.

1.08 PUBLIC NOTIFICATION:

A. Notify all property owners who discharge sewage directly into the sewer to be lined that their sewage service will be discontinued while the liner is being installed. Deliver written notices to each affected resident one week prior to, and again 48 hours in advance of commencement of the work being conducted in their section, giving the date, start time and time when service will be completely restored. Contractor shall notify residents immediately prior to installation of SLC. Also provide a telephone number for Contractor which residents can call for information during

the work. Contact any home or business that cannot be reconnected within time stated in written notice.

B. Maximum amount of time any home or business shall be without sanitary sewer service is 2 hours for installation of the SLC liner between 9:00 am and 3:00 pm.

1.09 GUARANTEE

A. All lining work shall be fully guaranteed by the Contractor and manufacturer for a period of two years from the date of final completion. A written warranty shall be submitted. During this period, all serious defects discovered by the City shall be removed and replaced in a satisfactory manner at no additional cost to the City. The City may conduct an independent television inspection, at its own expense, of the lining work prior to the completion of the guarantee period. Any defects replaced at that time shall be fully guaranteed by the Contractor and manufacturer for a period of two years from the date the defect was repaired. Wrinkles, blisters, dry spots in resin or other defects in the finished SLC liner, which in the opinion of the Engineer, negatively affect the integrity or strength of the SLC or the flow capacity of the pipe, are unacceptable. Contractor shall remove and repair all such defects in a manner that is satisfactory to the Engineer, at no additional cost to the City. Defects include but are not limited to:
   1. Leakage through the liner or between liner and pipe
   2. Reduction of the liner thickness of more than 10 percent
   3. Separation of the liner from the pipe
   4. Excessive wrinkles inhibiting flow

   The liner shall be as free as commercially practical from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. The liner surface shall have a smooth finish and must be free of leaks, cracks, and crazing. Some minor aberrations that, in the Engineer's opinion, will not appreciably decrease the flow cross section or affect the flow characteristics shall be permissible.

PART 2 – PRODUCTS

2.01 MATERIALS:

A. The SLC liner shall be a resin-impregnated flexible polyester felt, non-woven textile tube, needle punched felt, circular knit or circular braided, E-glass corrosion-resistant flexible fiberglass laminate liner or equivalent material tube which is cured-in-place by an acceptable curing method. The resin shall be suitable for the design conditions as well as the curing process. The SLC liner system shall provide a service life of 50 years. The portion of the liner system that extends into the lateral itself shall have the minimum structural properties listed below.

Mechanical Property	Minimum Standard Polyester Resin	Vinylester/Epoxy
Flexural Strength (ASTM D790)	4,500 psi	5,000 psi
Flexural Modulus of Elasticity (ASTM D790)	250,000 psi	400,000 psi

B. The portion of the liner system that extends into the lateral itself shall be designed, fabricated, and installed for the actual conditions encountered for this application including the material of the host pipe, in accordance with the applicable provisions of ASTM F1216, and shall meet the following minimum design conditions:
   1. AASHTO H-20 live load with two trucks passing.
   2. Soil Weight 120 pounds per cubic foot. Coefficient of friction Ku′=0.130.
   3. Estimated maximum groundwater level at ground surface.

4. Fully deteriorated pipe with 2 percent (min.) ovality. If ovality of existing pipe is found to be worse, use actual percent up to 5 percent (max.).
5. Soil Modulus 1,000 psi.
6. Factor of Safety = 2
7. Soil Depth: Depth of Cover will be determined by field measurements.

C. The SLC liner system shall be designed to withstand all imposed loads, including live loads and hydrostatic pressure. The SLC liner shall have sufficient wall thickness to withstand all anticipated external pressures and loads that may be imposed after installation.

D. The cured SLC liner product shall form a continuous, tight-fitting, hard, impermeable liner which is chemically resistant to domestic sewage over the expected life of the rehabilitated pipe. The liner material and resin shall be completely compatible.

E. The insert must use a hydrophilic waterstop component or an adhesive sealant to form a sealing watertight bond between the SLC lining product and the host lateral and mainline pipe walls.

2.02 RESIN:

A. The resin system shall meet the requirements of ASTM F1216, and ASTM D5813. The resin installed SLC liner system shall produce an SLC liner that will comply with the structural requirements specified herein and shall provide chemical resistance as indicated in ASTM F1216. The resin shall be compatible with the rehabilitation process, shall be able to cure in the presence or absence of water, and shall have an initiation temperature for cure as recommended by the resin manufacturer. Unless otherwise specified, provide a general purpose or enhanced strength unsaturated, thermosetting, polyester, vinyl ester, epoxy or silicate resin and a catalyst system compatible with the installation process.

B. Submit documentation from the resin manufacturer specifically describing the chemical characteristics of the resin system, including allowable mixing, impregnation, and handling time, transportation and storage time, and recommended curing cycle including temperatures, pressures, and times. The resin manufacturer's documentation must also include maximum allowable time for handling the impregnated tube prior to insertion and the maximum allowable elapsed time from insertion to exotherm. If remedial measures are available to extend either of the maximum allowable times indicated above, without affecting the physical properties of the resin, the resin manufacturer should describe these measures and the time limits beyond which even these measures will not prevent alteration of the physical properties of the resin.

2.03 FULL WRAP LINERS:

A. The mainline portion of the lateral lining system that connects to the main/lateral interface shall be a full circumferential sleeve. The mainline portion of the carrier packer shall accommodate pipe diameters ranging from 8 inches through 24 inches. The insert shall be continuous over the length of the rehabilitated portion of the service lateral. The insert must extend a minimum of 16 inches of the mainline pipe, i.e., end to end measurement of the full wrap (5 inches on either side of a 6-inch lateral connection or 6 inches on either side of a 4-inch lateral connection).

B. The SLC liner shall be manufactured and installed by: T-Liner Shorty by LMK, Cosmic Service Lateral Liner by Cosmic Engineering GmbH, or Engineer approved equal.

2.03 BRIM STYLE LINERS:

A. Brim style liners are allowed only under the conditions mentioned in Paragraph 1.06A of this specification.

B. The mainline portion of the lateral lining system that connects to the main/lateral interface shall be a brim extending at least 3 inches from the perimeter of the lateral connection. The mainline portion of the carrier packer shall accommodate 6-inch nominal pipe diameters.

C. The SLC liner shall be manufactured and installed by: T-Liner Shorty by LMK, Cosmic Service Lateral Liner by Cosmic Engineering GmbH, or Engineer approved equal.

PART 3 – EXECUTION

3.01 PRE-INSPECTION:

A. Perform television inspection on the mainline pipe as specified in Section 330130.11 to confirm that the proposed repair falls within the limitation parameters set by the manufacturer on the following aspects:
   a. Location and clock reference of the lateral junctions to be lined
   b. Offsets, any intrusion from the lateral into the main
   c. Angle at which the connection comes in
   d. Changes in angle of approach of the lateral for the length of the repair
   e. Potential flows coming throughout the lateral pipe
   f. Potential flows going through the main pipe
   g. Diametric size of the connection for the length of the liner
   h. Size of the main pipe at the point of the SLC
   i. Presence of active infiltration within the vicinity of the work area

3.02 LINE PREPARATION:

A. Prior to installing the SLC liner product, the area around the internal lateral sealing surface in both the main and lateral shall be inspected. Waste product build-up, hard scale, roots, lateral cutting debris or resin slugs must be removed using high pressure water jetting or in-line cutters. All laterals to be lined shall be cleaned as required prior to lining. The term "cleaned" shall mean the removal of all sand, dirt, roots, grease, all other solids, semisolids, and materials that could interfere with the bonding of the SLC liner to the interior face of the sewer lines.
B. Built-up deposits on the main and lateral pipe walls shall be removed. The removal shall reach at least one foot beyond the SLC liner product to allow the bladder to inflate tightly against the pipe walls ensuring a smooth transition from SLC liner product to the existing pipe wall.
C. Prior to installing a brim-style liner, remove the polyurethane coating on the mainline liner within the limits of the brim to provide an acceptable surface for bonding.
D. Provide Pre-Installation CCTV and Post-Mainline CCTV digital recordings, photographs and inspection logs as specified in Section 330130.11 Television Inspection. Immediately prior to liner insertion, the CCTV camera shall traverse the lateral to inspect for debris which may have entered the line after the previous CCTV inspection.
E. Where active infiltration is present and when it is recommended by the SLC liner manufacturer, the infiltration shall be stopped in advance by grouting.
F. The Contractor is responsible for bypassing of sewage as necessary during the installation of the SLC liner product.

3.03 INSTALLATION:

A. The SLC liner shall be 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 lateral tube shall be acceptable upon visual inspection.

B. The SLC liner product shall be loaded on the applicator apparatus, attached to a robotic manipulator device and positioned in the mainline pipe at the service connection that is to be rehabilitated. The robotic device, together with CCTV inspection, shall be used to correctly position the SLC liner in the lateral opening prior to curing. Pressure shall be adjusted to fully deploy the SLC liner product into the lateral connection and hold the SLC product tight to the main and lateral pipe walls.
C. The pressure apparatus shall include a bladder of sufficient length in both the main and lateral lines such that the inflated bladder extends beyond the ends of both the lateral tube and main line tube or brim of the SLC liner product, pressing the end edges flat against the internal pipe wall, thus forming a smooth transition from SLC liner product to pipe diameters without a step, ridge or gap between the SLC product and the inner diameters of the lateral and mainline pipes.
D. For systems with hydrophilic gaskets or strips, the mainline liner and bladder shall be wrapped around the "T" launching device and held firmly by placing 2 gaskets or strips around the main liner with an additional gasket or strip positioned at the terminal end of the liner that extends into the lateral. For systems utilizing a hydrophilic paste or adhesive sealant, the material shall be applied to the main/lateral interface as a 2-inch-wide band on either side of the lateral in the mainline liner as well as at the terminal end of the liner that extends into the lateral. The main bladder shall be inflated causing the main sheet to unwrap and expand, embedding the sealant material between the main liner or brim and the main pipe.
E. The SLC liner product shall be inverted from the mainline into the lateral connection in a continuous tight fitting, watertight pipe-within-a-pipe to eliminate any visible ground water leakage and future root growth at the lateral to mainline connection.
F. After inversion is completed, recommended pressure must be maintained on the impregnated SLC liner product, pressing the liner firmly against the inner pipe wall for the duration of the curing process. The liner is chemically cured at ambient temperatures, by a suitable heat source such as steam or hot water, or by UV light.
G. The finished SLC liner product shall be free of dry spots, lifts and delamination. The installed SLC product should not inhibit the post installation video inspection, using a closed-circuit television camera, of the mainline and service lateral pipes or future pipe cleaning operations. For SLC liners with a mechanical seal, the CIPP shall taper at each end providing a smooth transition for accommodating video equipment and maintaining proper flow in the mainline. In all cases, the finished product must provide an airtight/watertight verifiable non-leaking connection between the main sewer and sewer service lateral. During the warranty period, any defects with the SLC that affect the performance or cleaning of the lateral connection shall be repaired at the Contractor’s expense in a manner acceptable to the City.
H. The Contractor shall inform the Engineer of service laterals in which a SLC liner product cannot be installed as specified herein. These service laterals will be identified, documented, photographed by the Contractor, and the Engineer will be informed via RFI of the conditions encountered. The Contractor will not attempt to install a SLC liner product in these services unless directed by the Engineer.

3.04 FIELD TESTING AND ACCEPTANCE:

A. Following installation of SLC liners in each segment, provide digital recordings, photographs and CCTV Inspection logs for the mainline sewer as specified in Section 330130.11 Television Inspection.
B. Final acceptance of the SLC liner will be based on the Engineer’s review of the installation and the CCTV inspection. The SLC liner in place will be evaluated for the following features.
   1. Groundwater infiltration of the liner shall be zero.

2. Service connection shall be open, clear and watertight.
3. There shall be no evidence of splits, cracks, breaks, lifts, kinks, delamination or crazing in the liner.

C. If any defective liner is discovered after it has been installed, it shall be removed and replaced with either a sound liner or a new pipe approved by the Engineer at no additional cost to the City.

D. The City may elect to perform additional testing of SLC liners in place with an independent entity at its own cost.

END OF SECTION 330130.74

This page was intentionally left blank.

SECTION 330130.77 – CURED-IN-PLACE PIPE SHORT LINERS:

PART 1 – GENERAL

1.01 SCOPE OF WORK:

A. Furnish all materials, labor and equipment and perform all incidental work necessary to install and test cured-in-place pipe short liners (CIPPSL), including cleaning; removal and disposal of debris; television inspection; performing sample testing; removing protruding taps by remote methods; stopping active leaks that might interfere with the integrity of the liner to be installed; providing water; complete and accepted.

B. Removal and replacement of fences, repair to yards, lawns, sidewalks, driveways, and other public or private property, due to actions or processes related to the work being performed shall be included in the cost of the Work.

C. The Contractor shall not change any material, design values or procedural matters stated or approved herein, without informing the Engineer and receiving written approval of the change. Unapproved changes shall result in rejection and removal of work done with the unapproved materials or processes at no additional cost to the City.

D. Maintenance and Protection of Traffic, confined space entry and work site protection are the responsibility of the Contractor and costs of these items are included in the cost of the Work.

1.02 RELATED WORK:

A. Television Inspection is included in Section 330130.11.

B. Cured-in-Place Pipe Lining is included in Section 330130.72.

1.03 SUBMITTALS:

A. Submit the name of CIPPSL supplier and a list of materials to be furnished.

B. Submit copies of certified test reports to confirm that CIPPSL materials have been manufactured and tested in accordance with the ASTM Standards specified herein.

1. Submit test reports for the materials to be used for this work. Test results shall be the manufacturer's standards for acceptance of field fabricated and installed CIPPSL.
2. Prior to the installation of any CIPPSL, make test specimens from the materials to be utilized for this work. Make sufficient number of specimens for conducting the referenced testing. Specimens shall be cut from the resin-impregnated patch prior to insertion into the pipe.

C. Submit a pre-installation and post-installation CCTV of CIPPSL on liners not scheduled for additional rehabilitation.

1.04 REFERENCE STANDARDS:

A. American Society for Testing and Materials (ASTM)

1. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
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 D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
5. ASTM D2990 - Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics.
6. ASTM F1216 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube

7. ASTM F2599 – Standard Practice for The Sectional Repair of Damaged Pipe By Means of An Inverted Cured-In-Place Liner

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

1.05 QUALITY ASSURANCE:

A. The Contractor shall be fully qualified, experienced and equipped to complete the work in a timely and satisfactory manner. Submit the following information to the Engineer for review and approval before CIPPSL work is performed.
   1. Name of the CIPPSL manufacturer and supplier for this work and previous work performed. The Contractor shall be certified by the manufacturer to install the CIPPSL.

B. All CIPPSL's, regardless of pipe size or length, shall be furnished, fabricated and installed by a single manufacturer.

1.06 GUARANTEE:

A. All CIPPSL's shall be guaranteed by the Contractor for a period of 2 years from the date of final completion. During this period, all defects in the CIPPSL's shall be repaired in a manner satisfactory to the Engineer or the affected pipe shall be removed and replaced with new pipe at no additional cost to the City.

PART 2 – PRODUCTS

2.01 HEAT-CURED: FIBERGLASS/POLYESTER FELT REPAIR MATERIAL:

A. The CIPPSL shall be a resin impregnated fiberglass/polyester felt sleeve which is wrapped around an inflatable packer and positioned in the sewer to be rehabilitated and cured in place by circulating hot water to cure the resin.

B. The CIPPSL sleeve shall be fabricated from a minimum of two layers of fiberglass with a single layer of polyester felt sandwiched between the fiberglass layers. The material shall be sewn together with multiple polyester threads using zigzag stitching spaced evenly over the full width of the material. The three-layer composite reinforcement material shall have a minimum mass of 40.6 oz/sq yd with a thickness not less than 0.24-in. Fiberglass alone is not acceptable.

C. The fiberglass shall be woven roving having a minimum weight of 24 oz/sq yd and shall be made of "E" glass coated with a sizing compatible with the resin being used.

D. The polyester felt shall be needle punched and have a minimum weight of 16.5 oz/sq yd.

E. The resin shall be a two-part epoxy type liquid thermosetting resin suitable for the intended use as well as the proposed curing method. The diluted epoxy resin shall contain at least 60 percent of bisphenol A, 10 to 20 percent of bisphenol F with the remainder of the mixture being a diluent. Epoxy resin shall be D.E.R. (R) 353 by the Dow Chemical Company; ME 948 by Micon or Engineer approved equal.

F. The epoxy resin shall be delivered in the resin manufacturer's original containers. Each container shall be clearly labeled as to contents and product data. The resin shall be stored, mixed and applied in accordance with the manufacturer's recommendations.

G. The CIPPSL shall provide a service life of 50 years and shall have, as a minimum, the initial and long-term properties listed below.

MECHANICAL PROPERTY	INITIAL	LONG-TERM
Flexural Strength	8,000 psi	-------
Flexural Modulus of Elasticity	280,000 psi	140,000 psi
Tensile Strength	5,000 psi	------
Tensile Modulus of Elasticity	280,000 psi	140,000 psi

H. CIPPSL shall form a continuous, tight-fitting, hard, impermeable liner which is resistant to chemicals identified in ASTM F1216. The CIPPSL shall have a suitable membrane coating for protection of the interior surface and to provide a uniform, smooth flow surface. No membranes or plastic coating shall be allowed between the repair patch and the pipe wall.

I. The fiberglass/polyester felt sleeve shall be fabricated to a size that will tightly fit the sewer being rehabilitated after being installed and cured. The transition from the patch to the existing pipe must be smoothly tapered.

J. The CIPPSL shall be by Avanti International of Webster, TX, AP/M Permaform of Johnston, IA, or Engineer approved equal.

K. Thickness of the cured liner shall be as recommended by the manufacturer but shall not exceed 1/4-in when cured unless authorized in writing by the Engineer.

L. CIPPSL shall have a minimum length of 3-ft and shall not exceed 30-ft in length. CIPPSL lengths shall extend a minimum of 1-ft beyond the pipe defects at each end of the repaired section. Length of each required repair shall be verified in the field prior to installation.

M. CIPPSL shall not begin or end within one foot of a pipe joint or point repair joint.

N. All CIPPSL shall be one piece. Separately fabricated or installed CIPPSL's utilizing overlapped or "butted" ends shall not be acceptable.

2.02 AMBIENT-CURED MATERIAL:

A. The CIPPSL tube will consist of one or more layers of flexible non-woven needled felt or a reinforced non-woven material. The tube will be continuous in wall thickness based upon design calculations found in ASTM F1216.

B. The CIPPSL tube shall be compressible material at each end forming a smooth transition to the host pipe.

C. The liner will be capable of confirming to offset joints, bells, and disfigured pipe sections.

D. The resin will be polyester or, or vinyl-ester with proper catalysts as designated for the specific application.

E. The CIPPSL shall be by LMK Technologies of Ottawa, IL or Engineer approved equal.

F. Thickness of the cured liner shall be as recommended by the manufacturer but shall not exceed 1/4-in when cured unless authorized in writing by the Engineer.

G. CIPPSL shall have a minimum length of 3-ft and shall not exceed 30-ft in length. CIPPSL lengths shall extend a minimum of 1-ft beyond the pipe defects at each end of the repaired section. Length of each required repair shall be verified in the field prior to installation.

H. CIPPSL shall not begin or end within one foot of a pipe joint or point repair joint.

I. All cured-in-place spot repairs shall be one piece. Separately fabricated or installed CIPPSL's utilizing overlapped or "butted" ends shall not be acceptable.

MECHANICAL PROPERTY	INITIAL	LONG-TERM
Flexural Strength	4,500 psi	-------
Flexural Modulus of Elasticity	250,000 psi	-------

PART 3 - EXECUTION

3.01 LINE OBSTRUCTIONS:

A. It shall be the responsibility of the Contractor to clear the line of all obstructions such as solids,

joint sealing material, dropped joints in the sewer pipe and laterals, protruding service connections or collapsed pipe that will prevent the insertion of the short liner. Critical and/or hazardous utility crossings that occur through a sewer pipe (gas, electric, fiber optic etc.) shall be coordinated with the utility owner, prior to any work. If CCTV inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, or an internal cutter to remove such things like protruding services which are to be included in this pay item, then the Contractor shall inform the Engineer that a point repair excavation is required to uncover and remove or repair the obstruction. No excavation work shall be performed without the prior approval of the Engineer.

3.02 HEAT CURED INSTALLATION:

A. Clean each length of pipe to be lined and dispose of any resulting material as specified in Section 330130.41.
B. All obstructions in the sewer which may impede the insertion of the liner shall be removed by the Contractor.
C. Conduct a television inspection of each length of pipe after it is cleaned as specified in Section 330130.11. Document the location of all active service connections and verify the lengths of repairs as directed by the Engineer. A digital copy of these recordings shall be submitted to the Engineer via Email, Dropbox, or USB.
D. Furnish bypass pumping of sewage flows where the rehabilitation work is being performed.
E. The CIPPSL material shall be measured, cut and impregnated with epoxy resin in the field to the measurements determined from the videotape inspections. The installation and curing of the CIPPSL's shall be in complete accordance with the manufacturers' specifications and a representative of the manufacturer shall be present during the first day of installation.
F. The installed CIPPSL shall be cured by circulating hot water through the resin impregnated patch.
G. The inflatable element and hydrostatic pressure used during the installation process shall be sufficient to tightly hold the CIPPSL to the existing pipe wall, producing dimples at all service connections and squeezing surplus resin into any cracks in the pipe. This pressure shall be great enough to overcome or prevent infiltration from entering the existing pipeline during the curing process.
H. The Contractor shall ensure that the shroud covering the packer is completely removed from the repaired pipe.
I. Where CIPPSL's connect to existing manholes, the repair shall create a watertight seal at the pipe connection and into the trough. All cut edges of the cured liner shall be thoroughly sealed with the same resin as was used in the CIPPSL materials.
J. Reopen all of the existing active service connections on each length of sewer following patching. The active service connections shall be reopened from inside the sewer by means of a cutting device controlled by a closed-circuit television camera. All cut out material shall be removed from the sewer.
K. Each active service connection shall be cut completely open and shall have smooth edges with no protruding material capable of hindering flow or catching and holding solids contained in the flow stream.

3.03 AMBIENT CURED INSTALLATION:

A. The installation procedure shall conform to ASTM F2599
B. When required, the flow shall be bypassed.

C. Installer shall clean and inspect the line using a pan/tilt camera capable of verifying active or inactive service connections and the overall structural condition of the pipeline. All roots, debris, and protruding service connections will be removed prior to reconstruction of the pipe segment.

D. The liner tube shall have a breakaway connection to the inflation bladder at the leading end. A sufficient amount of approved catalyzed resin shall be introduced into the tube under a controlled vacuum. All resin shall be contained within the tube to ensure no public property or persons are exposed to the liquid resin. A resin-impregnated sample (wick), shall be retained by the installer.

E. The saturated tube along with the inflation bladder will be inserted into a flexible launcher device. The launching device shall be pulled into the pipe using a cable winch. The pull is complete when the end of the launching device is aligned with the beginning of the damaged pipe section. The resin and tube are to be completely protected during the pull. No resin shall be lost by contact with manhole walls or the pipe during the pull. The resin that provides a structural seal shall not contact the pipe until positioned at the point of repair. The resin should not be contaminated or diluted by exposure to dirt, debris, or water during the pull.

F. The installer shall be capable of viewing the entire liner contacting the host pipe from the beginning to the end of the liner verifying the liner has covered the entire damaged section. Video documentation of the entire liner contacting the host pipe, prior to curing shall be provided to the Engineer.

G. When the curing process is complete, the pressure shall be released. The inflation bladder and launching device shall be removed from the host pipe with the winch. Ensure that no barriers, coatings, or any material other than the cured tube/resin composite, specifically designed for desirable physical and chemical resistance properties, have been left in the host pipe. Any materials used in the installation other than the cured tube/resin composite must be removed from the pipe by installer.

H. Any service lateral connections covered by the sectional repair are to be opened using a self-propelled robotic cutting device specifically designed for cutting cured-in-place pipe.

3.04 PUBLIC NOTIFICATION:

A. A public notification program shall be implemented, and shall, at a minimum, require the Contractor to be responsible for contacting each home or business connected to the sanitary sewer and informing them of the work to be conducted, and when the sewer will be offline. The Contractor shall also provide the following:

1. Written notice to be delivered to each home or business describing the work, schedule, how it affects them, and a local telephone number of the Contractor that they can call to discuss the project or any problems, which could arise. This notice must be approved for use by the Engineer and shall be coordinated with the General Requirements.
2. All notices shall be prepared and distributed by the Contractor. Notices will be required prior to construction, 48 hours in advance of CIPPSL Work. Notices shall be prepared and handed out to all residents and businesses affected by CIPPSL Work. All notices shall be approved by the Engineer prior to distribution. Example notices will be furnished to the Contractor. Contractor shall copy and distribute notices at no additional cost to the City.
3. Communicate immediately with any home or business that cannot be reconnected within the time stated in the written notice. Notify the Engineer immediately regarding the delay.

3.05 CLEAN-UP OPERATIONS:

A. All materials removed from the sewer line and from the pipe lining process shall be satisfactorily disposed of offsite by the Contractor.
B. Prior to final completion, the Contractor shall demonstrate, in the presence of the Engineer, the capability of the liner to perform as specified. Any deficiencies found in the liner shall be corrected at no additional cost to the City.

3.06 FIELD TESTING AND ACCEPTANCE:

A. Field acceptance of all CIPPSL locations shall be based on the Engineer's evaluation of the installation and curing data along with review of CCTV and manhole inspections.
B. Groundwater infiltration of CIPPSL shall be zero.
C. All active service connections shall be open and clear.
D. Defective CIPPSL's shall be removed and replaced with new CIPPSL's. If the replacement CIPPSL is not satisfactory to the Engineer, then remove the entire section of pipe being rehabilitated and replace it with new PVC pipe at no additional cost to the City.

END OF SECTION 330130.77

This page was intentionally left blank.

SECTION 330130.81 – MANHOLE REHABILITATION

PART 1 – GENERAL

1.01 SUMMARY:

A. The Contractor shall rehabilitate the manholes by various methods as directed by the City within the boundaries of the project.

B. When excavation in pavements is required, removal and restoration of the pavements shall be as specified by the City.

1.02 SUBMITTALS:

A. All Contractor Project Submittals shall be submitted to the City within 14 days of Notice to Proceed issuance. All submittals shall be approved by the City before the start of construction. Required submittals are as follows:

1. The Contractor shall provide manufacturer specifications, details of physical properties, and handling/storage requirements for all materials used in manhole preparation for a Chimney Liner product and installation.
2. The Contractor shall submit manufacturer certification for Chimney Liner installation.

B. The Contractor shall provide one hard copy and one electronic copy via Email, Dropbox, or USB of each shop drawing, material certification, or manufacturer's literature for review and approval by the City prior to the start of Work. The Contractor shall be required to provide submittals for all materials to be incorporated in the project.

C. The City shall review and approve all materials before the work begins. The City may approve substitution of materials, requested by the Contractor.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.01 CHIMNEY LINER:

A. General:

Installation of the Chimney Liner shall consist of cleaning and preparation of frame, adjustment rings, and cone section if present. A minimum of 12 inches shall be installed on each manhole. The liner shall cover from the top of the frame to 6 inches below the top of the cone. The entire frame, any adjustment rings present, and the top six inches of cone shall be prepared according to the manufacturer's instructions. All grade adjustment shall be sealed regardless of the depth. The Contractor shall take into account grade adjustment depth when determining unit bid price. The Chimney Liner shall have a minimum thickness of 125 mils. The liner shall be installed at a minimum of 2.5 psi for cured-in-place chimney liners. Material shall have a minimum elongation of 150%. The Chimney Liner shall be approved by the City.

1. Cured-In-Place Chimney Liners are required for all hazardous manholes as determined in the field and approved by the City.

B. Materials:

1. The Contractor shall provide the City with independent third-party testing to support the Manufacturers design. All materials, such as grouts, used in manhole preparation for the Chimney Liner installation shall conform to the recommendations of the Chimney Liner manufacturer, and shall be compatible with the chimney liner materials.

C. Manhole steps that interfere (typically, only the top step) with the installation of a Chimney Liner shall be removed. These steps are not to be re-installed. Manhole preparation shall be in accordance with the manufacturer's instructions and specification unless directed otherwise by

the City or its representative. The manhole chimney and one foot of the Corbel/Cone section is to be cleaned with a 5000-psi pressure washer. The casting shall be cleaned with a grinder. The Contractor shall capture, remove, and dispose of all waste materials related to cleaning that could potentially cause a sewer backup, damage existing facilities such as pump stations or cause sedimentation in the downstream sewer system.

D. Detailed installation instructions shall be in accordance with the manufacturer's instructions. A minimum of 2.5-psi shall be used to pressurize the liner until cured.

E. Quality Control:
   1. All installations will be subject to visual inspection by the City or its representative before project closeout and final payment. The Contractor shall correct any deficiencies identified during the visual inspection at no additional cost to the City.
   2. For Cured-In-Place Chimney Liners, a Curing Log containing a minimum of; date, time of cure, temperature, weather conditions, resin usage, and other pertinent information, shall be completed and turned in to the City Representative within 48 hours after the Cured-In-Place Chimney Liner installation.
   3. All products shall have a minimum life expectancy of 20 years.
   4. The materials shall not be applied by hand or brush.
   5. The City may require the use of a Holiday Detector to determine if the liner is 100% impervious.

F. Warranty:
   1. The Contractor shall provide the City a warranty to be in force and effect for a period of one (1) year from the date of acceptance by the City. The warranty shall require the Contractor to repair or replace the chimney liner if leakage or other failure results from faulty material and/or installation, as determined by the City.

END OF SECTION 330130.81

This page was intentionally left blank.

SECTION 330130.82 – EPOXY LINING FOR CONCRETE MANHOLES

PART 1 – GENERAL

1.01 SUMMARY:

A. Installation of Non-Cementitious Manhole Liners shall consist of cleaning the entire manhole interior surface, and removal and replacement of any defective existing steps; preparation (plugging/patching) of the manhole interior surface for lining including repair of frame seal, grade adjustment cone/wall joint, pipe seals and bench and invert as required to prepare the manhole for lining. The Contractor shall line the entire manhole interior surface with an approved lining product.

B. These specifications are intended to set a standard of quality and design for the application of non-cementitious manhole liners used in the rehabilitation of manholes.

C. The City shall approve all materials, before work starts. The City will make final approval of any proposed material

D. Definitions:

1. The term "approved" shall mean that the proposed material shall meet or exceed each of the performance criteria set forth in this specification. Manufacturers and vendors of various name brand materials shall submit proof that any proposed material will meet the guidelines and requirements of this specification.

1.02 SUBMITTALS:

A. Submittals shall be required for the following items. The City may request submittals for additional items if necessary.

1. Lining product(s)

B. Quality Control:

1. The quality and performance of the material shall be maintained by one or all of the following measures to be determined and specified by the City.
   a. Exfiltration Testing
   b. Visual Inspection
   c. Material Testing

C. Warranty:

1. The product manufacturers and the Contractor shall warrant all materials free of defects product design and workmanship for a period of one year from the date of installation. Manufacturer shall provide replacement materials for any defective product. The Contractor shall remove defective materials and install new materials per the specifications.

PART 2 - MATERIALS

A. The required characteristics of Urethane Products and Epoxy lining systems for concrete:

SOLIDS CONTENT	URETHANE 100% SOLIDS SERIES	98-100% EPOXY SYSTEMS
ELONGATION	150% minimum	1-3%
ADHESION	800 PSI	1000 PSI
VOCs	ZERO (NO TASTE ISSUES)	ZERO (NO TASTE ISSUES)

ABILITY TO WITHSTAND SHOCK	OUTSTANDING	SATISFACTORY
LIFE EXPECTANCY	25 YEARS	25 YEARS
THICKNESS REQUIRED	160 MILS	125 MILS

B. The required characteristics of Urethane Products and Epoxy lining systems for steel:

SOLIDS CONTENT	POLYCOAT 100% SOLIDS SERIES	98-100% EPOXY SYSTEMS
ELONGATION	150%-350%	1-3%
ADHESION	1000	1600
VOCs	ZERO (NO TASTE ISSUES)	ZERO (NO TASTE ISSUES)
LOW TEMPERATURE APPLICATION	DOWN TO 35˚ F	MINIMUM 40˚ F
ABILITY TO WITHSTAND SHOCK	OUTSTANDING	SATISFACTORY
LIFE EXPECTANCY	25 YEARS	25 YEARS
THICKNESS REQUIRED BY AWWA	25 MILS	20 MILS

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

A. All surfaces to be coated shall be clean and dry and shall meet the recommendations of the coating manufacturer for surface preparation. Freshly coated surfaces shall be protected from dust and other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss on previously coated surfaces shall be dulled if necessary for proper adhesion of topcoats.

B. Surfaces shall be free of cracks, pits, projections, or other imperfections that would interfere with the formation of a smooth, unbroken coating film, except for concrete block construction where a rough surface is an inherent characteristic.

C. When applying touchup coating or repairing previously coated surfaces, the surfaces to be coated shall be cleaned as recommended by the coating manufacturer, and the edges of the repaired area shall be feathered by sanding or wire brushing to produce a smooth transition that will not be noticeable after the coating is applied.

3.02 MIXING AND THINNING:

A. Coating shall be thoroughly mixed each time any is withdrawn from the container. Coating containers shall be kept tightly closed except while coating is being withdrawn.

B. Coating shall be factory mixed to proper consistency and viscosity for hot weather application without thinning. Thinning will be permitted only as necessary to obtain recommended coverage at lower application temperatures. In no case shall the wet film thickness of applied coating be reduced, by addition of coating thinner or otherwise, below the thickness recommended by the coating manufacturer. Thinning shall be done in compliance with all applicable air quality regulations.

3.03 APPLICATION:

A. Coating shall be applied in a neat manner that will produce an even film of uniform and proper thickness, with finished surfaces free of runs, sags, ridges, laps, and brush marks. Each coat shall be thoroughly dry and hard before the next coat is applied. Each coat shall be a different color, if available. In no case shall coating be applied at a rate of coverage greater than the maximum rate recommended by the coating manufacturer.

1. Epoxy:
   a. When used, epoxy shall be applied in accordance with the coating manufacturer's recommendations, including temperature limitations and protection from sunlight until top-coated.
   b. When applying high build epoxy coatings with a roller or brush and where a dry film thickness of at least 4-6 mils per coat is required, two or more coats shall be applied to achieve the recommended dry film thickness equal to a spray applied coating.

B. Film Thickness:

1. The total coating film thickness including primer, intermediate coats and finish coat, shall not be less than recommended by manufacturer and shall be not less than the following:

Type of Coating	Minimum Dry Film Thickness
Epoxy	
Pipe interior	20 mils
Pipe exterior and support structures	28 mils (25 mils DFT for epoxy plus 3 mils DFT for aliphatic polyurethane)
Flake-filled epoxy (two coats)	30 mils

C. Coatings shall not be applied, except under shelter, during wet, damp, or foggy weather, or when windblown dust, dirt, debris, or insects will collect on freshly applied coating.

3.04 PROTECTION OF SURFACES:

A. Throughout the work Design-Builder shall use drop cloths, masking tape, and other suitable measures to protect adjacent surfaces. Design-Builder shall be responsible for correcting and repairing any damage resulting from its or its subcontractors' operations. Coatings spilled or spattered on adjacent surfaces which are not being coated at the time shall be immediately removed. Exposed concrete or masonry not specified to be coated which is damaged by coatings shall be either removed and rebuilt or, where authorized by the City, coated with two coats of masonry coating.

3.05 FIELD QUALITY CONTROL:

A. The following inspection and testing shall be performed:

1. Surface profile, visual inspection, adhesion testing, and wet and dry film thickness testing. The City shall be notified to allow the City the opportunity to witness the

inspection and testing. All inspection and testing records shall be available to the City for review.

2. Visual Inspection. The surface of the protective coatings shall be visually
3. Film Thickness:
   a. Coating film thickness shall be verified by measuring the film thickness of each coat as it is applied and the dry film thickness of the entire system. Wet film thickness shall be measured with a gauge that will measure the wet film thickness within an accuracy of ±0.5 mil. Dry film thickness shall be measured in accordance with SSPC-PA 2.

END OF SECTION 330130.82

This page was intentionally left blank.

Section 330130.86 – MANHOLE RIM ADJUSTMENTS

PART 1 - SUMMARY

1.01 SUBMITTALS:

A. The Contractor shall provide one hard copy and one electronic copy via Email, Dropbox, or USB of each shop drawing, material certification, or manufacturer's literature for review and approval by the City prior to the start of Work. The Contractor shall be required to provide submittals for all materials to be incorporated in the project.

B. The City shall review and approve all materials before the work begins. The City may approve substitution of materials, requested by the Contractor.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.01 SCOPE OF WORK:

A. Manhole Frame and Cover Remove and Replace:
   1. The work includes removing the existing frame and cover and installing a new frame, cover seal, and locking cover, and adjusting to grade.

B. Manhole Frame and Cover Adjustment (includes first foot of new masonry):
   1. The work includes adjusting manholes to grade as called out in the Standard Manhole Detail.
   2. If a manhole to be adjusted to grade is located within pavement, the Contractor shall be responsible for removing pavement to allow for one foot of adjustment, and replace the pavement to the existing, or higher, quality. The replacement shall be approved by the City.

C. Install New Manhole Cover:
   1. The work includes installing a new cover seal and locking cover and cleaning the existing frame. The existing frame shall be cleaned with high pressure water blasting with a minimum of 3500 psi. If needed, the casting shall be grounded to remove any debris or frame material that prevents proper seating of the cover in the frame. If a manhole to be adjusted is in pavement, a non-rocking style lid shall be installed if not already.

D. Adjust Manhole to Grade:
   1. The work includes adjusting manholes to grade as called out in the Standard Manhole Detail.
   2. If a manhole to be adjusted to grade is located within pavement, the Contractor shall be responsible for removing pavement to allow for the adjustment, and replace the pavement to the existing, or higher, quality. The replacement shall be approved by the City.
   3. The maximum adjustment ring height is 24". Any more adjustment will require the addition of a barrel section.

E. Pavement:
   1. Payment for pavement will be made at the respective unit bid price for the type of pavement being replaced.

F. Locate Buried Manholes

END OF SECTION 330130.86

This page was intentionally left blank.

SECTION 330524 - UTILITY CASINGS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes casing pipe, installed by boring and jacking, carrier pipe alignment skids, sand fill, and end seals where indicated or where constructed at Contractor's option. Use when required to pass other utilities, streets, highways, railroads or obstructions without open excavation.

1.02 REFERENCES:

A. Applicable Standards:
   1. American Petroleum Institute (API):
      a. API RP1102 - Recommended Practice for Liquid Petroleum Pipelines Crossing Railroads and Highways.
      b. API 1104 - Standard for Welding Pipelines and Related Facilities.
   2. American Society for Testing and Materials (ASTM):
      a. A36 - Carbon Structural Steel.
      b. A570 - Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality.
      c. C32 - Sewer and Manhole Brick (Made from Clay or Shale).
      d. C270 - Mortar for Unit Masonry.
   3. American Water Works Association (AWWA):
      a. C200 - Steel Water Pipe 6 Inches and Larger.
      b. C206 - Field Welding of Steel Water Pipe.
   4. Society for Protective Coatings (SSPC):
      a. SP-3 - Power Tool Cleaning.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.
B. Submit the following for acceptance prior to shipment:
   1. Pipe alignment guides.
   2. Guide spacer bands.
C. Affidavits:
   1. Furnish for acceptance prior to shipment to jobsite.
   2. Certify compliance with applicable standards for the following:
      a. Casing material.
      b. Casing paint coating/lining system.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Casing Pipe:
   1. New, smooth wall, welded steel pipe fabricated from ASTM A36 plate or ASTM A570 sheet with a minimum yield point of 36,000 psi, conforming to AWWA C200. Furnish pipe with minimum wall thickness as follows:

2. Minimum Casing Thicknesses:

Casing Diameter in.	Wall Thickness Under Highways in.	Under Railroads in.
Under 14	0.188	0.250
14 and 16	0.188	0.281
18	0.250	0.312
20	0.250	0.344
22	0.250	0.375
24	0.281	0.406
26	0.281	0.438
28 and 30	0.312	0.469
32	0.312	0.500
34	0.312	0.531
36	0.344	0.531
38, 40 and 42	0.344	0.563

3. See Standard Detail #4 for Casing Pipe and End Seal Detail.
4. Minimum casing inside diameter shall exceed the maximum diameter at the joint assembly at a minimum of 4-inches.
5. Casing shall be no smaller than 1.5 times the diameter of the carrier pipe.
6. Schedule:

Location	Carrier Pipe Diameter	Carrier Pipe Material	Carrier Joint Diameter	Casing Diameter	Casing Min. Thickness

B. Coatings and Linings:
   1. Coat exterior and line interior of all casing pipe with iron oxide primer applied at 1.5 mils minimum thickness.
   2. Hold coatings back from end joints to be welded at least 2 inches each side of joint.

C. Joints:
   1. All joints in steel pipe casings shall be field welded to conform to API 1104 or AWWA C206.
   2. Clean to SSPC-SP3 and apply iron oxide field coating to all exterior joints after field welding.
   3. Clean to SSPC-SP3 and apply iron oxide field coating to all interior joints on casings 24-inch diameter and larger after field welding.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. All Work shall, as a minimum, meet the requirements of API RP1102 and the highway, railroad, or utility having jurisdiction, and shall be subject to their inspection and approval.

B. Install Casing Pipes:
   1. By boring with continuous flight auger, pneumatic or hydraulic jacking, or other acceptable method. Reinforce leading end of casing with jacking band.

2. Including measures for maintaining indicated line and grade for casings less than 24-inch diameter within a plus or minus tolerance of 0.5%. Maintain indicated line and grade for casings 24-inch and larger within a plus or minus tolerance of 3 inches over length of casing.
3. With working pits of adequate size to provide safe working conditions. Install sheeting and bracing to conform to DIVISION 31.
4. In such a manner as not to disrupt traffic or damage the roadway grade or surface.
5. Casings rejected due to misalignment or other failures to conform to Specifications shall be abandoned in place and filled with concrete grout. Casing pipe shall not be recovered for reuse.

3.02 PIPE ALIGNMENT SKIDS:

A. Furnish skids for pipe alignment guides as indicated for all carrier pipe to be installed in casing.
   1. Minimum spacing of skids shall be 10 feet or every pipe joint, whichever is the lesser.
   2. Size to fit outside diameter of carrier pipe and inside diameter of casing pipe.
   3. Skids to be sized slightly larger than carrier pipe's outside joint diameter.

B. Provide either of the following:
   1. Hardwood timber skids notched for steel bands. Permanently attach each pair of skids with two 3/4-inch wide stainless steel bands. Wiring is not permitted.
   2. Stainless steel casing spacers with plastic runners, Cascade Waterworks Style CCS or Engineer-approved equal.

3.03 SAND FILL AND END SEALS:

A. Construct end seals (and fill annual space between carrier pipe and casing with dry sand) as indicated and as follows:
   1. After inside of casing has been thoroughly cleaned and approved by Engineer.
   2. After carrier pipe has been permanently placed inside casing, tested, and approved.
   3. Place dry sand by Engineer-approved method and equipment.
   4. Brick end seals shall conform to ASTM C32, Grade MS. Mortar shall conform to ASTM C270, Type M, with Type II portland cement and Type S lime.
   5. Gasket boot end seals are acceptable and shall be installed to manufacturer’s standards.

END OF SECTION 330524

This page was intentionally left blank.

SECTION 331100 – PRESSURE PIPE

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes all pressure pipe, fittings, specials, and appurtenances.

B. Related Work Specified Elsewhere:

1. Section 333150 - Pipe Installation.
2. Section 331216 – Utility Valves and Accessories.

1.02 REFERENCE STANDARDS:

A. Applicable Standards:

1. American Association of State Highway and Transportation Officials (AASHTO).
2. American Water Works Association (AWWA):
   a. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
   c. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   e. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
   f. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
   g. AWWA C153 - Ductile-Iron Compact Fittings.
   h. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   i. AWWA C606 - Grooved and Shouldered Joints.
   j. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In.
   k. AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In.
   l. AWWA C907 - Polyvinyl Chloride (PVC) Pressure Fittings for Water-4 in. through 12 In. for Water Distribution.
   m. AWWA M23 - PVC Pipe-Design and Installation.
   n. AWWA M41 - Ductile-Iron Pipe Fittings.
3. American National Standards Institute (ANSI):
   a. ANSI B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   b. ANSI B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
4. American Society for Testing and Materials (ASTM):
   a. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
   b. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
   c. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
   d. ASTM G62 - Standard Test Methods for Holiday Detection in Pipeline Coatings.
5. National Sanitation Foundation (NSF):
   a. NSF 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS:

A. Submit as specified in Division 01.

B. Submit the following for acceptance prior to fabrication:

1. Pipe and joint details.
2. Special, fitting, and coupling details.
3. Laying and installation schedule.
4. Specifications, data sheets, and affidavits of compliance for protective shop coatings and linings.
5. Manufacturer's design calculations including, but not limited to, wall thickness and deflection under specified live and dead loads.

C. Certificates and Affidavits: Furnish the Following Prior to Shipment:
1. Affidavit of compliance with applicable standard.
2. Certificate or origin for all steel flanges. Flanges shall be manufactured in the U.S.A.
3. Test certificates.

1.04 QUALITY ASSURANCE:

A. All grooved/shouldered joint couplings, fittings, adapter rings and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved couplings.

B. All castings used for grooved/shouldered coupling housings, fittings, etc., shall be date stamped for quality assurance and traceability.

PART 2 - PRODUCTS

2.01 PIPE REQUIREMENTS:

A. Furnish pipe of materials, joint types, and sizes as indicated or specified.

B. Pipe shall be designed to withstand all stresses resulting from external loads and internal pressures.

C. Pipe Marking: All pipe and fittings shall be marked conforming to the applicable standard specification under which the pipe is manufactured and as otherwise specified.

2.02 DUCTILE-IRON PIPE:

A. Design and Manufacture of Pipe:
1. Ductile-iron pipe shall conform to AWWA C115, C150 and C151 except as otherwise specified.
2. With laying condition Type 5 for ductile iron for load requirements tabulated herein.
a. Use E' of 700 and bedding angle of 90^{o}.
b. 3% deflection limit.
c. Add service allowance and standard casting tolerances of AWWA C150 and AWWA C151.
d. Select standard pressure class thickness next above total calculated thickness.
3. Minimum thickness for ductile-iron pipe threaded for screw-on flanges shall be in accordance with AWWA C115.
4. Pipe with grooved barrel for any type of restrained joint shall have wall thickness increased to provide a minimum wall thickness conforming to AWWA C606.

B. Joints:
a. Mechanical and Push-On Type: Provide mechanical or push-on-type joints for all buried pipe less than 30 inches in diameter unless otherwise specified or indicated. Provide push-on-type joints for sizes 30 inches in diameter and greater
b. Joints shall conform to AWWA C111.
2. Flanged:

a. Provide flanged joints for all interior pipe except where otherwise specified or indicated.
b. Flanges for pipe shall be ductile iron and conform to the applicable provisions of AWWA C110 and C115 and shall be drilled ANSI B16.1 Class 125.
c. Pipe with victaulic-style couplings and rigid joints conforming to AWWA C606 may be substituted for Class 125 flanged pipe where suitable.

3. Sleeved or Coupled:
   a. Provide for sleeves or couplings where indicated.
   b. Furnish pipe ends suitable for receiving style of sleeve or coupling indicated or specified.
   c. Provide anchored couplings where restraint is required to withstand specified operating or hydrostatic test pressure and where indicated.
4. Restrained:
   a. Furnish for all fittings and where joint restraint is required to offset internal pipeline forces.
   b. Provide restrained joints of following approved types:
      (1) Restrained mechanical and push-on joint.
      (2) Cut grooved type for rigid joint conforming to AWWA C606.
      (3) Anchored couplings.
   c. Restrained joints shall be Flex-Ring or Lok-Ring restrained joint by American Ductile Iron Pipe, TR FLEX or HP Lok restrained joint by U.S. Pipe, or equal.
   d. Mechanical joint retainer glands shall not be used where joint restraint is required unless indicated. When indicated, retainer glands shall be Megalug Model 1100 by EBAA Iron, Inc. or approved equal.

C. Fittings:
1. Fittings shall conform to AWWA C110 and shall have a pressure rating of not less than that specified for pipe.
2. Fittings shall be ductile iron.
3. Fittings for pipe with mechanical joint shall have mechanical joints.
4. Fittings for pipe with push-on joints shall be mechanical joint or push-on-type joint.
5. Fittings for pipe with grooved type joint shall have cut grooved type rigid joints per AWWA C606.
6. Include all specials, taps, plugs, flanges, and wall fittings as required.
7. Provide openings for air valve, drain, sampling, sensing, testing, and other connections with threaded bosses or flange outlets sized and located where indicated. Provide tangent blow-off and drain assemblies where indicated. Outlet size shall be 6 inches and have flanged end.

D. Lining:
1. All pipe and fittings for water shall be cement-mortar lined in accordance with AWWA C104.

E. Lining:
1. Pipe and Fittings.

F. Coating:
1. All iron pipe and fittings shall be coated with manufacturer's standard bituminous paint coating.
2. Flange faces shall be coated in accordance with AWWA C115.

2.03 STEEL PIPE:

A. Design of Pipe: Design shall conform to AWWA C200, AWWA M11, and as specified except that hydrostatic test of fittings after fabrication will not be required. Fittings shall be tested by dye penetrant method.
   1. Nominal length of pipe section shall be not less than 35 feet nor more than 40 feet. Shorter sections shall be used where required and where otherwise approved.
   2. External Loading:
      a. Earth dead load cover at 120 pcf plus AASHTO H-20 live loads. Use Cooper E-80 live loads for railroad crossings.
      b. Use 100% of earth prism above the pipe.
      c. 2% initial deflection limit and 1.5 time lag factor.
      d. Bedding condition as indicated.
   3. Use E' of 700 and bedding angle of 90^{O}.
   4. Allowable design stresses for steel shall be as follows:
      a. 50% of minimum yield stress when subjected to working pressure.
      b. 70% of minimum yield stress when subjected to working pressure plus surge.
   5. Allowable design deflection shall be 2% of mean diameter.
   6. Deflection lag factor shall be 1.25 for the dead load and 1.0 for live loads.

B. Joints:
   1. Push-On Type:
      a. Provide push-on-type joints for all buried pipe unless otherwise specified or indicated.
      b. Joints shall conform to AWWA C200.
   2. Flanged:
      a. Provide certificate of origin for all flanges.
      b. Provide flanged joints for all interior and exposed exterior pipe except where otherwise specified or indicated.
      c. Joints shall conform to AWWA C200 and AWWA C207.
      d. Flanges shall have a pressure rating not less than that required for pipe. Flanges shall be Class D and be drilled ANSI B16.1 Class 125.
      e. Pipe with AWWA C606 shouldered-type joints may be substituted for Class D flanged pipe.
   3. Sleeved or Coupled:
      a. Provide for sleeves or couplings where indicated.
      b. Furnish pipe ends suitable for receiving style of sleeve or coupling indicated or specified.
      c. Provide anchored couplings where restraint is required to withstand specified operating or hydrostatic test pressure and where indicated.
   4. Restrained: Furnish where joint restraint is required to offset internal pipeline forces. Shouldered type joints for victaulic-style couplings shall be rigid and conform to AWWA C606. Roll grooved type joints shall not be used.

C. Fittings and Specials:
   1. Fabricate from tested pipe to conform to AWWA C208 except where otherwise indicated or specified.
   2. Design to withstand internal and external loading specified for pipeline in which located.
   3. Reinforce tees, laterals, and outlets conforming to applicable provisions of AWWA M11.
   4. Include wall fittings with approved anchor ring where indicated.
   5. Include all adapters, outlets, taps, plugs, and other specials as required to complete installation as specified or indicated.

6. Provide openings for air valve, drain, sampling, sensing, testing, and other connections with threaded bosses or flanged outlets sized and located where indicated.
7. Provide tangent blow-off assemblies where indicated. Outlet size shall be 6 inches and have flanged end.

D. Test Plugs:
1. Provide pressure test plugs where required to test the installation.
2. Design test plugs to withstand the internal and external loading.
3. Join test plug to pipe and tie as required to sustain internal and external loading.

E. Lining:
1. All pipe and fittings shall be lined with fusion-bonded epoxy to conform to AWWA C213.
2. Termination of lining at ends shall be as follows:
a. End of steel on spigot, flanged, or plain end.
b. Anticipated termination of mating spigot on bell end of push-on type joints.

F. Coating:
1. All pipe and fittings for buried service shall be coated with epoxy to conform to AWWA C213.
2. Flange faces shall be coated with one of the following rust preventive compounds:
a. Houghton "Rust Veto 344."
b. Rust-Oleum "R-9."
c. Engineer-approved equal.
3. All pipe and fittings for exposed exterior installation shall be shop finish coated in conformance with AWWA C218.

G. Marking Pipe: In addition to the marking specified in paragraph "Pipe Marking," the following information shall be on all pipe, fittings, and specials:
1. Design pressure in feet.
2. Point of installation on all fittings and specials.
3. Length of any short pipe.

2.04 PVC PIPE:

A. Materials:
1. Materials shall conform to AWWA C900 for all major crossings and depths of 9 feet and more. For pressure mains less than 9 feet deep, Class 200 PVC is acceptable.
2. Gaskets shall conform to ASTM F477 and be synthetic rubber.

B. Design of Pipe: Design shall conform to AWWA C900 and as specified:
1. Internal Loading:
a. Internal pressure specified plus allowance for surge pressure conforming to AWWA C900.
b. Hydrostatic test pressure as specified.
2. External Loading:
a. Earth dead load cover at 120 pcf plus AASHTO H-20 live loads.
b. 5% deflection limit.
c. Bedding condition as indicated.
3. Use E' of 700 and bedding angle of 90^{o}.

C. Diameters: PVC pressure pipe shall have Cast-Iron-Pipe-Equivalent (CI) outside diameters.

D. Joints: Pipe shall be furnished with integral bell-type pipe ends designed for joint assembly using elastomeric gaskets.

E. Fittings:

1. Fittings shall conform to AWWA C110 or C153 and be ductile iron. Fittings shall be mechanical joint or push-on-type joint.
2. Fittings for 4-inch through 8-inch pipe shall be injection-molded PVC with push-on-type joint, Class 150, conforming to AWWA C907.

F. Marking: Identification markings on pipe shall conform to AWWA C900.

2.05 SLEEVES AND COUPLINGS:

A. Sleeves:
1. AWWA C110 mechanical joint ductile-iron solid-sleeve type:
   a. Pipe end space shall not exceed one-third of the sleeve laying length.
   b. Interior, exposed, exterior, or buried service as indicated.

B. Couplings:
1. Center sleeve and compression gland-type end ring conforming to AWWA C219.
2. Center sleeve shall be without pipe stop.
   Couplings for joining steel pipe shall be steel.
3. Couplings for joining direct buried, exposed exterior, vault or pit installations of iron, or PVC pipe up to 12-inch diameter shall be iron. Provide lined and coated steel couplings for larger pipe diameters.
4. Couplings for exposed interior iron or PVC pipe may be steel or iron.
5. Fastener bolts shall be stainless steel for iron couplings and high-strength, low-alloy steel for steel couplings. Bolts for direct buried coupling installations shall be stainless steel.
6. Center sleeve and end rings shall be:
   a. Ductile or malleable iron for iron couplings.
   b. Steel for steel couplings.
7. Lining and Exterior Coating:
   a. Use for all steel couplings intended for direct bury, exposed exterior, vault or pit installations.
   b. Completely coat center sleeve and end rings.
   c. Two-part epoxy or nylon fuse-coated to a minimum 10 mils thickness.
   d. Line interior of all steel couplings intended for exposed-interior installations. Coat exterior with normal shop coating.

C. Flanged Coupling Adapters:
1. Flanged end and body to be one unit conforming to AWWA C219. Coupling end to be compression gland type with follower ring.
2. Adapters for joining direct buried, exposed exterior, vault or pit installations of iron pipe shall be iron.
3. Adapters for joining exposed interior iron pipe may be steel or iron.
4. Flanged end bolt circle, bolt size, and spacing shall conform to the applicable provisions of ANSI B16.1 and shall be drilled Class 125 for iron adapters. Flanges on steel adapters shall be AWWA C207, Class D, drilled ANSI B16.1 Class 125.
5. Bolts and nuts shall be ductile iron for iron adapters and high-strength, low-alloy steel for steel adapters.
6. Anchor studs shall not be used where joint restraint is required. Furnish adapters with tie rod harness assemblies where indicated.
7. Lining and Exterior Coating for Steel Adapters:
   a. Two-part epoxy or nylon fuse-coated to a minimum 10 mils thickness.
   b. Completely coat adapter sleeve and end follower gland plus line interior for adapters intended for exposed exterior, vault or pit installations.

c. Line interior of all adapters intended for exposed interior installations. Coat exterior with normal shop coating.

D. Expansion Joint Couplings:
1. Furnish steel pipe expansion joints where indicated.
2. Slip-pipe's exterior section, which is in contact with the packing, is to be hard chrome-plated on a machined surface.
3. Furnish with limit rods where joint restraint is required.
4. Lining and Exterior Coating:
a. Normal shop coating.
b. Line slip-pipe with epoxy.
c. Line body-pipe with epoxy.
5. Bolts and limit rods shall be stainless steel.
6. Acceptable manufacturers are as follows:
a. Dresser Industries, Inc. - Style 63.
b. Rockwell International Corp. - Type 611 or 612.
c. Ford Style 811 or 812, Ford Meter Box Company, Inc.
d. Engineer-approved equal.

E. Anchored Couplings:
1. Furnish where joint restraint required to offset internal pipeline forces.
2. Provide harnessed sleeve couplings and flanged coupling adapters with tie rod harnesses where indicated.
a. Harnesses shall consist of lugs or clamps welded or otherwise securely fastened to opposite joint elements with tie bolts between opposing lugs. "Dog ear" lugs shall be fabricated as indicated.
b. Design of harnesses for steel pipe shall conform with applicable provisions of AWWA M11.
3. Provide expansion couplings with limit rods.
4. Provide couplings for grooved and shouldered type joints conforming to AWWA C606.
a. Furnish grooved ends on ductile-iron end pipe.
b. Furnish shouldered ends on steel pipe.
5. Mechanical joint retainer glands shall not be used where joint restraint is required unless indicated. When indicated, retainer glands shall be MegaLug Model 1100 by EBAA Iron, Inc., or Engineer approved equal.
6. See Standard Detail #2 for Anchor Coupling Detail.

F. Insulated Couplings:
1. Couplings shall be insulated to prevent electrical conductivity where indicated.
2. Insulated coupling design shall be otherwise conforming to the standard types and styles specified.

G. Dismantling Couplings (Dismantling Joint):
1. Consists of a mechanical joint fitting located between two pipe flanges with restraining rods across the mechanical joint section, providing a restrained system with integral space for removal of adjacent equipment.
2. Shall conform to AWWA C-219.
3. Materials shall be steel.
4. When connected to DIP system, install insulating flange kit.
5. Coating finish shall be fusion-bonded epoxy.

2.06 GASKETS AND BOLTING MATERIALS:

A. Provide all gaskets, bolts, lubricant, and other accessories required to install pipe, fittings, and specials complete and ready for service.

B. Gaskets for flanged joints shall conform to ANSI B16.21, American Cast Iron Pipe Company Toruseal 1/8-inch thick full-face gasket Provide full-face gaskets for all pump and equipment connections.

C. Gaskets for ductile iron flanged pipe and fittings 12 inch and smaller shall have "nominal" inside diameters, not the larger inside diameters per ANSI B16.21.

D. Bolts for flanged joints shall conform to ASTM A307, Grade B. Nut and bolt heads shall be hexagonal.

E. Gaskets and bolts for other than flanged joints shall be as otherwise specified for pipe and pipe joints.

F. Gaskets for grooved and shouldered couplings shall be flushseal shaped with a center leg. Coupling gaskets are to be molded of synthetic rubber specially compounded to conform to pipe surfaces for the application. Elastomers shall have properties as designated in ASTM D2000 and conform to AWWA C606.

G. Bolts for grooved and shouldered coupling joints shall be heat treated zinc plated carbon steel, track head, conforming to the physical properties of STM A183, minimum tensile strength 110,000 PSI.

2.07 TRACER WIRE

A. A minimum of 12-gauge single strand conductive tracer wire shall be installed as a tracer wire. All wire splices shall be made with either rigid fittings or weatherproof connectors specifically designed for direct burial.

   a. A 4’ copper grounding rod shall be driven into the trench bottom at 300 foot spacing, at the location where the pressurized pipe crosses property lines or changes direction and secured to the tracer wire with rigid fittings

2. Tracer wires for sewer laterals shall extend from a minimum 1’ grounding rod driven into the trench bottom at the point of connection to the sewer main to the clean out. The tracer wire shall be extended to the surface adjacent to the clean out and housed within a protective enclosure constructed of schedule 40 PVC pipe and a schedule 40 PVC threaded clean out. The protective enclosure shall be extended to grade and installed so that it is easily accessible.

3. Tracer wires for all other pressurize pipe shall be extended to the surface within a protective enclosure construct out of a suitable length of 6-inch diameter class 200 PVC and a cast iron mushroom cap. This protective enclosure shall not be located within any driving or parking surface.

   a. A 4’ copper grounding rod shall be driven into the trench bottom at 300 foot spacing, at the location where the pressurized pipe crosses property lines or changes direction and secured to the tracer wire with rigid fitting

2.08 SEWER MARKERS:

A. An aboveground wire station riser shall consist of a thermoplastic dome marker of a height of at least 36-inches above ground. These shall be placed every 1,000 feet, and at the location where the pressurized pipe crosses property lines or changes direction.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Specified in Section 333150.

3.02 FIELD TESTING:

A. Specified in Section 333150.

END OF SECTION 331100

This page was intentionally left blank.

SECTION 331216 - UTILITY VALVES AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes all valves and accessories.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. Pipe Installation: SECTION 333150.

1.03 REFERENCES:

A. Applicable Standards:

1. American National Standards Institute (ANSI):
   a. B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
2. American Society for Testing and Materials (ASTM):
   a. A126 - Gray Iron Castings for Valves, Flanges and Pipe Fittings.
   b. A276 - Stainless and Heat Resisting Steel Bars and Shapes.
   c. A536 - Ductile Iron Castings.
   d. A564 - Hot-Rolled and Cold-Finished Age-Hardening Stainless and Heat Resisting Steel Bars and Shapes.
3. American Water Works Association (AWWA):
   a. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 Inch Through 144 Inch.
   c. C500 - Metal-Seated Gate Valves for Water Supply Service.
   d. C502 - Dry-Barrel Fire Hydrants.
   e. C504 - Rubber-Seated Butterfly Valves.
   f. C507 - Ball Valves, 6 Inch Through 48 Inch.
   g. C508 - Swing-Check Valves for Waterworks Service, 2 Inch through 24 Inch NPS.
   h. C509 - Resilient-Seated Gate Valves for Water Supply Service.
   i. C512 - Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   j. C517 – Resilient-Seated Cast-Iron Eccentric Plug Valves.
   k. C540 - Power-Actuating Devices for Valves and Sluice Gates.
   l. C550 - Protective Epoxy Interior Coatings for Valves and Hydrants.
   m. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   n. C606 - Grooved and Shouldered Joints.
4. National Fire Protection Association (NFPA):
   a. 1963 - Screw Threads and Gaskets, Fire Hose Connections.

1.04 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Include, but not limited to, the following:

1. Catalog data or illustrations showing principal dimensions, parts, and materials.
2. Spare parts list referenced to illustration of parts.
3. Assembly and disassembly or repair instructions.
4. Dimensions of the clearance required for butterfly valve discs.

C. Certificates and Affidavits: Furnish prior to shipment. Include the following:

1. Test certificates.
2. Affidavit of compliance with applicable AWWA Standard.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Ship all valves with suitable end covers to prevent entrance of foreign material into valve body.
B. Protect valve threads, flanges, stems, and operators from damage.
C. Ship valves 2-1/2-inch and larger to the Project Site tagged with the valve number shown on the Drawings. Tag smaller valves to show the piping system in which it is to be used.

1.06 RESPONSIBILITY:

A. Actuators, their controls, and accessories shall be the responsibility of the valve manufacturer for sizing, assembly, certification, field testing, and any adjustments necessary to operate the valve as specified.

PART 2 - PRODUCTS

2.01 MECHANICAL JOINT RESTRAINT:

A. Acceptable Manufacturers:
   1. EBAA Iron Megalug.
   2. Engineer approved equal.

2.02 THRUST BLOCKS:

A. See Standard Detail #23 for Thrust Block Detail.

2.03 DOUBLE-DISC GATE VALVES:

A. Acceptable Manufacturers:
   1. Mueller Company.
   2. Clow Valve Company.
   3. Engineer approved equal.
B. Design:
   1. Conform to AWWA C500 and as specified.
   2. Double-disc type.
   3. Non-rising stem seals shall be double O-ring type.
C. Actuators:
   1. All valves shall open counterclockwise.
   2. Provide indicators on OS&Y valves to show position of gate.
D. Testing:
   1. Testing shall be performed conforming to AWWA C500.
   2. Furnish affidavit of compliance.
E. Valve Schedule:

No.	Type	Size	Location	Installation	Valve Ends	Actuator Type	Valve Stem Position

F. Valve Accessories:
   1. Furnish rollers, tracks and scraper for valves installed with stem in horizontal position in a horizontal line.
   2. Furnish double square bottom design for valves installed with stem in horizontal position in a vertical line.

3. Furnish all valves 16-inch and larger with bypass gate valve.
4. Cleanouts.
5. Bevel or spur gears.
6. Electric motor actuators.

2.04 RESILIENT-SEATED GATE VALVES:

A. Acceptable Manufacturers:
1. Clow Valve Company.
2. Mueller Company.
3. Engineer approved equal.

B. Design:
1. Conform to AWWA C509 and as specified.
2. All stem seals shall be double O-ring type.

C. Actuators:
1. All valves shall open counterclockwise.
2. Provide indicators on OS&Y valves to show gate position.

D. Interior Coating:
1. Conform to AWWA C550.
2. Apply to all interior ferrous metal surfaces.

E. Testing:
1. Testing shall be performed conforming to AWWA C509.
2. Furnish affidavit of compliance.

F. Valve Schedule:

No.	Type	Size	Location	Installation	Valve Ends	Actuator Type	Valve Stem Position

G. Valve Accessories:
1. Post Indicator.
2. Electric Motor Actuators. Conform to AWWA C540.

2.05 BUTTERFLY VALVES:

A. Acceptable Manufacturers:
1. DeZurik, a unit of General Signal Corporation.
2. Henry Pratt Company.
3. Engineer approved equal.

B. Design:
1. Conform to AWWA C504, AWWA C540, and as specified.
2. Suitable for type of installation specified.
3. Conform to criteria indicated in Design Data and Valve Schedule Tables.
4. All valve end flanges shall conform to the following:
   a. ANSI B16.1, Class 125 for cast-iron body, Class 25A through Class 150B valves.
   b. AWWA C207, Class D with ANSI B16.1 Class 125 drilling for steel body, Class 25A through Class 150B valves.

c. ANSI B16.1, Class 125 for ductile-iron bodies.
d. AWWA C207, Class E for steel body, Class 250 valves.

5. Mechanical or push-on type rubber-gasket joint ends shall conform to AWWA C111.
6. Valves with a stop or lug cast integrally or mechanically secured to the body for the purpose of limiting disc travel will not be acceptable.
7. See Standard Detail #15 for Restrained Line Valve Installation.

C. Design Data:

			Pressure (psi)		Flow (cfs)		
No.	Size	Class	Normal	Maximum Nonshock Shutoff	Normal	Extreme Maximum Opening	Extreme Maximum Closing

D. Materials and Construction:
1. Body shall be of cast iron for Class 25A through Class 150B valves and ductile iron for Class 250 valves.
2. Shafts shall be ASTM A276 Type 304 or 316 stainless steel for Class 25A through Class 150B valves and ASTM 564 Type 630 stainless steel for Class 250 valves. Design velocity for Class 250 valves shall be 16 fps.
3. Disc shall be cast or ductile iron for Class 25A through Class 150B valves and ductile iron for Class 250 valves.
4. Seats shall be synthetic rubber and be body mounted. Provide field replaceable and adjustable seat accessible from down pressure side of valve for sizes 30-inch and larger. Mating seat surface shall be stainless steel or Monel. Sprayed or plated mating surfaces are not acceptable.
5. Shaft seals shall be designed for use of standard self-adjusting split-V-type packing or standard O-ring seals. Pull-down packing is not acceptable.

E. Actuators:
1. Manual Actuators:
a. All valves shall open counterclockwise.
b. Provide indicators to show position of disc. Provide handwheels with raised cast arrow and word OPEN on rim oriented to specified opening direction.
c. Actuators shall be oil or grease-lubricated, totally-enclosed compound lever, traveling nut type to provide characterized closure. Actuator shall be self-locking at all variable opening positions.
d. Actuators shall be totally enclosed oil or grease-lubricated worm gear type with spur gear. Actuators shall have AWWA input stops. Gear ratio shall be a minimum of 72:1 for all valves. Actuator shall be self-locking at all variable opening positions.
e. Travel limiting stop nuts or collars installed in the actuating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. Clamps or setscrews are not acceptable.
f. Actuators and handwheels shall be located in positions indicated or as otherwise determined when manufacturer's drawings are submitted.
g. Furnish actuators with AWWA operating nuts for all buried installations unless otherwise scheduled.

h. Exposed buried actuator case, supports, and connection to the valve shall be cast iron.
i. Exposed, buried service actuator shafting, bolts, and fastening hardware shall be stainless steel.
j. Hand chains shall be cadmium plated.

2. Cylinder Actuators:
   a. Provide factory mounted positioners and other accessories as specified.
   b. Provide indicators to show position of disc.
   c. Valve actuator mechanism coupled to the cylinder shall be totally enclosed. The cylinder shall be attached rigidly to the actuator mechanism and shall not pivot or rotate during operation. The cylinder piston rod shall be chromium plated 316 stainless steel and shall be enclosed.
   d. Nonmetallic cylinders and accessories as manufactured by Chicago Fluid Power Corporation and Henry Pratt Company are acceptable as preferred alternatives to the AWWA standard metal cylinders.
3. Pneumatic Diaphragm Actuators:
   a. Provide indicator to show position of disc.
   b. Yoke shall be cast iron. Diaphragm case shall be cast iron or pressed steel with fabric inserted neoprene diaphragm.
   c. Provide adjusting screw for initial spring compression, and adjustable travel indicator.
   d. Provide handwheel for emergency operation.
   e. Products of the following manufacturers shall be acceptable:
      (1) DeZurik, a unit of General Signal Corporation.
      (2) Honeywell, Inc.
      (3) Engineer approved equal.
4. Electric Motor Actuators:
   a. Provide factory-mounted electric motor actuators conforming to AWWA C540.
   b. Provide indicator to show position of disc.
   c. Furnish complete with integral motor starter push button station and L/R selector switch
   d. Products of the following manufacturers shall be acceptable:
      (1) Auma Actuators, Inc.
      (2) Limitorque Corporation.
      (3) Rotork Controls, Incorporated.
      (4) Engineer approved equal.

F. Valve Controls:
1. Operate valve actuator to perform control function required.
   a. Open or close valve.
   b. Maintain metered flow rate.
   c. Pump stop-check service with functions indicated and specified.
   d. Refer to electrical control diagrams for valve control requirements.
2. Include all pilot valves, needle valves, strainers, interconnecting piping, fittings, positioners, solenoid valves, limit switches, and other accessories essential to valve function factory-assembled on valve body or actuator.
   a. Small control valves shall be bronze or brass; and piping shall be copper.
3. Equip actuators with heavy-duty, screw type terminal strip assemblies, designed to accept ring-tongue terminals for minimum size number 14 AWG wire.

G. Testing: Furnish certified copies of results of performance, leakage, and hydrostatic tests performed in compliance with Section 5, AWWA C504.

H. Valve Schedule:

No.	Size	Location	Installation	Body Type	Valve Ends	Shaft Position

I. Actuator Schedule:

No.	Size	Location	Actuator Type

J. Shop Painting: Paint exterior surface of valves in compliance with AWWA C504 for installation as noted. Apply interior coating conforming to AWWA C550 to exposed ferrous metal surfaces. Provide affidavit or certificate of compliance per AWWA C550.

2.06 ECCENTRIC PLUG VALVES:

A. Acceptable Manufacturers:
1. DeZurik, a unit of General Signal Corporation.
2. Henry Pratt Company.
3. Milliken Valve Company, Inc.
4. Clow Valve Company.
5. Val-Matic Valve and Manufacturing Corporation.
6. Engineer approved equal.

B. Design:
1. Quarter-turn nonlubricated eccentric type with resilient faced plug. Valves with vane type seat rings are not acceptable. Shutoff up to scheduled rating with pressure in reverse direction where scheduled.
2. Flanged valve ends shall be faced and drilled to conform to ANSI B16.1, Class 125 for thickness and drilling.
3. Mechanical or push-on type rubber-gasketed joint ends shall conform to AWWA C111.
4. Screwed ends shall be to the NPT standard. Grooved ends shall conform to AWWA C606 rigid joint specifications.
5. Port areas for valves through 20-inch shall be at least 80% of full pipe area. Port areas of 24-inch and larger valves shall be at least 70% of full pipe area.
6. Plugs shall be eccentric type with no backing ring or frame.
7. Valve body cavity shall be smooth without protrusions or baffles.
8. Power actuators shall conform to AWWA C540.

C. Materials and Construction:
1. Bodies shall be of ASTM A126, Class B cast iron.
2. Valve plug shall be ASTM A126, Class B cast iron or ASTM A536 ductile iron. Resilient plug facing or replaceable style body seats shall be synthetic rubber, neoprene, or Buna N compound suitable for use with water and wastewater applications.

3. Seat rings shall be threaded or welded of corrosion-resistant 18-8 stainless steel, nickel, or Monel conforming to AWWA C504. Sprayed or plated mating seat surfaces are not acceptable.
4. Bearings shall be replaceable. Sleeve type and thrust bearings in the upper and lower journals shall be corrosion-resistant stainless steel.
5. Shaft seals shall be multiple O-ring, self-adjusting U-cup or chevron type packing conforming to AWWA C504. Pull-down packing is not acceptable.
6. Shaft seals shall be field adjustable or replaceable without valve disassembly.
7. All exposed fastening hardware shall be zinc plated or stainless steel. Provide stainless steel for buried service.

D. Actuators:
1. Manual Actuators:
   a. All valves shall open counterclockwise.
   b. Provide indicators to show position of plug.
   c. Nut operators shall be AWWA 2-inch size for operation by valve key.
   d. Worm gear actuators shall be totally enclosed, grease sealed, gear type furnished with AWWA nut, crank, handwheel, or chainwheel. All buried valves shall be provided with worm gear actuators, AWWA nut, and enclosed cover plate. All valves with reverse pressure capacity requirement shall be provided with worm gear actuators. Worm gear actuators shall be self-locking at all variable opening positions and sized to meet the torque ratings of AWWA C504. The shaft in a worm gear actuator shall have a nonmetallic or bronze sleeve type bearing. Submit manufacturer's parts and materials drawings.
   e. Handwheels shall be located in positions indicated or as otherwise determined when manufacturer's drawings are submitted.
2. Cylinder Actuators:
   a. Cylinder and accessory materials shall conform to AWWA C507. Nonmetallic cylinders and accessories as manufactured by DeZurik, Henry Pratt Company, and Chicago Fluid Power Corporation are acceptable alternatives.
   b. Provide factory mounted for positioners and other accessories as specified.
3. Provide indicators to show position of eccentric plug. Electric Motor Actuators:
   a. Provide factory-mounted electric motor actuators for open-close or throttling service to operate on 480-volt, 3-phase, 60-hertz, AC supply.
   b. An open-close actuator shall move plug from fully open to fully closed position, or reverse, in approximately 30 seconds. Modulating actuators shall have a similar rate of travel. Modulating actuators shall have hard wired communication via 4-20mA input signal and a 4-20mA output signal, internally powered. Provide indication to show position of plug for either open-close or modulating service.
   c. Furnish complete with integral motor starter, push button station, disconnect and L/R selector switch. Actuators specified for installation in hazardous environments shall not be provided with integral disconnect.
   d. Valve shall utilize limit switches for open/closed status.
   e. Actuator shall include a monitor relay for fault indications for lost phase, valve jammed and motor over temperature for a valve alarm input.
   f. Products of the following manufacturers shall be acceptable:
      (1) Auma Actuators, Inc.
      (2) Limitorque Corporation.
      (3) Rotork Controls, Incorporated.
      (4) EIM

(5) Engineer approved equal.

g. Provide the addition of a contact-less transmitter to give a 4-20mA analog signal corresponding to valve travel for remote indication when required.

h. Provide the addition of a current torque transmitter (CTT) to provide a 4-20mA analog signal corresponding to valve torque demand for remote indication when required.

E. Valve Controls:

1. Operate valve actuator to perform control function required.
2. Include all pilot valves, needle valves, strainers, interconnecting piping, fittings, positioners, solenoid valves, limit switches, and other accessories essential to valve function factory-assembled on valve body or operator.
3. Equip actuators with heavy-duty, screw type terminal strip assemblies, designed to accept ring tongue terminals for minimum size number 14 AWG wire.

F. Testing: Furnish certified copies of results of tests prior to shipment. All valves shall be subjected to an AWWA C504 procedure cycle life and pressure leak test at 150 psi and a body hydrostatic test at 300 psi. Valves shall be capable of providing drip-tight shutoff up to the full leak test rating. Certify reverse pressure capacity.

G. Valve Schedule:

No.	Size	Location	Installation	Body Type	Valve Ends	Shaft Position

H. Actuator Schedule:

No.	Size	Location	Actuator Type

I. Shop Painting: Apply interior coating conforming to AWWA C550 to exposed ferrous metal surfaces. Provide affidavit or certificate of compliance per AWWA C550.

2.07 CUSHIONED SWING CHECK VALVES:

A. Acceptable Manufacturers:

1. Dezurik-APCO
2. VAL-MATIC (Valve and Manufacturing Corporation).
3. Engineer approved equal

B. Operational Requirements:

1. Prevent reverse flow and cushioned to reduce shock or hammer.
2. Seat tightly with internal pipeline forces.
3. Cushioned with air cylinder controls in manner permitting adjustment of speed of closure.

C. Design: Conform to AWWA C508 and as specified.

1. Swing disc type with single shaft and flanged body. Flanges shall be ANSI B16.1, Class 125.
2. Cushion chamber(s) shall be mounted externally on valve body.
3. Valve disc shall have external lever and counterweight to initiate closure.
4. Suitable for 100 psi operating pressure.

D. Materials and Construction:
   1. Valve body shall be cast iron, ductile iron, or steel.
   2. Valve disc shall be cast iron, ductile iron, or stainless steel.
   3. Seats and seat ring shall be renewable. Seats shall be bronze or stainless steel. Seat rings shall be Buna-N or bronze.

2.08 STANDARD SWING CHECK VALVES:

A. Acceptable Manufacturers:
   1. Apco Willamette Valve and Primer Corporation.
   2. Val-Matic Valve & Manufacturing Corporation.
   3. Engineer approved equal.

B. Design:
   1. Conform to AWWA C508 and as specified.
   2. Iron body, bronze mounted, full opening.
   3. Extended stainless steel hinge pin with outside lever and weight.

C. Materials and Construction:
   1. Body and cover shall be cast iron. Flanges shall be ANSI B16.1, Class 125.
   2. Rubber faced discs or disc rings shall be Buna N for liquid applications and Viton for compressed air applications.

2.09 SILENT CHECK VALVES:

A. Acceptable Manufacturers:
   1. Apco Willamette Valve and Primer Corporation.
   2. GA Industries, Inc.
   3. Mueller Steam Specialty Company, Inc.
   4. Val-Matic Valve and Manufacturing Corporation.
   5. Engineer approved equal.

B. Design:
   1. Silent non-slam type with internal spring-loaded, single-piece disc.
   2. Body shall be of ductile iron or cast iron. Flanges shall be ANSI B16.1, Class 125.
   3. Valve seats assembly design shall be adequate to withstand design pressures without external backup flanges or other devices.

2.10 DOUBLE-DOOR WAFER CHECK VALVES:

A. Acceptable Manufacturers:
   1. Mueller Steam Specialty.
   2. Val-Matic Valve and Manufacturing Corporation.
   3. Valve and Primer Corporation.
   4. Engineer approved equal.

B. Operational Requirements:
   1. Internal spring on double-door hinge pin to prevent reverse flow with non-slam action.
   2. Seal tight from internal pipeline forces.

C. Design:
   1. Valve body shall be flat-faced wafer-type to fit between ANSI B16.1, Class 125 flanges.

D. Materials and Construction:
   1. Valve body shall be ductile iron or cast iron.
   2. Seats shall be Buna N for liquid applications and Viton for compressed air applications.
   3. Doors shall be directly attached to hinge pin.
   4. Hinge, spring, stop pin, and other internal trim shall be stainless steel.

5. Furnish 6-inch and larger valves with steel lifting eyebolt.

2.11 WAFER SWING CHECK VALVES:

A. Acceptable Manufacturers:
   1. Henry Pratt Company.
   2. KF Industries.
   3. Keystone Valve USA, Inc.
   4. Engineer approved equal.

B. Operational Requirements:
   1. Internal spring on single-door hinge pin to prevent reverse flow with non-slam action.
   2. Seal tight from internal pipeline forces.

C. Design:
   1. Valve body shall be flat-faced wafer type to fit between ANSI B16.1, Class 125 flanges.

D. Materials and Construction:
   1. Seat shall be Buna N for liquid applications and Viton for compressed air applications.
   2. Door, hinge, spring, and other internal trim shall be stainless steel.
   3. Furnish 6-inch and larger valves with steel lifting eyebolt.

2.12 BALL CHECK VALVES:

A. Acceptable Manufacturers:
   1. Flomatic Valve Division, the Danfoss Group, Type 408.
   2. Flygt Corporation, Type HDL.
   3. Engineer approved equal.

B. Design:
   1. Clog-proof design with ball check for viscous liquids or solids applications.
   2. Seal tight from internal pipeline forces.

C. Materials and Construction:
   1. Flanged iron body with internal rubber-covered metal ball. Flanges shall be ANSI B16.1, Class 125.
   2. Top cover to provide access to inside of valve without removal of the valve from the line.
   3. Ball shall be of sufficient weight to sink in liquid under a non-flow condition.

2.13 BALL VALVES:

A. Acceptable Manufacturers:
   1. Apco Willamette Valve and Primer Corporation.
   2. Henry Pratt Company.
   3. Engineer approved equal.

B. Design: Conform to AWWA C507, AWWA C540 and as specified.
   1. Valves shall consist of essentially three main parts:
      a. Body with full unrestricted circular inlet and outlet with diameter equal to rated size of valve.
      b. A moveable plug having a full, unobstructed circular waterway opening equal to valve body opening.
      c. A totally enclosed operating mechanism mounted on and attached to valve body.
   2. Seats shall consist of flexible metal on the ball or resilient rubber on the body and rigid stainless-steel seats opposite and located on both ends of valve.
   3. Shaft seals shall be self-adjusting split-V-type or rubber O-ring type designed for replacement under line pressure.
   4. Valve body shall have flanged ends. Flanges shall be ANSI B16.1, Class 125.

C. Valve Operating Mechanism:
   1. Valve shall be equipped with a traveling cross-head type operator and shall operate plug by means of a cross-head linked to a rotator lever.
   2. Rotator lever shall impart rotary motion to plug shaft.
   3. Provide an indicator to show position of plug with respect to body opening.

D. Actuators:
   1. Manual Actuators:
      a. Valve shall open counterclockwise.
      b. Provide non-rising stem mechanism self-locking in all positions.
      c. Provide gear actuator as required to limit maximum operating torque at pressure differential equal to working pressure specified.
         (1) Totally enclose all gearing.
         (2) Attach operating nut or handwheel with shear pins designed to protect mechanism from excessive torque.
   2. Cylinder Actuators:
      a. Provide factory mounting for positioners, solenoid valves and other accessories as required.
      b. Provide indicators to show position of ball.
      c. Cylinders shall be double-acting and designed to prevent drifting throughout stroke. Materials shall conform to AWWA C507. Nonmetallic cylinders and accessories as manufactured by Chicago Fluid Power Corporation and Henry Pratt Company are acceptable alternatives.
   3. Air/Oil cylinder Actuators:
      a. Provide factory-mounted, air-operated oil-opposed cylinders for open-close service.
      b. Cylinder shall be capable of operating valve under all conditions when supply air pressure varies from 60 to 100 psi.
      c. Provide factory-mounted limit switches, solenoid valves, and other accessories as required.
      d. Provide indicators to show position of ball.
      e. Cylinder shall be double-acting and designed to prevent drifting throughout stroke. Air and oil cylinders shall be the same diameter. Materials shall confirm to AWWA C507. Nonmetallic cylinders and accessories as manufactured by Chicago Fluid Power Corporation and Henry Pratt Company are acceptable alternatives.
      f. Provide translucent oil reservoir with a minimum capacity of 16 ounces for oil cylinder.
   4. Electric Motor Actuators:
      a. Actuator shall move plug from fully open to fully closed position or the reverse in not less than 120 seconds at normal speed.
      b. Furnish auxiliary handwheel for manual operation.
      c. Furnish complete with integral motor starter (push button station and L/R selector switch).
      d. Products of the following manufacturers shall be acceptable:
         (1) Auma Actuators, Inc.
         (2) Limitorque Corporation.
         (3) Rotork Controls, Incorporated.
         (4) Engineer approved equal.

E. Valve Controls:
   1. Operate valve actuator to perform control function required.
      a. Open or close valve.

b. Maintain metered flow rate.
c. Pump stop-check service with functions indicated and specified:
d. Refer to electrical control diagram for valve control requirements.

2. Include all pilot valves, needle valves, strainers, interconnecting piping, fittings, positioners, solenoid valves, limit switches, and other accessories essential to valve function factory assembled on valve body or operator.
   a. Small control valves shall be bronze or brass; piping shall be copper.
3. Equip actuators with heavy-duty, screw type terminal strip assemblies, designed to accept ring tongue terminals for minimum size number 14 AWG wire.

F. Testing: Furnish certified copies of results of tests performed in compliance with Section 13, AWWA C507.

G. Shop Painting: Apply interior epoxy coating conforming to AWWA C550 and NSF to exposed ferrous metal surfaces. Provide affidavit or certificate of compliance per AWWA C550 and NSF.

2.14 CONE VALVES:

A. Acceptable Manufacturers:
1. Apco Willamette Valve and Primer Corporation.
2. Henry Pratt Company.
3. Rodney Hunt Company.
4. Engineer approved equal.

B. Design:
1. Valve shall consist essentially of three main parts:
   a. Body with full unrestricted circular inlet and outlet with diameter equal to rated size of valve.
   b. A movable conical plug having a full unobstructed circular waterway opening equal to valve body opening.
   c. A totally enclosed operating mechanism mounted on and attached to the valve body.
2. Valve shall have monel seats fused to body around inlet and outlet bore. Plug shall be provided with two pair of monel seat rings fused into plug material; one pair to mate with body seats in open position. Seats shall be externally adjustable.
3. Valve body shall have flanged ends. Flanges shall be ANSI B16.1, Class 125.
   a. Pump side - ANSI B16.1, Class 125.
   b. System side - ANSI B16.1, Class 125.
4. Power actuators shall conform to AWWA C540.

C. Materials and Construction:
1. Furnish valve complete with operating mechanism and accessories suitable for accomplishing specified operation.

D. Valve Operating Mechanism:
1. Operating mechanism shall be a self-contained unit readily removable from valve body.
2. Operation of valve shall employ an axial motion to lift plug from seat, a rotary motion to open plug, and an axial motion to resist plug.
3. Mechanism shall consist of a lifter lever to perform seating and unseating, a rotation lever attached to plug shaft, and a linkage to connect these to a cross-head operating on guide rods.
4. Provide an indicator showing position of plug with respect to body opening.

E. Actuator:
1. Manual Actuators:

a. Valve shall open counterclockwise.
b. Provide non-rising stem mechanism self-locking in all positions.
c. Provide gear actuator as required to limit maximum operating torque to 60 foot-pounds at pressure differential equal to working pressure specified.
(1) Totally enclose all gearing.
(2) Attach operating nut or handwheel with shear pins designed to protect mechanism from excessive torque.

2. Cylinder Actuators:
a. Provide mounting provisions for positioners, solenoid valves, and other accessories as required.
b. Provide indicators to show position of plug.
c. Cylinders shall be double-acting and designed to prevent drifting throughout stroke. Materials shall conform to AWWA C507. Nonmetallic cylinders and accessories as manufactured by Chicago Fluid Power Corporation and Henry Pratt Company are acceptable alternatives.

3. Air/Oil Cylinder Actuators:
a. Provide factory-mounted, air-operated oil-opposed cylinders for open-close service.
b. Cylinder shall be capable of operating valve under all conditions when supply air pressure varies from 60 to 100 psi.
c. Provide factory-mounted limit switches, solenoid valves, and other accessories as required.
d. Provide indicators to show position of ball.
e. Cylinder shall be double-acting and designed to prevent drifting throughout stroke. Air and oil cylinders shall be the same diameter. Materials shall confirm to AWWA C507. Nonmetallic cylinders and accessories as manufactured by Chicago Fluid Power Corporation and Henry Pratt Company are acceptable alternatives.
f. Provide translucent oil reservoir with a minimum capacity of 16 ounces for oil cylinder.

4. Electric Motor Actuators:
a. Furnish auxiliary handwheel for manual operation.
b. Products of the following manufacturers shall be acceptable:
(1) Auma Actuators, Inc.
(2) Limitorque Corporation.
(3) Rotork Controls, Incorporated.
(4) Engineer approved equal.

F. Valve Controls:
1. Operate valve actuator to perform control function required.
a. Open or close valve.
b. Maintain metered flow rate.
c. Pump stop-check service with functions indicated and specified.
d. Refer to electrical diagrams for valve control requirements.

2. Include all pilot valves, needle valves, strainers, interconnecting piping, fittings, positioners, solenoid valves, limit switches, and other accessories essential to valve function factory assembled on valve body or actuator.
a. Small control valves shall be bronze or brass; piping shall be copper.

3. Equip actuators with heavy-duty, screw type terminal strip assemblies, designed to accept ring tongue terminals for minimum size number 14 AWG wire.

G. Testing:

1. Factory operate valves a minimum of three times from the fully open to closed position under no-flow conditions to demonstrate that the operating mechanism and plug are not binding or vibrating during any position of travel.
2. Perform hydrostatic tests on valves with plug in partially open position and test heads bolted to each waterway flange. Apply 400-psi internal water pressure for 60 minutes with no evidence of structural failure, seeps, or leakage at any point.
3. Perform leakage tests on valves with plug in closed position and one waterway test flange removed. Apply 200-psi water pressure between test flange and plug for 60 minutes with no evidence of seeps or leakage through valve. Reverse test flange and repeat test from opposite side.
4. Furnish certified copies of the reports covering these tests.

H. Shop Painting: Apply interior coating conforming to AWWA C550 to exposed ferrous metal surfaces. Provide affidavit or certificate of compliance per AWWA C550.

2.15 AUTOMATIC PISTON (DIAPHRAGM) VALVES:

A. Acceptable Manufacturers:
1. Cla-Val Company.
2. GA Industries, Inc.
3. Ross Valve Manufacturing Company.
4. Singer Valve.
5. Watts Automatic Control Valve Company.
6. Engineer approved equal.

B. Operational Requirements:
1. Cushioned to permit operation without causing shock or water hammer.
2. Operate without continuous waste of water.
3. Provide tight closure when shut and full pipe line opening when open.

C. Design:
1. Valves shall be of flanged globe or angle body pattern.
2. Inlet flange or pump side flange shall be ANSI B16.1, Class 125 outlet flange or system side flange) shall be ANSI B16.1, Class 125.
3. Valves shall be external pilot actuated.
4. Provide indicator rod to show position of opening of the piston or diaphragm.
5. Such that internal main valve assembly can be dismantled without removing valve body from pipeline.
6. Provide shutoff cocks and Y-strainers on control tubing.

D. Materials and Construction:
1. Body shall be cast iron, ductile iron, or stainless steel.
2. Trim shall be bronze or stainless steel.
3. Seats shall be leather or other resilient material and shall be replaceable.

E. Valve Controls:
1. Control Function:
a. Pressure regulation - maintain preadjusted downstream pressure for varying rates of flow and upstream pressure.
b. Back pressure regulation and check valve - maintain preadjusted upstream pressure for varying rates of flow and prevent reverse flow if upstream pressure drops below that downstream.
c. Pump stop-check - open when pump reaches preset discharge pressure, close with normal pump shut down, close in event of power loss, capable of manual control.
d. Open when line pressure exceeds preset value.

e. Open at abnormal or subnormal pressure to prevent any surge.
f. Open upon pump failure or emergency stop to prevent any surge.
g. Flow regulation - maintain preadjusted downstream flow for varying rates of upstream and downstream pressures. Valve pilot control to be actuated by the differential pressure produced across an integral or separate orifice plate.

2. Include all pilot valves, needle valves, strainers, interconnecting piping, fittings, cylinders, positioners, solenoid valves, limit switches, and other accessories essential to valve function factory assembled on valve body.
   a. Small control valves shall be bronze or brass; piping shall be copper.
   b. Provide orifice plate assembly for flow control function.

F. Testing:
1. Factory test valves at a hydrostatic pressure of not less than 300 psi and check leakage across the valves at a pressure of not less than 150 psi.
2. Submit copies of all test results.

G. Valve Schedule:

2.16 ALTITUDE VALVE:

A. Acceptable Manufacturers:
1. Cla-Val Company.
2. GA Industries, Inc.
3. Ross Valve Manufacturing Company.
4. Singer Valve.
5. Watts Automatic Control Valve Company.
6. Engineer approved equal.

B. Design:
1. Internal components shall be designed such that there are no metal- to-metal contacts.
2. Valve shall be designed to prevent water hammer and include needle valve for adjusting closing speed.
3. Closure shall be regulated by a 3-way pilot valve.
4. Valve shall provide indicator to show degree of opening at all times.

C. Valve Controls:
1. Include all pilot valves, needle valves, strainers, interconnecting piping, fittings, cylinders, positioners, solenoid valves, limit switches, and other accessories essential to valve function factory assembled on valve body.
   a. Small control valves shall be bronze or brass; piping shall be copper.

D. Testing:
1. Factory test valves at a hydrostatic pressure of not less than 300 psi and check leakage across the valves at a pressure of not less than 150 psi. Set valves to operate at the pressures specified previously.
2. Submit copies of all test results.

2.17 AIR VALVES:

A. Acceptable Manufacturers:
1. Apco Williamette Valve and Primer Corporation.
2. Crispin Valves, Multiplex Manufacturing Company.
3. GA Industries, Inc.
4. Val-Matic Valve and Manufacturing Corporation.
5. Engineer approved equal.

B. Design: Conform to AWWA C512 and as specified.

1. Valve shall be heavy-duty combination air release style.
2. Body and cover shall be cast or ductile iron.
3. Float shall be stainless steel.
4. All internal parts shall be stainless steel.

C. Operation:
1. Release air when filling line.
2. Admit air when emptying line.
3. Release accumulated air while pipeline is full and operating under pressure.

D. Connection:
1. Connect air valves 2 inches and smaller to pipeline through corporation stops.
2. Connect air valves 3 inches and larger through tapped bosses or flanged outlets.
3. Connecting fittings and pipe shall be bronze, brass, or copper rated for 150 psi service.
4. Isolation valves shall be provided for all air valves and shall be bronze gate valves, Crane No. 424 or Engineer-approved equal for sizes 3 inches and smaller unless otherwise noted. Isolation valves 4 inches and larger shall be flanged AWWA C504 butterfly valves.
5. Couplings or unions indicated between pipeline and air valve piping shall be insulated style.
6. See Standard Detail #1 for Air Release Valve Manhole Detail.

E. Valve Schedule:

2.18 AIR/VACUUM VALVES:

A. Acceptable Manufacturers:
1. Apco Willamette Valve and Primer Corporation.
2. Crispin Valves, Multiplex Manufacturing Company.
3. G.A. Industries, Inc.
4. Val-Matic Valve and Manufacturing
5. A.R.I. USA, Inc.
6. Engineer approved equal.

B. Materials:
1. The valve body and cover shall be constructed for ASTM A126 Class B cast iron. The orifice, float and linkage mechanism shall be constructed of Type 316 stainless steel. Connecting parts in the pit or manhole shall be of Type 316 Stainless steel. Non-metallic floats or linkage mechanisms are not acceptable. The orifice button shall be Buna-N.
2. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The CONTRACTOR may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

C. Equipment:
1. Each air valve shall be furnished and shall consist of an inlet shut-off valve. Accessory valves shall be quarter-turn, full ported bronze ball valves. The well service air valves shall be furnished with throttling valves mounded on the top of the main valve to control the rate of air release.
2. Optional body materials include ASTM A536 Grade 65-45-12 ductile iron, ASTM A351 Grade CF8M stainless steel, and ASTM B584 Alloy C83600 cast bronze. Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550 when specified.

D. Coatings:

1. Each valve body interior surface shall be coated using fusion bonded epoxy coating system.
2. Connect air valves 3 inches and larger through tapped bosses or flanged outlets.
3. Connecting fittings and pipe shall be bronze, brass, or copper rated for 150 psi service.
4. Isolation valves shall be provided for all pump air/vacuum valves and shall be bronze gate valve, Crane No. 424 or Engineer-approved equal for sizes 3 inches and smaller unless otherwise noted. Isolation valves 4 inches and larger shall be flanged AWWA C504 butterfly valves.
5. Couplings or unions indicated between pipeline and air valve piping shall be insulated style.

2.19 FIRE HYDRANTS:

A. Acceptable Manufacturers:
1. Clow Valve Company.
2. Mueller Company, model Centurion.
3. WaterMaster 5CD250, EJ Group
4. Engineer approved equal.

B. Design:
1. Conform to AWWA C502 and as specified.
2. Provide compression type main valve designed to open against pressure. Valve facings shall be of nontoxic materials suitable for potable water service.
3. Provide internal main valve seat opening of not less than 5 inches diameter.
4. Design to open counterclockwise.
5. Provide dry-type bonnet with lubricant reservoir protected by O- or Quad-ring seals.
6. Provide mechanical joint bell on shoe.
7. Furnish for minimum bury depth of 4 feet. Include extensions as required for blow-offs.
8. Furnish with two 2-1/2-inch hose nozzles and one 4-1/2-inch pumper nozzle with NFPA 1963 standard threads. Nozzle caps shall be chained to hydrant.
9. Provide traffic break-off joint located above and near ground surface designed to minimize accident repairs.
10. See Standard Detail #5 for Fire Hydrant with Isolation Valve Detail.
11. See Standard Detail #6 for Fire Hydrant with Isolation Valve for Deep Mains Detail.

C. Shop Painting:
1. Shop paint exterior of hydrants safety yellow.
2. Interior Coating:
   a. Conform to AWWA C550.
   b. Apply to exposed interior ferrous metal surfaces.

2.20 CORPORATION STOPS:

A. Provide corporation stops as specified to isolate air valves or as manual air release or inlet valves.

B. Mueller Company Style H-10003, H-10013, or H-10045 or Engineer-approved equal as applicable.

2.21 FLOOR STANDS:

A. Provide cast-iron floor stands where indicated.
1. Base shall be suitable for bolting to supporting structure.
2. Equip with bronze shaft bearing.
3. Equip with an indicating device.

B. Provide extension shafts where required.

1. Include bronze-bushed, cast-iron shaft guides adjustable in two directions.

2.22 VALVE BOXES:

A. Acceptable Manufacturers:
   1. Clay and Bailey Manufacturing Company.
   2. Dresser Industries, Inc.
   3. Mueller Company.
   4. Neenah Foundry Company.
   5. Tyler Company.
   6. Engineer approved equal.

B. Provide for all buried valves.
   1. Provide extension stem to bring operating nut within 2 feet of valve box top.
   2. Drop cover shall be marked "WATER" or "SEWER" for the appropriate system.

C. Prepare surfaces and paint or coat all valves, fire hydrants, floor stands, valve boxes, corporation stops, and all related accessories standard of the manufacturer unless otherwise specified herein.

D. Paint and coatings shall be suitable for the service intended.

E. Submit type of paint or coating proposed with drawings and data for Engineer approval prior to fabrication.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Comply with provisions of AWWA C600 and as specified.

B. Thoroughly clean and remove all shipping materials prior to setting. Operate all valves from fully opened to totally closed.

C. Install eccentric plug valves in reverse position, flow and pressure against the plug face when closed, in lines with solids or stringy materials. When installed horizontally with shaft in the horizontal, the plug shall rotate open to the top recess of the valve body.

D. Install double-door wafer check valves with hinge pin in the vertical position for horizontal flow applications.

E. Install single-door wafer swing check valves with hinge pin in the horizontal position for horizontal flow applications.

F. Equip with anchorage where indicated.

G. Set fire hydrants with lowest nozzle 18 inches above finished grade. Check and fill stem bonnet lubricant reservoir.

3.02 FIELD TESTING:

A. Perform on piping and valves for the following:
   1. Gate valves.
   2. Butterfly valves.
   3. Eccentric plug valves.
   4. Check valves.
   5. Ball valves.
   6. Cone valves.
   7. Automatic piston valves.
   8. Altitude valves.
   9. Air and air/vacuum valves.
   10. Fire hydrants.

B. Automatic Piston Valves, Altitude Valves, and Non-manual Valves:
   1. Furnish services of manufacturer's engineer to perform field tests to determine that the valve will operate as specified and to make any adjustments required to improve operation of the valves.
   2. Furnish all instruments required to record pressure during tests when any combination of high-service pumps are started or stopped to simulate possible occurrences under actual operating conditions. Instruments will remain property of the manufacturer.
   3. Field tests shall be witnessed by Engineer.

END OF SECTION 331216

This page was intentionally left blank.

SECTION 331223 – SUBMERSIBLE LIFT STATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Provide all labor, equipment, and materials as required to construct and place into operation submersible pump lift stations as specified herein.

B. Related Work Specified Elsewhere:

1. Section 312050 – Site Preparation and Earthwork.
2. Section 331100 – Pressure Pipe.
3. Section 331216 – Utility Valves and Accessories.
4. Section 333900 – Utility Structures.

1.03 REFERENCE STANDARDS:

A. Lift station shall be in conformance with the applicable provisions of the following standards which establish the minimum level of quality required. Exceptions to the following standards have been made throughout these Specifications. When an exception to a standard is specified, the Specifications shall govern.

B. Applicable Standards:

1. American Society for Testing and Materials (ASTM).
2. American National Standard Institute (ANSI).
3. American Society of Mechanical Engineers (ASME).
4. National Electrical Code (NEC).
5. National Electrical Manufacturers' Association (NEMA).
6. American Bearing Manufacturer's Association (ABMA).
7. American Welding Society (AWS).
8. American Water Works Association (AWWA).
9. Standards of the Hydraulic Institute (HI).
10. Society for Protective Coatings (SSPC).

1.04 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Submittals shall include, but are not limited to, the following:

1. Complete dimensional drawing of pump and control panel.
2. Detailed cross-section of pump, seals, and motor indicating materials of construction.
3. Performance curves for each pump. Curves shall cover range from shutoff to at least 150% of design flow rate at the conditions specified, and shall be submitted for the following parameters as a function of capacity at design temperature:
   a. Total dynamic head.
   b. Efficiency.
   c. Required brake horsepower.
4. Provide the rated motor horsepower.
5. Detailed layout drawing of control panel. Show all terminal blocks.
6. Product data on all electrical and control components defining functional requirements and construction.
7. Complete installation, operating, and maintenance instruction books.
8. Certificates of completion of factory tests.

9. Three (3) hard copy sets of O & M Manuals.

1.05 QUALITY ASSURANCE:

A. Acceptable Manufacturers:
   1. Flygt Corporation.
   2. Gorman-Rupp Company.
   3. Ebara Pumps
   4. Engineer-approved equal.

B. Factory Tests and Reports:
   1. Include all manufacturer's standard factory tests on equipment and materials.
   2. All pumps shall be tested as follows:
      a. For dynamic and static balance.
      b. For normal functioning in conformance with the "Standards of the Hydraulic Institute."

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Delivery, storage, and handling shall conform to the following requirements:
   1. After completion of factory tests, ready pumps for operation such that no field disassembly, cleaning, or flushing is required. The pumps will not be flushed in the field prior to start-up.
   2. Ship equipment as completely assembled as possible.
   3. Tag each individual item of equipment with the pump designation indicated on the Drawings.
   4. Flanged connections shall be sealed with 1/2-inch thick plywood covers bolted to the flange with not less than four bolts.
   5. Crate electrical and control equipment to prevent damage during shipment and on-site storage.
   6. Any components removed for shipment shall be match-marked prior to removal.

PART 2 - PRODUCTS

2.01 GENERAL:

A. More than one pump is required for any flows over 1,500 gallons per day.
B. Lift station shall include two or more electrically driven submersible pumps, pump mounting plates with discharge, elbows, pump rail guides and rail guide supports, access frame with cover, pump lifting chain with hooks, wiring channel, NEMA 4 weatherproof control box with valves, and reinforced concrete sump basin.
C. Fencing is required.
D. Pump stations must be accessible by authorized personnel from a public right-of-way at all times.
E. Pump stations shall be at least fifty feet (50') in a horizontal direction from any existing or proposed public water supply well or other water supply sources or structures.
F. Flood protection will be required for facilities within the 100-year floodplain. Protections shall include structures, electrical equipment, and mechanical equipment.
G. Design Requirements will be determined by the Engineer of Record. The following requirements at a minimum shall be established for each pump and provided to the City for review and approval prior to ordering of any equipment. The City will review all submittals in a timely manner.

2.02 PUMPS:

A. Pumps shall be totally sealed submersible electrically operated pumps capable of handling screened sewage and miscellaneous plant drains containing solids.

B. Performance Requirements:
   1. Capacity (gpm): [_____].
   2. Total Dynamic Head (ft.): [_____].
   3. Maximum Speed (rpm): [1,750] [3,600].
   4. Maximum Solid: 3 inches.
   5. Brake horsepower of motors furnished shall not be exceeded at any point on the head capacity performance curves.

C. Materials and Construction:
   1. Motor housing and pump casing shall be constructed of cast iron.
   2. Impeller:
      a. Nonclog, open type.
      b. Impeller shall be ceramic coated (if available) iron construction. If not available, bronze or nylon-coated is acceptable.
      c. Hydraulically and dynamically balanced.
      d. Impeller shall be keyed to shaft by a self-locking device, not screwed or pinned to the motor pump shaft.
   3. Cutter assembly: Shall be stainless steel.
   4. Shaft:
      a. Constructed of 303 stainless steel.
      b. Shall be of sufficient size to handle vibratory forces that occur when impeller passes solids.
   5. All required bearings shall be designed for a bearing life of 5 years minimum.
   6. All external fasteners shall be of 18-8 stainless steel.
   7. The pump discharge shall be fitted with either a diaphragm-type sealing flange or a machined metal-to-metal type sealing flange.
      a. Flange shall be connected to the discharge piping and anchored to the floor of the sump.
      b. Flange shall be designed to receive the pump connection without need of bolts or accessing the sump.
   8. Pump and motor assembly, including discharge elbow, shall be coated with two 8-mil dry film thickness coats of coal-tar epoxy.
   9. Additional nameplates shall come with each pump. The nameplates shall be identical to the ones that are attached to the pumps.
   10. Each pump shall be identified with metal nameplate including:
      a. Manufacturer.
      b. Type of unit and model number.
      c. Serial number.
      d. Rated capacity, discharge head, horsepower, voltage, and other pertinent information.

2.03 PUMP BASINS AND ACCESSORIES:

A. Concrete Basin:
   1. Each basin shall contain all pumps and other equipment as specified.
   2. The wet well basin should be designed for 2 hours of retention at peak hourly flow for design flows greater than 100,000 GPD and 4 hours of retention at peak hourly flow for design flows less than 100,000 GPD for emergency storage.

B. Pump Mounting Bases and Discharge Piping:

1. Pipe shall be Schedule 80, ASTM A53, Grade B electric-resistant welded carbon steel or Class 53 cement mortar lined ductile iron.
2. Separate mounting assemblies shall be furnished for each pump. Mounting assemblies shall include specially designed discharge elbow. Discharge elbow shall have a mounting shoe designed to be anchored to sump floor and support the pump assembly. Discharge elbow shall have a sliding quick disconnect flange designed to provide a bubble tight seal to the pump discharge without the need to access the connection allowing pump removal by vertically raising pump from the top of the sump. Discharge elbow shall discharge vertically and have a discharge flange designed to connect to an ANSI 150-pound flanged discharge pipe.
3. Provide all necessary nuts, bolts, and gaskets required for making up flanged connections.
4. Guide rail assembly shall be adjustable and run from the mounting assembly on the sump floor to the access door on the top of the sump. It shall be designed to support and guide the pump allowing removal of pump without entering the sump. Provide with all required hardware to firmly attach pump to rail assembly and rail assembly to concrete sump. Rail guides shall be fastened to pump so that all lifting loads will be applied to guide supports and not to the pump or motor housing. A lifting chain and hook shall be provided for each pump.
5. Materials of construction.
    a. Guide rail and slide assembly: Stainless steel minimum of schedule 20 2-inch pipe. Over 50 Hp, the guide rails shall be a minimum of 3-inch schedule 40 stainless steel pipe. At no time shall these specifications override the actual size of the guide rails required to support the pumps and the installation / removal of the pumps.
    b. Mounting shoe, plates, and hardware: Cast iron on carbon steel.
    c. Any hardware used in the wet well used for mounting of the guide rails or anything else that is above normal wet well level shall be of stainless steel.
6. Coat all non-stainless-steel pump mounting plates, guide rails, discharge piping, mounting hardware, valves, and related items with at least two 8-mil dry film thickness coats of coal-tar epoxy.

C. Valves: Furnish discharge gate and check valve. Locate gate valve operator so it can be operated by opening the access door and without entering the sump.
1. Valves shall be located in a separate valve chamber.
2. The valve chamber shall have a minimum access hatch of 24 inches by 26 inches.
3. Dry wells, including their superstructure, shall be completely separated from the wet well with gas tight common walls.

D. Access Frame and Door:
1. Provide separate access for each pump.
2. Constructed of steel or aluminum.
3. Frame shall have attached upper guide rail brackets, chain hook and level sensor wiring channel.
4. Cover shall be provided with lifting handle and safety latch to hold cover in the open position.
5. Steel portions of access frame and door assembly shall be coated inside and outside with coal-tar epoxy coating.

2.04 EMERGENCY POWER AND CONNECTIONS:

A. All lift stations shall have for backup power supply, generators sufficiently sized to operate all the pumps in the station running at the same time, with power in reserve. Depending upon the size of the generator required and the location, they shall be fueled by natural gas if within 200 feet proximity to a natural gas. Otherwise, the generator shall be fueled by diesel as approved by

the City.

B. Emergency pump connections shall be installed.

2.05 CONTROLS:

A. The Engineer shall submit the items following as part of the design for City approval.

B. Operating Conditions:
   1. Depth of lift stations: As indicated.
   2. Fluids: As specified this Section.
   3. Control voltage: 120Vac, 60 hertz.

C. Elevation and Function:
   1. [_____] - Start lag pump.
   2. [_____] - Start lead pump.
   3. [_____] - Stop all pumps.
   4. [_____] - Low level cutoff switch.

D. Level Sensors:
   1. Magnetrol T10, Roto Float or approved equal.
   2. Provide a weight attached to cord above float switches to hold switches in place in sump.
   3. Design float switches to hang from wiring channel.
   4. Provide one wiring channel with bolting type mounting brackets to accommodate level sensors and pump motor leads as defined above.
   5. Provide terminal blocks in the control panel for terminating all level sensors.
   6. Provide 20 feet of type 50 W-A, UL-listed hard service cord for each level sensor. Cord shall be attached and sealed at the level sensor.

E. Wiring Channel:
   1. Wiring channel shall provide cord grip holders for the pump cords and the float switch cords.
   2. There shall be easy adjustment of float switch cords to permit level setpoint changes. All cords must be continuous without splices from control panel to pumps and float switches.
   3. Wiring channel shall mount on supports fastened to access frame.

2.06 ELECTRICAL EQUIPMENT:

A. Electric Motors:
   1. Design Details:
      a. General Design:
         (1) Rated 460V, 3 phase, 60 hertz.
         (2) Service factor of 1.15.
         (3) Motors shall be of submersible design and capable of operating totally submerged in liquid.
         (4) Designed for Class 1, Groups C and D, Division 1 hazardous location as defined by the National Electrical Code.
         (5) Motors shall be listed with Underwriters Laboratories as Class 1, Groups C and D, Division 1, explosion proof.
         (6) Insulation shall be Class B or Class F, with Class B temperature rise in accordance with NEMA MG-1-12-42.
         (7) Motors shall be designed for full-voltage starting.
         (8) All motors shall have squirrel-cage rotors.
         (9) Motor shall be designed to operate continuously with only 2/3 of the motor submerged for cooling.
         (10) The nameplate horsepower rating of each motor at 1 service factor shall equal or exceed the horsepower required to drive the pump at 120% of the design conditions specified and within normal operating ranges. For each motor

furnished, the nameplate horsepower rating multiplied by the service factor shall equal or exceed the horsepower required to drive the pump under any condition the pump is capable of operating.

b. Enclosure:
   (1) Motor shall be housed in an air-filled cast-iron, watertight enclosure.
   (2) Enclosure shall be sealed by use of O-rings and shall have rabbet joints with large overlap.
   (3) Cable leads through enclosure shall be epoxy sealed with Buna-N grommets.
   (4) Lifting eyes shall be cast into the motor enclosure and be of sufficient strength to lift the entire pump-motor unit.
c. Shaft: Shall be vertical, solid, two-piece construction.
d. Bearings:
   (1) Bearings shall be prelubricated at the factory and designed for an ABMA L-10 rating life of not less than 40,000 hours at rated speed.
   (2) Shaft extension bearings shall be locked to prevent axial shaft movement and to withstand high thrust loads.
e. Mechanical Seals:
   (1) Tandem mechanical seals with oil chamber between seals shall be used to provide increased protection from moisture contamination of electrical components.
   (2) Upper seals shall be carbon/silicon carbide.
   (3) Lower seal faces shall be tungsten carbide/silicon carbide.
   (4) Metal parts shall be 302 stainless steel.
   (5) A watertight seal and separate strain relief shall be provided for all pump electrical flexible cables.
f. Lead Cables:
   (1) Power and control cables shall be Type SOW-A, UL-listed hard service cord.
   (2) Cables shall be covered by a neoprene jacket.
   (3) Furnish a minimum 30-foot length per pump.
g. Moisture Protection:
   (1) Provide two moisture-sensing probes in the oil-filled chamber between the mechanical seals to detect the influx of any conductive fluid past the outer seal.
   (2) Probes to provide sufficiently early warning of outer seal failure to fully protect all electrical components.
   (3) Wire probes to control panel common trouble alarm to annunciate moisture detection.
h. Thermal Protection:
   (1) Install thermostats in adjacent phases of the motor winding to provide thermal overload protection.
   (2) Thermostats shall be of the automatic reset, normally closed type.
   (3) Thermostats shall be wired into the motor control circuit at the control panel.

B. Electrical Control Panels:
   1. Control equipment shall be mounted in a dead front NEMA 4R enclosure supplied with separate removable inside panel to protect electrical equipment.
   2. Lock hasp shall be provided on the outside door.
   3. Stand shall be provided to mount panel on top of basin.
   4. Circuit breakers shall be provided for each pump.
   5. Provide ground fault equipment protection for each pump.
   6. Magnetic, full-voltage, nonreversing motor starters with three thermal overload relays

(one per phase) suitable for 460V, 3-phase, 60-hertz operation shall be provided. Starters shall have auxiliary contacts to operate both pumps on override condition.

7. An interlock relay shall be provided to automatically reconnect the control circuit in case of circuit breaker trip on one pump.
8. Provide a common dry contact to alarm on failure of pumps to start on level control actuation.
9. Terminal strip shall be provided for connecting pump and control wires with additional terminals provided for alarm.
10. Include 115V transformer for equipment control.
11. Include 110V power receptacle inside any control panels located outdoors.
12. Provide ground fault circuit interruption (GCFI) protection for all outdoor receptacles.
13. Provide alternator to provide alternate switching of pump motors as specified.
14. Provide a 60-watt, 120Vac heating element with thermostat designed to maintain temperature within control panel at 40ºF.
15. Panel shall be mounted with bottom located a minimum of 3 ft.-0 inches above top of basin.
16. If pumping conditions permit:
    a. Variable frequency drives (VFDs) with programmable logic control (PLC) and human machine interface (HMI) control shall be installed and used for wet well level control and pump control.
    b. Either pressure transducers or ultra-sonic measurement shall be used for level control and speed control of VFDs.
17. If installed with VFD/PLC, the ability to switch standard mercury switch floats by manipulation of a two-position switch shall be included.

C. Disconnect Switch:
1. NEMA 4 construction.
2. Mounted to control panel rack.
3. Adequately sized to interrupt power feeder to lift station.
4. Rated for 460V, 3-phase, 60-hertz operation.
5. Must contain a fuse.

D. Control Switches:
1. Shall be Manual-Stop-Auto.
2. Shall be mounted on the front of the control panel.
3. Provide one for each pump with green (stop) and red (running) lights, and white phenolic name tags with black letters.

E. Electromagnetic Flow Meters:
1. Shall be provided on discharge force main.
2. Acceptable manufacturers:
    a. Siemens.
    b. Krohne.
    c. Toshiba.
    d. Engineer-approved equal.

F. Alarm Systems
1. All lift stations shall have local alarms that include visual and audible alarms.
    a. The alarm system must have an uninterrupted power source.
2. All lift stations shall have telemetry cellular dialing systems.
    a. Cellular dialing systems shall be OmniSite brand cellular radio supported by GUARDDOG.
    b. Approved Models shall be Crystal Ball. No substitutions are allowed unless otherwise approved by the City.

3. Alarms shall be included for all of the following:
    a. Loss of power
    b. High wet well
    c. Pump failure
    d. Phase failure
    e. Generator failure
    f. Low fuel
    g. Seal failure
    h. Motor/pump high temperature
    i. Unauthorized entry
    j. VFD/PLC failure (if applicable)
    k. Others to be determined by the City

PART 3 - EXECUTION

3.01 TRANSPORTATION AND SHIPMENT:

A. Shipment Preparation:
1. Contractor shall prepare Equipment and Materials for shipment in a manner to facilitate unloading and handling, and to protect against damage or unnecessary exposure in transit and storage. Provisions for protection shall include the following:
    a. Crates or other suitable packaging materials.
    b. Covers and other means to prevent corrosion, moisture damage, mechanical injury, and accumulation of dirt in motors, electrical equipment, and machinery.
    c. Suitable rust-preventive compound on exposed machined surfaces and unpainted iron and steel.
    d. Grease packing or oil lubrication in all bearings and similar items.

B. Marking: Each item of Equipment and Material shall be tagged or marked as identified in the delivery schedule or on Submittals. Complete packing lists and bills of material shall be included with each shipment. Each piece of every item need not be marked separately, provided that all pieces of each item are packed or bundled together, and the packages or bundles are properly tagged or marked.

3.02 DELIVERY:

A. Delivery:
1. Deliver Equipment and Materials to the Site in manufacturer's sealed containers or other packaging system with identifying labels and instructions for handling, storing, unpacking, protecting, and installing.

3.03 INSTALLATION:

A. Pump and Accessories:
1. Install pump mounting assembly, guide rail assembly, and access frame and door in concrete pump structure.
2. Install pump in sump as indicated and in accordance with manufacturer's recommendations.
3. Install all discharge piping as required for complete functional system.

B. Control Panel:
1. Install on top slab of pump structure as indicated.
2. Provide a support base such that the bottom of the panel is 3 feet above the top of concrete.
3. Provide all required support and mounting hardware to provide rigid mounting.

C. Odor and Corrosion Control:

1. Force main discharge manhole and five (5) manholes downstream of that point shall receive a full depth hydrogen sulfide (H_2S) resistant liner. Liner shall be a hydrogen sulfide epoxy coating that is easily identifiable from a standard concrete manhole.
2. Project specific guidance shall be provided in the case where H_2S levels require alternative pipe materials (e.g., PVC or HDPE), special concrete admixtures, or specific H_2S treatment systems.

3.04 ELECTRICAL WIRING:

A. Wire all devices and equipment as specified.

3.05 START UP:

A. Adjustment:
   1. Adjust all level switches to provide proper response.
   2. Calibrate all monitoring devices to provide correct response.

B. Field Quality Control:
   1. Contractor shall demonstrate the correct response for all monitors and devices.

END OF SECTION 331223

This page was intentionally left blank.

SECTION 333150 - PIPE INSTALLATION

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes handling, installation and testing of pipes, fittings, specials, and appurtenances as indicated or specified.

B. Related Work Specified Elsewhere:
   1. Utility Structures: SECTION 333900.
   2. Pressure Pipe: SECTION 331100.
   3. Utility Valves and Accessories: SECTION 331216.

1.02 REFERENCES:

A. Applicable Standards:
   1. American Society for Testing and Materials (ASTM):
      a. C969 – 17 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
      b. C1244 – 11 (2018) – Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
      c. D2321 - Underground Installation of Flexible Thermoplastic Sewer Pipe.
      d. F1417 – 11a (2015) – Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.

   2. American Water Works Association (AWWA):
      a. C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
      b. C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipelines -Enamel and Tape- Hot-Applied.
      c. C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inch and Larger - Shop Applied.
      d. C206 - Field Welding of Steel Water Pipe.
      e. C209 - Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
      f. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
      g. C651- Disinfecting Water Mains.
      h. M11 - Steel Pipe - A Guide for Design and Installation.
      i. M23 - PVC Pipe - Design and Installation.
   3. Federal Specifications (FS):
      a. SS-S-00210 - Sealing Compound, Preformed Plastic, For Expansion Joints and Pipe Joints.

1.03 DELIVERY, STORAGE AND HANDLING:

A. Handle in a manner to ensure installation in sound and undamaged condition.
   1. Do not drop or bump.
   2. Use slings, lifting lugs, hooks, and other devices designed to protect pipes, joint elements, linings, and coatings.
   3. Do not drag across ground, as this may scrape off coating and is grounds for rejection of material.

B. Ship, move, and store with provisions to prevent movement or shock contact with adjacent units.

C. Handle equipment capable of working with adequate factor of safety against overturning or other unsafe procedures.

PART 2 - PRODUCTS

2.01 Specified in respective Sections.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL:

A. Use equipment, methods, and materials ensuring installation to lines and grades indicated.
   1. Maintain within tolerances specified or acceptable laying schedule.
      a. Alignment: ±1 inch per 100 feet in open cut or tunnel.
      b. Grade: ±1 inch per 100 feet.
   2. Do not lay on blocks unless pipe is to receive total concrete encasement.
   3. Accomplish horizontal and vertical curve alignments with bends, bevels, and joint deflections.
      a. Limit joint deflection with ductile-iron pipe to conform to AWWA C600. Deflection may, with approval, exceed standard deflections by using machined bells.
      b. Use short specials preceding curves as required.
   4. Obtain acceptance of method proposed for transfer of line and grade from control to the Work.
B. Install pipe of size, materials, strength class, and joint type with embedment indicated for plan location.
C. All sewers shall either have minimum cover of thirty-six inches (36-inches), or sufficiently insulated with other material such as concrete encasement to prevent freezing and to protect them from superimposed loads.
D. Heavier weight pipe required when at depths of 9 feet or greater.
E. Insofar as possible, commence laying at downstream end of line and install pipe with bell ends in direction of flow. Obtain Engineer approval for deviations therefrom.
F. Clean interior of all pipe, fittings, and joints prior to installation. Exclude entrance of foreign matter during installation and at discontinuance of installation.
   1. Close open ends of pipe with snug-fitting closures.
   2. Do not let water fill trench. Include provisions to prevent flotation should water control measures prove inadequate.
   3. Remove water, sand, mud, and other undesirable materials from trench before removal of end cap.
G. Brace or anchor as required to prevent displacement after establishing final position.
H. Perform only when weather and trench conditions are suitable. Do not lay in water.
I. Observe extra precaution when hazardous atmospheres might be encountered.

3.03 DUCTILE-IRON PIPE:

A. See Standard Detail #8 for Laying Conditions for Ductile Iron Pipe Type 1 (Under Driving Surface).
B. See Standard Detail #9 for Laying Conditions for Ductile Iron Pipe Type 2 (Not Under Driving Surface).

3.04 TRACER WIRES:

A. A tracer wire shall be installed directly above and adjacent to all pressure pipe and water/sewer laterals during backfill operations. All wire splices shall be made with either rigid fittings or

weatherproof connectors specifically designed for direct burial.

1. Tracer wires for water mains shall be extended to the surface into valve boxes at each gate valve and fire hydrant isolation valve. Construct additional access points as described herein to obtain a maximum spacing of access points of 1,000 feet.
    a. A 4' copper grounding rod shall be driven into the trench bottom at 1,000 foot spacing, at the location where the pressurized pipe crosses property lines or changes direction and secured to the tracer wire with rigid fittings
2. Tracer wires for water laterals shall be rigidly affixed to the water main's tracer wire and extended into each meter pit.
3. Tracer wires for sewer laterals shall meet state standards.

3.05 SEWER MARKERS:

A. Aboveground sewer force main markers are required on property lines, at every change in direction and every 1,000 feet.

3.06 JOINTING:

A. General Requirements:
    1. Locate joint to provide for differential movement at changes in type of pipe embedment, impervious trench checks, and structures.
        a. Not more than 8 inches from structure wall, or
    2. Support pipe from wall to first joint with concrete cradle structurally continuous with base slab or footing. Perform conforming to manufacturer's recommendations.
    3. Clean and lubricate all joint and gasket surfaces with lubricant recommended.
    4. Use methods and equipment capable of fully seating or making up joints without damage.
    5. Check joint opening and deflection for specification limits.
B. Special Provisions for Jointing Ductile-Iron Pipe:
    1. Conform to AWWA C600.
    2. Visually examine while suspended and before lowering into trench.
        a. Paint bell, spigot, or other suspected portions with turpentine and dust with cement to check for cracks invisible to the eye.
        b. Remove turpentine and cement by washing when test is satisfactorily completed.
C. Special Provisions for Jointing Steel Pressure Pipe:
    1. Conform to AWWA M11.
    2. Check for holidays in coating and make repairs as required.
    3. Weld pipe and fittings to conform to AWWA C206.
    4. Grout inside joints of welded pipe and fittings mortar lined conforming to AWWA C205.
    5. Apply epoxy coating to inside of welded joints in pipe 24 inches and larger.
    6. Apply cold tape coating conforming to AWWA C209 to buried exterior connections, special sections, fittings, couplings, and bare metal.
D. Special Provisions for Jointing PVC Pipe and Composite Sewer Pipe:
    1. Conform to ASTM D2321. (Pressure pipe installation shall also conform to AWWA M23.)
    2. Excavate bell holes at each joint or coupling to provide full length barrel support of the pipe and to prevent point loading at the bells or couplings.
    3. Seal cut face of any joint of Composite Sewer Pipe installed to prevent exfiltration during air testing.
    4. Connect pipe to new or existing rigid structures or manhole tie-ins with manhole couplings.
E. Special Provisions for Grooved-End and Shouldered Type Joints:

1. Use fittings and couplings that are made by the same manufacturer that are listed for use together.
2. Assemble joints with coupling, gasket, lubricant, and bolts according to manufacturer's written instructions.

F. Special Provisions for Jointing Subaqueous Installations:

3.07 ELECTRICAL BONDING AND INSULATION:

A. Electrically bond adjacent lengths of pipe and fittings as indicated.
B. Use materials specified in SECTION 331100 applied to conform to manufacturer's instructions.
C. Install insulated joints of dielectric materials.
   1. Where indicated.
   2. Between dissimilar materials which could cause galvanic action.
   3. Conform to manufacturer's instructions.

3.08 CUTTING:

A. Cut in neat manner without damage to pipe.
B. Observe Specifications regarding joint locations.
C. Cut cast-iron, ductile-iron, and steel pipe with carborundum saw or other acceptable method per manufacturer's instructions.
   1. Smooth cut by power grinding to remove burrs and sharp edges.
   2. Repair lining as required and approved.

3.09 CLOSURE PIECES:

A. Connect two segments of pipeline or a pipeline segment and existing structure with short sections of pipe fabricated for the purpose.
B. Observe Specifications regarding location of joints, type of joints, and pipe materials and strength classifications.
C. Field-fabricated closures, where required, shall be concrete encased between adjacent flexible joints.
D. May be accomplished with sleeve coupling:
   1. Of length such that gaskets are not less than 3 inches from pipe ends.
   2. Wrap exterior of buried steel couplings with polyethylene encasement conforming to AWWA C105.

3.10 TEMPORARY PLUGS:

A. Furnish and install temporary plugs at each end of Work for removal by others when completed ahead of adjacent contract.
B. Remove from pipe laid under adjacent contract in order to complete pipe connection when work by other contractor is finished prior to work at connection point under this Contract.
C. Plugs:
   1. Test plugs as manufactured by pipe supplier.
   2. Fabricated by Contractor of substantial construction.
   3. Watertight against heads up to 1.5 times test pressure.
   4. Secured in place in a manner to facilitate removal when required to connect pipe.

3.11 CONNECTIONS TO EXISTING STRUCTURES:

A. Connect pipe to existing structures and pipelines where indicated.
B. Prepare structure by making an opening with at least 3 inches clearance all around fitting to be inserted.
C. Observe pertinent articles of Specifications pertaining to joint locations and closures.

D. Repair wall opening with non-shrink grout.

3.12 POLYETHYLENE ENCASEMENT:

A. Encase pipe, fittings, valves, and other appurtenances with polyethylene film as indicated or specified.

B. Materials:
   1. Polyethylene material shall be as follows:
      a. Conform to AWWA C105.
      b. Class C Black.
   2. Adhesive tape shall be as follows:
      a. Approximately 2 inches wide and plastic backed.
      b. Capable of bonding securely to metal surfaces and/or polyethylene material.
      c. Polyken No. 900, Scotchrap No. 50, or Engineer-approved equal.

C. Installation:
   1. Perform to conform to AWWA C105.
   2. Use adhesive tape to fasten polyethylene film in place.
   3. Minimize exposure of polyethylene film to sunlight.
   4. Wrap pipe, valves, fittings, and couplings per AWWA C105 installation standards.

3.13 FIELD TESTING:

A. Acceptance Tests for Gravity and Low-Pressure Pipelines:
   1. Alignment:
      a. Sewer shall be inspected by flashing a light between manholes or by physical passage where space permits.
      b. Contractor shall clean pipe of excess mortar, joint sealant, and other dirt and debris prior to inspection.
      c. Determine from Illumination or Physical Inspection:
         (1) Presence of any misaligned, displaced, or broken pipe.
         (2) Presence of visible infiltration or other defects.
      d. Correct defects as required prior to conducting leakage tests.
   2. Leakage Test:
      a. Exfiltration testing of all manholes shall be performed by Contractor and shall be tested separately from the pipe.
         (1) Manholes shall be tested by vacuum testing. Vacuum testing shall conform to the test procedures in ASTM C1244 – 11(2017)
         (2) Contractor shall locate any leaks and repair any leaks located by vacuum testing.
   3. Air Testing: Perform air tests per ASTM F1417 – 11a(2015) for plastic pipe at Contractor's option in lieu of exfiltration test for pipe sizes up to and including 42 inches in diameter.
      a. Furnish all facilities required including:
         (1) Necessary piping connections.
         (2) Test pumping equipment.
         (3) Pressure gauges or manometers.
         (4) Bulkheads.
         (5) All miscellaneous items required.
      b. Obtain approval of equipment and acceptance of methods proposed for use.
      c. Conduct initial test on first section of pipe laid by each crew.
         (1) Include a minimum of 10 lengths of pipe but not to exceed 90 m (300 feet).
         (2) Satisfactorily complete test before crew is permitted to continue pipe installation.

d. Test remaining pipe in sections determined by Contractor and approved by Engineer.
e. Plug ends of line and cap or plug all connections to withstand internal test pressures.
f. Introduce low-pressure air until internal air pressure is 4.0 psi greater than the average back pressure of ground water above the pipe invert.
g. Allow two to five minutes for air pressure to stabilize. Adjust pressure to 3.5 psi and start test.
h. Time required for pressure to decrease 1.0 psi from 3.5 to 2.5 psig greater than the average back pressure of any ground water above the pipe invert shall not be less than the minimum test time in the following table for the given diameters:

Minimum Test Times (Minutes) in Plastic Pipe

Nominal Pipe Diameter	Minimum Time (min.)*	Length for Min. Time	Time for Longer Length(s)*
4 in.	3:46	597 ft.	0.380 L
6 in.	5:40	398 ft.	0.854 L
8 in.	7:34	298 ft.	1.520 L
10 in.	9:26	239 ft.	2.374 L
12 in.	11:20	199 ft.	3.418 L
15 in.	14:10	159 ft.	5.342 L
18 in.	17:00	133 ft.	7.692 L
21 in.	19:50	114 ft.	10.470 L
24 in.	22:40	99 ft.	13.674 L
27 in.	25:30	88 ft.	17.306 L
30 in.	28:20	80 ft.	21.366 L
33 in.	31:10	72 ft.	25.852 L
36 in.	34:00	66 ft.	30.768 L

* For 0.5 psi pressure test drop, required test times shall be exactly one-half the values shown.

i. Repeat test as necessary after all leaks and defects have been repaired.

B. Acceptance Tests for Pressure Pipelines:
1. Perform hydrostatic pressure and leakage tests.
a. Conform to AWWA C600 procedures.
(1) As modified herein.
(2) Shall apply to all pipe materials specified.
b. Perform after backfilling.
2. Test separately in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs.
a. Select test segments such that adjustable seated valves are isolated for individual checking.
b. Contractor shall furnish and install test plugs.
(1) Including all anchors, braces, and other devices to withstand hydrostatic pressure on plugs.
(2) Be responsible for any damage to public or private property caused by failure of plugs.
3. Limit fill rate of line to available venting capacity. Fill rate shall be regulated to limit velocity in lines when flowing full to not more than 0.05 to 1 fps.
4. The City shall make water for testing available to Contractor at nearest source.
5. Pressure and Leakage Test:

a. Test pressure shall not be less than 1.5 times the working pressure at the highest point along the test section.
b. Be at least 2-hour duration. Maintain pressure throughout test ±5 psi of test pressure.
c. Leakage test shall be conducted concurrently with the pressure test.
d. Acceptable when leakage does not exceed that determined by the following formula:
(1) In English units:
$L = 0.0000075\ SD(P)^{1/2}$, in which
L = allowable leakage, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average actual leakage test pressure in psi
e. These formulas are based on an allowable leakage of 11.65 gpd/mile/in of nominal diameter at a pressure of 150 psi.
f. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/hr/in of nominal valve size shall be allowed.
g. When hydrants are in the test section, the test shall be made against the main valve in the hydrant.
h. Repeat test as necessary.
(1) After location of leaks and repair or replacement of defective joints, pipe, fittings, valves or hydrants. All visible leaks are to be repaired regardless of the amount of leakage.
(2) Until satisfactory performance of test.
i. The City will witness pressure and leakage test.

C. Deflection Testing:
1. Maximum installed deflections of flexible pipe shall be as follows:

Type of Pipe	Deflection - Percent of Mean Internal Diameter
Composite Pipe	5
PVC Pipe	5
Steel Pipe (lined)	2

2. Deflection testing on pipe between manholes shall occur no sooner than 30 days after backfill has been in place.
a. Provide rigid ball or mandrel deflection testing equipment and labor.
b. Obtain approval of equipment and acceptance of method proposed for use. Test shall be performed without mechanical pulling devices.
c. Remove and replace pipe exceeding deflection limits.

D. Soil Corrosion Testing:
1. Perform electrical conductivity test on bonded pipe segments.
2. Perform pipe-to-soil potential surveys.
3. Submit 3 copies of test and survey reports to Engineer.

3.14 DISINFECTION:

A. Disinfection of Pipelines for Conveying Potable Water:
1. Conform with AWWA C651.
a. As modified herein.
b. Include preliminary flushing, chlorination, and final flushing.
2. The City will accomplish chlorination.

a. In conjunction with pressure testing.
b. At minimum initial dosage of 25 mg/L (ppm) chlorine in all portions.
c. Contractor provide labor assistance and service connections as indicated or as requested.

3. Contractor shall perform preliminary and final flushing.
4. Minimum preliminary flushing rates to produce 2.5 fps velocity in main shall be as follows:

Pipe Size	Flow Rate	Hydrant Outlets No. of (2-1/2-inch
4"	100 gpm	1
6"	200 gpm	1
8"	400 gpm	1
10"	600 gpm	1
12"	900 gpm	1
16"	1600 gpm	2

a. Valve hydrant outlet to control flow. With a 40 psi pressure in the main with the hydrant flowing to atmosphere, a 2-1/2-inch hydrant outlet will discharge approximately 1,000 gpm and a 4-1/2-inch hydrant outlet will discharge approximately 2,500 gpm.
b. Flush pipeline before use for potable water supply purposes. Dispose of preliminary flushing water without damage to public or private property.

5. Dispose of final flushing water without damage to public or private property. Continue until tests conducted by the City prove acceptable.
6. Repeat disinfection process should initial treatment fail to yield satisfactory results.
   a. At the expense of Contractor, including cost of additional water.
   b. The City will provide sampling and laboratory testing.

B. Disinfection of Pipelines for Conveying Potable Water:
1. Contractor shall provide all equipment and materials and perform conforming to AWWA C651.
   a. As modified herein.
   b. Include preliminary flushing, chlorination, and final flushing.
2. Obtain approval of materials and acceptance of methods proposed for use.
3. May be conducted in conjunction with acceptance tests.
4. The City will provide sampling and laboratory testing.
5. Minimum preliminary flushing rates to produce 2.5 fps velocity in main shall be as follows:

Pipe Size	Flow Rate	Hydrant Outlets No. of 2-1/2-inch
4"	100 gpm	1
6"	200 gpm	1
8"	400 gpm	1
10"	600 gpm	1
12"	900 gpm	1
16"	1600 gpm	2

a. Valve hydrant outlet to control flow. With a 40 psi pressure in the main with the

hydrant flowing to atmosphere, a 2-1/2-inch hydrant outlet will discharge approximately 1,000 gpm and a 4-1/2-inch hydrant outlet will discharge approximately 2,500 gpm.

b. Flush pipeline before use for potable water supply purposes. Dispose of preliminary flushing water without damage to public or private property.

6. At minimum initial dosage of 50 mg/L (ppm) in all portions.
   a. Allow to stand for 8 hours.
   b. Minimum residual shall be at least 10 mg/L (ppm).
   c. Flush pipeline before use for potable water supply purposes. Dispose of final flushing water without damage to public or private property.
7. Repeat disinfection procedure should initial treatment fail to yield satisfactory results.
   a. At no additional cost to the City.
   b. The City will provide water under terms stipulated for acceptance tests.

END OF SECTION 333150

This page was intentionally left blank.

SECTION 333213 - SEWAGE LIFT STATION - WET WELL MOUNTED

PART 1 - GENERAL

1.01 SUMMARY:

A. Furnish and install one, wet well mounted, suction lift, sewage lift station(s) with (two) (three), (constant) (variable) speed, electric motor driven pumps and fully automatic operation.

B. Related Work Specified Elsewhere:
   1. Site Work: DIVISION 31.

1.02 REFERENCES:

A. Applicable Standards:
   1. American Institute of Steel Construction (AISC):
      a. Steel Construction Manual
      b. Quality Criteria and Inspection Standards.
   2. American National Standards Institution (ANSI):
      a. B16.1 Cast-Iron Pipe Flanges and Flanged Fittings.
   3. American Society for Testing and Materials (ASTM):
      a. A36 - Carbon Structural Steel.
      b. A283 - Low and Intermediate Tensile Strength Carbon Steel Plates of Structural Quality.
      c. A126 - Gray Iron Casting for Valves, Flanges and Pipe Fittings.
      d. B88 - Copper Water Tube.
   4. American Water Works Association (AWWA):
      a. C150 - Thickness Design of Ductile Iron Pipe.
      b. C110 - Cast Iron Fittings 2-inch Through 48-inch For Water and Other Liquids.
      c. C111 - Rubber Gasket Joints for Cast-Iron Pressure Pipe and Fittings.
   5. American Welding Society (AWS):
      a. D1.1 – Structural Welding Code.
   6. American Bearing Manufacturing Association (ABMA).
   7. Institute of Electrical and Electronic Engineers (IEEE).
   8. National Fire Protection Association (NFPA):
      a. 70- National Electrical Code (NEC).
   9. National Electrical Manufacturing Association (NEMA).
   10. Hydraulics Institute Standards.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Provide initial Submittals for general arrangement and dimensions, anchorage details, pipe and utility connections, and pump head capacity curves.

C. Instruction Books:
   1. Provide instruction books containing information for all apparatus furnished with the lift station, including but not limited to:
      a. Pumps and Motors.
      b. Ventilating Fans or Blowers.
      c. Heaters.
      d. Vacuum Pumps.
      e. Piping and Valves.
      f. Electrical Power Panels and Starters.

g. Controls and Alarms.

h. Corrosion Protection.

2. Provide complete installation, start-up and operating instructions for each station and all apparatus included.

D. Include a schedule of maintenance requirements, complete with specifications for consumable items such as lubricants, filters, paints, packing, and related items.

1.04 DELIVERY AND HANDLING:

A. Provide for delivery, handling, unloading, and storage:
1. As specified in DIVISION 1.
2. In compliance with manufacturer's instructions.

B. Maintain all internal bracing, closures, covers, caps, or plugs in place until station is installed and external connections are made.

1.05 FACTORY TESTS:

A. Conduct an operational test to all Equipment of completed lift station to check for:
1. Excessive vibration.
2. Leaks in all piping and seals.
3. Faults in the automatic control system.
4. Faults in auxiliary Equipment.

B. Test completed lift station under simulated service conditions for one hour.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Complete Lift Station:
1. Dakota Pump, Inc.
2. Smith & Lovelace, Inc.
3. Engineer approved equal.

B. Motors:
1. General Electric.
2. Reliance Electric.
3. Siemens Energy and Automation.
4. U.S. Motors.
5. Engineer approved equal.

2.02 ENCLOSURE (ABOVE GRADE):

A. Fabricate a complete factory-built unit housing all components of the station except suction piping and level sensors.
1. Size to rest on wet well as indicated.
2. Floor shall be ASTM A36 or A283 mild or intermediate grade steel.
a. Minimum thickness of 3/8 inches.
b. Reinforce to prevent deflection with station equipment dead load and 300 pounds live load.
3. Provide a sliding fiberglass cover of weatherproof construction, when applicable and a hinged lid when a sliding cover is not feasible with the following:
a. A means of securely locking cover to the enclosure floor.
b. With a hinged lid, include a lifting handle and latch mechanism to maintain lid in the open position under 60 mph wind load, from any direction.

c. With a hinged lid, gas assisted struts shall be provided for lift assistance.

d. Adjustable ventilating louvers capable of being closed during cold weather operation.

4. Provide a steel wet well access cover in the station floor with the following:
   a. Hinged along one edge.
   b. A means of securely locking cover to the floor.
   c. A lifting handle.
   d. Minimum opening size: 18x24 inches.
   e. Exterior to the pump enclosure.
5. Covered wet wells must have provisions for air displacement to the atmosphere. An inverted and screened "J" tube or other means may be used.
   a. Housed wet well ventilation shall be in accordance with 10 CSR 20-8.30(2)(E) and 10 CSR 20-8.140(8)(J) per DNR.
   b. Ventilation shall include the following:
      (1) Isolate all pumping stations and wastewater treatment components installed in a building where other equipment or offices are located from the rest of the building by an air-tight partition, provide separate outside entrances, and provide separate and independent fresh air supply.
      (2) Force fresh air into enclosed screening device areas or open pits more than four feet (4') deep. Also see 10 CSR 20- 8.130(3)(F).
      (3) Dampers. Dampers are not to be used on exhaust or fresh air ducts. Avoid the use of fine screens or other obstructions on exhaust or fresh air ducts to prevent clogging.
      (4) Continuous ventilation. Where continuous ventilation is needed (e.g., housed facilities), provide at least twelve (12) complete air changes per hour. Where continuous ventilation would cause excessive heat loss, provide intermittent ventilation of at least thirty (30) complete air changes per hour when facility personnel enter the area. Base air change demands on one hundred percent (100%) fresh air.
      (5) Electrical controls. Mark and conveniently locate switches for operation of ventilation equipment outside of the wet well or building. Interconnect all intermittently operated ventilation equipment with the respective wet well, dry well, or building lighting system. The manual lighting/ventilation switch is expected to override the automatic controls. For a two (2) speed ventilation system with automatic switch over where gas detection equipment is installed, increase the ventilation rate automatically in response to the detection of hazardous concentrations of gases or vapors.
      (6) Fans, heating, and dehumidification. Fabricate the fan wheel from non-sparking material. Provide automatic heating and dehumidification equipment in all dry wells and buildings. Follow the provisions in subsection (7)(B) of this rule for electrical controls per DNR Section 10 CSR 20- 8.140(7)(B).

2.03 ENCLOSURE: (BELOW GRADE):

A. Fabricate a complete factory-built unit housing all components of the station except suction piping and level sensors.
   1. Size to rest on wet well as indicated.
   2. Minimum diameter 6 feet 10 inches.
   3. Floor walls shall be ASTM A36 or A283 mild or intermediate grade steel.

4. Covered wet wells must have provisions for air displacement to the atmosphere. An inverted and screened "J" tube or other means may be used.
5. Floor plate:
   a. Minimum thickness of 3/8 inches.
   b. Reinforced to prevent deflection with station Equipment dead load and 300 pounds live load.
6. Wall Shell:
   a. Minimum thickness of 1/4 inches.
   b. Reinforced to resist earth backfill loads.
7. Equipment Chamber:
   a. Completely isolated from the wet well access chamber.
   b. Gas-tight construction.
   c. Provide with a sliding fiberglass (or steel) cover if possible. If a sliding cover is not possible, provide a hinged cover gas assisted struts to be provided with the following:
      (1) A means of securely locking cover to wall rim.
      (2) Lifting handles and brackets to provide support and restraint for cover in the open position.
   d. Provide with access ladder.
8. Wet Well Access Chamber:
   a. Provide with a hinged access cover with the following:
      (1) Minimum opening size: 18x24 inches.
      (2) A means of securely locking to the chamber roof.
      (3) A lifting handle.
   b. Provide with vent pipe for wet well.
   c. Provide with access ladder to wet well steps.

2.04 SEWAGE PUMPS:

A. The Engineer shall submit the items following as part of the design for City approval.
B. Capable of delivering_____gpm of raw unscreened sewage at_____feet total dynamic head.
C. Rated at a maximum of_____rpm.
D. Maximum suction lift as indicated.
E. Minimum pump efficiency of_____.
F. Large enough to permit passage through openings and passages of a 3-inch-diameter sphere and all trash of stringy material which can pass through a 4-inch pipe.
G. Operating head range from_____feet static to approximately_____feet maximum at shutoff.
H. Not less than 4-inch size.
I. Vertical, close coupled, "Nonclog" sewage pumps especially designed for the use of mechanical seals and vacuum priming.
J. Heavy cast-iron construction.
K. Vertical motor with pump impeller mounted directly on the one piece motor-pump shaft.
L. Motor mounted directly on a short adapter.
M. Combination pump and motor shaft of high-strength carbon steel. If welded into a one-piece shaft, anneal shaft before machining with stainless steel sleeves.
N. All required bearing designed for L10 bearing life of 50,000 hours minimum.
O. Seals:
   1. Single or double mechanical seals are acceptable.
   2. Carbon and ceramic construction.
   3. Rotating ceramic(s) held in mating position with the stationary carbon(s) by a

stainless-steel spring.

4. Lubricating water - low pressure systems.
   a. Fill around seal each time pump is primed.
   b. Drain from around seal automatically with loss of prime.
5. Lubricating water - high pressure systems.
   a. Pressurized, filtered water from pump volute.
   b. Seal water lubrication filtering shall be of multiple stage filtering, with the final filter providing filtration of no larger than 50 microns.

P. Enclosed type impellers:
1. Made of close-grained cast iron.
2. Impeller shall be ceramic coated (if available).
3. Hydraulic and dynamic balanced.
4. Keyed to shaft by a self-locking device, not screwed or pinned to the motor pump shaft.
5. Removable without the use of special tools.
6. All trimming of impeller shall be done inside the shrouds. Shrouds shall remain full diameter.

Q. Equipped with volutes of heavy cast-iron construction.
1. Free from opening or projections that might cause clogging or interference with flow through the pump.
2. Furnished with mounting lugs bolted to floor for gas tight seal.
3. Flanged and drilled for 125-psi American Standard flange connections.

2.05 PUMP MOTORS

A. Conform to NEMA, IEEE, ANSI, and ABMA.
B. Vertical, solid shaft, open drip-proof, squirrel cage induction type suitable for___-V,____-Hz, and____-phase operation. The Engineer shall submit these as part of the design to the City for approval.
C. NEMA design B.
D. Adequately sized to drive pump at any head in the operating range without using more than 10 percent of the motor service factor.
E. Oversized, grease-lubricated ball bearings with the thrust bearing at the bottom locked in position to eliminate shaft end play, with minimum bearing life of 5 years to conform to ABMA.
F. Motor pump shaft of one-piece construction from top of motor down through impeller.
G. Motor shaft of adequate strength and stiffness for intended service.
H. Fitted with heavy lifting "eyes" capable of supporting the entire weight of pump and motor.

I. Coated with special rust-preventative compounds on the interior elements and furnished with special moisture-resistance insulation to protect the motor against high-humidity conditions.
J. Rated for 40 degrees C ambient temperature with 1.15 service factor.
K. Stator winding insulation of Class "F," nonhygroscopic type insulation.

2.06 ELECTRICAL EQUIPMENT:

A. Conform to NEC, NEMA, and IEEE on all electrical Equipment.
B. The Engineer shall submit items specified herein as part of the Design to the City for approval.
C. Controls:
1. Include 110V power receptacle inside any control panels located outdoors.
2. Provide ground fault circuit interruption (GCFI) protection for all outdoor receptacles.
3. Install a fused disconnect switch located above ground for the main power feed.
4. Install lighting and surge protection systems.

5. Control Equipment mounted in a NEMA Type 1 enclosure to conform to the following:
   a. Enclosure fabricated of code gage steel.
   b. Size to provide ample clearances of Equipment and wiring.
   c. Circuit breaker, motor starter and control Equipment section of the dead front design with hinged doors.
   d. Selector switches, blower timer, humidistat and thermostat and 115-volt convenience outlet accessible from cabinet front.
6. Thermal Magnetic Air-Circuit Breakers:
   a. Minimum interrupting capacity of____A symmetrical at____V ac and____A at _____V ac.
   b. Operable from front of panel without opening door.
   c. Used on circuits requiring a disconnecting means.
   d. Used to provide overcurrent protection for each circuit.
7. Motor Starter:
   a. Magnetic, full-voltage, nonreversing type.
   b. Suitable for_____-V,_____-phase,____-Hz service.
   c. _____thermal overload relays (one in each phase) and a_____-V control transformer.
   d. Overload heaters and starters sized for motors furnished.
8. Transformers:
   a. Dry-type rated_____V,_____Hz, and single phase.
   b. Adequately sized for all control and lighting circuits including_____watts of exterior lighting.
9. Pump Control Switches:
   a. Control the starting and stopping of individual pumping units.
   b. Stagger starting of both pump sets when the lag float is called to start both pump sets.
   c. Mercury displacement, float type switches.
   d. Provide with a minimum of____feet of cord. Cord splices will not be approved.
   e. Cord wiring to be stranded.
   f. Cord jacket to be corrosion resistant vinyl.
   g. Capable of a minimum differential of____inches of water.
   h. Low water cut off float switch (emergency off).
   i. Operating Levels:
      (1) Lead pump:
          ON-Elev
          OFF-Elev
      (2) Second pump:
          ON-Elev _____
          OFF-Elev _____
      (3) High Level Alarm Elev_____.
10. Automatic alternator to provide alternate selection of the base loaded pump on the completion of each pumping cycle and as follows:
    a. Selector switch to permit manual operation of either pump.
    b. Relays, wiring and other equipment as required to allow pumps to operate in parallel.
    c. Pumps shall alternate after each cycle to promote even wear.

D. Line Voltage and Phase Monitor Unit:
   1. Pump motors protected against undervoltage and single-phasing conditions.
   2. Time delay relay unit for staggered starting on pumps on restoration of power.

3. Model MM480 Motor Minder as manufactured by Palo Duro Industries Corporation, or engineer approved equal.
4. Resetable counter to indicate number of outages.

E. Enclosure Lighting:
1. 20 FC illumination at 24 inches above enclosure floor.
2. Controlled by a limit switch on enclosure cover and a manual switch.
3. Manufacturer's standard rough service LED fixtures with wire graded.

F. Wiring:
1. Conform to NEC.
2. Color-coded wiring.
3. In rigid hot-dip galvanized conduit, except that within panel and____-V ac accessory items which are provided with connecting insulated service cord.
4. Provide power and alarm conduits from control panel to threaded exterior service conduit connections. Terminate in an adequately sized gasketed pull box or conduit fitting inside enclosure.
5. Grounded, polarized, convenience outlets, conveniently located, for accessory equipment unless conduit is used.
6. Intrusion alarm system in a rigid conduit system.

2.07 EMERGENCY POWER AND CONNECTIONS:

A. All lift stations shall have for backup power supply, generators sufficiently sized to operate all the pumps in the station running at the same time, with power in reserve. Depending upon the size of the generator required and the location, they shall be fueled by diesel fuel or natural gas.

B. Emergency pump connections shall be installed.

C. If independent substations are used for emergency power, each separate substation and associated distribution lines shall be capable of starting and operating the pump station at its rated capacity.

2.08 PIPING, VALVES, AND PRESSURE GAUGE:

A. Pump Suction Lines:
1. One for each pump as indicated.
2. Shall be ductile-iron pipe.
3. Drilled and/or tapped as required to mate with lift station pump suction connections.

B. Pump Discharge Pipe, Fittings and Valves:
1. ____-inch minimum ductile-iron pipe forming a common discharge outlet.
2. Bronze fitted clapper type check and nonlubricated, eccentric plug valves installed in each pump discharge line.
   a. Installed above floor plate.
3. Check valves of the spring-loaded lever type so the clapper can be lifted to backflush the pump and suction line. Make shafts of stainless steel with nonlubricated packing glands.
4. Common discharge outlet with sleeved connection to station discharge pipe.
5. Steel pipe and piping fittings must coated and lined with paint system specified for corrosion protection herein.

C. Pressure Gauge:
1. Suitable for indicating the pumping head.
2. Mounted on the common discharge outlet pipe.
3. Threaded-ring type with stainless steel movement, hot forged Bourdon tube, forged steel or bronze socket as required, pointer with integral micrometer adjustment, dial with black numerals and graduations, covered with a clear plastic surface and case of bonderized

aluminum alloy.

4. Equipped with a seal and snubber.
5. Installed complete with a brass stop valve between the gauge and the header.
6. Provide with iso ring mounting.
7. Ashcroft Figure No. 1379 "Duragauge" with a dial and scale in feet with a range of 0 to ___feet.

D. Penetrations through the floor shall be sealed gas tight at the factory.

2.09 VACUUM PRIMING SYSTEM:

A. Provide separate and independent system for each pump. Provide for each system:
   1. Vacuum pump.
      a. Corrosion resistant internal components.
      b. Capable of priming pump and suction piping in 60 seconds under static suction lift conditions at the project site.
   2. Vacuum control solenoid valve.
   3. Prime level sensing probe.
   4. Float operated check valve.
      a. Installed ahead of vacuum pump.
      b. Prevent liquid from entering vacuum pump.
      c. Transparent body for visual inspection.
      d. Automatically drain when vacuum pump shuts off.

B. Two (2) vacuum pumps shall be provided for each pump set. Each vacuum pump is required to be compatible with each pump set. Each vacuum pump must be capable of automatically and completely removing air from the suction lift pump.

C. Automatically provide positive lubrication of the sewage pump being primed on low pressure lubrication systems.

2.10 VENTILATING BLOWER AND ELECTRIC HEATER:

A. Ventilating Blower: (Below grade enclosure)
   1. Capable of delivering 200 cfm in the enclosure.
      a. Exhaust heat generated by continuous motor operation.
   2. Rigidly mounted to the enclosure wall.
   3. Discharge duct through the enclosure wall to atmosphere.
   4. Squirrel-cage high-efficiency type.
   5. Controlled by pre-set thermostat.

B. Ventilating Blower (Above Grade Enclosure):
   1. Capable of delivering 200 cfm in the enclosure.
      a. Exhaust heat generated by continuous motor operation.
   2. Rigidly mounted to floor of enclosure.
   3. Fitted with resilient gasket on discharge to mate with discharge in enclosure cover when it is closed.
   4. Squirrel-cage, high-efficiency type.
   5. Controlled by preset thermostat.

C. Electric Heater:
   1. Rigidly mounted to floor of enclosure.
   2. Controlled by preset thermostat.

2.11 REMOTE ALARM SYSTEM:

A. Frequency shift-tone transmitter in a NEMA 12 control cabinet inside lift station.

B. Auxiliary relays, limit switch and key-operated switch for intrusion alarm as indicated.

C. Hermetically-sealed DPDT plug-in relays equal to Magnecraft No. W88AHPX-24 with matching sockets.
D. All lift stations shall have telemetry cellular dialing systems.
   1. Cellular dialing systems shall be OmniSite brand cellular radio supported by GUARDDOG.
   2. Approved Models shall be Crystal Ball. No substitutions are allowed unless otherwise approved by the City.
E. Audio and visual indicators, with manual push button shut off (can be together) are required.
F. The alarm system must have an uninterrupted power source.
G. Required alarm systems:
   1. High water alarm
   2. Pump failure alarm
   3. Low water shut off
   4. Phase alarm
   5. Loss of power
   6. Motor tripped
   7. Generator alarm
   8. Other alarms will be based on project specific conditions.

2.12 WELDING:

A. Weld all structural steel members.
B. Electric arc welding with fillets of adequate section for the joint involved.
C. Continuous welds where required to exclude ground water or for structural reasons.
D. Inside and out where pipe or conduit inserts pass through the walls, bottom and top of horizontal plates.

2.13 CORROSION PROTECTION: After welding, protect all steel parts and as follows:

A. Blast with grit to a white color to remove rust, mill scale, weld slag, and dirt.
B. Remove by grinding, all weld splatter and surface roughness.
C. Give two coats minimum of 10 mils dry film thickness to all inside and outside surfaces of an amide cured epoxy resin.
   1. Apply one coat 90 degrees to the preceding coat.
   2. Vehicle to contain at least 85 percent epoxy resin and hardener with a minimum of thinner required for blowout purposes.
   3. Pigment shall be comprised of only inert coloring and corrosion preventive materials.
   4. No filler or extenders shall be used.
D. A touch-up kit shall be provided for repair of all scratches or mars occurring during installation.
E. Protect with two 17-pound packaged magnesium anodes for cathodic protection.
   1. Buried on opposite sides of the chamber during installation.
   2. Securely connected with No. 12 AWG Type TW insulated copper wire.
   3. Attach wires to chamber wall with factory installed copper lugs.
   4. Braze wires to anode core and seal with coal tar or hot pitch.

2.14 SUMP PUMP:

A. Submersible, closed coupled driven with vertical motor.
B. Installed in sump in station floor.
C. Fitted with mechanical seal.
D. Controlled automatically by float switch with a minimum 5-inch differential.
E. Rated at_____gph at design head.
F. Discharge to the wet well.

2.15 SPARE PARTS:

A. Two complete shaft mechanical seal assemblies with complete installation instructions.
B. One spare volute gasket for each sewage pump in the lift station.
C. Two sets of spare filters for seal water filter.
D. One spare float switch.
E. One operating wrench for the plug valves.
F. Minimum of three (3) hard copies of O & M manuals .
G. Digital O & M manual.
H. Ship in a single container, directly to the City of Republic with written confirmation of delivery to Contractor.
   1. Shipping address:
      City of Republic
      213 North Main Street
      Republic, MO 65738
      Attn: _____
      _____
   2. Note project reference on container as follows:
      SPARE PARTS:
      PROJECT: _____
      PROJECT NO. _____

2.16 WATER SUPPLY:

A. Per DNR Section 10 CSR 8.130 (3)(G), there shall be no physical connection between any potable water supply and a wastewater pumping station, which under any conditions, might cause contamination of the potable water supply. If a potable water supply is brought to the station, it shall comply with conditions stipulated under 10 CSR 20-8.140(7)(D).

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install in accordance with written instructions furnished by the manufacturer.
B. Place all fill concrete in wet well prior to installation of the lift station.
C. Place station on wet well as indicated:
   1. Seat in a layer of grout for uniform support and seal.
   2. Using lifting points provided by the manufacturer only.
D. Connect suction pipes after station has been permanently installed and discharge pipe connected.
E. Odor and Corrosion Control:
   1. Force main discharge manhole and five (5) manholes downstream of that point shall receive a full depth hydrogen sulfide (H_2S) resistant liner. Liner shall be a hydrogen sulfide epoxy coating that is easily identifiable from a standard concrete manhole.
   2. Project specific guidance shall be provided in the case where H_2S levels require alternative pipe materials (e.g. PVC or HDPE), special concrete admixtures, or specific H_2S treatment systems.

3.02 FIELD QUALITY CONTROL: Provide manufacturer's field services as specified in DIVISION 1.

END OF SECTION 333213

This page was intentionally left blank.

SECTION 333900 - UTILITY STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the following structures and related appurtenances:
   1. Manholes.
   2. Accessory vault.
   3. Air valve vaults.
   4. Concrete anchor and thrust blocks.
   5. Flow meter structure.

B. Related Work Specified Elsewhere:
   1. Section 333150 – Pipe Installation.

C. Applicable Standards:
   1. American Society for Testing and Materials (ASTM):
      a. A48 - Gray Iron Castings.
      b. C32 - Sewer and Manhole Brick (Made from Clay or Shale).
      c. C76 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
      d. C270 - Mortar for Unit Masonry.
      e. C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
      f. C478 - Precast Reinforced Concrete Manhole Sections.
      g. C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
   2. Federal Specification (FS):
      a. FF-H-106 - General Hardware, Builder's; Locks and Door Trim.
      b. SS-S-00210 - Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Concrete: Reinforced, 4000 psi.

B. Mortar:
   1. Conform to ASTM C270 Type M.
   2. Type II portland cement, Type S lime.
   3. Proportion 1 part portland cement to 1/4 part lime to not less than 2-1/4 nor more than 3 times the sum of the cement and lime used of loose damp sand.

C. Castings:
   1. Steel reinforced polypropylene plastic or rubber, M.A. Industries Model PS2-PF, American Step Company Model ML, or equal as approved by Engineer. Manhole Frames and Covers:
      a. ASTM A48, Class 30B., pattern as specified for each structure under PART 3, this Section.
      b. Interchangeable within same pattern.
   2. Conform to Drawings in all essentials of design
   3. Machine-bearing surfaces to provide even seating.
   4. Coat with coal-tar pitch varnish.

PART 3 - EXECUTION

3.01 MANHOLES:

A. Design:
   1. Construct as follows:
      a. Precast manhole with cast-in-place concrete base or precast concrete base:
         (1) Precast manhole shall conform to ASTM C478.
         (2) Provide Submittal for concrete manholes prior to installation.
      b. Cast-in-place reinforced concrete manhole.
      c. Conform to Drawings.
      d. Provide Submittal for concrete manholes prior to installation.
      e. Caulk and repair any leaks or remove entire Work and rebuild to obtain watertight construction.
      f. Manhole steps will not be allowed in new manholes.
      g. See Standard Detail #18 for Standard Manhole Detail.
      h. See Standard Detail #19 for Standard Outside Drop Manhole Detail.
      i. See Standard Detail #20 for Standard Inside Drop Manhole Detail.
      j. When utilizing precast manholes, proposed drop connections must not enter the manhole at a joint.

B. Manhole Frames and Cover:
   1. Frame should be set on RAMNEK as a sealant, then frame grouted around on adjustment ring.
   2. See Standard Detail #10 for Manhole Frame and Cover Seal – Type A detail.
   3. See Standard Detail #11 for Manhole Frame and Cover Seal – Type B detail.
   4. See Standard Detail #12 for Manhole Frame and Cover Seal – Type C detail.

C. Connections:
   1. Grout around pipes with nonmetallic non-shrink grout.
   2. Install all piping using a flexible-rubber, entrance- hole gasket joint of pattern approved by the Engineer.
   3. Make provisions for future connections where indicated.
   4. Place pipe stub in manhole wall with bell or coupling outside manhole wall to provide flexible joint as indicated.
   5. Include plug or stopper capable of withstanding 10 feet 4.3 psi of internal or external pressure without leakage for future connections.

D. Installation of manhole on existing sewer main:
   1. Contractor shall meet necessary requirements:
      a. Remove existing portion of sewer main
      b. Stub lines in new manhole
      c. Set new manhole with new line sections in place
      d. Make connection with HYMAX style coupling

E. Invert Channels:
   1. Form invert channel with 4,000 psi Type II portland cement concrete.
   2. Make changes in direction of flow with smooth curves of as large a radius as size of manhole permits.
   3. Make changes in size and grade smoothly and uniformly.
   4. Slope floor of manhole adjacent to channels as indicated.
   5. Finish channel bottom smoothly without roughness, irregularity, or pockets.

F. Waterproofing:
   1. Apply coal-tar coating to exterior walls on all manholes from base to finish grade:

a. Carboline - Bitumastic 300M.
b. International - Intertuf 100.
c. Tnemec - HB Tnemecol 46-465.

2. Apply coating in two coats to minimum 12-mil dry-film thickness per coat.
3. Mac Wrap all manhole structures per ASTM C877 (Type II) requirements.

3.02 ACCESSORY VAULT:

A. Design: Construct to conform to Drawings of reinforced concrete pipe conforming to ASTM C76, Class II or clay pipe conforming to ASTM C700.
B. Installation:
1. Install vaults where indicated.
2. Notch lower section 2 inches greater than pipe od and include fiberglass batt to prevent transmission of loads to pipe barrel.
C. Manhole Frame and Cover:
1. Set frame level and to grade in mortar.

3.03 AIR VALVE VAULT:

A. Design:
1. Precast and masonry construction as indicated.
2. Precast concrete footings.
3. Riser of ASTM C76, Class II pipe.
4. Top slab shall be precast as indicated.
B. Installation:
1. Install within 8 feet of station indicated.
2. Include fiberglass batt to prevent transmission of loads to pipe barrel.
3. Interior of concrete vault shall have epoxy coating or similar engineer-approved equal, to resist hydrogen sulfide.
4. All fittings and hardware shall be stainless steel.
5. Provide three courses of brick between top slab and manhole frame:
a. Lay in mortar.
b. Remove surplus mortar from inside joints and tool.
C. Manhole Frame and Cover:
1. Set frame level and to grade in full bed of mortar.
D. Insulation Fill:
1. Insulate all air-valve vaults. Insulate inside of vault around piping and air valve to prevent freezing.
2. Use water-repellent granular form of vermiculite known as masonry fill insulation.
3. Fill to depth to cover top of air valve. Do not block air valve's vent-piping outlet.
4. Install by pouring; do not rod or tamp.

3.04 CONCRETE ANCHOR AND THRUST BLOCKS:

A. Install at tees, elbows, bends, and dead ends where indicated.
B. Place against undisturbed earth or rock.
C. Of design indicated or specified:
1. Bearing surface area may be adjusted should field conditions be in variance with design assumption:
a. May be increased with compensation therefore conforming to adjusted Unit Prices.
b. May be reduced in rock trench as approved.
2. Removable thrust blocks shall be constructed by using a sheet of 3/8-inch plywood to

prevent concrete adherence to pipe, fittings, or accessories.

3. Apply two coats of coal-tar coating to minimum 20-mil dry-film thickness on anchor bars, straps, and hardware.

3.05 FLOW METER STRUCTURE:

A. Construct of reinforced concrete as indicated.

B. Furnish and install hollow metal door and frame complete with hardware:

1. Frame:
   a. Rough buck shall be 12-gage steel provided with holes for anchor bolts approximately 24 inches o.c., floor clip, and removable spreader.
   b. Jamb shall be 16-gage, 1-piece rust-resistant steel with intersections mitered, welded, and ground smooth.
   c. Rabbet properly for doors.
   d. Fasten jamb to rough buck with countersunk oval-head machine screws.
2. Door:
   a. Full flush type, 1-3/4-inch thickness.
   b. Construct of two outer sheets of 18-gage steel.
   c. Reinforce inside with 20-gage stiffeners spaced a maximum of 6 inches o.c. and horizontal steel channels top and bottom spot-welded to face. Channels shall be flush with top and bottom of door.
   d. Continuously arc-weld vertically where outer sheets are jointed, and dress smooth with no exposed seams.
   e. Sound-deaden with manufacturer's standard insulation.
3. Hardware:
   a. Reinforce door and frame properly for hardware with minimum of 14-gage steel.
   b. Furnish and install the following:
      (1) 1-1/2 pair butts 4-1/2 x 4-1/2, 2 ball-bearing steel, US 26D.
      (2) 1 entrance lock FS FF-H-00106 Series 161-A, US 26D.
      (3) 1 threshold 4" width x 13 mm 1/2" high, corrugated aluminum.
      (4) Chain and snap on inside face of door.
4. Finish: Door and frame shall be cleaned, bonderized, and given one coat of baked-on rust-inhibitive primer and two coats of baked-on gray exterior enamel.

C. Pit Hatch:

1. Single-leaf gutter type with 1/4-inch checkered plate cover, designed to withstand loading of 300 psf, aluminum construction, with automatic hold-open arm, 1-1/2-inch diameter drainage coupling, inside snap lock and removable wrench-lift handle on outside, Babcock-Davis Associates, Inc., Type AM222A.
2. Coat surfaces of aluminum frame to be embedded in concrete with bitumastic material.

D. Handrail:

1. Furnish and install nominal 1-1/2 in id aluminum handrail as detailed.
2. Provide hold-open provisions for hatch and door as indicated.

END OF SECTION 333900

This page was intentionally left blank.

SECTION 347000 – CONCRETE

PART 1 – GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This section includes concrete and related items.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. American Concrete Institute (ACI):
      a. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary
      b. ACI 121R - Guide for Concrete Construction Quality Systems in Conformance with ISO 9001
      c. ACI 213R - Guide for Structural Lightweight-Aggregate Concrete
      d. ACI 301 - Specifications for Structural Concrete
      e. ACI 302.1R - Guide for Concrete Floor and Slab Construction
      f. ACI 304.2R - Guide to Placing Concrete by Pumping Methods
      g. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete
      h. ACI 305.1 - Specification for Hot Weather Concreting
      i. ACI 305R - Guide to Hot Weather Concreting
      j. ACI 306.1 - Standard Specification for Cold Weather Concreting
      k. ACI 306R - Guide to Cold Weather Concreting
      l. ACI 308.1 - Specification for Curing Concrete
      m. ACI 318 – Building Code Requirements for Structural Concrete and PCA Notes
      n. ACI 347R - Guide to Formwork for Concrete
      o. ACI SP-2 - ACI Manual of Concrete Inspection
      p. ACI SP-15 - Field Reference Manual: Standard Specifications for Structural Concrete ACI 301-05 with Selected ACI References
   2. American Welding Society (AWS):
      a. AWS D1.4 - Structural Welding Code - Reinforcing Steel
   3. ASTM International (ASTM):
      a. ASTM A36 - Standard Specification for Carbon Structural Steel
      b. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
      c. ASTM A184 - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
      d. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
      e. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
      f. ASTM A767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
      g. ASTM A775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars
      h. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

i. ASTM A820 - Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
j. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
k. ASTM A934 - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
l. ASTM A955 - Standard Specification for Deformed and Plain Stainless-Steel Bars for Concrete Reinforcement
m. ASTM A970 - Standard Specification for Headed Steel Bars for Concrete Reinforcement
n. ASTM A1022 - Standard Specification for Deformed and Plain Stainless-Steel Wire and Welded Wire for Concrete Reinforcement
o. ASTM A1044 - Standard Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete
p. ASTM A1055 - Standard Specification for Zinc and Epoxy Dual Coated Steel Reinforcing Bars
q. ASTM A1060 - Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete
r. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
s. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field
t. ASTM C33 - Standard Specification for Concrete Aggregates
u. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
v. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
w. ASTM C78 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
x. ASTM C94 - Standard Specification for Ready-Mixed Concrete
y. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
z. ASTM C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
aa. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
bb. ASTM C150 - Standard Specification for Portland Cement
cc. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete
dd. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ee. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ff. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete
gg. ASTM C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
hh. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete
ii. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete
jj. ASTM C567 - Determining Density of Structural Lightweight Concrete
kk. ASTM C595 - Standard Specification for Blended Hydraulic Cements
ll. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

mm. ASTM C803 - Standard Test Method for Penetration Resistance of Hardened Concrete
nn. ASTM C845 - Standard Specification for Expansive Hydraulic Cement
oo. ASTM C873 - Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds
pp. ASTM C900 - Standard Test Method for Pullout Strength of Hardened Concrete
qq. ASTM C920 - Standard Specification for Elastomeric Joint Sealants
rr. ASTM C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars
ss. ASTM C1012 - Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
tt. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
uu. ASTM C1074 - Standard Practice for Estimating Concrete Strength by the Maturity Method
vv. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ww. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
xx. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete
yy. ASTM C1157 - Standard Performance Specification for Hydraulic Cement
zz. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
aaa. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures
bbb. ASTM C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ccc. ASTM C1293 - Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ddd. ASTM C1567 - Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
eee. ASTM C1602 - Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
fff. ASTM C1778 - Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
ggg. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
hhh. ASTM D471 - Standard Test Method for Rubber Property - Effect of Liquids
iii. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
jjj. ASTM D1752 - Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
kkk. ASTM D2628 - Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
lll. ASTM D2835 - Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
mmm. ASTM D3042 - Standard Test Method for Insoluble Residue in Carbonate Aggregates

nnn. ASTM D5759 - Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ooo. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ppp. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials
qqq. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
rrr. ASTM E1155 - Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
sss. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
ttt. ASTM E1745 - Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
uuu. ASTM E1993 - Standard Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs

4. Concrete Reinforcing Steel Institute (CRSI):
   a. CRSI 10MSP - Manual of Standard Practice
   b. CRSI RB4.1 - Supports for Reinforcement Used in Concrete

1.04 DEFINITIONS:

A. CEMENTITIOUS MATERIAL: As used herein must include all portland cement, pozzolan, fly ash, slag cement, and silica fume.
B. EXPOSED TO PUBLIC VIEW: Means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.
C. CHEMICAL ADMIXTURES: Materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.
D. SUPPLEMENTARY CEMENTING MATERIALS (SCM): Inclusive of coal fly ash, silica fume, slag cement, natural or calcined pozzolans, and ultra-fine coal ash when used in such proportions to replace the portland cement that result in improvement to sustainability and durability and reduced cost.
E. DESIGN STRENGTH, f'c: Specified compressive strength of concrete at time(s) specified in this section to meet structural design criteria.
F. MASS CONCRETE: Any concrete system that approaches a maximum temperature of 158 degrees F within the first 72 hours of placement. In addition, it includes all concrete elements with a section thickness of 3 feet or more regardless of temperature.
G. MIXTURE PROPORTIONING: The process of designing concrete mixture proportions to enable it to meet the strength, service life and constructability requirements of the project while minimizing the initial and life-cycle cost.
H. MIXTURE PROPORTIONS: The masses or volumes of individual ingredients used to make a unit measure (cubic meter or cubic yard) of concrete.
I. POZZOLAN: A siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.
J. WORKABILITY (or consistence): The ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.05 INFORMATIONAL SUBMITTALS:

A. General: Submit each item in this Article according to the Conditions of the Contract and as specified here.

B. Include, but not limited to, product data and shop drawings for the following:

1. Product Data:
   a. Joint Sealants
   b. Joint Filler
   c. Formwork Materials
   d. Recycled Aggregate Materials
   e. Cementitious Materials
   f. Vapor Retarder and Vapor Barrier
   g. Concrete Curing Materials
   h. Reinforcement
   i. Liquid Chemical Floor Hardeners and Sealers
   j. Admixtures
   k. Reinforcing Fibers
   l. Mechanical Reinforcing Bar Connectors
   m. Waterstops
   n. Local/Regional Materials; (LEED NC)
   o. Nonshrink Grout
2. Design Data:
   a. Concrete Mix Design
3. Test Reports:
   a. Concrete Mix Design
   b. Fly Ash
   c. Pozzolan
   d. Slag Cement
   e. Aggregates
   f. Compressive Strength Tests
   g. Unit Weight of Structural Concrete
   h. Air Content
   i. Slump Tests
   j. Water
4. Certificates
   a. Reinforcing Bars
   b. Field Testing Technician and Testing Agency

1.06 DELIVERY, STORAGE, AND HANDLING

A. General: Follow ACI 301, ACI 304R and ASTM A934 requirements and recommendations. Do not deliver concrete until vapor retarder, vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

B. Materials:

1. Reinforcement:
   a. Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.07 QUALITY ASSURANCE

A. Design Data:
   1. Concrete Mix Design:
      a. Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, supplementary cementitious materials, and admixtures; and applicable reference specifications.
      b. Submit mill test and all other test for cement, supplementary cementitious materials, aggregates, and admixtures.
      c. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size.
      d. Provide mix proportion data for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes. For previously approved concrete mix designs used within the past twelve months, the previous mix design may be re-submitted without further trial batch testing if accompanied by material test data conducted within the last six months. Obtain mix design approval from the Design Engineer prior to concrete placement.

B. Test Reports:
   1. Fly Ash and Pozzolan
      a. Submit test results in accordance with ASTM C618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date.
   2. Slag Cement
      a. Submit test results in accordance with ASTM C989 for slag cement. Submit test results performed within 6 months of submittal date.
   3. Aggregates
      a. Submit test results in accordance with ASTM C33, or ASTM C330 for lightweight aggregate, and ASTM C1293 or ASTM C1567 as required in the paragraph titled ALKALI-AGGREGATE REACTION.
   4. Fiber-Reinforced Concrete
      a. Test to determine flexural toughness index I5 in accordance with ASTM C1116.

C. Quality Control Plan:
   1. Develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R and as specified herein. The plan must include approved laboratories. Provide direct oversight for the concrete qualification program inclusive of associated sampling and testing. All quality control reports must be provided to the City, Quality Manager and Concrete Supplier. Maintain a copy of ACI SP-15 and CRSI 10MSP at project site.

D. Quality Control Personnel Certifications
   1. The Contractor must submit for approval the responsibilities of the various quality control personnel, including the names and qualifications of the individuals in those positions and a quality control organizational chart defining the quality control hierarchy and the responsibility of the various positions. Quality control personnel must be employed by the Contractor.
   2. Submit American Concrete Institute certification for the following:
      a. CQC personnel responsible for inspection of concrete operations.

b. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews.
c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

3. Quality Manager Qualifications:
   a. The quality manager must hold a current license as a professional engineer in a U.S. state or territory with experience on at least five similar projects. Evidence of extraordinary proven experience may be considered by the City as sufficient to act as the Quality Manager.
4. Field Testing Technician and Testing Agency:
   a. Submit data on qualifications of proposed testing agency and technicians for approval by the City prior to performing testing on concrete.
   b. Work on concrete under this contract must be performed by an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with ACI SP-2 or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in ACI SP-2.
   c. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.
   d. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077.
5. Laboratory Qualifications for Concrete Qualification Testing
   a. The concrete testing laboratory must have the necessary equipment and experience to accomplish required testing. The laboratory must meet the requirements of ASTM C1077 and be Cement and Concrete Reference Laboratory (CCRL) inspected.
6. Laboratory Accreditation
   a. Laboratory and testing facilities must be provided by and at the expense of the Contractor. The laboratories performing the tests must be accredited in accordance with ASTM C1077, including ASTM C78 and ASTM C1260. The accreditation must be current and must include the required test methods, as specified. Furthermore, the testing must comply with the following requirements:
   b. Aggregate Testing and Mix Proportioning: Aggregate testing and mixture proportioning studies must be performed by an accredited laboratory and under the direction of a registered professional engineer in a U.S. state or territory competent in concrete materials and must sign all reports and designs.
   c. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31.
   d. Contractor Quality Control: All sampling and testing must be performed by an approved, onsite, independent, accredited laboratory.

PART 2 – PRODUCTS

2.01 FORMWORK MATERIALS

A. General:
   1. Form-facing material in contact with concrete must be lumber, plywood, tempered concrete-form-grade hardboard, metal, or plastic. Submit product information on proposed form-facing materials if different from that specified herein.

2. Design formwork, shores, reshores, and backshores to support loads transmitted to them and to comply with applicable building code requirements.
3. Design formwork and shoring for load redistribution resulting from stressing of post-tensioned reinforcement. Ensure that formwork allows movement resulting from application of prestressing force.
4. Design formwork to withstand pressure resulting from placement and vibration of concrete and to maintain specified tolerances.
5. Design formwork to accommodate waterstop materials in joints at locations indicated in Contract Documents.
6. Provide temporary openings in formwork if needed to facilitate cleaning and inspection.
7. Design formwork joints to inhibit leakage of mortar.
8. Limit deflection of facing materials for concrete surfaces exposed to view to 1/240 of center-to-center spacing of facing supports.
9. Do not use earth cuts as forms for vertical or sloping surfaces.
10. Submit product information on proposed form-facing materials if different from that specified herein.
11. Submit shop drawings for formwork, shoring, reshoring, and backshoring. Shop drawings must be signed and sealed by a licensed design engineer.
12. Submit design calculations for formwork, shoring, reshoring, and backshoring. Design calculations must be signed and sealed by a licensed design engineer.
13. Submit procedure for reshoring and backshoring, including drawings signed and sealed by a licensed design engineer. Include on shop drawings the formwork removal procedure and magnitude of construction loads used for design of reshoring or backshoring system. Indicate in procedure the magnitude of live and dead loads assumed for required capacity of the structure at time of reshoring or backshoring.
14. Submit manufacturer's product data on form liner proposed for use with each formed surface.

E. Wood Forms
1. Use lumber as follows. Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with NIST PS 1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining.

F. Steel Forms
1. Provide steel form surfaces that do not contain irregularities, dents, or sags.

2.02 FORMWORK ACCESSORIES

A. General:
1. Use commercially manufactured formwork accessories, including ties and hangers.
2. Form ties and accessories must not reduce the effective cover of the reinforcement.

B. Accessories:
1. Form Ties
   a. Use form ties with ends or end fasteners that can be removed without damage to concrete.
   b. Where indicated in Contract Documents, use form ties with integral water barrier plates or other acceptable positive water barriers in walls.
   c. The breakback distance for ferrous ties must be at least 2 in. for Surface Finish-2.0 or Surface Finish-3.0, as defined in ACI 301.
   d. If the breakback distance is less than 3/4 in., use coated or corrosion-resistant ties.
   e. Submit manufacturer's data sheet on form ties.
2. Waterstops

a. Submit manufacturer's data sheet on waterstop materials and splices.
b. PVC Waterstop
    1) Polyvinylchloride waterstops must conform to COE CRD-C 572.
b. Rubber Waterstop
    1) Rubber waterstops must conform to COE CRD-C 513.
a. Thermoplastic Elastomeric Rubber Waterstop
    1) Thermoplastic elastomeric rubber waterstops must conform to ASTM D471.
a. Hydrophilic Waterstop
    1) Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water must conform to the following requirements when tested in accordance to ASTM D412: Tensile strength 420 psi minimum; ultimate elongation 600 percent minimum. Hardness must be 50 minimum on the type A durometer and the volumetric expansion ratio in distilled water at 70 degrees F must be 3 to 1 minimum.

3. Biodegradable Form Release Agent
    a. Provide form release agent that is colorless, biodegradable.
    b. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
    c. Provide form release agent that reduces formwork moisture absorption, and does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene. Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.
    d. Submit manufacturer's product data on formwork release agent for use on each form-facing material.
4. Chamfer Materials
    a. Use lumber materials with dimensions of 3/4 x 3/4 in.
5. Construction and movement joints
    a. Submit details and locations of construction joints in accordance with the requirements herein.
    b. Locate construction joints within middle one-third of spans of slabs, beams, and girders. If a beam intersects a girder within the middle one-third of girder span, the distance between the construction joint in the girder and the edge of the beam must be at least twice the width of the larger member.
    c. For members with post-tensioning tendons, locate construction joints where tendons pass through centroid of concrete section.
    d. Locate construction joints in walls and columns at underside of slabs, beams, or girders and at tops of footings or slabs.
    e. Make construction joints perpendicular to main reinforcement.
    f. Provide movement joints where indicated in Contract Documents or in accepted alternate locations.
    g. Submit location and detail of movement joints if different from those indicated in Contract Documents.
    h. Submit manufacturer's data sheet on expansion joint materials.
    i. Provide keyways where indicated in Contract Documents. Longitudinal keyways indicated in Contract Documents must be at least 1-1/2 in. deep, measured perpendicular to the plane of the joint.
6. Other Embedded items
    a. Use sleeves, inserts, anchors, and other embedded items of material and design indicated in Contract Documents.

2.03 CONCRETE MATERIALS

A. Cementitious Materials
   1. Portland Cement
      a. Unless otherwise specified, provide cement that conforms to ASTM C150 Type I, II, II(MH), III, IV, V with the approval of a Registered Engineer for its intended use.
      b. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.
      c. Submit information along with evidence demonstrating compliance with referenced standards. Submittals must include types of cementitious materials, manufacturing locations, shipping locations, and certificates showing compliance.
      d. Cementitious materials must be stored and kept dry and free from contaminants.
   2. Fly Ash
      a. ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed 3 percent, unless specified otherwise by Engineer.
      b. If fly ash is used it shall range from 15 to 20 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, it shall not be used. Report the chemical analysis of the fly ash in accordance with ASTM C311. Evaluate and classify fly ash in accordance with ASTM D5759.
   3. Slag Cement
      a. ASTM C989, Grade 100 or 120.
   4. Silica Fume
      a. Silica fume must conform to ASTM C1240, including the optional limits on reactivity with cement alkalis. Silica fume may be furnished as a dry, densified material or as slurry. Proper mixing is essential to accomplish proper distribution of the silica fume and avoid agglomerated silica fume which can react with the alkali in the cement resulting in premature and extensive concrete damage. Supervision at the batch plant, finishing, and curing is essential. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume. This representative must be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume. A High Range Water Reducing admixture (HRWRA) must be used with silica fume.
   5. Other Supplementary Cementitious Materials
      a. Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirement for uniformity.
      b. Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:
         1) The strength activity index at 28 days of age must be at least 95 percent of the control specimens.
         2) The average particle size must not exceed 6 microns.
         3) The sum of $SiO_2 + Al_2O_3 + Fe_2O_3$ must be greater than 77 percent.

B. Water
   1. Water or ice must comply with the requirements of ASTM C1602.
   2. Minimize the amount of water in the mix. Improve workability by adjusting the grading of the aggregate and using admixture rather than by adding water.
   3. Water must be potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.
   4. Protect mixing water and ice from contamination during storage and delivery.

5. Submit test report showing water complies with ASTM C1602.

C. Aggregate
   1. Normal-Weight Aggregate
      a. Aggregates must conform to ASTM C33 unless otherwise specified in the Contract Documents or approved by the City and Design Engineer.
      b. Aggregates used in concrete must be obtained from the same sources and have the same size range as aggregates used in concrete represented by submitted field test records or used in trial mixtures.
      c. Store and handle aggregate in a manner that will avoid segregation and prevents contamination by other materials or other sizes of aggregates. Store aggregates in locations that will permit them to drain freely. Do not use aggregates that contain frozen lumps.
      d. Submit types, pit or quarry locations, producers' names, aggregate supplier statement of compliance with ASTM C33, and ASTM C1293 expansion data not more than 18 months old.
   2. Lightweight Aggregate
      a. Lightweight aggregate in accordance with ASTM C330.

D. Admixtures
   1. Chemical admixtures must conform to ASTM C494.
   2. Air-entraining admixtures must conform to ASTM C260.
   3. Chemical admixtures for use in producing flowing concrete must conform to ASTM C1017.
   4. Do not use calcium chloride admixtures, unless approved by a Registered Engineer for it's intended use.
   5. Use a corrosion-inhibiting admixture for concrete classified under exposure category C1 or C2 when recommended for it's intended use by a Registered Engineer.
   6. Admixtures used in concrete must be the same as those used in the concrete represented by submitted field test records or used in trial mixtures.
   7. Protect stored admixtures against contamination, evaporation, or damage.
   8. To ensure uniform distribution of constituents, provide agitating equipment for admixtures used in the form of suspensions or unstable solutions. Protect liquid admixtures from freezing and from temperature changes that would adversely affect their characteristics.
   9. Submit types, brand names, producers' names, manufacturer's technical data sheets, and certificates showing compliance with standards required herein.

2.04 MISCELLANEOUS MATERIALS

A. Concrete Curing Materials
   1. Provide concrete curing material in accordance with ACI 301 Section 5 and ACI 308.1 Section 2. Submit product data for concrete curing compounds. Submit manufacturer's instructions for placement of curing compound.

B. Nonshrink Grout
   1. Nonshrink grout in accordance with ASTM C1107.

C. Floor Finish Materials
   1. Liquid Chemical Floor Hardeners and Sealers
      a. Hardener must be a colorless aqueous solution containing a blend of inorganic silicate or siliconate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufactures instructions for placement of liquid chemical floor hardener.

b. Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content. Submit manufactures instructions for placement of sealers.

D. Expansion/Contraction Joint Filler
1. ASTM D1751 or ASTM D1752 Type I or Type II. Material must be 1/2 inch thick, unless otherwise indicated].

E. Joint Sealants
1. Submit manufacturer's product data, indicating VOC content.
a. Horizontal Surfaces, 3 Percent Slope, Maximum
1) ASTM D6690 or ASTM C920, Type M, Class 25, Use T.
b. Vertical Surfaces Greater Than 3 Percent Slope
1) ASTM C920, Type M, Grade NS, Class 25, Use T, NT. or FS SS-S-200, no sag.
c. Preformed Polychloroprene Elastomeric Type
1) ASTM D2628.
d. Lubricant for Preformed Compression Seals
1) ASTM D2835.

F. Vapor Barrier
1. ASTM E1745 Class C polyethylene sheeting, minimum 10 mil (Residential) or 15 mil (Commercial) thickness or other equivalent material with a maximum permeance rating of 0.04 perms per ASTM E96; ASTM E1745 Class C or B polyethylene sheeting, minimum 15 mil thickness or ASTM E1993 bituminous membrane or other equivalent material with a maximum permeance rating of 0.01 perms per ASTM E96, or unless otherwise approved.

G. Dovetail Anchor Slot
1. Preformed metal slot approximately 1 inch by 1 inch of not less than 22 gage galvanized steel cast in concrete. Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material.

2.05 CONCRETE MIX DESIGN

A. Properties and Requirements
1. Use materials and material combinations listed in this section and the contract documents.
2. Cementitious material content must be adequate for concrete to satisfy the specified requirements for strength, w/cm, durability, and finishability described in this section and the contract documents.
3. The minimum cementitious material content for concrete used in floors must meet the following requirements:

SIEVE	PERCENT PASSING
3/8 in.	100
No. 4	95 to 100
No. 8	65 to 80
No. 16	45 to 65
No. 30	25 to 45
No. 50	5 to 15
No. 100	0 to 5

4. Selected target slump must meet the requirements of this section, the contract documents, and must not exceed 6 in, unless approved otherwise by the City Engineer or Engineer of Record. Concrete must not show visible signs of segregation.
5. The target slump must be enforced for the duration of the project. Determine the slump by ASTM C143. Slump tolerances must meet the requirements of ACI 117.
6. The nominal maximum size of coarse aggregate for a mixture must not exceed three-fourths of the minimum clear spacing between reinforcement, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.
7. Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3. The total air content must be in accordance with the requirements of the paragraph titled DURABILITY.
8. Measure air content at the point of delivery in accordance with ASTM C173 or ASTM C231.
9. Concrete for slabs to receive a hard-troweled finish must not contain an air-entraining admixture or have a total air content greater than 3 percent, unless otherwise approved.
10. Concrete properties and requirements for each portion of the structure are specified in the table below. Refer to the paragraph titled DURABILITY for more details on exposure categories and their requirements.

Nominal maximum size of aggregate, in.	Minimum cementitious material content, pounds per cubic yard
1-1/2	470
1	520
3/4	540
3/8	610

B. Durability
   1. Alkali-Aggregate Reaction
      a. Do not use any aggregate susceptible to alkali-carbonate reaction (ACR). Use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction (ASR):
         1) For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 must not exceed 0.04 percent at one year.
         2) For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 must not exceed 0.10 percent at an age of 16 days.
         3) Alkali content in concrete (LBA) must not exceed 4 pounds per cubic yard for moderately reactive aggregate or 3 pounds per cubic yard for highly reactive aggregate. Reactivity must be determined by testing in accordance with ASTM C1293 and categorized in accordance with ASTM C1778. Alkali content is calculated as follows:

            LBA = (cement content, pounds per cubic yard) × (equivalent alkali content of portland cement in percent/100 percent)

      b. Freezing and Thawing Resistance

1) a. Provide concrete meeting the following requirements based on exposure class assigned to members for freezing-and-thawing exposure in Contract Documents:

	Minimum f'c psi	Exposure Categories^	Miscellaneous Requirements
Footings	3000 at 28 days or as specified by Design Engineer at 28 days	As specified by Engineer of Record.	Max. slump: 6 in. Submit to Engineer of Record for approval.
Columns and walls	5000 or as specified by Design Engineer at 28 days	As specified by Engineer of Record.	Nominal maximum aggregate size must be 3/4 in. Submit to Engineer of Record for approval.
Beams and elevated slabs	5000 or as specified by Design Engineer at 28 days	As specified by Engineer of Record.	Nominal maximum aggregate size must be 1/2 in. Submit to Engineer of Record for approval.
Slabs-on-ground	3000 or as specified by Design Engineer at 28 days	As specified by Engineer of Record.	Submit to Engineer of Record for approval.

	Minimum f'c psi	Exposure Categories^	Miscellaneous Requirements
Lightweight concrete suspended slab	5000 or as specified by Design Engineer at 28 days	As specified by Engineer of Record.	Submit to Engineer of Record for approval.
Concrete Toppings	5000 or as specified by Design Engineer at 28 days	As specified by Engineer of Record.	Max. slump: 6 in. Submit to Engineer of Record for approval.

*The maximum *w/cm* limits do not apply to lightweight concrete.

2) Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3. The total air content must meet the requirements of the following table:

Exposure class	Maximum w/cm*	Minimum f'c, psi	Air content	Additional Requirements
F0	N/A	2500	N/A	
F1	0.55	3500	Depends on aggregate size	N/A
F2	0.45	4500	Depends on aggregate size	See limits on maximum cementitious material by mass
F3	0.40	5000	Depends on aggregate size	See limits on maximum cementitious material by mass

Exposure class	Maximum w/cm*	Minimum f'c, psi	Air content	Additional Requirements
F3 plain concrete	0.45	4500	Depends on aggregate size	See limits on maximum cementitious material by mass

*Tolerance on air content as delivered must be plus/minus 1.5 percent.
^For f'c greater than 5000 psi, reducing air content by 1.0 percentage point is acceptable.

3) Submit documentation verifying compliance with specified requirements.

4) For sections of the structure that are assigned Exposure Class F3, submit certification on cement composition verifying that concrete mixture meets the requirements of the following table:

Nominal maximum aggregate size, in.	Total air content, percent*^	
	Exposure Class F2 and F3	Exposure Class F1
3/8	7.5	6.0
1/2	7.0	5.5
3/4	6.0	5.0
1	6.0	4.5
1-1/2	5.5	4.5
2	5.0	4.0
3	5.5	3.5

*Total cementitious material also includes ASTM C150, ASTM C595, ASTM C845, and ASTM C1157 cement. The maximum percentages above must include:

5) Fly ash or other pozzolans present in ASTM C1157 or ASTM C595 Type IP blended cement.
6) Slag cement present in ASTM C1157 or ASTM C595 Type IS blended cement.
7) Silica fume conforming to ASTM C1240 present in ASTM C1157 or ASTM C595 Type IP blended cement.

^Fly ash or other pozzolans and silica fume must constitute no more than 25 percent and 10 percent, respectively, of the total mass of the cementitious materials.

c. Corrosion and Chloride Content
   1) Provide concrete meeting the requirements of the following table based on the exposure class assigned to members requiring protection against reinforcement corrosion in Contract Documents.
   2) Submit documentation verifying compliance with specified requirements.
   3) Water-soluble chloride ion content contributed from constituents including water, aggregates, cementitious materials, and admixtures must be determined for the concrete mixture by ASTM C1218 at age between 28 and 42 days.
   4) The maximum water-soluble chloride ion (Cl-) content in concrete, percent by mass of cement is as follows:

Cementitious material	Maximum percent of total cementitious material by mass*
Fly ash or other pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM C989/C989M	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or other pozzolans, slag cement, and silica fume	50^
Total of fly ash or other pozzolans and silica fume	35^

*The maximum w/cm limits do not apply to lightweight concrete.

d. Sulfate Resistance
   1) Provide concrete meeting the requirements of the following table based on the exposure class assigned to members for sulfate exposure.

Exposure class	Maximum w/cm*	Minimum f'c, psi	Maximum water-soluble chloride ion (CL-) content in concrete, percent by mass of cement
Reinforced concrete			
C0	N/A	2500	1.00
C1	N/A	2500	0.30
C2	0.4	5000	0.15
Prestressed concrete			
C0	N/A	2500	0.06
C1	N/A	2500	0.06
C2	0.4	5000	0.06

* For seawater exposure, other types of portland cements with tricalcium aluminate (C3A) contents up to 10 percent are acceptable if the w/cm does not exceed 0.40.
** The amount of the specific source of the pozzolan or slag cement to be used shall be at least the amount determined by test or service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slag used shall not be less than the amount tested in accordance with ASTM C1012 and meeting the requirements maximum expansion requirements listed herein.
^ Other available types of cement, such as Type III or Type I, are acceptable in exposure classes S1 or S2 if the C3A contents are less than 8 or 5 percent, respectively.

2) The maximum w/cm limits for sulfate exposure do not apply to lightweight concrete.
3) Alternative combinations of cementitious materials of those listed in this paragraph are acceptable if they meet the maximum expansion requirements listed in the following table:

Exposure Class	Maximum w/cm	Minimum f'c,psi	Required cementitious materials-types			Calcium chloride admixture
			ASTM C150	ASTM C595	ASTM C1157	
S0	N/A	2500	N/A	N/A	N/A	No restrictions
S1	0.50	4000	II*^	IP(MS);IS(<70)(MS); IT(MS)	MS	No restrictions
S2	0.45	4500	IV^	IP(HS);IS(<70)(HS); IT(HS)	HS	Not permitted
S3	0.45	4500	V + pozzolan or slag cement**	IP(HS)+ pozzolan or slag cement^; IS (<70)(HS) + pozzolan or slag cement^; IT (HS) + pozzolan or slag cement**	HS + pozzolan or slag cement**	not permitted

^The 12-month expansion limit applies only when the measured expansion exceeds the 6-month maximum expansion limit.

e. Concrete Temperature
   1) The temperature of concrete as delivered must not exceed 95°F.
f. Concrete permeability
   1) Provide concrete meeting the requirements of the following table based on exposure class assigned to members requiring low permeability in the Contract Documents.
   2) Submit documentation verifying compliance with specified requirements.

C. Trial Mixtures
   1. Trial mixtures must be in accordance to ACI 301.

D. Ready-Mix Concrete
   1. Provide concrete that meets the requirements of ASTM C94.
   2. Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C94.
      a. Type and brand cement
      b. Cement and supplementary cementitious materials content in 94-pound bags per cubic yard of concrete
      c. Maximum size of aggregate
      d. Amount and brand name of admixtures
      e. Total water content expressed by water cementitious material ratio

2.06 REINFORCEMENT

A. General Requirements
   1. Bend reinforcement cold. Fabricate reinforcement in accordance with fabricating tolerances of ACI 117.
   2. When handling and storing coated reinforcement, use equipment and methods that do not damage the coating. If stored outdoors for more than 2 months, cover coated reinforcement with opaque protective material.
   3. Submit manufacturer's certified test report for reinforcement.
   4. Submit placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports. Placing drawings must indicate locations of splices, lengths of lap splices, and details of mechanical and welded splices.
   5. Submit request with locations and details of splices not indicated in Contract Documents.
   6. Submit request to place column dowels without using templates.
   7. Submit request and procedure to field-bend or straighten reinforcing bars partially embedded in concrete at locations not indicated in Contract Documents. Field bending or straightening of reinforcing bars is permitted where indicated in the Contract Documents.
   8. Submit request for field cutting, including location and type of bar to be cut and reason field cutting is required.

B. Reinforcing Bars
   1. General:
      a. Reinforcing bars must be deformed, except spirals, load-transfer dowels, and welded wire reinforcement, which may be plain.
      b. ASTM A615 with the bars marked S, Grade 60; or ASTM A996 with the bars marked R, Grade 60, or marked A, Grade 60. Cold drawn wire used for spiral reinforcement must conform to ASTM A1064.
      c. Submit mill certificates for reinforcing bars.
   2. Galvanized Reinforcing Bars
      a. Provide zinc-coated (galvanized) reinforcing bars that conform to ASTM A767, Class 1 or Class 2, as required by the contract Documents.
      b. Coating damage incurred during shipment, handling, and placing of zinc-coated (galvanized) reinforcing bars must be repaired in accordance with ASTM A780. Damaged areas must not exceed 2 percent of surface area in each linear foot of each bar or bar must not be used. The 2 percent limit on maximum allowed damaged coating area must include previously repaired areas damaged before shipment as required by ASTM A767.
   3. Epoxy-Coated Reinforcing Bars

a. Provide epoxy-coated reinforcing bars that conform to ASTM A775 or ASTM A934, Grade 60, or as indicated in Contract Documents.
b. Coatings must be applied in plants that are certified in accordance with Concrete Reinforcing Steel Institute (CRSI) Epoxy Coating Plant Certification Program or an equivalent program acceptable to the City.
c. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated reinforcing bars must be repaired. Repair damaged coating areas with patching material conforming to ASTM A775 or ASTM A934 as applicable and in accordance with material manufacturer's written recommendations. Damaged coating area must not exceed percent of surface area in each linear foot of each bar or bar must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A775 or ASTM A934 as applicable. Fading of coating color shall not be cause for rejection of epoxy-coated reinforcing bars.

4. Dual-coated Reinforcing Bars
   a. Zinc and epoxy dual-coated reinforcing bars must conform to ASTM A1055
   b. Coating damage incurred during shipment, storage, handling, and placing of zinc and epoxy dual-coated reinforcing bars must be repaired. Repair damaged coating areas with patching material conforming to ASTM A1055 and in accordance with material manufacturer's written recommendations. Damaged coating area must not exceed 2 percent of surface area in each linear foot of each bar or bar must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A1055. Fading of coating color shall not be cause for rejection of zinc and epoxy dual-coated reinforcing bars.
5. Stainless Steel Reinforcing Bars
   a. Stainless steel bars must meet the requirements of ASTM A955.
6. Headed Reinforcing Bars
   a. Headed reinforcing bars must conform to ASTM A970 including Annex A1, and other specified requirements.
7. Bar Mats
   a. Bar mats must conform to ASTM A184.
   b. If coated bar mats are required, repair damaged coating as required in the paragraph titled GALVANIZED REINFORCING BARS EPOXY-COATED REINFORCING BARS and DUAL-COATED REINFORCING BARS.
8. Headed Shear Stud Reinforcement
   a. Headed studs and headed stud assemblies must conform to ASTM A1044.

C. Mechanical Reinforcing Bar Connectors
   1. General:
      a. Provide 125 percent minimum yield strength of the reinforcement bar.
      b. Mechanical splices for galvanized reinforcing bars must be galvanized or coated with dielectric material.
      c. Mechanical splices used with epoxy-coated or dual-coated reinforcing bars must be coated with dielectric material.
      d. Submit data on mechanical splices demonstrating compliance with this paragraph.

D. Wire
   1. General:
      a. Plain or deformed steel wire must conform to ASTM A1064.
      b. Stainless steel wire must conform to ASTM A1022.
      c. Epoxy-coated wire must conform to ASTM A884. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated wires must be repaired.

Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire, wire must not be used.

E. Welded wire reinforcement
   1. General:
      a. Use welded wire reinforcement specified in Contract Documents and conforming to one or more of the specifications given herein.
      b. Plain welded wire reinforcement must conform to ASTM A1064, with welded intersections spaced no greater than 12 in. apart in direction of principal reinforcement.
      c. Deformed welded wire reinforcement must conform to ASTM A1064, with welded intersections spaced no greater than 16 in. apart in direction of principal reinforcement.
      d. Epoxy-coated welded wire reinforcement must conform to ASTM A884. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated welded wire reinforcement must be repaired in accordance with ASTM A884. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used.
      e. Stainless steel welded wire reinforcement must conform to ASTM A1022.
      f. Zinc-coated (galvanized) welded wire reinforcement must conform to ASTM A1060. Coating damage incurred during shipment, storage, handling, and placing of zinc-coated (galvanized) welded wire reinforcement must be repaired in accordance with ASTM A780.

F. Reinforcing Bar Supports
   1. General:
      a. Provide reinforcement support types within structure as required by Contract Documents. Reinforcement supports must conform to CRSI RB4.1. Submit description of reinforcement supports and materials for fastening coated reinforcement if not in conformance with CRSI RB4.1.

G. Reinforcing Fibers
   1. Synthetic Fibers
      a. In addition to the requirements specified above, provide fiber reinforced concrete in accordance with ASTM C1116 Type III, synthetic fiber reinforced concrete, and as indicated in Contract Drawings.
   2. Steel Fibers
      a. If steel fiber-reinforced concrete is specified in Contract Documents for providing shear resistance, steel fibers must be deformed and conform to ASTM A820. Steel fibers must have a length-to-diameter ratio of at least 50 and not exceed 100.

H. Dowels for Load Transfer in Floors
   1. Provide greased dowels for load transfer in floors of the type, design, weight, and dimensions indicated. Provide dowel bars that are plain-billet steel conforming to ASTM A615, Grade 60 or as indicated in Contract Documents. Provide dowel pipe that is steel conforming to ASTM A53.

I. Welding
   1. General:
      a. Provide weldable reinforcing bars that conform to ASTM A706 and ASTM A615 and Supplement S1, Grade 60, except that the maximum carbon content must be 0.55 percent.

b. Comply with AWS D1.4 unless otherwise specified. Do not tack weld reinforcing bars.
c. Welded assemblies of steel reinforcement produced under factory conditions, such as welded wire reinforcement, bar mats, and deformed bar anchors, are allowed.
d. After completing welds on zinc-coated (galvanized), epoxy-coated, or zinc and epoxy dual-coated reinforcement, coat welds and repair coating damage as previously specified.

PART 3 – EXECUTION

3.01 EXAMINATION

A. General:
1. Do not begin installation until substrates have been properly constructed; verify that substrates are level.
2. If substrate preparation is the responsibility of another installer, notify the City of unsatisfactory preparation before processing.
3. Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify the City and wait for instructions before beginning installation.

3.02 PREPARATION

A. General
1. Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.
2. Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.
3. Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

B. Subgrade Under Foundations and Footings
1. When subgrade material is semi-porous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited, or seal subgrade surface by covering surface with specified vapor retarder.
2. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder.

C. Subgrade Under Slabs on Ground
1. Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.
2. Previously constructed subgrade or fill must be cleaned of foreign materials
3. Finish surface of capillary water barrier under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.
4. Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

D. Edge Forms and Screed Strips for Slabs
1. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment.
2. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

E. Reinforcement and Other Embedded Items

1. Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.
2. When concrete is placed, reinforcement must be free of materials deleterious to bond. Reinforcement with rust, mill scale, or a combination of both will be considered satisfactory, provided minimum nominal dimensions, nominal weight, and minimum average height of deformations of a hand-wire-brushed test specimen are not less than applicable ASTM specification requirements.

3.03 FORMS

A. General:
1. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade.
2. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch unless noted otherwise in Contract Documents. Place chamfer strips in corners of formwork to produce beveled edges on permanently exposed surfaces. Do not bevel reentrant corners or edges of formed joints of concrete.
3. Provide formwork with clean-out openings to permit inspection and removal of debris.
4. Inspect formwork and remove foreign material before concrete is placed.
5. At construction joints, lap form-facing materials over the concrete of previous placement. Ensure formwork is placed against hardened concrete so offsets at construction joints conform to specified tolerances.
6. Provide positive means of adjustment (such as wedges or jacks) of shores and struts. Do not make adjustments to formwork after concrete has reached initial setting. Brace formwork to resist lateral deflection and lateral instability.
7. Fasten form wedges in place after final adjustment of forms and before concrete placement.
8. Provide anchoring and bracing to control upward and lateral movement of formwork system.
9. Construct formwork for openings to facilitate removal and to produce opening dimensions as specified and within tolerances.
10. Provide runways for moving equipment. Support runways directly on formwork or structural members. Do not support runways on reinforcement. Loading applied by runways must not exceed capacity of formwork or structural members.
11. Position and support expansion joint materials, waterstops, and other embedded items to prevent displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with removable material to prevent concrete entry into voids.
12. Clean surfaces of formwork and embedded materials of mortar, grout, and foreign materials before concrete placement.

B. Coating
1. Cover formwork surfaces with an acceptable material that inhibits bond with concrete.
2. If formwork release agent is used, apply to formwork surfaces in accordance with manufacturer's recommendations before placing reinforcement. Remove excess release agent on formwork prior to concrete placement.
3. Do not allow formwork release agent to contact reinforcement or hardened concrete against which fresh concrete is to be placed.

C. Reshoring
1. Do not allow structural members to be loaded with combined dead and construction loads in excess of loads indicated in the accepted procedure.
2. Install and remove reshores or backshores in accordance with accepted procedure.
3. For floors supporting shores under newly placed concrete, either leave original supporting shores in place, or install reshores or backshores. Shoring system and

supporting slabs must resist anticipated loads. Locate reshores and backshores directly under a shore position or as indicated on formwork shop drawings.

4. In multistory buildings, place reshoring or backshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads.

D. Reuse
   1. Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.
   2. Wood forms must not be clogged with paste and must be capable of absorbing high water-cementitious material ratio paste.
   3. Remove leaked mortar from formwork joints before reuse.

E. Forms for Standard Rough Form Finish
   1. Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-1.0, for formed surfaces that are to be concealed by other construction.

F. Forms for Standard Smooth Form Finish
   1. Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-3.0, for formed surfaces that are exposed to view.

G. Form Ties
   1. For post-tensioned structures, do not remove formwork supports until stressing records have been accepted by the City.
   2. After ends or end fasteners of form ties have been removed, repair tie holes in accordance with ACI 301 Section 5 requirements.

H. Forms for Concrete Pan Joist Construction
   1. Pan-form units for one-way or two-way concrete joist and slab construction must be factory-fabricated units of the approximate section indicated. Units must consist of steel or molded fiberglass concrete form pans. Closure units must be furnished as required.

I. Tolerances for Form Construction
   1. Construct formwork so concrete surfaces conform to tolerances in ACI 117.
   2. Position and secure sleeves, inserts, anchors, and other embedded items such that embedded items are positioned within ACI 117 tolerances.
   3. To maintain specified elevation and thickness within tolerances, install formwork to compensate for deflection and anticipated settlement in formwork during concrete placement. Set formwork and intermediate screed strips for slabs to produce designated elevation, camber, and contour of finished surface before formwork removal. If specified finish requires use of vibrating screeds or roller pipe screeds, ensure that edge forms and screed strips are strong enough to support such equipment.

J. Removal of Forms and Supports
   1. If vertical formed surfaces require finishing, remove forms as soon as removal operations will not damage concrete.
   2. Remove top forms on sloping surfaces of concrete as soon as removal will not allow concrete to sag. Perform repairs and finishing operations required. If forms are removed before end of specified curing period, provide curing and protection.
   3. Do not damage concrete during removal of vertical formwork for columns, walls, and sides of beams. Perform needed repair and finishing operations required on vertical surfaces. If forms are removed before end of specified curing period, provide curing and protection.
   4. Leave formwork and shoring in place to support construction loads and weight of concrete in beams, slabs, and other structural members until in-place required strength of concrete is reached unless allowed otherwise by Design Engineer.
   5. Form-facing material and horizontal facing support members may be removed before in-place concrete reaches specified compressive strength if shores and other supports are designed to allow facing removal without deflection of supported slab or member.

K. Strength of Concrete Required for Removal of Formwork
   1. If removal of formwork, reshoring, or backshoring is based on concrete reaching a specified in-place strength, mold and field-cure cylinders in accordance with ASTM C31. Test cylinders in accordance with ASTM C39. Alternatively, use one or more of the methods listed herein to evaluate in-place concrete strength for formwork removal.
   2. Tests of cast-in-place cylinders in accordance with ASTM C873. This option is limited to slabs with concrete depths from 5 to 12 in.
   3. Penetration resistance in accordance with ASTM C803.
   4. Pullout strength in accordance with ASTM C900.
   5. Maturity method in accordance with ASTM C1074.

3.04 WATERSTOP INSTALLATION AND SPLICES

A. General:
   1. Provide waterstops in construction joints as indicated.
   2. Install formwork to accommodate waterstop materials. Locate waterstops in joints where indicated in Contract Documents. Minimize number of splices in waterstop. Splice waterstops in accordance with manufacturer's written instructions. Install factory-manufactured premolded mitered corners.
   3. Install waterstops to form a continuous diaphragm in each joint. Make adequate provisions to support and protect waterstops during progress of work. Protect waterstops protruding from joints from damage.

B. PVC Waterstop
   1. Make splices by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. Reform waterstops at splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. The spliced area, when cooled, must show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

C. Rubber Waterstop
   1. Rubber waterstops must be spliced using cold bond adhesive as recommended by the manufacturer.

D. Thermoplastic Elastomeric Rubber Waterstop
   1. Fittings must be shop made using a machine specifically designed to mechanically weld the waterstop. A portable power saw must be used to miter or straight cut the ends to be joined to ensure good alignment and contact between joined surfaces. Maintain continuity of the characteristic features of the cross section of the waterstop (for example ribs, tabular center axis, and protrusions) across the splice.

E. Hydrophilic Waterstop
   1. Miter cut ends to be joined with sharp knife or shears. The ends must be adhered with adhesive.

3.05 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

A. Unless otherwise specified, placing reinforcement and miscellaneous materials must be in accordance to ACI 301. Provide bars, welded wire reinforcement, wire ties, supports, and other devices necessary to install and secure reinforcement.

B. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

C. Nonprestressed cast-in-place concrete members must have concrete cover for reinforcement given in the following table:

Exposure class	Maximum w/cm*	Minimum f'c, psi	Additional minimum requirements
W0	N/A	2500	None
W1	0.5	4000	None

D. Cast-in-place prestressed concrete members must have concrete cover for reinforcement, ducts, and end fittings given in the following table:

E. Precast nonprestressed or prestressed concrete members manufactured under plant conditions must have concrete cover for reinforcement, ducts, and end fittings given in the following table:

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	Slabs, joists, and walls	All	1-1/2
	All other	All	1-1/2
Not exposed to weather or in contact with ground	Slabs, joists, and walls	All	3/4
	Beams, columns, and tension ties	Primary reinforcement	1-1/2
		Stirrups, ties, spirals, and hoops	1

F. General
   1. Provide details of reinforcement that are in accordance with the Contract Documents.

G. Vapor Retarder and Vapor Barrier
   1. Install in accordance with ASTM E1643. Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches and tape.
   2. Remove torn, punctured, or damaged vapor retarder and vapor barrier material and provide with new vapor retarder and vapor barrier prior to placing concrete. Concrete placement must not damage vapor retarder and vapor barrier material. Place a 2-inch

layer of clean concrete sand on vapor retarder and vapor barrier before placing concrete. Place vapor barrier directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular material which could puncture the vapor barrier. In this case, a thin layer of approximately 1/2 inch of fine graded material should be rolled or compacted over the fill before installation of the vapor barrier to reduce the possibility of puncture. Control concrete placement so as to prevent damage to the vapor barrier.]

H. Perimeter Insulation
   1. Install perimeter insulation at locations indicated. Adhesive must be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

I. Reinforcement Supports
   1. Provide reinforcement support in accordance with CRSI RB4.1 and ACI 301 Section 3 requirements. Supports for coated or galvanized bars must also be coated with electrically compatible material for a distance of at least 2 inches beyond the point of contact with the bars.

J. Epoxy Coated Reinforcing
   1. Epoxy Coated Reinforcing must meet the requirements of ASTM A934 "Guidelines for Job Site Practices" except as otherwise specified herein.
   2. Epoxy Coated Reinforcing Steel Placement and Coating Repair
      a. Carefully handle and install bars to minimize job site patching. Use the same precautions as described in the paragraph titled EPOXY-COATED REINFORCING BARS. Do not drag bars over other bars or over abrasive surfaces. Keep bar free of dirt and grit. When possible, assemble reinforcement as tied cages prior to final placement into the forms. Support assembled cages on padded supports. It is not expected that coated bars, when in final position ready for concrete placement, are completely free of damaged areas; however, excessive nicks and scrapes which expose steel is cause for rejection. Criteria for defects which require repair and for those that do not require repair are as indicated. Inspect for defects and provide required repairs prior to assembly. After assembly, reinspect and provide final repairs.
      b. Immediately prior to application of the patching material, manually remove any rust and debonded coating from the reinforcement by suitable techniques employing devices such as wire brushes and emery paper. Exercise cars during this surface preparation so that the damaged areas are not enlarged more than necessary to accomplish the repair. Clean damaged areas of dirt, debris, oil, and similar materials prior to application of the patching material.
      c. Do repair and patching in accordance with the patching material manufacturer's recommendations. These recommendations, including cure times, must be available at the job site at all times.
      d. Allow adequate time for the patching materials to cure in accordance with the manufacturer's recommendation prior to concrete placement.
      e. Rinse placed reinforcing bars with fresh water to remove chloride contamination prior to placing concrete.

K. Splicing
   1. As indicated in the Contract Documents. For splices not indicated follow ACI 301. Do not splice at points of maximum stress. Overlap welded wire reinforcement the spacing of the cross wires, plus 2 inches. AWS D1.4. Approve welded splices prior to use. Repair the cut ends of hot-dipped galvanized reinforcement steel to completely coat exposed steel, ASTM A780.

L. Future Bonding

1. Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

M. Setting Miscellaneous Material
   1. Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement and support against displacement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

N. Fabrication
   1. Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:
      a. Provide fabrication tolerances that are in accordance with ACI 117.
      b. Provide hooks and bends that are in accordance with the Contract Documents. Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

         Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.
   2. Do not use reinforcement that has any of the following defects:
      a. Bar lengths, depths, and bends beyond specified fabrication tolerances
      b. Bends or kinks not indicated on drawings or approved shop drawings
      c. Bars with reduced cross-section due to rusting or other cause
      d. Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

O. Placing Reinforcement
   1. General:
      a. Place reinforcement in accordance with ACI 301.
      b. For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire reinforcement on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.
      c. For slabs other than on grade, supports for which any portion is less than 1 inch from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless-steel protected bar supports. Precast concrete units must be wedge shaped, not larger than 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.
   2. Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:
      a. Provide supports for reinforcing bars that are sufficient in number and have sufficient strength to carry the reinforcement they support, and in accordance with ACI 301 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.
      b. Equip supports on ground and similar surfaces with sand-plates.
      c. Support welded wire reinforcement as required for reinforcing bars.
      d. Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

e. Reinforcement must be accurately placed, securely tied at intersections, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to the Contract Documents.
f. Bending of reinforcing bars partially embedded in concrete is permitted only as specified in the Contract Documents.

P. Spacing of Reinforcing Bars
1. Spacing must be as indicated in the Contract Documents.
2. Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to preapproval by the City.

Q. Concrete Protection for Reinforcement
1. Additional concrete protection must be in accordance with the Contract Documents.

R. Welding
1. Welding must be in accordance with AWS D1.4.

3.06 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

A. General:
1. In accordance with ASTM C94, ACI 301, ACI 302.1R and ACI 304R, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready-mix concrete.

B. Measuring
1. Make measurements at intervals as specified in paragraphs SAMPLING and TESTING.

C. Mixing
1. Mix concrete in accordance with ASTM C94, ACI 301 and ACI 304R.
2. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the concrete temperature is less than 84 degrees F.
3. Place concrete within 60 minutes if the concrete temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and submitted water-cementitious material ratio are not exceeded and the required concrete strength is still met. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required.
4. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture, within the manufacturer's recommended dosage, to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch. Do not reconstitute concrete that has begun to solidify.
5. When fibers are used, add fibers together with the aggregates and never as the first component in the mixer. Fibers must be dispensed into the mixing system using appropriate dispensing equipment and procedure as recommended by the manufacturer.

D. Transporting
1. Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.07 PLACING CONCRETE

A. Place concrete in accordance with ACI 301 Section 5. Concrete shall be placed within 15 minutes of discharge into non-agitating equipment.

B. Footing Placement
   1. Concrete for footings may be placed in excavations without forms upon inspection and approval by the City. Excavation width must be a minimum of 4 inches greater than indicated.

C. Pumping
   1. ACI 304R and ACI 304.2R. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches at discharge/placement. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well-rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.
   2. Pumping Lightweight Concrete
      a. In accordance with ACI 213R unless otherwise specified. Presoak or presaturate aggregates. Cement content must be minimum of 564 pounds per cubic yard and be sufficient to accommodate a 4 to 6 inch slump. Make field trial run in accordance with ACI 213R.

D. Cold Weather
   1. Do not place concrete when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees. Cold weather concrete must meet the requirements of ACI 301 and ACI 306.1, unless otherwise specified. Do not allow concrete temperature to decrease below 50 degrees F. Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

E. Hot Weather
   1. Hot weather concrete must meet the requirements of ACI 301 and ACI 305.1, unless otherwise specified. Maintain required concrete temperature using Figure 4.2 in ACI 305R to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

F. Bonding
   1. Surfaces of set concrete at joints, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the

aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

2. Obtain bonding of fresh concrete that has set as follows:
   a. At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.
   b. At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.
   c. Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

3.08 WASTE MANAGEMENT

A. General
   1. Provide as specified in the Waste Management Plan and as follows.

B. Mixing Equipment
   1. Before concrete pours, designate on-site area for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

C. Reinforcing Steel
   1. Collect reinforcing steel and place in designated area for recycling.

D. Other Waste
   1. Will be the responsibility of the Contractor to dispose of at an approved location.

3.09 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

A. Defects
   1. Repair surface defects in accordance with ACI 301 Section 5.

B. Not Against Forms (Top of Walls)
   1. Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

C. Formed Surfaces
   1. Tolerances in accordance with ACI 117 and as indicated.
   2. As-Cast Rough Form
      a. Provide for surfaces not exposed to public view a surface finish SF-1.0. Patch holes and defects in accordance with ACI 301.
   3. Standard Smooth Finish
      a. Provide for surfaces exposed to public view a surface finish SF-3.0. Patch holes and defects in accordance with ACI 301.

3.10 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

A. General:
   1. In accordance with ACI 301 and ACI 302.1R, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Depress the concrete base slab where quarry tile, ceramic tile, or as indicated in Contract Documents. Steel trowel and fine-broom finish concrete slabs that are to receive quarry tile, ceramic tile, or paver tile or as indicated in Contract Documents. Where straightedge measurements are specified, Contractor must provide straightedge.

B. Finish

1. Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater. Grate tampers ("jitterbugs") shall not be used.
2. Scratched
    a. Use for surfaces intended to receive bonded applied cementitious applications. Finish concrete in accordance with ACI 301 Section 5 for a scratched finish.
3. Floated
    a. Use for surfaces to receive roofing, waterproofing membranes, sand bed terrazzo, , exterior slabs where not otherwise specified. Finish concrete in accordance with ACI 301 Section 5 for a floated finish.
4. Steel Troweled
    a. Use for floors intended as walking surfaces, and for reception of floor coverings. Finish concrete in accordance with ACI 301 Section 5 for a steel troweled finish.
5. Nonslip Finish
    a. Use on surfaces of exterior platforms, steps, and landings; and on exterior and interior pedestrian ramps. Finish concrete in accordance with ACI 301 Section 5 for a dry-shake finish. After the selected material has been embedded by the two floatings, complete the operation with a broomed finish, unless noted otherwise in Construction Documents.
6. Broomed
    a. Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Finish concrete in accordance with ACI 301 Section 5 for a broomed finish.
7. Pavement
    a. Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary.
8. Concrete Toppings Placement
    a. The following requirements apply to the placement of toppings of concrete on base slabs that are either freshly placed and still plastic, or on hardened base slabs.
        1) Placing on a Fresh Base: Screed and bull float the base slab. As soon as the water sheen has disappeared, lightly rake the surface of the base slab with a stiff bristle broom to produce a bonding surface for the topping. Immediately spread the topping mixture evenly over the roughened base before final set takes place. Give the topping the finish indicated on the Contract Documents.
        2) Bonding to a Hardened Base: When the topping is to be bonded to a floated or troweled hardened base, roughen the base by scarifying, grit-blasting, scabbling, planing, flame cleaning, or acid-etching to lightly expose aggregate and provide a bonding surface. Remove dirt, laitance, and loose aggregate by means of a stiff wire broom. Keep the clean base wet for a period of 12 hours preceding the application of the topping. Remove excess water and apply a 1:1:1/2 cement-sand-water grout, and brush into the surface of the base slab. Do not allow the cement grout to dry, and spread it only short distances ahead of the topping placement. Do not allow the temperature differential between the completed base and the topping mixture to exceed 41 degrees F at the time of placing. Place the topping and finish as indicated in Construction Documents.
9. Chemical-Hardener Treatment

a. Apply liquid-chemical floor hardener where indicated after curing and drying concrete surface. Dilute liquid hardener with water and apply in three coats. First coat must be one-third strength, second coat one-half strength, and third coat two-thirds strength. Apply each coat evenly and allow to dry 24 hours between coats.
b. Approved proprietary chemical hardeners must be applied in accordance with manufacturer's printed directions.

10. Heavy-Duty Wear-Resistant Finish
    a. Give finish to slab surfaces where indicated.

11. Flat Floor Finishes
    a. Provide finish in accordance ACI 302.1R. Construct in accordance with one of the methods recommended in Table 10.15.3a, "Slab-on-ground flatness/levelness construction guide" or Table 10.15.3b, "Suspended slab flatness/levelness construction guide" appropriate for the type of construction. ACI 117 for tolerance tested by ASTM E1155.
    b. Measurement of Floor Tolerances
        1) Test slab within 24 hours of the final troweling. Provide tests to City within 12 hours after collecting the data. Floor flatness inspector is required to provide a tolerance report which must include:
        3.10.B.11.b.1.1 a. Key plan showing location of data collected.
        3.10.B.11.b.1.2 b. Results required by ASTM E1155.
    c. Remedies for Out of Tolerance Work
        1) Contractor is required to repair and retest any floors not meeting specified tolerances. Prior to repair, Contractor must submit and receive approval for the proposed repair, including product data from any materials proposed. Repairs must not result in damage to structural integrity of the floor. For floors exposed to public view, repairs must prevent any uneven or unusual coloring of the surface.
12. Concrete Walks
    a. Provide 4 inches thick minimum unless specified otherwise in Contract Documents. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints 1 inch deep, or one fourth the slab thickness whichever is deeper, with a jointing tool after the surface has been finished. Provide 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 1/4 inch in 5 feet.
13. Pits and Trenches
    a. Place bottoms and walls monolithically or provide waterstops and keys.
14. Curbs and Gutters
    a. Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Perform pavement finish.
15. Splash Blocks
    a. Provide at outlets of downspouts emptying at grade. Splash blocks may be precast concrete, and must be 24 inches long, 12 inches wide and 4 inches thick, unless otherwise indicated, with smooth-finished countersunk dishes sloped to drain away from the building.

3.11 JOINTS

A. Construction Joints, unless otherwise specified in Construction Documents:
   1. Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Joints must be perpendicular to main reinforcement. Reinforcement must be continued and developed across construction joints. Locate construction joints as follows:
   2. Maximum Allowable Construction Joint Spacing:
      a. In walls at not more than 60 feet in any horizontal direction.
      b. In slabs on ground, so as to divide slab into areas not in excess of 1,200 square feet.
   3. Construction Joints for Constructability Purposes
      a. In walls, at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall.
      b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier.
      c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.
      d. Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

B. Isolation Joints in Slabs on Ground
   1. Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
   2. Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

C. Contraction Joints in Slabs on Ground
   1. Provide joints to form panels as indicated.
   2. Under and on exact line of each control joint, cut 50 percent of welded wire reinforcement before placing concrete.
   3. Sawcut contraction joints into slab on ground in accordance with ACI 301 Section 5.
   4. Joints must be 1/8-inch wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean groove of foreign matter and loose particles.
   5. Sawcutting will be limited to within 12 hours after set and at 1/4 slab depth.

D. Sealing Joints in Slabs on Ground
   1. Contraction and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.
   2. Sealed groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.12 CONCRETE FLOOR TOPPING

A. Standard Floor Topping

1. Provide topping for treads and platforms of metal steel stairs and elsewhere as indicated.
2. Preparations Prior to Placing
    a. When topping is placed on a green concrete base slab, screed surface of base slab to a level not more than 1-1/2 inches nor less than 1 inch below required finish surface. Remove water and laitance from surface of base slab before placing topping mixture. As soon as water ceases to rise to surface of base slab, place topping.
    b. When topping is placed on a hardened concrete base slab, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from base slab surface, leaving a clean surface. Prior to placing topping mixture, 2-1/2-inches minimum, slab surface must be dampened and left free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Do not allow cement grout to set or dry before topping is placed.
    c. When topping is placed on a metal surface, such as metal pans for steel stairs, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from metal surface.
3. Placing
    a. Spread standard topping mixture evenly on previously prepared base slab or metal surface, brought to correct level with a straightedge, and struck off. Topping must be consolidated, floated, checked for trueness of surface, and refloated as specified for float finish.
4. Finishing
    a. Give trowel finish standard floor topping surfaces.
    b. Give other finishes standard floor topping surfaces as indicated in Construction Documents.

B. Heavy-Duty Floor Topping
1. Provide topping where indicated in Construction Documents.
2. Base Slab
    a. Screed surface of slab to a level no more than 1-1/2 inches nor less than 1 inch below grade of finished floor.
    b. Give slab a scratch finish as specified.
    c. Preparations prior to placing.
        1) Remove dirt, loose material, oil, grease, asphalt, paint and other contaminants from base slab surface. Prior to placing topping mixture, dampen slab surface and leave free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Allow cement grout to set or dry before topping mixture is placed.
3. Placing
    a. Spread heavy-duty topping mixture evenly on previously prepared base slab, and bring to correct level with a straightedge, and strike off. Provide topping that is consolidated, floated, and checked for trueness of surface as specified for float finish, except that power-driven floats is the impact type.
4. Finishing
    a. Give trowel finish heavy-duty floor topping surfaces. Provide trowel finish as specified, except that additional troweling after first power troweling must be not less than three hand-troweling operations.

3.13 CURING AND PROTECTION

A. Curing and protection in accordance with ACI 301 Section 5, unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations.

Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer, hardener, or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

B. Requirements for Type III, High-Early-Strength Portland Cement
   1. The curing periods are required to be not less than one-fourth of those specified for portland cement, but in no case less than 72 hours.

C. Curing Periods
   1. ACI 301 Section 5, except 10 days for retaining walls, pavement or chimneys. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the City.

D. Curing Formed Surfaces
   1. Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

E. Curing Unformed Surfaces
   1. Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.
   2. Accomplish final curing of unformed surfaces by any of curing methods specified, as applicable.
   3. Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

F. Temperature of Concrete During Curing
   1. When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.
   2. When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.
   3. Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

G. Protection from Mechanical Injury
   1. During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

H. Protection After Curing
   1. Protect finished concrete surfaces from damage by construction operations.

3.14 FIELD QUALITY CONTROL

A. Aggregate Testing
   1. Fine Aggregate
      a. At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C136 and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall be immediately reported to the City, concreting shall be stopped, and immediate steps taken to correct the grading.
   2. Coarse Aggregate
      a. At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the City. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and reported to the City. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

B. Concrete Sampling
   1. ASTM C172. Collect samples of fresh concrete to perform tests specified. ASTM C31 for making test specimens.

C. Concrete Testing
   1. Slump Tests
      a. ASTM C143. Take concrete samples during concrete placement/discharge. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cementitious material ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.
   2. Temperature Tests
      a. Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.
   3. Compressive Strength Tests
      a. ASTM C39. Make six 6 inch by 12-inch test cylinders for each set of tests in accordance with ASTM C31, ASTM C172 and applicable requirements of ACI 305R and ACI 306R. Take precautions to prevent evaporation and loss of water from the

specimen. Test two cylinders at 7 days, two cylinders at 28 days, and hold two cylinder in reserve. Take samples for strength tests of each concrete placed each day not less than once a day, nor less than once for each 100 cubic yards of concrete for the first 500 cubic yards, then every 500 cubic yards thereafter, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. Concrete compressive tests must meet the requirements of this section, the Contract Documents, and ACI 301. Retest locations represented by erratic core strengths. Where retest does not meet concrete compressive strength requirements submit a mitigation or remediation plan for review and approval by the Design Engineer. Repair core holes with non-shrink grout. Match color and finish of adjacent concrete.

4. Air Content
   a. ASTM C173 or ASTM C231 for normal weight concrete and ASTM C173 for lightweight concrete. Test air-entrained concrete for air content at the same frequency as specified for slump tests.
5. Unit Weight of Structural Concrete
   a. ASTM C56 and ASTM C138. Determine unit weight of lightweight and normal weight concrete. Perform test for every 20 cubic yards maximum.
6. Chloride Ion Concentration
   a. Chloride ion concentration must meet the requirements of the paragraph titled CORROSION AND CHLORIDE CONTENT. Determine water soluble ion concentration in accordance with ASTM C1218. Perform test once for each mix design.
7. Strength of Concrete Structure
   a. The strength of the concrete structure will be considered to be deficient if any of the following conditions are identified:
      1) Failure to meet compressive strength tests as evaluated.
      2) Reinforcement not conforming to requirements specified.
      3) Concrete which differs from required dimensions or location in such a manner as to reduce strength.
      4) Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified.
      5) Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.
      6) Poor workmanship likely to result in deficient strength.
      7) Where the strength of the concrete structure is considered deficient submit a mitigation or remediation plan for review and approval by the City.
8. Non-Conforming Materials
   a. Factors that indicate that there are non-conforming materials include (but not limited to) excessive compressive strength, inadequate compressive strength, excessive slump, excessive voids and honeycombing, concrete delivery records that indicate excessive time between mixing and placement, or excessive water was added to the mixture during delivery and placement. Any of these indicators alone are sufficient reason for the City to request additional sampling and testing.
   b. Investigations into non-conforming materials must be conducted at the Contractor's expense. The Contractor must be responsible for the investigation and must make written recommendations to adequately mitigate or remediate the non-conforming material. The City may accept, accept with reduced payment, require mitigation, or

require removal and replacement of non-conforming material at no additional cost to the Government.

9. Testing Concrete Structure for Strength
    a. When there is evidence that strength of concrete structure in place does not meet specification requirements or there are non-conforming materials, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C42, and as follows:
        1) Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the City.
        2) Test cores after moisture conditioning in accordance with ASTM C42 if concrete they represent is more than superficially wet under service.
        3) Air dry cores, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.
        4) Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.
        5) Core specimens will be taken and tested by an independent testing agency. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required must be borne by the Contractor.
        6) Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.
        7) Correct concrete work that is found inadequate by core tests in a manner approved by the City.

3.15 REPAIR, REHABILITATION AND REMOVAL

A. General:
    1. Before the City accepts the structure, the Contractor must inspect the structure for cracks, damage and substandard concrete placements that may adversely affect the service life of the structure. A report documenting these defects must be prepared which includes recommendations for repair, removal or remediation must be submitted to the City for approval before any corrective work is accomplished.

B. Crack Repair
    1. Prior to final acceptance, all cracks in excess of 0.02 inches wide must be documented and repaired. The proposed method and materials to repair the cracks must be submitted to the City for approval. The proposal must address the amount of movement expected in the crack due to temperature changes and loading.

C. Repair of Weak Surfaces
    1. Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Concrete surfaces with weak surfaces less than 1/4 inch thick must be diamond ground to remove the weak surface. Surfaces containing weak surfaces greater than 1/4 inch thick must be removed and replaced or mitigated in a manner acceptable to the Design Engineer.

D. Failure of Quality Assurance Test Results
    1. Proposed mitigation efforts by the Contractor must be approved by the City prior to proceeding.

END OF SECTION 347000

This page was intentionally left blank.

SECTION 347100 - CONCRETE CURBS, GUTTERS, SIDEWALKS, MEDIANS AND PAVED DRAINAGE

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This section includes related items specified elsewhere:
   1. Section 312050 – Site Preparation and Earthwork
   2. Section 347000 – Concrete

B. Refer to City Standard Details for related items
   1. Concrete Curb and Gutter
   2. Concrete Sidewalk and Driveway
   3. Curb Ramp with Detectable Warning
   4. Curb Ramp Type I
   5. Curb Ramp Type II
   6. Concrete Joint Details

1.03 REFERENCES:

A. Applicable Standards (Latest Edition)
   1. American Association of State Highway and Transportation (AASHTO):
      a. AASHTO M 182 - Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats
   2. American Concrete Institute (ACI):
      a. ACI 305 – Hot-Weather Concreting
      b. ACI 306 – Cold-weather Concreting
   3. American Society for Testing and Materials (ASTM):
      a. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
      b. ASTM A1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
      c. ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
      d. ASTM C94 – Standard Specification for Ready-Mixed Concrete
      e. ASTM C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete
      f. ASTM C171 – Standard Specification for Sheet Materials for Curing Concrete
      g. ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete
      h. ASTM C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
      i. ASTM C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
      j. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
      k. ASTM C920 – Standard Specification for Elastomeric Joint Sealants
      l. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

m. ASTM D1752 – Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
n. ASTM D5893 – Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

4. Federal Specifications:
   a. TT-S-00227 – Sealing Compound; Elastomeric Type, Multi component. (For caulking, sealing, and glazing in buildings and other structures.)
5. International Code Council (ICC):
   a. ICC A117.1 – Standard and Commentary Accessible and Usable Buildings and Facilities

1.04 INFORMATIONAL SUBMITTALS

A. General Requirements: Submit each item in this Article according to the Conditions of the Contract and as specified herein.
B. Product Data
   1. Concrete
   2. Test Reports
   3. Field Quality Control

1.05 EQUIPMENT, TOOLS, AND MACHINES

A. General Requirements
   1. Plant, equipment, machines, and tools used in the work will be subject to approval and must be maintained in a satisfactory working condition at all times. Use equipment capable of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Discontinue using equipment that produces unsatisfactory results. Allow the City Engineer or City Representative access at all times to the plant and equipment to ensure proper operation and compliance with specifications.
B. Slip Form Equipment
   1. Slip form paver or curb forming machines, will be approved based on trial use on the job and must be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one pass.

1.06 WEATHER LIMITATIONS

A. Placing During Cold Weather
   1. Do not place concrete when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection must be approved in writing. Approval will be contingent upon full conformance with the following provisions. Prepare and protect the underlying material so that it is entirely free of frost when the concrete is deposited. Use only aggregates that are free of ice, snow, and frozen lumps before entering the mixer. Provide covering or other means as needed to maintain the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the

remainder of the curing period. Conform to ACI 306 when temperature is below 40 degrees F within a 24-hour period after placement of concrete.

B. Placing During Warm Weather
   1. The temperature of the concrete as placed must not exceed 85 degrees F except where an approved retarder is used. The placing temperature must not exceed 95 degrees F at any time. Conform to ACI 305 when temperature is above 90 degrees F, or is likely to rise above 90 degrees F within a 24-hour period after placement of concrete.

PART 2 – PRODUCTS

2.01 CONCRETE

A. General Requirements:
   1. Provide concrete conforming to the applicable requirements of Section 347000 CONCRETE except as otherwise specified. Concrete must have a minimum compressive strength of 4000 psi at 28 days. Size of aggregate must not exceed 1-1/2 inches. Submit copies of certified delivery tickets for all concrete used in the construction.

B. Air Content:
   1. Use concrete mixtures that have an air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

C. Slump:
   1. Use concrete with a slump of 3 inches plus or minus 1 inch for hand placed concrete or 1 inch plus or minus 1/2 inch for slip formed concrete as determined in accordance with ASTM C143.

D. Reinforcement Steel:
   1. Use reinforcement bars conforming to ASTM A615. Use wire mesh reinforcement conforming to ASTM A1064.

2.02 CONCRETE CURING MATERIALS

A. Impervious Sheet Materials
   1. Use impervious sheet materials conforming to ASTM C171, type optional, except that polyethylene film, if used, must be white opaque.

B. Burlap
   1. Use burlap conforming to AASHTO M 182.

C. White Pigmented Membrane-Forming Curing Compound
   1. Use white pigmented membrane-forming curing compound conforming to ASTM C309, Type 2.

2.03 CONCRETE PROTECTION MATERIALS

A. General Requirements:
   1. Use concrete protection materials consisting of a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.04 JOINT FILLER STRIPS

A. Contraction Joint Filler for Curb and Gutter
   1. Use hard-pressed fiberboard contraction joint filler for curb and gutter.

B. Expansion Joint Filler, Premolded
   1. Unless otherwise indicated, use 1/2 inch thick premolded expansion joint filler conforming to ASTM D1751 or ASTM D1752.

2.05 JOINT SEALANTS

A. Use cold-applied joint sealant conforming to ASTM C920 or ASTM D5893.

2.06 FORM WORK

A. General Requirements:
   1. Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Use wood or steel forms that are straight and of sufficient strength to resist springing during depositing and consolidating concrete.

B. Wood Forms
   1. Use forms that are surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Use forms with a nominal length of 10 feet. Radius bends may be formed with 3/4-inch boards, laminated to the required thickness.

C. Steel Forms
   1. Use channel-formed sections with a flat top surface and welded braces at each end and at not less than two intermediate points. Use forms with interlocking and self-aligning ends. Provide flexible forms for radius forming, corner forms, form spreaders, and fillers as needed. Use forms with a nominal length of 10 feet and that have a minimum of 3 welded stake pockets per form. Use stake pins consisting of solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

D. Sidewalk Forms
   1. Use sidewalk forms that are of a height equal to the full depth of the finished sidewalk.

E. Curb and Gutter Forms
   1. Use curb and gutter outside forms that have a height equal to the full depth of the curb or gutter. Use rigid forms for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

F. Biodegradable Form Release Agent
   1. Use form release agent that is colorless and biodegradable and that is composed of at least 87 percent biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

2.07 DETECTABLE WARNING SYSTEM

A. General Requirements:
   1. Detectable Warning Systems shown on the Contract plans are to meet requirements of ICC A117.1 - Section 705.

PART 3 – EXECUTION

3.01 SUBGRADE PREPARATION

A. General Requirements:
   1. Provide subgrade preparation to the applicable requirements of Section 312050 SITE PREPARATION AND EARTHWORK except as otherwise specified in Contract Documents.

B. Sidewalk Subgrade:
   1. Place and compact the subgrade in accordance with Section 312050 SITE PREPARATION AND EARTHWORK. Test the subgrade for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

C. Curb and Gutter Subgrade:
   1. Place and compact the subgrade in accordance with Section 312050 SITE PREPARATION AND EARTHWORK. Test the subgrade for grade and cross section by means of a template extending the full width of the curb and gutter. Use subgrade materials equal in bearing quality to the subgrade under the adjacent pavement.

D. Medians and Paved Drainage:
   1. Place and compact the subgrade in accordance with Section 312050 SITE PREPARATION AND EARTHWORK. Test the subgrade for grade and cross section by means of a template extending the full width of the pavement and median. Use subgrade materials equal in bearing quality to the subgrade under the adjacent pavement.

E. Maintenance of Subgrade:
   1. Maintain subgrade in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade must be in a moist condition when concrete is placed. Prepare and protect subgrade so that it is free from frost when the concrete is deposited.

3.02 FORM SETTING

A. General Requirements:
   1. Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Use additional stakes and braces at corners, deep sections, and radius bends, as required. Use clamps, spreaders, and braces where required to ensure rigidity in the forms. Remove forms in a manner that will not injure the concrete. Promptly and satisfactorily repair concrete found to be defective after form removal. Clean forms and coat with form oil or biodegradable form release agent each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

B. Sidewalks:
   1. Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10-foot-long section. After forms are set, grade and alignment must be checked with a 10-foot straightedge. Sidewalks must have a transverse slope as indicated in Contract Documents. Do not remove side forms less than 12 hours after finishing has been completed.

C. Curbs and Gutters:
   1. Remove forms used along the front of the curb not less than 2 hours nor more than 6 hours after the concrete has been placed. Do not remove forms used along the back of

curb until the face and top of the curb have been finished, as specified for concrete finishing. Do not remove gutter forms while the concrete is sufficiently plastic to slump in any direction.

3.03 SIDEWALK AND MEDIAN CONCRETE PLACEMENT AND FINISHING

A. Formed Sidewalks and Medians

1. Place concrete in the forms in one layer. When consolidated and finished, the sidewalks and medians must be of the thickness indicated. Use a strike-off guided by side forms after concrete has been placed in the forms to bring the surface to proper section to be compacted. Consolidate concrete by tamping and spading or with an approved vibrator. Finish the surface to grade with a strike off.

B. Concrete Finishing:

1. After straight edging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. Produce a scored surface by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

C. Edge and Joint Finishing:

1. Finish all slab edges, including those at formed joints, with an edger having a radius of 1/8 inch. Edge transverse joints before brooming. Eliminate the flat surface left by the surface face of the edger with brooming. Clean and solidly fill corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing with a properly proportioned mortar mixture and then finish.

D. Surface and Thickness Tolerances:

1. Finished surfaces must not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.04 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

A. Formed Curb and Gutter:

1. Place concrete to the required section in a single lift. Consolidate concrete using approved mechanical vibrators. Curve shaped gutters must be finished with a standard curb "mule".

B. Curb and Gutter Finishing

1. Approved slip formed curb and gutter machines may be used in lieu of hand placement.

C. Concrete Finishing

1. Float and finish exposed surfaces with a smooth wood float until true to grade and section and uniform in texture. Brush floated surfaces with a fine-hair brush using longitudinal strokes. Round the edges of the gutter and top of the curb with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the front curb surface, while still wet, in the same manner as the gutter and curb top. Finish the top surface of gutter to grade with a wood float.

D. Joint Finishing:

1. Finish curb edges at formed joints as indicated.

E. Surface and Thickness Tolerances:

1. Finished surfaces must not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.05 SIDEWALK JOINTS

A. General Requirements:

1. Construct sidewalk joints to divide the surface into rectangular areas. Space transverse contraction joints at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and continuous across the slab. Construct longitudinal contraction joints along the centerline of all sidewalks 10 feet or more in width. Construct transverse expansion joints at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, install transverse expansion joints as indicated. Form expansion joints around structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

B. Sidewalk Contraction Joints:

1. Form contraction joints in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness. Unless otherwise approved or indicated, either use a jointer to cut the groove or saw a groove in the hardened concrete with a power-driven saw. Construct sawed joints by sawing a groove in the concrete with a 1/8-inch blade. Provide an ample supply of saw blades on the jobsite before concrete placement is started. Provide at least one standby sawing unit in good working order at the jobsite at all times during the sawing operations.

C. Sidewalk Expansion Joints

1. Form expansion joints using 1/2-inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D1752 or building paper. Hold joint filler in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, round joint edges using an edging tool having a radius of 1/8 inch. Remove any concrete over the joint filler. At the end of the curing period, clean the top of expansion joints and fill with cold-applied joint sealant. Use joint sealant that is gray or stone in color. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Apply joint sealing material only when the concrete at the joint is surface dry and atmospheric and concrete temperatures are above 50 degrees F. Immediately remove any excess material on exposed surfaces of the concrete and clean the concrete surfaces.

D. Reinforcement Steel Placement

1. Accurately and securely fasten reinforcement steel in place with suitable supports and ties before the concrete is placed.

3.06 CURB AND GUTTER JOINTS

A. General Requirements:

1. Construct curb and gutter joints at right angles to the line of curb and gutter.

B. Contraction Joints:

1. Construct contraction joints directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length.
    a. Construct contraction joints (except for slip forming) by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Remove separators as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

b. When slip forming is used, cut the contraction joints in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb and gutter, using a power-driven saw. Cut the contraction joint to a depth of at least one-fourth of the gutter/curb depth using a 1/8 inch saw blade.

C. Expansion Joints:

1. Form expansion joints by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Construct expansion joints in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement using the same type and thickness of joints as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, provide expansion joints at least 1/2 inch in width at intervals not less than 30 feet nor greater than 120 feet. Seal expansion joints immediately following curing of the concrete or as soon thereafter as weather conditions permit. Seal expansion joints and the top 1-inch depth of curb and gutter contraction-joints with joint sealant. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Concrete at the joint must be surface dry and atmospheric and concrete temperatures must be above 50 degrees F at the time of application of joint sealing material. Immediately remove excess material on exposed surfaces of the concrete and clean concrete surfaces.

3.07 CURING AND PROTECTION

A. General Requirements:

1. Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete must be on hand and ready for use before actual concrete placement begins. Protect concrete as necessary to prevent cracking of the pavement due to temperature changes during the curing period.
2. Mat Method
   a. Cover the entire exposed surface with two or more layers of burlap. Overlap mats at least 6 inches. Thoroughly wet the mat with water prior to placing on concrete surface and keep the mat continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.
3. Impervious Sheeting Method
   a. Wet the entire exposed surface with a fine spray of water and then cover with impervious sheeting material. Lay sheets directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. Use sheeting that is not less than 18-inches wider than the concrete surface to be cured. Secure sheeting using heavy wood planks or a bank of moist earth placed along edges and laps in the sheets. Satisfactorily repair or replace sheets that are torn or otherwise damaged during curing. Sheeting must remain on the concrete surface to be cured for not less than 7 days.
4. Membrane Curing Method
   a. Apply a uniform coating of white-pigmented membrane-curing compound to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Coat formed surfaces immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Do not allow concrete surface to dry before application of the membrane. If drying has occurred, moisten the surface of the concrete with a fine spray of water and apply the curing compound as soon as the free water disappears. Apply curing compound

in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet/gallon for the total of both coats. Apply the second coat in a direction approximately at right angles to the direction of application of the first coat. The compound must form a uniform, continuous, coherent film that will not check, crack, or peel and must be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes. Respray concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied by the method and at the coverage specified above. Respray areas where the curing compound is damaged by subsequent construction operations within the curing period. Take precautions necessary to ensure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. Tightly seal the top of the joint opening and the joint groove at exposed edges before the concrete in the region of the joint is resprayed with curing compound. Use a method used for sealing the joint groove that prevents loss of moisture from the joint during the entire specified curing period. Provide approved standby facilities for curing concrete pavement at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Adequately protect concrete surfaces to which membrane-curing compounds have been applied during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from other possible damage to the continuity of the membrane.

B. Backfilling
   1. After curing, remove debris and backfill, grade, and compact the area adjoining the concrete to conform to the surrounding area in accordance with lines and grades indicated.

C. Protection
   1. Protect completed concrete from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Remove and reconstruct concrete that is damaged for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Dispose of removed material as directed.

D. Protective Coating
   1. Apply a protective coating of linseed oil mixture to the exposed-to-view concrete surface after the curing period, if concrete will be exposed to de-icing chemicals within 6 weeks after placement. Moist cure concrete to receive a protective coating.
      a. Application
         1) Complete curing and backfilling operation prior to applying two coats of protective coating. Concrete must be surface dry and clean before each application. Spray apply at a rate of not more than 50 square yards/gallon for first application and not more than 70 square yards/gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture must be in accordance with the manufacturer's instructions. Protect coated surfaces from vehicular and pedestrian traffic until dry.
      b. Precautions
         1) Do not heat protective coating by direct application of flame or electrical heaters and protect the coating from exposure to open flame, sparks, and fire

adjacent to open containers or applicators. Do not apply material at ambient or material temperatures lower than 50 degrees F.

3.08 FIELD QUALITY CONTROL

A. General Requirements
   1. Submit copies of all test reports within 24 hours of completion of the test.
   2. Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take action and submit reports as required below, and additional tests to ensure that the requirements of these specifications are met.

B. Concrete Testing:
   1. Strength Testing:
      a. Take concrete samples in accordance with ASTM C172/C172M not less than once a day nor less than once for every 250 cubic yards of concrete placed. Mold cylinders in accordance with ASTM C31/C31M for strength testing by an approved laboratory. Each strength test result must be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.
   2. Air Content:
      a. Determine air content in accordance with ASTM C173/C173M or ASTM C231. Use ASTM C231/C231M with concretes and mortars made with relatively dense natural aggregates. Make two tests for air content on randomly selected batches of each class of concrete placed during each shift. Make additional tests when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. Notify the placing foreman if results are out of tolerance. The placing foreman must take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.
   3. Slump Test:
      a. Perform two slump tests on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Perform additional tests when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.
   4. Thickness Evaluation:
      a. Determine the anticipated thickness of the concrete prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, construct the subgrade true to grade prior to concrete placement. The thickness will be determined by measuring each edge of the completed slab.
   5. Surface Evaluation:
      a. Provide finished surfaces for each category of the completed work that are uniform in color and free of blemishes and form or tool marks.

3.09 SURFACE DEFICIENCIES AND CORRECTIONS

A. Thickness Deficiency:

1. When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

B. High Areas:

1. In areas not meeting surface smoothness and plan grade requirements, reduce high areas either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete must not exceed 5 percent of the area of any integral slab, and the depth of grinding must not exceed 1/4 inch. Remove and replace pavement areas requiring grade or surface smoothness corrections in excess of the limits specified.

C. Appearance:

1. Exposed surfaces of the finished work will be inspected by the City Engineer or City Engineer or City Representative and deficiencies in appearance will be identified. Remove and replace areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work.

3.10 DETECTABLE WARNING SYSTEM

A. General:

1. Install Detectable Warning Systems required by Contract documents in accordance with ICC A117.1, Section 705, and by manufacturers' installation instructions.

END OF SECTION 347100

This page was intentionally left blank.

SECTION 347200 – ASPHALT CONCRETE PAVEMENT

PART 1 – GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This section includes asphalt pavement and related items.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
      a. AASHTO M 156 – Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
      b. AASHTO T 304 – Standard Method of Test for Uncompacted Void Content of Fine Aggregate
      c. AASHTO T 329 –Standard Test Method for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method
   2. ASPHALT INSTITUTE (AI)
      a. AI MS-2 – Asphalt Mix Design Methods
   3. ASTM INTERNATIONAL (ASTM)
      a. ASTM C29 – Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
      b. ASTM C88 – Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
      c. ASTM C117 – Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
      d. ASTM C127 – Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
      e. ASTM C128 – Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
      f. ASTM C131 – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
      g. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
      h. ASTM C142 – Standard Test Method for Clay Lumps and Friable Particles in Aggregates
      i. ASTM C566 – Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
      j. ASTM D75 – Standard Practice for Sampling Aggregates
      k. ASTM D140 – Standard Practice for Sampling Asphalt Materials
      l. ASTM D242 – Mineral Filler for Bituminous Paving Mixtures
      m. ASTM D946 – Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
      n. ASTM D979 – Sampling Bituminous Paving Mixtures
      o. ASTM D2041 – Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

p. ASTM D2172 – Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
q. ASTM D2419 – Sand Equivalent Value of Soils and Fine Aggregate
r. ASTM D2726 – Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
s. ASTM D2872 – Standard Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)
t. ASTM D2950 - Density of Bituminous Concrete in Place by Nuclear Method.
u.
v. ASTM D3203 – Standard Test Method for Percent Air Voids in Compacted Asphalt Mixtures
w. ASTM D3665 – Standard Practice for Random Sampling of Construction Materials
x. ASTM D3666 – Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
y. ASTM D4791 – Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
z. ASTM D4867 – Effect of Moisture on Asphalt Concrete Paving Mixtures
aa. ASTM D5361 – Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
bb. ASTM D5444 – Mechanical Size Analysis of Extracted Aggregate
cc. ASTM D5821 – Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
dd. ASTM D6084 – Standard Test Method for Elastic Recovery of Asphalt Materials by Ductilometer
ee. ASTM D6307 – Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ff. ASTM D6373 – Standard Specification for Performance Graded Asphalt Binder
gg. ASTM D6925 – Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
hh. ASTM D6926 – Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus
ii. ASTM D6927 – Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
jj. ASTM D7405 – Standard Test Method for Multiple Stress Creep and Recovery (MSCR) of Asphalt Binder Using a Dynamic Shear Rheometer
kk. ASTM D8239 – Standard Specification for Performance-Graded Asphalt Binder Using the Multiple Stress Creep and Recovery (MSCR) Test
ll. ASTM E1274 – Standard Test Method for Measuring Pavement Roughness Using a Profilograph

4. MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION
   a. Section 304 – Aggregate Base Course.
   b. Section 401 - Plant Mix Bituminous Base and Pavement.
   c. Section 403 - Asphaltic Concrete Pavement.
   d. Section 404 - Bituminous Mixing Plant.
   e. Section 407 - Tack Coat.

1.04 INFORMATIONAL SUBMITTALS:

A. General: Submit each item in this Article according to the Conditions of the Contract and as specified herein.

B. Include, but not limited to, product data and shop drawings for the following:

1. Product and Design Data:
    a. Mix Design:
        1) Contractor shall provide mix designs and prepare a job mix formula for each mixture specified. Mix designs shall be accomplished by a qualified, independent, commercial testing laboratory.
        2) Furnish copies of the proposed job mix formula, including the laboratory test report, to the Engineer for approval not less than 30 days prior to beginning production of paving mixture. Test reports shall indicate the following:
            a) Gradation: Each component aggregate and combined aggregates.
            b) Asphalt cement content in percent of total mix by weight.
            c) Graphic plots of:
                (1) Density versus asphalt content.
                (2) Stability versus asphalt content.
                (3) Percent voids total mix versus asphalt content.
                (4) Flow versus asphalt content.
    b. Contractor Quality Control
2. Certificates:
    a. Tack Coat
    b. Asphalt cement binder
3. Samples:
    a. Core or saw undamaged Samples from the completed pavement courses.
        1) Core Samples shall be not less than 6-inch diameter.
        2) Take three Samples from each day's production or from each 300 tons of mixture placed, whichever is the greater number of samples.
        3) Deliver Samples to the laboratory designated by the Engineer. Samples may be tested for density and extraction.

1.05 TESTING:

A. Completed pavement will be tested to determine density, gradation, and asphalt content (by extraction):
    1. At Engineer's option, density may be tested by any of the following methods:
        a. As specified in Section 401.7.8 of Missouri Standard Specifications for Highway Construction.
        b. ASTM D2950.
B. Contractor shall perform such other tests as he deems necessary to assure production of asphaltic concrete conforming to specified quality.
C. Contractor shall test surface smoothness by applying a 10-foot straightedge both parallel and at right angles to the centerline of paved areas:
    1. Test at 50-foot (maximum) intervals, and more frequently when requested by the City.
    2. City will observe straightedge testing. A rolling straightedge of the "Skorch" type may be used at the Contractor's option.

1.06 TOLERANCES:

A. Density of completed pavement shall not be less than the following percentage of the density of the laboratory mix design:
    1. All lifts: 92%
B. Smoothness shall be such that variation from a 10-foot straightedge does not exceed the following limits:
    1. Final Lift of Base Course: 1/2-inch.
    2. Surface Course: 1/4-inch.

PART 2 – PRODUCTS

2.01 GENERAL:

A. Equipment and Materials shall conform to the requirements of Missouri Standard Specifications for Highway Construction.

2.02 MATERIAL:

A. Base Rock
   1. Aggregate: Type 1
B. Bituminous Materials
   1. Asphalt Cement: Penetration grade 60 to 70 or 85 to 100 at Contractor's option.
   2. Tack Coat: Any of the following liquid asphalts at Contractor's option:
   3. SS-1h emulsion diluted 1 part emulsion to 2 parts water.
C. Asphaltic Concrete Mixture:
   1. Mixtures:
      a. Base Course: Section 401 Plant Mix Bituminous Base or Section 403 Asphaltic Concrete Pavement, Type SP190 or Type 250, Missouri Standard Specifications for Highway Construction.
   2. Surface Course: Section 401, Type BP-2 or Section 403, Type SP125, Missouri Standard Specifications for Highway Construction.
   3. Mix Properties:
      a. Marshall Stability: 1,200 minimum
      b. Number of Compaction Blows: 50.c. Flow: 8 to 16.
      c. Percent Air Voids:
         1) Base: 4 to 7.
         2) Surface: 4 to 7.

PART 3 – EXECUTION

3.01 GENERAL:

A. Performance shall conform to the requirements of Missouri Standard Specifications for Highway Construction, Sections 304, 401, and 403.

3.02 TACK COAT:

A. Apply tack coat to the surface of all existing pavement and all previously placed asphaltic concrete lifts or courses before placing the succeeding lift.
B. Apply at the following rates:
   1. Emulsion: Maximum of 0.2 and a minimum of 0.10 gallon per square yard.
   2. Liquid Asphalt: 0.15 ± 0.05 gallon per square yard.

END OF SECTION 347200